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ONE GOVERNMENT CENTER
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I. SUMMARY

During the week of March 20 to 23, 1989, the National Institute for Occupational Safety and Health (NIOSH) performed an environmental and medical survey at One Government Center, an office building located in Toledo, Ohio. This evaluation was conducted in response to a request from the Ohio Department of Health to evaluate indoor air quality and employee symptoms. Industrial hygiene measurements for temperature, relative humidity (RH), carbon dioxide (CO_2), and airborne particulates were made on floors 15 through 22. Four hundred thirty-eight self-administered questionnaires were distributed to employees in these areas as part of this evaluation. A total of 301 completed questionnaires were returned for analysis.

In general, the CO_2 concentrations on floors 15, 16, 17, 18, 21, and 22 were below 1000 parts per million (ppm), a guideline which NIOSH investigators use to determine the adequacy of the ventilation in an office work area. Two exceptions were floors 19 and 20, which had CO_2 levels ranging up to 1150 and 1250 ppm, respectively. These elevated CO_2 levels, measured in the late afternoon, possibly reflected the higher occupancy levels (20th floor) and the more extensive use of office partitions (19th floor) which existed in these areas. The ambient CO_2 concentration outside the office building averaged 300 ppm.

All work areas surveyed were within the American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. (ASHRAE) guidelines for both temperature and RH. The ASHRAE "comfort chart", a comfort range considered to be both comfortable and healthful, lies between 73 and 77°F and 20 to 60% RH.

Concentrations of respirable particulate matter were measured with a direct reading aerosol monitor at various office locations and in one smoking lounge. Respirable particulate levels in a smoking lounge located on the 17th floor ranged up to 454 micrograms per cubic meter (ug/M^3), a level which exceeds the Environmental Protection Agency's (EPA) Ambient Air Quality Standard for respirable particulate matter (PM_{10} standard, 150 ug/M^3 for 24 hours). Outside of this smoking lounge, particulate concentrations at other office locations on the 17th floor ranged from 13 to 109 ug/M^3. Particulate concentrations on all the remaining floors were consistently below 150 ug/M^3.

Measurements for temperature, RH, CO_2 concentration, and respirable particulates were linked to the questionnaire data for all respondents who gave the location of their workstations. None of these industrial hygiene measurements were statistically associated with the two definitions selected for work-associated illness, also termed "sick building syndrome" in this report.

A statistical analysis of the questionnaire results provided the basis for the main conclusions from this evaluation. One definition of work-associated illness was associated with female gender, irritation from tobacco smoke, new carpets, working in densely populated areas of the building, and being more depressed. By a second definition, work-associated illness was associated with being female, noting irritation from office solvents, noting body odor, and being more depressed.

NIOSH investigators found that persons reporting symptoms consistent with higher levels of seasonal affective disorder (SAD) were more likely to complain of building-related symptoms. Seasonal affective disorder is a recurring mood disorder recognized by the American Psychiatric Association and is characterized by depressive symptoms in fall and winter. The condition generally remits in spring. It is thought to be caused by reduced light intensity and the shortened photoperiod of winter.

NIOSH investigators have concluded that the indoor air quality parameters which were measured (carbon dioxide, temperature, relative humidity, and particulates) were within acceptable limits in most of the areas which were surveyed. Elevated CO_2 levels were measured on the 19th and 20th floors; however, neither these CO_2 concentration nor the other industrial hygiene measurements made were statistically associated with the two definitions used in this report for "sick building syndrome." Sick building syndrome was associated with female gender, irritation from tobacco smoke, new carpets, working in densely populated areas of the building, depression, noting irritation from office solvents, and noting body odor. Given the lack of separate, dedicated ventilation systems for the designated smoking areas in this building, exposure to tobacco smoke could also be contributing to the level of complaints among employees. Recommendations were made to modify the existing smoking policy to eliminate the possibility of reentrainment and recirculation of any secondary cigarette smoke and continued surveillance to insure that temperature and RH for all offices are maintained within recommended comfort zones. In addition, to maximize employee comfort, either the number of employees in several work areas should be reduced or the ventilation should be increased to provide the minimum amount of fresh air per person.

Keywords: SIC 9199 (General Government), indoor air quality, carbon dioxide, ventilation, temperature, relative humidity, particulates.

II. INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH) received a request, dated November 30, 1988, for technical assistance from the Ohio Department of Health (ODOH) in investigating a history of numerous health complaints among employees at One Government Center, a modern 22-story municipal office building located in downtown Toledo, Ohio. The reported health complaints included fatigue, nausea, headache, and other effects and were thought to result from various indoor air quality problems. Specifically, the ODOH requested NIOSH assistance in designing a health questionnaire and analyzing the data to determine the nature and magnitude of the perceived problems in the building.

Preliminary site visits by NIOSH investigators to One Government Center were conducted on January 30-31, and February 17, 1989, to meet with the appropriate city, state, and union officials and to plan the protocol for the evaluation. A follow-up survey was conducted on March 20-23, 1989, to distribute 438 questionnaires and conduct industrial hygiene measurements on floors 15 through 22. Two letters, dated April 13 and June 16, 1989, respectively, were distributed which summarized the NIOSH activities on this project and the results of environmental sampling for temperature, relative humidity (RH), carbon dioxide (CO_2), and respirable particulates. A third letter, dated April 23, 1990, was distributed which summarized the results from the questionnaire used in this evaluation.

III. BACKGROUND

A. ONE GOVERNMENT CENTER

This 22-story building, owned by the State of Ohio, was completed in 1983 and is located in downtown Toledo, Ohio. With approximately 500,000 square feet of office space (about 23,000 square feet per floor), the building houses offices for the city of Toledo, the county, and the state of Ohio. There are floor to ceiling windows on all exterior walls of the structure.

The majority of space on floors 15 to 22 is occupied by city offices. Strong interest was expressed by the City of Toledo (both management and union) in helping to conduct this survey. Since city employees comprised the largest portion of workers in the building, their offices on the upper floors were the focus for this evaluation. Since all the floors in this building have similar uses (general office space), and the separate heating, ventilating, and air conditioning (HVAC) systems are identically designed for each floor, it was assumed that the conditions found in the areas surveyed should be representative for the entire building.

City agencies located on floors 15 through 22 include the offices of the mayor and city manager of Toledo, as well as various city departments. The largest departments and divisions (by number of personnel) include the following: Inspection and Rehabilitation, Engineering and Construction, Community Development, Human Resources, Accounting, Taxation, City Law, Utilities, Councilmen, Affirmative Action, County Planning Commission, and Data Processing. The following are the occupancy levels per floor (based on a February 19, 1988 census):

Floor Number	Total Occupancy
15	61
16	76
17	65
18	45
19	54
20	81
21	30
22	41

It should be emphasized that these occupancy levels have generally increased since this 1988 census. However, the proportional relationships between floors have remained essentially the same. For example, at the time of this evaluation the 20th floor was considered the have the highest occupancy, the 21st and 22nd floors among the lowest occupancy.

B. HEALTH COMPLAINTS

Previous complaints of headache, coughing, sore throats, and sinus problems were intermittently reported at One Government Center. Several industrial hygiene surveys were conducted in 1988 by the Industrial Commission of Ohio in response to these health complaints. Measurements for CO_2, formaldehyde, dust, hydrocarbons, and RH were within acceptable ranges.

C. SICK BUILDING SYNDROME

Nonspecific symptom complaints related to working in office workplaces have increased over the past 15 years. The concept of "sick-building syndrome" has emerged to describe a high frequency of irritive symptoms of the eyes, nose, throat and skin, headache and mental fatigue among persons working in a particular building. These symptoms are noted to be work-related in that they intensify with the duration of the workday but abate or resolve when the worker leaves the building. At present, the etiology for sick-building syndrome is not fully understood. Based on changes in building construction following the energy crisis of the early 1970's, an attractive hypothesis is that reduced levels of fresh

air intake or increased levels of air contaminants, accompanying inadequate building ventilation, may account for this condition.

In many of the remaining sections of this report, the term "sick building syndrome" has been used. From a historical perspective, the phrase "sick building syndrome" (SBS) has been commonly used, although it may be somewhat misleading. Frequently, studies initiated in buildings with SBS-type complaints have not revealed clear deficiencies in environmental conditions. Thus, it may be inappropriate to label a building as "sick." In this report, SBS does not automatically imply that there were deficiencies within the building that were associated with the illnesses reported by employees.

Mandel has performed a re-analysis of six European studies, each of which studied worker symptoms in multiple office buildings which had not been identified as "complaint" buildings.[1] It has been assumed that studies done in buildings previously characterized by numerous SBS complaints suffer from a bias of over-reporting of symptoms. These European studies have shown that SBS symptoms are both relatively prevalent and variable in "non-complaint" buildings. Mandel's re-analysis of these studies suggests that sealed buildings with air-conditioning are associated with higher prevalence of SBS than unsealed buildings with no air-conditioning. Furthermore, it suggests that although air-conditioned buildings with steam humidification have no higher SBS rates than air-conditioned buildings without humidification, air-conditioned buildings with water-based humidification may have higher prevalence of eye, nose, and throat symptoms than those with steam humidification.

Skov studied Danish town halls and found that factors such as gender, job category, work functions (handling carbonless paper, photocopying, work at video display terminals), and psychosocial factors of work (dissatisfaction with superiors or colleagues and quantity of work causing job dissatisfaction) were associated with SBS.[2] However, these factors did not account for variations in SBS between buildings. In a subsequent analysis, Skov showed that variations in SBS included the following building factors: the concentrations of macromolecular organic dust, carpeting, number of workplaces in an office, newer building age, supplied air instead of natural ventilation systems, shelving area, and quantity of fleecy material.[3]

Norback studied 11 complaint buildings in three counties in Sweden.[4] This study found that SBS was associated with several personal factors as well as total indoor hydrocarbon concentrations.

Robertson found considerable differences in prevalence of SBS between two adjacent buildings for which environmental parameters were judged to be similar but the ventilation systems differed.[5] One building had sealed windows and air-conditioning while the other had natural ventilation with opening windows and radiator heating. In a separate article, Robertson reported that the air-conditioned building had both significantly more SBS and significantly less natural lighting.[6]

D. SEASONAL AFFECTIVE DISORDER (SAD)

Seasonal affective disorder (SAD) is a recurring mood disorder recognized by the American Psychiatric Association in its Diagnostic and Statistical Manual of Mental Disorders (Third Edition-Revised). Seasonal affective disorder is characterized by depressive symptoms in fall and winter which remits in spring, with some persons exhibiting hypomanic or even manic symptomatology in spring or summer.[7] It is thought to be caused by reduced light intensity and the shortened photoperiod of winter.[8] This is supported by noting that the winter symptoms are treatable with bright light in numerous clinical trials, that the prevalence of SAD increases in northern latitudes, and that patients with the disorder are less symptomatic if they spend the winter at a southern latitude.[7]

The prevalence of SAD is estimated to be between 4 and 7% from a population-based survey which included clinical correlation for a subset of cases detected by a survey instrument.[9] Other population surveys have agreed with this estimate. A milder form of the disorder has been labelled subsyndromal-SAD, which is characterized by symptoms which are considered problematic but do not lead a person to seek clinical care.[10] The prevalence of subsyndromal-SAD is estimated at 17 percent.[10] It should be noted that even cases of subsyndromal-SAD benefit from bright light exposure.[10]

A rationale can be made to study a possible association between office lighting and SAD. The typical range of office illumination, 200-600 lux, is well below illumination levels (2000 to 3000 lux) which have been found to be effective in treating SAD.[11] This suggests that persons working in modern office buildings who are susceptible to SAD may be receiving inadequate illumination, especially in the winter season when they spent the entire period of day light indoors.[7] It should be noted that outdoor illumination levels reach 10,000 lux on sunny days.[11] In addition, modern advances in architectural, lighting, and air-conditioning technology have allowed buildings to be constructed

such that much of the office space has no window exposure, meaning that many workers receive little or no sunlight exposure. Previously, when buildings depended on windows for both ventilation and lighting, a much higher proportion of the office work force received sunlight exposure during office hours. Furthermore, since the energy shortages of the early 1970's, new buildings have increasingly used tinted glass to reduce summertime heat load, a technique which also reduces sunlight to occupants.

Another justification for examining the role of office lighting and SAD is that SAD (or subsyndromal SAD) may have a relatively high prevalence in the general population and that office workers affected by this condition may have reduced productivity and increased absenteeism.[10] State of mental well-being has been related to employee absenteeism.[12] In addition, SAD symptomatology may be a contributing factor to the growing problem of SBS.[10] And finally, if office lighting is related to SAD symptomatology, possible interventions exist, including increased quantity or quality of illumination for susceptible persons, redesign of future office buildings to include more sunlight exposure, and increased time spent outdoors for persons susceptible to SAD.

E. VENTILATION

There are two HVAC systems per floor, each supplying 21,500 cubic feet per minute (cfm). Common supply (fresh air) and exhaust shafts span the height of the building to supply the individual HVAC systems on each floor. A common plenum (formed by the space between the suspended ceiling and the floor above) is the return arrangement for each floor (with the exception of dedicated exhausts for bathrooms and some designated smoking lounges). A penthouse, located on the 23rd floor, contains most of the mechanical equipment for the building. Pre-filters and higher efficiency replaceable pleated filters are positioned at the main outside air intake in the penthouse. Filters are also used on the HVAC systems located on every floor. Scheduled replacement of all filters are handled by the building's maintenance staff.

As with many large buildings, there is a perimeter heating and cooling system. The heating needs are provided by a boiler (usually natural gas, but can be switched to oil-fired), which is located on the ground floor. Pre-heaters are located at the outside air intakes, and a heat recovery wheel is used with the exhaust air to increase the overall efficiency of the heating system.

For the interior (core) office spaces, where only cooling is required, a variable air volume (VAV) system is used in conjunction with an energy management system to distribute air to eight cooling

zones per floor. In this dual duct system, the heating runs have a 10% minimum open position (there is no minimum open position for the cooling runs).

Controlled by an energy management system, the ventilation rate in the building is reduced starting around 9:30 p.m and returns to full operation at approximately 6:00 a.m. Relative humidity is monitored by computer through sensors located on each floor and is maintained between 38 and 60%. Direct steam injectors (steam obtained from the heating system) are used to maintain humidification. No corrosion inhibitors are used in the steam system for this building.

F. SMOKING POLICY AT ONE GOVERNMENT CENTER

The smoking policy varied throughout the building between city, county, and state offices. In general, the city of Toledo offices permitted smoking only in designated smoking areas. However, in several instances these designated areas included individual private offices and conference rooms in addition to "smoking lounges." Many of the designated smoking areas, including the lounges, were not serviced by a separate dedicated exhaust system. Instead, air from these areas was mixed with the return air from the remaining office spaces on the floor via the common return air plenum (space above the suspended ceiling) for eventual recirculation.

On some floors the designated smoking areas were connected to a dedicated exhaust system (typically, an adjacent restroom). According to the head of the maintenance department, any remodeling or renovation work in the building, including ventilation changes, was performed only after a request was made by the director of the city department where the work was to be done.

IV. METHODS

A. ENVIRONMENTAL

A sampling and analysis protocol was developed and implemented for One Government Center which included measuring temperature, RH, CO_2 concentration, and respirable particulates four times per day at each of 8 locations on each of the 8 floors studied. These measurements were then linked to the questionnaire data for all respondents who gave the location of their work-stations. Lighting measurements were also made at various locations on several floors. The environmental monitoring and analytical procedures used in this survey included the following variables:

Temperature and Relative Humidity (RH)

Real-time temperature and relative humidity measurements were conducted using a Vista Scientific, Model 784, battery-operated psychrometer. Dry and wet bulb temperature readings were monitored and the corresponding RH calculated.

Carbon Dioxide (CO_2)

Real-time CO_2 levels were determined using Gastech Model RI-411A, Portable CO_2 Indicators. This portable, battery-operated instrument monitors CO_2 (range 0-4975 parts per million (ppm)) via non-dispersive infrared absorption with a sensitivity (limit of detection) of 25 ppm. Instrument zeroing and calibration was performed daily prior to use with zero air and a known CO_2 span gas (800 ppm). The monitor was also post-calibrated after each day of use.

Respirable Particles (RSP)

Real-time RSP concentrations were measured using GCA Environmental Instruments Model RAM-1 monitors. This portable, battery-operated instrument assesses changes in particle concentrations via an infrared detector, centered on a wavelength of 940 nanometers. Air is sampled (2 liters per minute) first through a cyclone preselector which restricts the penetration of particles greater than 9 micrometers in diameter. The air sample then passes through the detection cell. Operating on the 0-2 milligrams per cubic meter (mg/M^3) range with a 32-second time constant yields a limit of detection of 0.001 mg/M^3 (equivalent to 1 microgram per cubic meter (ug/M^3)).

Illumination

Illumination measurements were performed on March 22, 1989, on two floors of One Government Center. All measurements are expressed in lux (equal to one lumen per square meter) and were made with a model 500 Litemate photometer system manufactured by Photo Research, Inc. This system had been calibrated by the manufacturer within six months of these measurements.

Measurements were made at sites where workers actually sat or at locations where it was apparent, to the investigator, workers carried out the bulk of their tasks. Proximity to windows and the presence of an intervening wall or partition between the worker(s) and the window were major influences in the lighting intensity levels at many locations. Based on these factors office lighting levels were categorized as low

and high. The high category was defined by the location of a respondent's workstation as being within 15 feet of a window without intervening walls or partitions.

B. MEDICAL

Study Design

A self-administered questionnaire was distributed to all employees on floors 15 through 22 on March 21, 1989. The questionnaire asked for information on demographic characteristics, health history, health symptoms, and comfort concerns. The topics covered included the following: 1) location of work-station (to link questionnaire data with industrial hygiene measurements); 2) description of work-station, including proximity to potential irritant sources (photocopiers, blueprint machines, etc.); 3) amount of time spent at work-station; 4) health symptoms experienced while working in the building, both in the previous week and last year; 5) health issues, including smoking, allergies, asthma, eczema, etc.; 6) mucous membrane and upper respiratory irritation from tobacco smoke or other chemical exposures; 7) environmental quality issues, including temperature, humidity, air movement, noise, dust, light, and odors during the previous year; 8) job characteristics, including job satisfaction and job stresses; and 9) education and job classification. This questionnaire was adapted from the one used in another extensive NIOSH indoor air quality and work environment study.[13]

The following two mood scales were added to the questionnaire: 1) the Center for Epidemiologic Studies Depression Scale (CES-D); and 2) a seasonal affective disorder (SAD) symptomatology scale. The CES-D scale was developed for the Community Mental Health Assessment Program sponsored by the Center for Epidemiologic Studies (CES), National Institute for Mental Health (NIMH).[14] The CES-D is an epidemiologic instrument for measuring the presence and severity of depressive symptomatology in the general population. The SAD symptomatology scale, designed for this survey, elicits symptoms consistent with a history of SAD symptomatology.

These two scales were added to answer several questions:

- Is the CES-D score for current depression associated with "sick building syndrome?"
- Is the SAD scale score associated with "sick building syndrome?"
- Is the SAD scale score associated with office lighting levels?

- ! Is current depression (based on the CES-D scale) among workers with a history of SAD symptoms associated with levels of office lighting?

C. VENTILATION SYSTEM

A qualitative evaluation was directed at observing the operation of the ventilation systems supplying the One Government Center building. The following methods were used:

1. Drawings of the ventilation system were reviewed to identify the air handling units (AHU's) that supply air to the sample sites being monitored. Each of these air handlers was visited to perform a visual check and record operating parameter data. The outside air dampers were checked for position and the pre- and main filters were checked for loading, visible damage, or other problems. Areas such as condensate pans were checked for the presence of stagnant water, inadequate or blocked drainage, and other problems conducive to microbiological growth in the ventilation system.

   a. Throughout the study period, operating parameter data were obtained from the computer monitoring of dry-bulb temperature and RH through sensors located throughout the building. This information was compared to the environmental data collected on floors 15 to 22 by NIOSH investigators.

V. EVALUATION CRITERIA

A. ENVIRONMENTAL

Standards for indoor air quality in office buildings do not exist. 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. The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) has published recommended building design criteria.[15] With few exceptions, pollutant concentrations observed in the office work environment fall well below these published standards or recommended exposure limits. It is possible that work-related complaints may be attributable not to individual environmental species, but to the cumulative effect resulting from exposures to low concentrations of multiple pollutants. The monitoring study protocol measured individual species concentrations to provide the data base necessary to investigate and assess relationships between worker complaints, health symptoms, and low-level exposures to the multiple contaminants measured.

The basis for monitoring individual or classes of environmental parameters are presented below:

Temperature and Relative Humidity (RH)

The perception of comfort is related to one's metabolic heat production, the transfer of heat to the environment, physiological adjustments, and body temperatures. Heat transfer from the body to the environment is influenced by factors such as temperature, humidity, air movement, personal activities, and clothing. The American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) Standard 55-1981 specifies conditions in which 80% or more of the occupants would be expected to find the environment thermally comfortable.[16]

Carbon Dioxide (CO_2)

Carbon dioxide (CO_2) is a normal constituent of exhaled breath; measurement of CO_2 concentrations can be used as a screening technique to evaluate whether adequate quantities of fresh air are being introduced into an occupied space. ASHRAE's Ventilation Standard, ASHRAE 62-1989, Ventilation for Acceptable Indoor Air Quality, recommends outdoor air supply rates of 20 cubic feet per minute per person (cfm/person) for office spaces, 15 cfm/person for reception areas, classrooms, libraries, auditoriums, and corridors, and 60 cfm/person for smoking lounges. This standard also provides estimated maximum occupancy figures for each area.[15]

Indoor CO_2 concentrations are normally higher than the generally constant ambient CO_2 concentration (range 300-350 ppm). When indoor CO_2 concentrations exceed 1000 ppm in areas where the only known source is exhaled breath, inadequate ventilation is suspected. Elevated CO_2 concentrations suggest that other indoor contaminants may also be increased. Maintaining the recommended ASHRAE outdoor air supply rates should provide for acceptable indoor air quality, barring any unusual emission source and assuming good quality outdoor air.

Respirable Suspended Particles (RSP) & Inhalable Particles (PM_{10})

Respirable suspended particles (smaller then 2.5 micrometers) are associated with combustion source emissions. The greatest contributor to indoor RSP is tobacco smoke (TS). In buildings where smoking is not allowed, RSP levels are influenced by outdoor particle concentrations, with minor contributions from

other indoor sources. In buildings with oil, gas, or kerosene heating systems, increased RSP concentrations associated with the heating source may predominate. PM_{10} concentrations (particles smaller than 10 micrometers in diameter) combine combustion, soil, dust, and mechanical source particle contributions. The larger particles are associated with outdoor particle concentrations, mechanical processes, and human activity. When indoor combustion sources are not present, indoor particle concentrations generally fall well below the Environmental Protection Agency's (EPA's) Ambient Air Quality PM_{10} standard (150 ug/M^3 averaged over a 24 hour period; 75 ug/M^3 averaged over a 1 year period).[17]

VI. RESULTS

A. ENVIRONMENTAL

The layout of a typical floor at One Government Center is shown in Figure 1 and can be used to determine the air sampling locations. The results from the direct reading samples collected for CO_2 throughout the work day are presented in Figures 2 and 3. In general, the CO_2 concentrations on floors 15, 16, 17, 18, 21, and 22 were below 1000 ppm, a guideline which NIOSH investigators use to determine the adequacy of the ventilation in an office work area. Two exceptions were floors 19 and 20, which had CO_2 levels ranging up to 1150 and 1250 ppm, respectively. These elevated CO_2 levels were measured in the late afternoon and may have been influenced by the following conditions: (1) the higher occupancy level on the 20th floor; (2) the extensive use of partitions in offices located on the 19th floor; and (3) deficiencies within the ventilation systems on these floors. The ambient CO_2 concentration outside the office building averaged 300 ppm.

Figures 4 and 5 show the concentrations of respirable particulate matter that were measured on floors 15 through 22 with a direct reading aerosol monitor. Although there are no established criteria for exposure to airborne total particulate in office buildings, as a guideline, the EPA's Ambient Air Quality Standard for respirable particulate matter (PM_{10} standard, 150 ug/M^3 for 24 hours) was used. Particulate concentrations on all but the 17th floor were below 150 ug/M^3. The highest respirable particulate concentration (454 ug/M^3) was measured in a designated smoking lounge on the 17th floor. Particulate levels in the remaining office spaces on the 17th floor, however, ranged from 13 to 109 ug/M^3.

All work areas surveyed were within ASHRAE's guidelines for both temperature and RH. The ASHRAE "comfort chart," a comfort range considered to be both comfortable and healthful, lies between 73 and 77°F and 20 to 60% RH. These results are shown in Figures 6 and 7.

Lighting measurements made during this evaluation in the high category office areas (defined by the location of a respondent's workstation as being within 15 feet of a window without interviewing walls or partitions) ranged from 450 to 1000 lux. Measurements in the lower category areas ranged from 300 to 500 lux. Of 300 workers who provided information on the location of their workstation, 70% were in the higher lighting category and the remaining 30% were in the lower lighting category.

B. QUESTIONNAIRE

Response Rate

A total of 438 questionnaires were distributed to the employees of Toledo city government who occupied floors 15-22. Of these, 301 were returned for a response rate of 69%. Of the 301 returned, 4 failed to provide workstation location, precluding them from the analysis involving industrial hygiene data. A breakdown of the response rate by age, gender, job category, etc. was not possible since this information about non-respondents was not available.

Employee Survey Results

Respondents were asked to report how often (never, rarely, sometimes, often, always) they experienced each of 32 health symptoms in the past year and whether these symptoms typically changed when not at work (got better, no change, got worse). Table 1 shows the frequency distribution of symptoms reported last year, and Table 2 shows the proportion of employees reporting these symptoms with a frequency of "often" or "always" in the past year. Table 2 also shows the proportion of employees for whom these symptoms were work-related, meaning that they got better when not at work. The most commonly reported work-related symptoms were stuffy nose (27%), headache (26%), sore eyes (25%), fatigue (25%), dry eyes (24%), sleepiness (22%), dry throat (18%), runny nose (15%), and tension (15%).

Employees were asked to assess the effects of their symptoms on their work (Table 3). More than one-third of respondents (36%) reported at least sometimes that symptoms reduced their ability

to work during the past year. Approximately one-fifth of respondents (21%) reported that at least "sometimes" they stay home or leave work early because of symptoms.

Employees were asked if they associated their health symptoms with conditions in the building and whether their symptoms had improved, worsened, or remained unchanged over the past (Table 4). Of those responding, 70% associated their symptoms with their work in the building; most (72%) reported that their symptoms remained unchanged; 24% reported that their symptoms became worse; and 4.4% reported that they improved over the past year.

Employees were also asked about the frequency and durations of "infections" (upper respiratory tract infections) since beginning to work at the Toledo Government Building (Table 5). Of those responding, 44% reported having infections more frequently and 48% reported infections that last longer.

Table 6 shows the frequency with which respondents associated symptoms with seasons. Most (158) reported no relationship to seasons. Winter was the season most often associated with symptoms, more than the other 3 seasons combined.

Since the symptoms of headache, sleepiness, fatigue, stuffy nose, runny nose, dry eyes, burning eyes, and dry throat are often associated with work in office buildings and other settings, a combination of these symptoms was used to create a case definition for "sick building syndrome."

As previously discussed, the phrase "sick building syndrome" (SBS), although a commonly used term in many indoor air quality investigations, can be misleading. In the context of this report, SBS does not imply that there were any deficiencies identified within the building, such as in the ventilation system, that were associated with the illnesses reported by employees.

An employee was considered a case of sick building syndrome (SBS) if he or she had one or more nonspecific symptoms (headache, sleepiness, or fatigue) temporally related to work, experienced "often" or "always" in the past year, and two or more irritative symptoms (runny nose, stuffy nose, dry eyes, burning eyes, or dry throat) temporally related to work, experienced "often" or "always" in the past year. Of 301 respondents, 62 (21%) met this case definition for SBS. The prevalence of SBS was highly associated with female gender for SBS (Table 7A), with women being six times more likely to meet the case definition than men. Of 290 respondents reporting gender, 43% were male and 57% were female.

Since by this case definition the association between female gender and SBS was unusually high, the following question arises: could women be responding to symptom questions differently than men? More specifically, would a woman be more likely to say that a symptom bothered her "often" when a man would say that the same symptom bothered him "sometimes," assuming that they each experience comparable discomfort. In other words, do men answer symptom questions with more stoicism? Accordingly, a second but parallel case definition for SBS was constructed and named SBS2 (the first definition will be referred to as SBS1).

An employee was considered a case of SBS2 if he or she had two or more nonspecific symptoms (headache, sleepiness, or fatigue) temporally related to work, experienced "sometimes," "often," or "always" in the past year, and four or more irritative symptoms (runny nose, stuffy nose, dry eyes, burning eyes, or dry throat) temporally related to work, experienced "sometimes," "often," or "always" in the past year. This second case definition was met by 19% of respondents; and the ratio of female to male cases was less extreme, with women being only 2.3 times more likely to met this case definition than men (Table 7B).

Demographic Characteristics of Respondents and SBS

Age categories for male and female employees are given in Table 8. Table 9 shows the prevalence of the two definitions (SBS1 and SBS2) by age category, adjusted for gender. There is no apparent trend and no statistical association between SBS (by either definition) and age adjusted for gender.

Education level categories for male and female employees are shown in Table 10. Table 11 shows that there is no clear trend and no statistical association between SBS (by either definition -- SBS1 or SBS2) and education level adjusted for gender. Table 12 shows the distribution of job categories for males and females. Among women responding, 80% were in the lower rank category (clerical, computer operator, administrative support, etc.) and only 20% were in higher rank positions (managers or professionals). On the other hand, 60% of men responding were managers or professionals. While women managers and professionals had a lower prevalence of SBS than women in the lower job categories, there was no significant association between SBS1 and job category adjusted for gender (Table 13). There was, however, significance at the 0.05 level to the association between SBS2 and job category after controlling for gender (women with lower job rank were more likely to be SBS2 cases).

Sick Building Syndrome and Sources of Irritation

Respondents were asked about occurrence of eye, nose, throat, or respiratory irritation from numerous potential sources on a continuum of "never," "rarely," "sometimes," "often," or "always" (Table 14). Tobacco smoke was the most frequently reported source, with 19% of respondents reporting irritation at lease sometimes. The next most frequent irritant was office chemical "fumes" (adhesives, glues, typewriter correction fluid, rubber cement, etc.), with 9.9% of respondents reporting irritation at least sometimes.

Table 15 shows the prevalence of SBS (by the first definition, SBS1) for men and women by report of exposure (at least sometimes) to a number of potential irritants. Those reporting irritation from tobacco smoke had a risk ratio of 1.7 for SBS1, meaning that they were 1.7 times more likely to be SBS1 cases than those who did not report irritation from this source. Similarly, the risk ratio for office chemicals was 2.5; for paint, 2.4; and for carpet and other cleaners, 1.8. These were the only statistically significant associations between SBS1 and potential irritant sources but positive associations might be expected since the case definitions involve irritant symptoms.

Table 15 also shows the prevalence of SBS (by the second definition, SBS2) for men and women by report of exposure to potential irritants. Those reporting irritation from tobacco smoke had a risk ratio of 3.2 for SBS2, meaning that they were 3.2 times more likely to be SBS2 cases than those who did not report irritation from tobacco smoke at least sometimes. Similarly, the risk ratio for using photocopy machines was 2.5; for office chemicals, 2.9; for pesticide exposure, 2.8; for new carpet, 4.2; for paint fumes, 2.1; and for carpet or other cleaners, 2.2.

Sick Building Syndrome and Work-station Environment

Respondents were asked about numerous characteristics of their work environment, including workstation furnishings and equipment, use of computers and other machines, type of office space, type of office sharing, duration of exposure to the building, and odors. We examined the relationship between these characteristics and SBS.

Table 16 gives the proportion of respondents who report various types of furniture, equipment, and changes within 15 feet of their workstations in the past year. Those employees reporting a photocopy machine within 15 feet of their workstation were

1.7 times more likely to be classified as SBS1 cases than those who did not (Table 17). Those who reported new carpeting within 15 feet of their workstation in the preceding year were 2 times more likely to be cases of SBS1 and 2.3 times more likely to be cases of SBS2 than those who did not (Table 18). Workers reporting that the walls were painted within 15 feet of their work stations in the past year were 3.1 times more likely to be cases of SBS2, and those working near partitions which were rearranged in the preceding year were 2 times more likely to be SBS2 cases. It should be noted, however, from Table 16 that few workers reported having had walls painted near their work stations.

The mean and median for a number of variables characterizing respondent's time spent in the building and time performing various activities are shown in Table 19. Respondents had worked a mean of 4.4 years in the building, but half had worked there for 5 years.

Table 20 examines the association between SBS and the use of various office equipment and chemicals. None of these activities, including computer, photocopy machine, blueprint machine, or chemical use were statistically associated with SBS1. Workers who used photocopy machines for more than one hour per day were 2 times more likely to be cases of SBS2.

Table 21 examines the associations between SBS and a number of variables characterizing work in the building. None of these variables, including hours per week spent in the building, years working in the building, number of times a respondent goes outside, or density of workers, is statistically associated with SBS1. However, workers in more densely populated work areas were more likely to be cases of SBS2.

Table 22 shows that the prevalence of both SBS1 and SBS2 were not statistically associated with type of workstation space. The type of workstation space sharing was also not statistically associated with the prevalence of either SBS1 or SBS2 (Table 23).

The percentages of respondents reporting various odors at their workstations are shown in Table 24. Table 25 shows the association between reporting an odor (at least sometimes) and the prevalence of SBS. Body odor, tobacco smoke, and musty smells were associated with SBS1, while these odors plus fishy smells, and odors of cosmetics, new carpet, new curtains, photocopy machines, office chemicals, pesticides, carpet cleaners, and paint were all associated with SBS2.

Physical Comfort and Sick Building Syndrome

The questionnaire asked respondents to evaluate the environmental conditions of their workstation, including air flow, temperature, humidity, stuffiness, noise, dust, lighting, glare, and comfort of their chair and desk. We looked for associations between these conditions and the prevalence of SBS.

Table 26 shows employee responses for air flow, temperature, humidity, stuffiness, noise, and dust. Of those responding, 42% reported too little air flow (often or always), 47% reported that the air was "too dry," and 51% reported that the air was "too stuffy." Complaints about environmental conditions which were statistically associated with both SBS1 and SBS2 included the following: "too cold," "too dry," "too stuffy," and "too dusty" (Table 27). "Too noisy" was associated with the first case definition.

Table 28 shows employee rating of lighting at their work-stations. Most (63%) reported that lighting was "just right", 29% reported lighting to be too dim, and 8.5% reported it to be too bright. Respondents reporting lighting to be too dim were 1.7 times more likely to be SBS1 cases (Table 29). Other conditions (Table 29) which were statistically associated with both SBS1 and SBS2 included glare (often or always), specifically glare from windows and glare from fluorescent lights, uncomfortable chairs, and uncomfortable desk setups. Lighting which was "too bright" and glare from video display screens were associated with the first case definition.

Health History and Sick Building Syndrome

Table 30 lists the proportion of respondents with various health conditions. SBS1 was statistically associated with physician diagnosed eczema and self-reported allergy to dust (Table 31), while SBS2 was marginally associated with self-reported mold allergy.

Industrial Hygiene Measurements and Sick Building Syndrome

Measurements for temperature, RH, CO_2 concentration, and respirable particulates were linked to the questionnaire data for all respondents who gave the location of their workstations. None of these industrial hygiene measurements were statistical associated with either SBS1 or SBS2 (Tables 32A and 32B).

Job Satisfaction, Job Stress and Sick Building Syndrome

Since stress can cause health symptoms that resemble those attributed to an office's physical environment, employees were asked a series of questions to assess their experience of work-related stressors, external stressors, and job satisfaction. These questions were combined to create scores for each work-related stressor scale, the external stressor scale, and the job satisfaction scale. The scores for each of these scales were then categorized into low, medium, and high groups. The level of these stressors for each respondent was analyzed for associations with SBS by the two definitions -- SBS1 and SBS2 (Table 33). Low job satisfaction was associated with an increased prevalence of SBS by both definitions. High quantitative workload was associated with SBS by the second definition (SBS2), but not by the first (SBS1), and role conflict was associated with the first case definition.

The relationship between depression and level of work-related stressors, external stressors, and job satisfaction was also examined (Table 34). Depression was defined as having a score above 15 on the Center for Epidemiologic Studies-Depression Scale. This score has been used in previous population-based studies to define high levels of depressive symptomatology.[18] It should be emphasized that this score does not constitute a clinical diagnosis of depression. High levels of current depression were significantly associated with low job satisfaction, high role conflict, low utilization of abilities, and high role ambiguity.

Sick Building Syndrome, Current Depression, Seasonal Affective Disorder, and Office Lighting Levels

Scores for the Center of Epidemiologic Studies-Depression (CES-D) Scale were grouped into three levels (Table 35). Scores of zero to 15 have accounted for 80 percent of community populations in previous studies and scores above 15 characterize the presence of depressive symptoms in other studies which correlate the CES-D scale with the diagnosis of clinical depression.[18] Among respondents in this study, approximately 10 percent had CES-D Scores above 25, which would indicate the most depressed group.

After adjusting for the effects of gender, respondents with CES-D, scores above 25 were 2.4 times more likely to be SBS cases by the first definition (SBS1) and 3.6 times more likely to be SBS cases by the second definition (SBS2) than

respondents with CES-D scores of 15 or less (Table 36). Likewise, respondents with CES-D scores above 15 were 2.1 times more likely to be SBS1 cases and 2.8 times more likely to be SBS2 cases than those with CES-D scores of 15 or less.

Scores for the Seasonal Affective Disorder (SAD) Scale were constructed by adding one point for each of 13 symptoms consistent with a history of SAD.[19] These symptoms were scored positive when experienced for at least 2 weeks in fall or winter but not in summer and spring. Scores for the SAD scale were grouped into three categories (Table 37). Respondents with scores from 0 to 2 were expected to be essentially free of SAD symptoms, since the proportion with these scores is comparable to that for population based studies of SAD.[20] The category with SAD scores of 6 to 13 represents approximately 10% of respondents who would have the most severe level of SAD symptoms. Respondents with SAD scores of 3 to 5 would be in an intermediate category with a mild level of SAD symptoms.

After adjusting for any effects of gender, respondents with SAD scores of 6 or more were 2.2 times more likely to be SBS1 cases and 2.4 times more likely to be SBS2 cases than respondents with SAD scores of 2 or less (Table 38). Likewise, respondents with SAD scores of 3 or more were 1.7 times more likely to be SBS1 cases and 2.1 times more likely to be SBS2 cases than those with scores of 2 or less.

The prevalence of SBS was not associated with office lighting levels after adjusting for gender (Table 39). Office lighting levels were categorized as low and high. The high category was defined by the location of a respondent's workstation as being within 15 feet of a window without intervening walls or partitions. Of 300 respondents, 70% were in this higher lighting category and the remaining 30% were in the lower lighting category. Lighting measurements made during this evaluation in the high category office areas ranged from 450 to 1000 lux, while measurements in the lower category areas ranged from 300 to 500 lux.

Table 40 shows the prevalence of depression by lighting level category and by SAD score category. Depression is here defined by a CES-D score above 15. For those respondents with low SAD scores, there is no effect of lighting level on the prevalence of depression. However, those with high SAD scores are 1.7 times more likely to be depressed if they work in low lighting areas. This risk of depression persisted after adjusting for gender and education level, which was used as a measure for socioeconomic status (Table 41).

Logistic Regression Models for Predictors of Sick Building Syndrome

In the preceding discussion we have described how SBS was associated with a number of factors characterizing workers or their jobs. Some factors are associated with SBS because they are also correlated with other factors which are also associated with SBS. For this reason statistical tests were performed which adjusted each factor for all of the other factors which are also associated with SBS. Table 42 shows the factors which were associated with SBS after adjusting for all other associated factors. By the first definition (SBS1), SBS is associated with the following factors: female gender; irritation from chemicals such as adhesives, glues, cleaners, typewriter correction fluid, rubber cement, etc.; noticing body odor; and a high score for current depression. By the second definition (SBS2), SBS was associated with female gender; irritation from tobacco smoke; irritation from new carpet fumes; work in a densely populated area; and a high score for current depression. The risk ratio for each of these factors indicates how highly it is associated with SBS after adjusting for all other statistically significant associations. For example, persons who report irritation from tobacco smoke are 3.7 times more likely to be cases of SBS by the second definition then are person who did not report such irritation.

Analysis of Current Building-Related Symptoms

The case definition for SBS was derived from symptoms reported by respondents over the previous year, while the industrial hygiene measurements were made the week the questionnaire was administered. Likewise, the Center for Epidemiologic Studies-Depression scale asked about mood state for the previous week. For this reason a case definition for current building-related symptoms was constructed. Each of five irritative symptoms (runny nose, stuffy nose, dry/itchy eyes, burning eyes, and dry throat) was scored positive if present for three or more days "last week" and if the symptom improved when away from work. Similarly, each of three nonspecific symptoms (headache, sleepiness, and fatigue) was scored positive if present for 3 or more days "last" week and the respondent improved when away from work. Respondents were cases (for current building-related symptom syndrome) if they were positive for one or more nonspecific work-related symptoms, plus two or more irritative work-related symptoms. Of employees responding, 18.3% met this case definition. The risk of being a case of "current building-related symptom syndrome" was 4.4 times higher among women than among men (Table 43).

Table 44 shows the prevalence of current building-related symptom syndrome by categories of industrial hygiene measurements. After adjusting for gender, none of the industrial hygiene measurements were associated with SBS by either definition -- SBS1 or SBS2 (Table 44).

Tables 45 and 46 show that after adjusting for gender there is an association between case status for "current building-related symptom syndrome" and high CES-D and SAD scores. Since some of the symptoms which characterize SBS, such as headache and fatigue, are also common in depressed persons, NIOSH investigators considered the possibility that high depression scale scores would be associated with the nonspecific type of SBS symptoms (headache and fatigue), but not with the irritative type (stuffy or runny nose, and dry or burning eyes). Table 47 shows that high levels of depression, as well as high levels of SAD symptoms, were associated with both irritative and nonspecific building related symptoms.

VII. DISCUSSION

A. ENVIRONMENTAL EVALUATION

On the days of this survey the CO_2 concentrations at One Government Center were generally below 1000 ppm, a guideline which NIOSH investigators use to determine the adequacy of the ventilation in an office work area. While the CO_2 levels on floors 15, 16, 17, 18, 21, and 22 increased during the work day, the levels peaked at approximately 1000 ppm. The lower occupancy levels on some of these floors, better office planning and design, and differing performance levels of the individual ventilation systems, may have all been significant factors in maintaining these CO_2 levels.

Floors 19 and 20, which had CO_2 levels ranging up to 1150 and 1250 ppm, respectively, were the exception to the trend seen on the other floors surveyed. These elevated CO_2 levels were measured in the late afternoon, possibly reflecting the higher occupancy levels (such as on the 20th floor) or more extensive use of office partitions which could disrupt the ventilation patterns for an area (such as on the 19th floor).

Although the respirable particulate levels measured throughout the building were generally well within acceptable limits, there were notable exceptions such as the designated smoking lounges (up to 454 ug/M^3 in a smoking lounge on the 17th floor). In the regular office areas, the highest average respirable particulate concentrations were measured on the 20th floor and, as with CO_2,

these particulate levels may have been influenced by the higher occupancy load on this floor, as well as by the inconsistent and ineffective smoking policy for city offices. It is also possible that the HVAC systems for each floor, while similarly designed, may operate more (or less) efficiently throughout the building. When compared to the EPA PM_{10} annual outdoor limit (75 ug/M^3), the particulate concentrations on the 20th floor may warrant a closer examination as to the cause and possible corrective action.

B. VENTILATION EVALUATION

Based on data provided by the building maintenance staff, a maximum of approximately 1000 cfm of fresh air is supplied to each floor in the building. ASHRAE, in their most current guidance for maintaining acceptable indoor air quality, recommends 20 cfm of fresh air for each employee in an office work area. This calculates to a maximum recommended occupancy of approximately 50 employees per floor at One Government Center. As previously discussed, several floors (most notably the 20th floor) exceeded this number. This situation may explain the gradual rise in CO_2 concentrations on these two floors to levels above 1200 ppm, a condition which suggests inadequate ventilation.

C. QUESTIONNAIRE RESULTS

In this study we examined building-related symptoms which are commonly referred to as Sick Building Syndrome (SBS).[21] There is no standard way to define this syndrome and since our first definition yielded an unexpectedly high association between female gender and work-associated illness (termed "SBS" in this report), we chose to also make a second case definition. If we assume that women tend to report comparable symptoms more readily than men, we might expect that a women would report a symptom's frequency as "often," while a man would report a comparable frequency for that symptom as "sometimes." This led us to base our second definition on work-related symptoms reported at least "sometimes," as opposed to the first definition, based on work-related symptoms at least "often." To compensate for the potential increase in false positives, however, the second definition required the presence of more irritative symptoms. For women the risk of being a case by this second definition was 2.3, a ratio which is comparable to that in another study.[(2)] On the other hand the risk for women by the first definition was 6.0. While we cannot be certain of our interpretation, we believe that the second definition is a better representation of work-associated illness, since it seems to be stricter. We reported associations between work-associated illness by both of these definitions and a number of factors, including worker and job characteristics and exposures in the building. Our

intent in using both of these definitions is to demonstrate that measuring health outcomes in office building investigations is not an exact science and that the associations found will vary with the way in which symptoms are measured.

The regression analysis, the statistical method for looking at all associations together, is the basis for our main conclusions. By the second definition, work-associated illness was associated with female gender, irritation from tobacco smoke, new carpets, working in densely populated areas of the building, and being more depressed. By the first definition, it was associated with being female, noting irritation from office solvents, noting body odor, and being more depressed.

VIII. CONCLUSIONS

Recent reports from the Surgeon General and the National Research Council have concluded that exposure to environmental tobacco smoke (ETS) may be associated with a wide range of health (e.g. lung cancer) and comfort (e.g. eye, nose, and throat irritation and odor) effects.[22-27] In previous investigations of office building workers tobacco smoke has been identified as a suspected indoor air pollutant. Given the lack of separate, dedicated ventilation systems for the designated smoking areas in this building, exposure to tobacco smoke could be contributing to the level of complaints. While direct measurements of fresh air exchange were not made as part of this survey, the CO_2 levels suggest that the building is inadequately ventilated, especially for work areas that are more densely populated (such as the 20th floor). Elevated CO_2 levels were also observed on floors where partitions were used to form "cubicle" offices. These partitions may disrupt the ventilation patterns in these areas, contributing to the gradual rise in CO_2 during the workday.

Historically, recommendations for outside air exchange in office buildings were based on levels which would minimize body odor detection by building occupants. The association between noticing body odors and reporting symptoms might suggest that the building is not sufficiently ventilated with outside air. New carpets have also been implicated in previous indoor air investigations and suggest the need for higher levels of outdoor air exchange, at least initially following installation, to control their odors.[21]

While higher levels of depression were associated with SBS, NIOSH investigators cannot conclude that depression causes building-related symptoms. An alternative conclusion is that building-related symptoms make workers more depressed. Neither of these conclusions can be established from this study, since both depressive symptoms and building-related symptoms were measured at the same time.

NIOSH investigators found that persons with higher levels of SAD were more likely to complain of building-related symptoms, but the level of current depression as measured by the Center for Epidemiologic Studies -Depression scale was a better predictor.

Lighting levels, as defined in this study, were not related to work-associated illness. However, those persons who had higher seasonal affective disorder (SAD) were also more depressed (by the scale for current depression) if they worked in dimmer parts of the building that were farther from the windows. This suggests that either the quality or quantity of building lighting may contribute to the mood state of those workers who experience SAD symptoms.

IX. RECOMMENDATIONS

1. Exposure to environmental tobacco smoke is one of the most important indoor air quality problems, contributing both particulates and gaseous contaminants. With this in mind, the existing smoking policy should be modified. If smoking is permitted, it should be restricted to designated smoking lounges. These smoking lounges should be provided with a dedicated air handling system (direct exhaust to the outside) which eliminates the possibility of reentrainment and recirculation of any secondary cigarette smoke. In addition, the smoking lounge should be under negative pressure as compared to surrounding occupied areas. The ventilation system supplying the smoking lounge should be capable of providing at least 60 cfm of outdoor air per person.[15]

2. For employee comfort, surveillance should continue to insure that temperature and RH for all offices are maintained within the ASHRAE recommended comfort zones. In addition, the performance of the HVAC systems in the building should be reviewed by ventilation engineers to insure compliance with current ASHRAE guidelines.

3. The current staffing levels on the 15th, 16th, and 20th floors are excessive considering the capabilities of the existing ventilation systems in these areas. Several other floors are near their occupancy capacity based on the limitations of the HVAC equipment. To maximize employee comfort, either the number of employees in these work areas should be reduced or the ventilation should be increased to provide the minimum amount of fresh air per person (20 cfm/person) as recommended by ASHRAE.

4. Current office space planning should be reviewed to optimize employee comfort and work space utilization. A trained environmental designer/space planner to review current and planned office layouts would help in ensuring that traffic patterns are not

congested and that appropriate work space is provided to maximize employee comfort and productivity. This environmental designer could also be consulted for suggestions in reducing workers' discomfort due to glare from work surfaces, video display terminals, and outside windows.

X. REFERENCES

1. Mendel MJ, Smith AH. [1990]. Consistent pattern of elevated symptoms in air-conditioned building; a reanalysis of epidemiologic studies. American Journal of Public Health, 80(10):1193-1199.

2. Skov P, Valbjorn O, Pedersen BV et al. [1989]. Influence of personal characteristics, job-related factors and psychosocial factors on the sick building syndrome. Scand. Journal of Work and Environmental Health, 15:286-295.

3. Skov P, Valbjorn O, Pedersen BV, et al. [1990]. Influence of indoor climate on the sick building syndrome in an office environment. Scand. Journal of Work and Environmental Health, 16:363-371.

4. Norback D, Michel I, and Widstrom J. [1990]. Indoor air quality and personal factors related to the sick building syndrome. Scand. Journal of Work and Environmental Health, 16:121-128.

5. Robertson AS, Burge PS, Hedge A, et al. [1985]. Comparison of health problems related to work and environmental measurements in two office buildings with different ventilation systems. British Medical Journal, 291:373-376.

6. Robertson AS, McInnes M, Glass D, et al. [1989]. Building sickness: are symptoms related to the office lighting? Annals of Occupational Hygiene, 33(1):47-59.

7. Jacobsen FM, et al. [1987]. Seasonal affective disorder: a review of the syndrome and its public health implications. American Journal of Public Health, 77(1):57-60.

8. Blehar MC, Rosenthal NE. [1989]. Seasonal affective disorder and phototherapy. Arch. of General Psychiatry, 46:469-474.

9. Kasper S, et al. [1989]. Epidemiological findings of seasonal changes in mood and behavior. Arch of General Psychiatry, 46.

10. Kasper S, et al. [1989]. Phototherapy in individuals with and without subsyndromal seasonal affective disorder. Arch of General Psychiatry, 46.

11. Lewy AJ. [1987]. Treating chronobiologic sleep and mood disorders with bright light. Psychiatric Annals, 17:664-669.

12. Estryn-Behar M, et al. [1990]. Stress at work and mental health status among female hospital workers. British Journal of Industrial Medicine.

13. National Institute for Occupational Safety and Health, U.S. Environmental Protection Agency, John B. Pierce Laboratory at Yale University, National Institute of Standards and Technology. [1991]. Indoor air quality and work environment study: Library of Congress, Madison Building, Washington, D.C., Vol. III, Association Between Health and Comfort Concerns and Environmental Conditions. Cincinnati, OH.: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, NIOSH Hazard Evaluation and Technical Assistance Report No. HETA 88-364-2104.

14. Weissman MM, Myers JK, Ross CE. [1986]. In: Community Surveys of Psychiatric Disorders, Series in Psychosocial Epidemiology. Volume 4. New Brunswick, NJ: Rutgers University Press.

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

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

17. Ambient PM_{10} standard [1987]. Environmental Protection Agency, Washington, D.C. U.S. Government Printing Office, Federal Register 52:24634.

18. Radloff LS, Locke B. [1986]. The community mental health assessment survey and the CES-D scale. In: Community Surveys of Psychiatric Disorders, Series in Psychosocial Epidemiology. Volume 4. New Brunswick, NJ: Rutgers University Press, pp. 177-189.

19. Jacobsen FM, Wehr TA, Sack DA, et al. [1987]. Seasonal affective disorder: a review of the syndrome and its public health implications. American Journal of Public Health 77(1):57-60.

20. Kasper S, Wehr TA, Bartko JJ, et al. [1989]. Epidemiological findings of seasonal changes in mood and behavior. A telephone survey of Montgomery County, Maryland. Arch Gen Psychiatry 46(9):823-33.

21. Kreiss K. [1989]. The epidemiology of building-related complaints and illness. In: Occupational Medicine: State of the Art Reviews, Vol 4(4):575-629. Philadelphia, PA: Hanley and Belfus, Inc.

22. U.S. Department of Health, Education, and Welfare [1979]. Smoking and health: A report of the Surgeon General. Office on Smoking and Health. Washington, D.C.: U.S. Government Printing Office.

23. U.S. Department of Health and Human Services [1982]. The health consequences of smoking -- cancer: A report of the Surgeon General. Office on Smoking and Health. Washington, D.C.: U.S. Government Printing Office.

24. U.S. Department of Health and Human Services [1984]. The health consequences of smoking -- Chronic obstructive lung disease: A report of the Surgeon General. Office on Smoking and Health. Washington, D.C.: U.S. Government Printing Office.

25. U.S. Department of Health and Human Services [1983]. The health consequences of smoking -- Cardiovascular disease: A report of the Surgeon General. Office on Smoking and Health. Washington, D.C.: U.S. Government Printing Office.

26. U.S. Department of Health and Human Services [1986]. The health consequences of involuntary smoking: A report of the Surgeon General. Office on Smoking and Health. Washington, D.C.: U.S. Government Printing Office.

27. National Research Council Committee on Indoor Air Quality [1987]. Policies and procedures for control of indoor air quality. National Academy Press, Washington, D.C., 75 pages.

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Table 1
Frequency Distribution of Symptoms During Preceding Year
Toledo Municipal Building
HETA 89-065

Symptoms	Never	Rarely	Sometimes	Often	Always	Total Reporting[a]
Headache	10%	21%	40%	27%	2%	299
Stuffy nose	13%	18%	32%	28%	10%	296
Sleepiness	14%	17%	43%	22%	4%	298
Sneezing	14%	28%	41%	14%	3%	301
Tension/nervousness	18%	22%	41%	14%	5%	296
Running nose	19%	22%	36%	19%	4%	296
Cough	19%	38%	34%	8%	1%	299
Fatigue/tiredness	23%	14%	31%	24%	8%	300
Sore, strained eyes	23%	14%	35%	22%	6%	294
Dry, itchy eyes	27%	17%	30%	19%	7%	299
Difficulty concentrating	28%	29%	36%	6%	1%	295
Dry throat	30%	18%	30%	18%	4%	297
Sore throat	32%	30%	33%	4%	1%	294
Dry skin	32%	14%	22%	22%	10%	297
Feeling depressed	35%	28%	29%	6%	2%	296
Lower back pain	38%	21%	22%	13%	6%	298
Burning eyes	38%	16%	30%	12%	4%	296
Aching muscles/joints	40%	20%	25%	11%	4%	295
Difficulty remembering	42%	28%	24%	5%	1%	294
Chills	42%	19%	26%	10%	3%	296
Shoulder/neck pain	46%	16%	20%	14%	4%	296
Dizziness/lightheadedness	46%	24%	23%	6%	1%	295
Upper back pain	47%	17%	18%	12%	6%	295
Hoarseness	51%	25%	20%	4%	0%	293
Nausea	53%	26%	19%	2%	0%	294
Blurry vision	61%	15%	18%	5%	1%	293
Fever	65%	29%	5%	1%	0%	291
Hand/wrist pain	66%	13%	13%	5%	3%	296
Chest tightness	69%	16%	12%	2%	1%	294
Shortness of breath	70%	14%	13%	5%	0%	295
Wheezing	70%	19%	10%	1%	0%	296
Problems with contacts	81%	5%	6%	4%	4%	266

a Number of participants answering question.

Table 2
Percent of Respondents Reporting Work-Related Symptoms
in the Preceding Year
Toledo Municipal Building
HETA 89-065

Symptoms	Sometimes, Often, or Always	Often or Always	Total Reporting[a]
Fever	4%	1%	291
Wheezing	7%	1%	296
Difficulty remembering	9%	2%	294
Hand/wrist pain	9%	3%	295
Chest tightness	10%	1%	293
Problems with contacts	10%	7%	266
Shortness of breath	12%	3%	295
Aching muscles/joints	14%	5%	291
Hoarseness	15%	4%	293
Nausea	16%	1%	293
Upper back pain	17%	9%	293
Blurry vision	18%	4%	293
Lower back pain	18%	8%	293
Shoulder/neck pain	19%	9%	293
Sore throat	19%	2%	294
Dry skin	20%	12%	292
Feeling depressed	22%	5%	296
Dizziness/lightheadedness	24%	5%	295
Cough	25%	7%	299
Difficulty concentrating	30%	6%	294
Chills	32%	13%	295
Running nose	32%	15%	295
Sneezing	38%	14%	300
Burning eyes	38%	14%	295
Dry throat	40%	18%	295
Tension/nervousness	42%	15%	295
Stuffy nose	46%	27%	294
Dry, itchy eyes	47%	24%	299
Fatigue/tiredness	47%	25%	296
Sore, strained eyes	51%	25%	294
Headache	55%	26%	298
Sleepiness	56%	22%	294

a Number of participants answering question.

Table 3
Impact of Symptoms on Employees' Ability to Work Last Year
Toledo Municipal Building
HETA 89-065

	Total Responding	Percent of Respondents				
		Never	Rarely	Sometimes	Often	Always
Symptoms Reduced Ability to work	287	32.4%	31.7%	29.3%	5.9%	0.7%
Symptoms Resulted in Staying Home or Leaving Work Early	288	55.6%	23.6%	19.1%	1.7%	0.0%

Table 4
Percentage of Responding Employees Who Associated
Symptoms With the Building Last Year
Toledo Municipal Building
HETA 89-065

	Percent	Total Responding
Percent Associating Symptoms with Building	70.4%	284
Symptoms Improved over Preceding Year	4.4%	228
Symptoms Became Worse over Preceding Year	24.1%	228
Symptoms Remained the Same over the Year	71.5%	228

Table 5
Percentage of Responding Employees Reporting Changes
in Frequency and Duration of Infections[a] Since Beginning
Work at Toledo Government Building
Toledo Municipal Building
HETA 89-065

Percent Who Report Having Infections:	
More Frequently	44%
Less Frequently	5%
Same Frequency	51%
Employees Responding	293
Percentage Whose Infections Reportedly:	
Last Longer	48%
Are Shorter	1%
Are Unchanged	51%
Employees Responding	291

a Upper respiratory tract infections.

Table 6
Season(s)* When Respondents Were Bothered by Symptoms
Toledo Municipal Building
HETA 89-065

Season	Frequency
Winter	119
Spring	31
Summer	27
Fall	43
No seasonal relationship	158

* The questionnaire allowed more than one season to be indicated.

Table 7A
Prevalence of Sick Building Syndrome (SBS1)* by Gender
Toledo Municipal Building
HETA 89-065

Gender**	Prevalence of SBS	Risk Ratio	95% C.I.***
Male	5.6%	1	
Female	33.3%	6.0	2.8 - 12.6

* SBS1 defined by reporting building-related symptoms "often" or "always."
** 290 respondents reported gender.
*** 95% confidence interval for risk ratio.

Table 7B
Prevalence of Sick Building Syndrome (SBS2)* by Gender
Toledo Municipal Building
HETA 89-065

Gender**	Prevalence of SBS2	Risk Ratio	95% C.I.***
Male	11.2%	1	
Female	25.6%	2.3	1.3 - 3.9

* SBS2 defined by reporting building-related symptoms "sometimes," "often," or "always."
** 290 respondents reported gender.
*** 95% confidence interval for risk ratio.

Table 8
Age and Gender Distribution for Respondents
Toledo Municipal Building
HETA 89-065

	Respondents	
	Male	Female
Employees Responding	123	160
Percent 24 years or younger	0.8%	3.7%
Percent 25-35 years	19.5%	22.5%
Percent 35-44 years	39.0%	39.4%
Percent 45-54 years	17.1%	18.8%
Percent 55-64 years	22.8%	15.6%
Percent 65 years or older	0.8%	0%

Table 9
Prevalence of Sick Building Syndrome by Two Definitions
(SBS1[a] and SBS2[b]) by Age Adjusted for Gender
Toledo Municipal Building
HETA 89-065

	Prevalence of SBS1		Prevalence of SBS2	
Age[c]	Men	Women	Men	Women
<25 years	0.0%	16.7%	0.0%	16.7%
25 - 34 years	4.2%	36.1%	4.2%	22.2%
35 - 44 years	6.3%	38.1%	8.3%	31.8%
45 - 54 years	9.5%	26.7%	14.3%	24.1%
55 - 64 years	3.6%	32.0%	17.9%	20.0%
<65 years	0.0%	-	0.0%	-

a SBS1 defined by reporting building-related symptoms "often" or "always" (1 nonspecific plus 2 irritative).
b SBS2 defined by reporting building-related symptoms "sometimes," "often," or "always" (2 nonspecific plus 4 irritative).
c P=0.87, Chi^2 for general association between SBS1 and age adjusted for gender.
P=0.87, Chi^2 for general association between SBS2 and age adjusted for gender.

Table 10
Education Among Respondents
Toledo Municipal Building
HETA 89-065

	Respondents	
	Male	Female
Employees Responding	120	154
8th grade or less	0%	0%
9th, 10th, or 11th grade	0.8%	0.6%
High School Graduate	12.5%	50.0%
2 yrs college or associate degree	23.3%	30.5%
Bachelor's or technical degree	30.0%	9.7%
Some graduate work	14.2%	4.5%
Graduate or professional degree	19.2%	4.5%

Table 11
Prevalence of Sick Building Syndrome by Two Definitions
(SBS1[a] and SBS2[b]) by Education Level Adjusted for Gender
Toledo Municipal Building
HETA 89-065

	Prevalence of SBS1[c]		Prevalence of SBS2[c]	
Education Level	Men	Women	Men	Women
9th, 10th,or 11th Grade	0.0%	0.0%	0.0%	-
High School	0.0%	37.7%	6.7%	27.3%
2 Years College	3.6%	36.2%	10.7%	25.5%
Bachelor's Degree	8.3%	20.0%	8.3%	6.7%
Some Graduate Work	11.8%	14.3%	23.5%	28.6%
Graduate or Professional Degree	0.0%	28.6%	8.7%	0.0%

a SBS1 defined by reporting building-related symptoms "often" or "always" (1 nonspecific plus 2 irritative symptoms).
b SBS2 defined by reporting building-related symptoms "sometimes," "often," or "always" (2 nonspecific plus 4 irritative symptoms).
c P=0.84 for general association between SBS1 and education level adjusted for gender. P=0.28 for general association between SBS2 and education level adjusted for gender.

Table 12
Distribution of Job Categories
Toledo Municipal Building
HETA 89-065

Job Categories	Male	Female
Number of Respondents	116	152
Managerial and Professional	59.5%	19.7%
Technicial, Support, Clerical, Service	40.5%	80.3%

Table 13
Prevalence of Sick Building Syndrome by Two Definitions (SBS1[a] and SBS2[b]) by Job Category and Gender
Toledo Municipal Building
HETA 89-065

	Prevalence of SBS1[a]		Risk Ratio[c]	Prevalence of SBS2[b]		Risk Ratio[c]
Job Category	Male	Female	(95% C.I.)[d]	Male[e]	Female	(95% C.I.)[d]
Managerial and Professional	4.4%	26.7%		7.3%	16.7%	
Technical,Support, Clerical,Service	4.3%	35.3%	1.3 (0.7-2.3)	17.0%	26.5%	1.8 (1.0-3.5)

a SBS1 is defined by reporting building-related symptoms "often" or "always" (1 nonspecific plus 2 irritative symptoms).
b SBS2 is defined by reporting building-related symptoms "sometimes," "often," or "always" (2 nonspecific plus 4 irritative symptoms).
c Summary statistic adjusted for gender.
d 95% Confidence Interval.
e p=0.1 for association between job category and SBS2 among men.

Table 14
Percentage of Responding Employees Who Report Eye, Nose, Throat or Respiratory Irritation to Various Causes at Workstation During Preceding Year
Toledo Municipal Building
HETA 89-065

Cause	Never	Rarely	Sometimes	Often	Always	Number Reporting
Tobacco Smoke	63.9%	17.3%	11.2%	4.4%	3.1%	294
Office Chemicals Fumes[a]	68.5%	21.6%	7.2%	2.4%	0.3%	292
Paint Fumes	70.5%	22.0%	6.4%	0.3%	0.7%	295
Carpet Cleaner Fumes	78.2%	15.0%	6.1%	0.0%	0.7%	294
Photocopy Fumes	81.2%	13.0%	3.8%	1.7%	0.3%	293
New Carpeting Fumes	84.6%	10.6%	4.1%	0.3%	0.3%	292
New Curtains Fumes	87.3%	11.0%	1.4%	0.0%	0.3%	291
Pesticide Fumes	91.4%	6.2%	2.1%	0.3%	0.0%	290

a The use of the word "fumes" in this report follows the wording used in the employee questionnaire. The more appropriate term would be vapors.

Table 15
Prevalence of Sick Building Syndrome by Two Definitions (SBS1[a] and SBS2[b]) by Irritation from Various Fumes Adjusted for Gender
Toledo Municipal Building
HETA 89-065

Fume[c]	Prevalence of SBS1 Men	Prevalence of SBS1 Women	Risk Ratio (95% C.I.)	Prevalance of SBS2 Men	Prevalance of SBS2 Women	Risk Ratio (95% C.I.)
Tobacco Smoke						
yes	4.5%	53.1%	1.7	22.7%	59.4%	3.2
no	5.8%	28.9%	(1.1-2.7)	8.7%	17.3%	(2.1-5.0)
Photocopy Machine						
yes	25.2%	33.3%	1.2	50.0%	50.0%	2.5
no	5.0%	34.0%	(0.5-2.5)	10.0%	24.0%	(1.3-4.6)
Office Chemicals						
yes	25.0%	66.7%	2.5	50.0%	52.4%	2.9
no	4.3%	29.0%	(1.6-3.9)	8.6%	21.9%	(1.8-4.7)
Pesticide						
yes	0.0%	40.0%	1.1	50.0%	60.0%	2.8
no	5.7%	33.8%	(0.3-3.5)	10.6%	24.7%	(1.2-6.5)
New Carpet						
yes	16.7%	57.1%	1.9	66.7%	71.4%	4.2
no	5.0%	32.7%	(0.9-4.1)	8.4%	23.5%	(2.3-7.5)
New Curtains						
yes	0.0%	75.0%	2.2	0.0%	75.0%	2.7
no	5.6%	32.7%	(0.8-5.6)	11.3%	24.3%	(1.0-7.4)
Paint						
yes	0.0%	75.0%	2.4	40.0%	43.8%	2.1
no	5.8%	29.2%	(1.4-4.0)	10.0%	23.8%	(1.1-3.9)
Carpet or other Cleaners						
yes	20.0%	53.3%	1.8	40.0%	46.7%	2.2
no	5.0%	31.7%	(1.0-3.2)	10.0%	23.6%	(1.2-4.1)

a SBS1 defined by reporting building-related symptoms "often" or "always" (1 nonspecific plus 2 irritative).
b SBS2 defined by reporting building-related symptoms "sometimes," "often," or "always" (2 nonspecific plus 4 irritative).
c Experiencing eye, nose, throat, or respiratory irritation "sometimes," "often," or "always" from fumes in the past year.

Table 16
Types of Furniture, Equipment, and Changes
Within 15 Feet of Respondent's Workstation
Toledo Municipal Building
HETA 89-065

	Responding Yes	Total Responding
Carpet on Workstation Floor	100.0%	299
File cabinet	83.2%	297
Fabric-Covered Partitions	80.4%	296
Wood or Composition Desk	72.2%	288
Live Plants	70.9%	292
Other Metal Furniture	70.1%	294
Metal Bookshelves	68.8%	295
Metal Desk	68.7%	297
Other Wood or Composition Furniture	59.7%	288
Rearranged Walls	44.1%	290
Wood or Composition Bookshelves	39.8%	284
New Furniture	21.9%	288
New Equipment/Computer	21.3%	287
Laser Printer	18.5%	281
Photocopy Machine	15.8%	284
New/Continuing Water Leaks	15.6%	288
New Carpeting	9.3%	289
Blue Print Machine	1.4%	278
Walls Painted	1.4%	287
Portable Humidifier	0.7%	281
New Curtains	0.0%	287

Table 17
Prevalence of Sick Building Syndrome by Two Definitions (SBS1[a] and SBS2[b]) by Presence of Items Located Within 15 Feet of Workstation (WS) Adjusted for Gender
Toledo Municipal Building
HETA 89-065

Item within 15 Feet of WS	Prevalence of SBS1 Male	Female	Risk Ratio[c] (95% C.I.)	Prevalence of SBS2 Male	Female	Risk Ratio[c] (95% C.I.)
Bookcases						
yes	4.9%	32.3%	0.8	13.7%	24.2%	1.1
no	9.5%	36.7%	(0.5-1.4)	0.0%	30.0%	(0.6-2.1)
File Cabinet						
yes	7.3%	33.6%	1.4	13.5%	25.2%	1.2
no	0.0%	29.2%	(0.7-2.7)	3.9%	29.2%	(0.6-2.3)
Wood Furniture						
yes	6.5%	34.1%	1.2	11.1%	24.8%	0.8
no	0.0%	30.6%	(0.7-2.1)	7.7%	30.6%	(0.5-1.5)
Fabric Partitions						
yes	7.6%	31.9%	1.0	14.1%	24.1%	1.2
no	0.0%	41.7%	(0.6-1.7)	3.2%	29.2%	(0.6-2.4)
Photocopy Machine						
yes	18.8%	45.5%	1.7	18.2%	30.3%	1.4
no	3.8%	30.4%	(1.0-2.6)	9.5%	23.4%	(0.8-2.4)
Laser Printer						
yes	0.0%	39.0%	1.2	10.0%	24.4%	1.0
no	5.7%	31.9%	(0.7-1.9)	10.4%	25.0%	(0.5-1.8)
Blueprint Machine						
yes	0.0%	50.0%	1.3	0.0%	50.0%	1.4
no	5.3%	33.1%	(0.3-6.8)	10.6%	24.7%	(0.3-8.2)
Live Plants						
yes	4.5%	31.6%	0.8	11.9%	22.7%	0.8
no	5.6%	42.9%	(0.5-1.2)	9.3%	35.7%	(0.5-1.4)

a SBS1 is defined by reporting building-related symptoms "often" or "always" (1 nonspecific plus 2 irritative symptoms)
b SBS2 is defined by reporting building-related symptoms "sometimes," "often," or "always" (2 nonspecific plus 4 irritative symptoms)
c Summary Statistic adjusted for gender.

Table 18
Prevalence of Sick Building Syndrome by two Definitions (SBS1[a] and SBS2[b])
and Changes at Respondent's Workstation (WS) Within the Past Year
Adjusted for Gender
Toledo Municipal Building
HETA 89-065

Change within 15 Ft. of WS within past year	Prevalence of SBS1		Risk Ratio[c] (95% C.I.)	Prevalence of SBS2		Risk Ratio[c] (95% C.I.)
	Men	Women		Men	Women	
New Carpeting						
yes	12.5%	61.1%	2.0	25.0%	50.0%	2.3
no	5.4%	30.1%	(1.2-3.4)	9.9%	22.5%	(1.3-4.0)
New Computer						
yes	7.7%	28.6%	0.9	15.4%	23.5%	1.0
no	5.5%	34.1%	(0.5-1.5)	10.0%	26.2%	(0.6-1.8)
Walls Painted						
yes	12.2%	34.1%	1.2	0.0%	75.0%	3.1
no	2.6%	32.5%	(0.8-1.9)	11.2%	24.5%	(1.2-8.0)
Walls Rearranged						
yes	-	25.0%	0.8	21.9%	30.9%	2.0
no	5.9%	33.3%	(0.2-3.8)	5.1%	19.5%	(1.2-3.2)
Water Leaks						
yes	11.1%	33.3%	1.1	16.7%	33.3%	1.5
no	4.9%	33.1%	(0.6-1.9)	9.9%	23.5%	(0.8-2.6)

a SBS1 is defined by reporting building-related symptoms "often" or "always" (1 nonspecific plus 2 irritative symptoms)
b SBS2 is defined by reporting building-related symptoms "sometimes," "often," or "always" (2 nonspecific plus 4 irritative symptoms)
c Summary statistic adjusted for sex.

Table 19
Tenure and Characterization of Respondent's Office Activities
Toledo Municipal Building
HETA 89-065

	Mean	Median
Years Working in Building	4.4	5.0
Years at Current Workstation	2.7	2.0
Hours/Week in Building	36.8	40.0
Hours/Day at Workstation	6.4	7.0
Hours/Day with Computer	2.7	1.0
Hours/Day with Photocopy Machine	1.1	1.0
Hours/Day with Office Chemicals	0.5	0.0
Hours/Day with Blueprint Machines	0.2	0.0

Table 20

Prevalence of Sick Building Syndrome By Two Definitions (SBS1[a] and SBS2[b]) and Office Activities Adjusted for Gender

	Prevalence of SBS1		Risk Ratio[c]	Prevalence of SBS2		Risk Ratio[c]
Office Activity	Men	Women	(95% CI)	Men	Women	(95% CI)
Computer or Word Processor Use						
More than 3 hours per day	4.2%	38.7%	1.3	8.3%	28.0%	1.2
3 or fewer hours per day	3.5%	30.4%	(0.8-1.9)	9.2%	21.5%	(0.7-2.1)
Photocopy Machine Use						
More than 1 hour per day	8.3%	47.1%	1.4	33.3%	35.3%	2.0
1 hour or less per day	5.7%	33.3%	(0.8-2.5)	7.6%	23.5%	(1.1-3.7)
Office Chemical Use						
1 hour or more per day	6.9%	31.6%	0.9	13.8%	24.1%	1.0
Less than 1 hour per day	4.8%	36.5%	(0.6-1.4)	9.6%	27.0%	(0.6-1.6)
Blueprint Machine Use						
1 hour or more per day	15.8%	27.3%	1.3	21.1%	36.4%	1.7
Less than 1 hour per day	3.3%	35.1%	(0.6-2.7)	8.9%	25.4%	(0.9-3.5)

a SBS1 is defined by reporting building-related symptoms "often" or "always" (1 nonspecific plus 2 irritative symptoms)
b SBS2 is defined by reporting building-related symptoms "sometimes," "often," or "always" (2 nonspecific plus 4 irritative symptoms)
c Summary statistic adjusted for sex.

Table 21
Prevalence of Sick Building Syndrome by Two Definitions (SBS1[a] and SBS2[b]) and Various Variables Adjusted for Gender
Toledo Municipal Building
HETA 89-065

Variable	Prevalence of SBS1 Men	Women	P Value[c]	Prevalence of SBS2 Men	Women	P Value[c]
Hours per wk in building						
greater than 40 hours	4.2%	41.3%	0.109	9.8%	27.6%	0.899
40 hours	6.3%	31.0%		8.3%	24.1%	
less than 40 hours	3.9%	23.3%		12.5%	23.9%	
Times you go outdoors[d]						
0 to 2 times per week	0.0%	34.6%	0.796	5.0%	25.5%	0.673
3 or 4 times per week	0.0%	33.3%		5.0%	28.9%	
5 times or more	6.9%	32.1%		13.9%	23.1%	
Years working in building						
less than 3 years	0.0%	23.9%	0.114	4.0%	19.6%	0.729
3 - 5 years	4.6%	37.5%		13.6%	35.0%	
more than 5 years	7.6%	35.1%		9.4%	22.4%	
Number of people near workstation						
less then 8 people	5.3%	26.8%	0.190	7.0%	24.4%	0.033
8 - 10 people	6.1%	31.0%		9.1%	12.3%	
more then 10 people	6.7%	39.3%		13.3%	39.3%	

a SBS1 is defined by reporting building-related symptoms "often" or "always" (1 nonspecific plus 2 irritative symptoms).
b SBS2 is defined by reporting building-related symptoms "sometimes," "often," or "always" (2 nonspecific plus 4 irritative symptoms).
c Mantel-Haenszel summary statistic adjusting for sex.
d Number of times per week that a worker leaves the building to go outside during the workday.

Table 22
Prevalence of Sick Building Syndrome by Two Definitions (SBS1[a] and SBS2[b]) and Type of Workstation Space Adjusted for Gender
Toledo Municipal Building
HETA 89-065

Type of Space	Prevalence of SBS1 Men	Female	P Value[c]	Prevalence of SBS2 Men	Women	P Value[c]
Office with door	0%	22.2%	0.160	3.7%	11.1%	0.257
Ceiling high partitions	0%	50.0%		0.0%	33.3%	
Mid height partitions	7.9%	27.8%		14.5%	21.4%	
Open office area	6.3%	43.1%		12.5%	31.4%	

a SBS1 is defined by reporting building-related symptoms "often" or "always" (1 nonspecific plus 2 irritative symptoms).
b SBS2 is defined by reporting building-related symptoms "sometimes," "often," or "always" (2 nonspecific plus 4 irritative symptoms).
c General association summary statistic adjusted for sex.

Table 23
Prevalence of Sick Building Syndrome by Two Definitions (SBS1[a] and SBS2[b]) and Type of Space Sharing Adjusted for Gender
Toledo Municipal Building
HETA 89-065

Type of Sharing	Prevalence of SBS1[a] Men	Women	P Value[c]	Prevalence of SBS2[b] Male	Female	P Value[c]
Single occupant	4.9%	27.9%	0.462	11.0%	18.6%	0.192
Share with one	13.3%	34.6%		13.3%	20.0%	
Share with two or more	3.7%	36.9%		11.1%	34.8%	

a SBS1 is defined by reporting building-related symptoms "often" or "always" (1 nonspecific plus 2 irritative symptoms).
b SBS2 is defined by reporting building-related symptoms "sometimes", "often" or "always" (2 nonspecific plus 4 irritative symptoms).
c General association summary statistic adjusted for gender.

Table 24
Percent Reporting Odors at Workstation During Past Year
Toledo Municipal Building
HETA 89-065

Odor	Total Reporting	Sometimes	Often	Always
Cosmetics	293	27.3%	7.8%	3.1%
Other Food Smells	290	17.6%	4.5%	0.0%
Tobacco Smoke	292	15.4%	3.8%	2.1%
Office Chemicals	291	13.1%	1.0%	0.7%
Body odor	293	9.9%	3.1%	0.3%
Paint	291	7.9%	0.0%	0.7%
Carpet Cleaners	291	7.9%	0.0%	0.3%
Blueprint Machine	291	6.2%	2.7%	1.7%
Musty/Damp Basement	293	5.5%	1.4%	0.0%
Photocopy Machine	288	4.9%	0.7%	0.7%
New Carpet Odor	292	4.8%	0.0%	0.7%
Diesel Engine Exhaust	292	2.1%	0.7%	0.0%
Pesticides	291	1.4%	0.0%	0.0%
Fishy Smells	291	1.0%	0.7%	0.0%
New Curtain Odor	291	0.7%	0.0%	0.0%

Table 25
Prevalence of Sick Building Syndrome by Two Definitions (SBS1[a] and SBS2[b]) and Odors Noticed at Workstation in the Past Year Adjusted for Sex
Toledo Municipal Building
HETA 89-065

Odor	Prevalence of SBS1 Men	Prevalence of SBS1 Women	Risk Ratio[c] (95% C.I.)	Prevalence of SBS2 Men	Prevalence of SBS2 Women	Risk Ratio[c] (95% C.I.)
Body Odor						
yes	12.5%	55.2%	2.0	50.0%	39.3%	2.3
no	5.2%	28.5%	(1.2-3.1)	8.6%	21.5%	(1.4-3.8)
Cosmetic Odor						
yes	0%	42.9%	1.5	21.2%	32.9%	2.0
no	7.7%	24.1%	(1.0-2.3)	7.7%	18.1%	(1.3-3.2)
Tobacco Smoke						
yes	7.4%	48.5%	1.6	14.8%	43.8%	2.0
no	5.2%	29.6%	(1.0-2.5)	10.3%	20.0%	(1.2-3.2)
Fishy Smells						
yes	0%	25.0%	0.7	0%	75.0%	2.8
no	5.7%	33.8%	(0.1-3.6)	11.5%	23.5%	(1.1-7.6)
Other Food Smells						
yes	0%	43.5%	1.3	15.8%	35.6%	1.7
no	6.7%	30.0%	(0.8-2.1)	10.5%	20.9%	(1.0-2.7)
Musty Smells						
yes	0%	61.1%	2.0	0%	55.6%	2.5
no	5.7%	29.8%	(1.2-3.4)	11.5%	20.7%	(1.4-4.6)
New Carpet						
yes	20.0%	27.3%	1.0	40.0%	60.0%	2.9
no	5.0%	34.0%	(0.4-2.3)	10.0%	22.5%	(1.5-5.5)
New Curtain						
yes	0%	50.0%	1.4	0%	100.0%	3.4
no	5.7%	33.3%	(0.3-7.1)	11.5%	23.9%	(1.0-11.0)
Diesel or Engine Exhaust						
yes	-	25.0%	0.7	-	25.0%	1.0
no	5.7%	34.0%	(0.2-2.3)	11.3%	24.8%	(0.3-3.5)
Photocopy Machine						
yes	28.6%	40.0%	1.6	42.9%	40.0%	2.3
no	4.31%	33.6%	(0.8-3.3)	9.5%	24.1%	(1.1-4.5)

Table 25 continued on next page.

Table 25, Continued
Prevalence of Sick Building Syndrome by Two Definitions (SBS1[a] and SBS2[b]) and Odors Noticed at Workstation in the Past Year Adjusted for Sex
Toledo Municipal Building
HETA 89-065

Odor	Prevalence of SBS1 Male	Prevalence of SBS1 Female	Risk Ratio[c] (95% C.I.)	Prevalence of SBS2 Male	Prevalence of SBS2 Female	Risk Ratio[c] (95% C.I.)
Blueprint Machine						
yes	14.3%	25.0%	1.0	21.4%	31.3%	1.5
no	4.6%	34.5%	(0.5-2.0)	10.1%	24.1%	(0.8-2.9)
Office Chemicals						
yes	18.2%	43.8%	1.5	36.4%	37.5%	2.0
no	4.4%	33.3%	(0.5-4.7)	8.9%	21.8%	(1.2-3.4)
Pesticide						
yes	-	50.0%	1.5	-	75.0%	3.2
no	5.7%	33.3%	(0.5-4.7)	11.3%	23.7%	(1.2-8.3)
Carpet Cleaners						
yes	16.7%	47.7%	1.6	33.3%	47.1%	2.3
no	5.1%	32.1%	(0.9-2.8)	10.2%	22.3%	(1.3-4.1)
Paint						
yes	0%	47.4%	1.4	33.3%	47.4%	2.3
no	6.0%	32.4%	(0.8-2.5)	10.3%	22.5%	(1.3-4.0)

a SBS1 is defined by reporting building-related symptoms "often" or "always" (1 nonspecific plus 2 irritative symptoms).
b SBS2 is defined by reporting building-related symptoms "sometimes," "often," or "always" (2 nonspecific plus 4 irritative symptoms).
c Summary Statistic adjusted for sex.

Table 26
Employee Responses Regarding Physical Environment at Their Workstation
Toledo Municipal Building
HETA 89-065

	Employee Response					Number
	Never	Rarely	Sometimes	Often	Always	Responding
Too much air	46.7%	27.4%	15.8%	7.0%	3.2%	285
Too little air	18.4%	15.3%	24.7%	19.8%	21.9%	288
Want to adjust air	16.5%	9.2%	27.8%	25.0%	21.5%	284
Too hot	21.6%	22.6%	32.4%	16.4%	7.0%	287
Too cold	14.6%	21.5%	38.9%	19.4%	5.6%	288
Want to adjust temp.	9.8%	8.8%	34.7%	24.2%	22.5%	285
Too humid	58.1%	24.3%	12.3%	3.5%	1.8%	284
Too dry	15.5%	14.1%	23.4%	20.3%	26.6%	290
Want to adjust humidity	27.4%	11.0%	22.8%	16.7%	22.1%	281
Too stuffy	11.8%	9.3%	27.7%	18.7%	32.5%	289
Too noisy	32.9%	26.2%	21.3%	9.8%	9.8%	286
Too quiet	67.2%	23.0%	7.3%	1.0%	1.4%	287
Too dusty	45.5%	27.4%	13.5%	8.3%	5.2%	288

Table 27
Prevalence of SBS by Two Definitions (SBS1[a] and SBS2[b]) and Complaints About Physical Environment at Workstation Adjusted for Gender
Toledo Municipal Building
HETA 89-065

Complaint[d]	Prevalence of SBS1 Men	Prevalence of SBS1 Women	Risk Ratio[c] (95% C.I.)	Prevalence of SBS2 Men	Prevalence of SBS2 Women	Risk Ratio[c] (95% C.I.)
Too much air movement						
yes	0%	33.3%	0.9	0%	33.3%	1.2
no	6.1%	32.6%	(0.4-2.5)	12.3%	22.7%	(0.6-2.5)
Too little air movement						
yes	8.3%	35.8%	1.3	19.4%	25.9%	1.4
no	4.6%	28.4%	(0.8-2.0)	8.1%	23.0%	(0.8-2.2)
Too hot						
yes	7.7%	32.5%	1.0	19.2%	22.5%	1.1
no	5.3%	33.6%	(0.6-1.7)	9.5%	26.7%	(0.6.1.8)
Too cold						
yes	7.7%	43.9%	1.6	23.1%	38.6%	2.1
no	5.6%	27.3%	(1.0-2.5)	10.2%	18.2%	(1.3-3.5)
Too humid						
yes	20.0%	50.0%	1.8	20.0%	40.0%	1.7
no	5.2%	31.3%	(0.9-3.6)	11.3%	24.3%	(0.7-3.7)
Too dry						
yes	11.1%	48.5%	5.2	25.0%	35.1%	3.7
no	3.5%	8.3%	(2.9-9.5)	5.8%	10.0%	(2.1-6.6)
Too stuffy						
yes	13.6%	40.4%	2.3	25.0%	32.3%	3.1
no	1.3%	20.7%	(1.4-3.8)	3.9%	13.8%	(1.8-5.3)
Too noisy						
yes	16.7%	48.4%	1.9	25.0%	22.6%	1.3
no	3.1%	29.8%	(1.2-3.0)	8.3%	26.6%	(0.7-2.2)
Too dusty						
yes	37.5%	60.0%	2.6	62.5%	43.3%	2.7
no	3.5%	26.4%	(1.7-4.0)	7.8%	20.8%	(1.7-4.3)

a SBS1 is defined by reporting building-related symptoms "often" or "always" (1 nonspecific plus 2 irritative symptoms).
b SBS2 is defined by reporting building-related symptoms "sometimes," "often," or "always" (2 nonspecific plus 4 irritative symptoms).
c Summary Statistic adjusted for Gender.
d Complaint of condition "often" or "always" in past year at workstation.

Table 28
Distribution of Responses Regarding Conditions at Employees' Workstation
Toledo Municipal Building
HETA 89-065

Condition	Male	Female
Lighting Too Dim		
yes	23.6%	32.5%
no	76.4%	67.5%
Lighting Too Bright		
yes	7.3%	10.0%
no	92.7%	90.0%
Glare (often or always)		
yes	15.3%	20.7%
no	84.7%	79.3%
Glare From Windows		
yes	8.9%	11.6%
no	91.1%	88.4%
Glare From Fluorescent Lights		
yes	6.5%	11.6%
no	93.5%	88.4%
Glare From Video Terminals		
yes	4.0%	8.5%
no	96.0%	91.5%
Uncomfortable Chair		
yes	26.4%	38.6%
no	73.6%	61.4%
Uncomfortable Desk Setup		
yes	15.3%	28.4%
no	84.7%	71.6%

Table 29
Prevalence of Sick Building Syndrome by Two Definitions (SBS1[a] and SBS2[b]) and Conditions at Employees' Workstation Adjusted for Gender
Toledo Municipal Building
HETA 89-065

Condition	Prevalence of SBS1 Male	Prevalence of SBS1 Female	Risk Ratio[c] (95% C.I.)	Prevalence of SBS2 Male	Prevalence of SBS2 Female	Risk Ratio[c] (95% C.I.)
Lighting too dim						
yes	13.8%	42.3%	1.7	24.1%	23.1%	1.2
no	3.2%	28.7%	(1.1-2.5)	7.5%	26.2%	(0.8-7.0)
Lighting too bright						
yes	11.1%	43.7%	1.4	11.1%	25.0%	1.0
no	5.3%	31.9%	(0.8-2.7)	11.4%	25.2%	(0.4-2.2)
Glare (often or always)						
yes	10.5%	52.9%	1.9	26.3%	35.3%	1.8
no	4.8%	28.5%	(1.2-2.9)	8.6%	23.3%	(1.1-2.9)
Glare from Windows						
yes	9.1%	63.2%	2.1	27.3%	36.8%	1.7
no	5.3%	29.7%	(1.3-3.4)	9.7%	24.3%	(1.0-3.2)
Glare from Fluorescent Lights						
yes	12.5%	63.2%	2.1	37.5%	42.1%	2.1
no	5.2%	29.7%	(1.3-3.5)	9.5%	23.6%	(1.2-3.7)
Glare from Video Display Screen						
yes	20.0%	71.4%	2.5	40.0%	35.7%	1.8
no	5.0%	30.0%	(1.5-4.2)	10.1%	24.8%	(0.9-3.5)
Uncomfortable Chair						
yes	15.2%	41.3%	1.7	21.2%	36.5%	2.2
no	2.2%	28.0%	(1.2-2.6)	7.6%	18.2%	(1.4-3.4)
Uncomfortable Desk Setup						
yes	21.1%	41.3%	1.6	31.6%	34.8%	2.0
no	2.9%	30.2%	(1.1-2.5)	7.6%	21.7%	(1.2-3.1)

a SBS1 is defined by reporting building-related symptoms "often" or "always" (1 nonspecific plus 2 irritative symptoms).
b SBS2 is defined by reporting building-related symptoms "sometimes," "often," or "always" (2 nonspecific plus 4 irritative symptoms).
c Summary statistic adjusted for sex.

Table 30
Health History of Employees
Toledo Municipal Building
HETA 89-065

Condition	Percent Reporting 'Yes' to Condition Male	Female
Physician diagnosed eczema	4.0%	6.7%
Physician diagnosed asthma	3.3%	6.1%
Self-reported pollen allergy	27.1%	22.3%
Self-reported animal allergy	9.0%	8.5%
Self-reported dust allergy	29.0%	33.3%
Self-reported mold allergy	15.5%	21.8%
Current Smoker	24.8%	27.3%

Table 31
Prevalence of Sick Building Syndrome By Two Definitions (SBS1[a] and SBS2[b]) and Health Conditions Adjusted for Gender
Toledo Municipal Building
HETA 89-065

Health Condition	Prevalence of SBS Men	Prevalence of SBS Women	Risk Ratio[c] (95% CI)	Prevalence of SBS2 Men	Prevalence of SBS2 Women	Risk Risk[c] (95% CI)
Physician diagnosed eczema						
yes	40.0%	54.6%	2.2	20.0%	36.4%	1.5
no	4.2%	32.1%	(1.2-3.9)	10.9%	25.0%	(0.7-3.4)
Physician diagnosed asthma						
yes	0%	50.0%	1.4	0%	22.2%	0.7
no	5.0%	32.5%	(0.7-3.1)	10.9%	26.0%	(0.2-2.5)
Self-reported pollen allergy						
yes	6.1%	42.9%	1.3	15.2%	28.6%	1.2
no	5.6%	31.2%	(0.8-2.1)	10.1%	24.8%	(0.7-2.1)
Self-reported animal allergy						
yes	0%	46.1%	1.2	9.1%	15.4%	0.6
no	6.3%	27.4%	(0.6-2.4)	11.7%	26.6%	(0.2-1.8)
Self-reported dust allergy						
yes	8.3%	49.1%	1.8	14.0%	34.0%	1.5
no	4.6%	27.4%	(1.2-2.7)	10.2%	21.9%	(0.9-2.4)
Self-reported mold allergy						
yes	0%	50.0%	1.5	21.1%	35.3%	1.7
no	6.7%	28.7%	(0.9-2.4)	9.6%	22.3%	(1.0-2.8)
Current Smoker						
yes	9.7%	37.2%	1.2	9.7%	26.7%	1.0
no	4.3%	31.7%	(0.8-2.0)	11.7%	25.2%	(0.6-1.7)

a SBS1 is defined by reporting building-related symptoms "often" or "always" (1 nonspecific plus 2 irritative symptoms).
b SBS2 is defined by reporting building-related symptoms "sometimes," "often," or "always" (2 nonspecific plus 4 irritative symptoms).
c Summary statistic adjusted for sex.

Table 32A
Distribution of Building Occupants by Industrial Hygiene Measurements[a] and Gender
Toledo Municipal Building
HETA 89-065

	Male	Females
Average Temperature		
≥ 71 and < 73 F	29.8%	25.2%
≥ 73 and < 74 F	47.3%	44.8%
≥ 74 and ≤ 75.25 F	24.2%	30.0%
Average Respirable Particulate[b]		
≥ 0.011 and ≤ 0.018	24.2%	35.0%
> 0.018 and < 0.035	42.7%	32.5%
> 0.035 and ≤ 0.277	33.1%	32.5%
Average Relative Humidity		
≥ 26% and ≤ 30%	34.7%	28.2%
> 30% and ≤ 39%	33.9%	32.5%
> 39% and ≤ 48%	33.1%	32.5%
Maximum CO_2 Concentration		
≥ 650 and ≤ 850 ppm	41.1%	29.5%
> 850 and ≤ 1000 ppm	33.1	27.0%
> 1000 and ≤ 1250 ppm	25.8%	43.5%

a Industrial Hygiene Measurements were taken at 4 times in one day at each of 8 locations on each of 8 floors.
b Respirable particulate measured in units of micrograms per cubic meter.

Table 32B
Prevalence of Sick Building Syndrome by Two Definitions (SBS1[a] and SBS2[b]) and Industrial Hygiene Measurements[c] Adjusted for Gender
Toledo Municipal Building
HETA 89-065

	Prevalence of SBS1		P[d]	Prevalence of SBS2		P[d]
	Male	Females	Value	Male	Females	Value
Average Temperature						
≥ 71 and < 73 F	8.1%	24.4%	0.45	10.8%	22.5%	0.82
≥ 73 and < 74 F	5.3%	38.4%		10.5%	27.4%	
≥ 74 and ≤ 75.25 F	3.3%	30.6%		10.0%	22.4%	
Average Respirable Particulate[e]						
≥ 0.011 and ≤ 0.018	3.3%	35.1%	0.19	16.7%	29.8%	0.22
> 0.018 and < 0.035	3.8%	24.5%		7.6%	19.2%	
> 0.035 and ≤ 0.150	9.8%	37.7%		9.8%	24.5%	
Average Relative Humidity						
≥ 26% and ≤ 30%	4.7%	30.4%	0.89	4.6%	35.6%	0.48
> 30% and ≤ 39%	9.5%	30.7%		14.3%	16.1%	
> 39% and ≤ 48%	2.6%	36.4%		12.8%	25.4%	
Maximum CO_2 Concentration						
≥ 650 and ≤ 850 ppm	5.9%	29.2%	0.42	11.8%	12.5%	0.22
> 850 and ≤ 1000 ppm	4.9%	27.3%		7.3%	34.9%	
> 1000 and ≤ 1250 ppm	6.3%	38.0%		17.5%	26.8%	

a SBS1 is defined by reporting building-related symptoms "often" or "always"(1 nonspecific plus 2 irritative symptoms).
b SBS2 is defined by reporting building-related symptoms "sometimes," "often," or "always" (2 nonspecific plus 4 irritative symptoms).
c Industrial Hygiene Measurements were taken at 4 times in one day at each of 8 locations on each of 8 floors.
d Summary Statistic for general association adjusted for gender.
e Respirable particulate measured in units of micrograms per cubic meter.

Table 33
Prevalence of Sick Building Syndrome by Two Definitions (SBS1[a] and SBS2[b]) and Work-Related Stressors and External Stress Adjusted for Sex
Toledo Municipal Building
HETA 89-065

Stress Variable[c]	Prevalence of SBS1 Men	Women	P[d] Value	Prevalence of SBS2 Men	Women	P[d] Value
Job Satisfaction			0.01			<.01
Low	12.5%	52.2%		21.9%	43.5%	
Medium	3.3%	28.1%		6.7%	21.9%	
High	3.8%	26.2%		7.7%	12.2%	
Job Control			0.83			0.14
Low	6.7%	34.9%		23.3%	30.2%	
Medium	6.5%	36.7%		10.0%	22.0%	
High	5.7%	31.4%		7.5%	23.5%	
Quantitative workload			0.28			0.03
High	9.1%	37.0%		21.2%	28.9%	
Medium	3.6%	27.4%		7.3%	14.5%	
Low	5.9%	38.5%		8.8%	32.7%	
Role conflict			0.01			0.10
High	7.0%	41.5%		16.3%	39.0%	
Medium	7.7%	43.3%		12.8%	23.7%	
Low	2.5%	19.3%		5.0%	15.8%	
Utilization of abilities			0.33			0.12
Low	10.0%	34.6%		20.0%	25.0%	
Medium	5.6%	40.0%		11.1%	31.1%	
High	2.2%	28.8%		4.4%	19.0%	
Role ambiguity			0.54			0.34
High	6.4%	38.9%		17.0%	28.6%	
Medium	6.8%	35.8%		9.1%	20.9%	
Low	3.5%	9.6%		6.9%	27.8%	
External stress			0.75			0.23
High	10.0%	34.9%		20.0%	28.6%	
Medium	2.8%	35.9%		5.6%	23.7%	
Low	3.6%	31.5%		7.3%	22.2%	

a SBS1 is defined by reporting building-related symptoms "often" or "always" (1 nonspecific plus 2 irritative symptoms).
b SBS2 is defined by reporting building-related symptoms "sometimes," "often," or "always" (2 nonspecific plus 4 irritative symptoms).
c Categories for each stress variable were constructed to approximate high, medium and low textiles before stratifying by sex.
d Mantel-Haenszel summary statistic adjusting for sex.

Table 34
Prevalence of High Depression Scale Scores[a] and Job Characteristic and Stress Levels Adjusted for Gender
Toledo Municipal Building
HETA 89-065

Stress Variable[b]	Prevalence of Depressive Symptoms Men	Women	P Value[c]
Job Control			0.34
Low	28.6%	40.5%	
Medium	28.6%	33.3%	
High	20.0%	28.6%	
Job Satisfaction			<.01
Low	44.4%	57.5%	
Medium	19.0%	30.0%	
High	7.7%	17.5%	
Quantitative workload			0.22
High	33.3%	34.1%	
Medium	9.8%	34.6%	
Low	34.4%	31.9%	
Role conflict			<.01
High	38.1%	50.0%	
Medium	14.3%	32.1%	
Low	13.9%	22.6%	
Utilization of abilities			<.01
Low	45.7%	44.4%	
Medium	20.0%	29.3%	
High	7.1%	27.6%	
Role ambiguity			0.03
High	36.6%	41.2%	
Medium	19.1%	33.9%	
Low	8.0%	28.6%	
External stress			0.33
High	32.1%	36.2%	
Medium	15.2%	28.9%	
Low	21.6%	34.7%	

a Center for Epidemiologic Studies - Depression (CES-D) Scale Score greater than or equal to 16.
b Categories for each stress variables were constructed to approximate high, medium, and low textiles before stratifying by sex.
c Mantel-Haenszel summary statistic adjusting for sex.

Table 35
Distribution of CES-D[a] Scale Scores by Gender
Toledo Municipal Building
HETA 89-065

CES-D Score	Proportion of Men	Proportion of Women	P-value[b]
0 to 15[c]	76.7%	65.5%	0.127
16 to 25	16.4%	22.3%	
>25[d]	6.9%	12.2%	

a Center for Epidemiological Studies - Depression Scale
b Summary Statistic for general association adjusted for gender.
c Interval chosen by score which accounted for 80% of a population-based sample.
d Interval chosen to account for approximately ten percent of respondents

Table 36
Prevalance of Sick Building Syndrome by Two Definitions (SBS1[a] and SBS2[b]) and CES-D[c] Scores Adjusted for Gender
Toledo Municipal Building
HETA 89-065

CES-D Score	Prevalence of SBS1		Risk Ratio[d]	Prevalence of SBS2		Risk Ratio[d]
	Men	Women	(95% C.I.)	Men	Woman	(95% C.I.)
>25[e]	12.5%	61.1%	2.4	25.0%	61.1%	3.6
≤25	2.3%	26.8%	(1.4-4.1)	5.6%	17.7%	(2.0-6.3)
>15	18.5%	49.0%	2.1	29.6%	41.2%	2.8
≤15[f]	2.3%	26.8%	(1.4-3.2)	5.6%	17.7%	(1.8-4.5)

a SBS1 is defined by reporting building-related symptoms "often" or "always" (1 nonspecific plus 2 irritative symptoms)
b SBS2 is defined by reporting building-related symptoms "sometimes," "often," or "always" (2 nonspecific plus 4 irritative symptoms)
c Center for Epidemiological Studies - Depression Scale
d Risk of being a SBS case comparing each higher CES-D score interval with the corresponding lower category. Risk ratios are adjusted for effects of gender.
e CES-D score which accounts for approximately 10% of respondents.
f CES-D score which corresponds to 80% a population based sample.

Table 37
Distribution of SAD[a] Symptomatology Scale Scores by Gender
Toledo Municipal Building
HETA 89-065

SAD Score	Proportion of Men	Proportion of Women	P-value[b]
0 to 2[c]	74.1%	71.3%	0.183
3 to 5	18.1%	14.0%	
6 to 13[d]	7.8%	14.6%	

a Seasonal Affective Disorder
b Summary statistic for general association adjusted for gender.
c Interval chosen to approximate the proportion of respondents expected not to have subsyndromal seasonal affective disorder.
d Interval chosen to account for approximately 10% of respondents.

Table 38
Prevalance of Sick Building Syndrome by Two Definitions (SBS1[a] and SBS2[b]) and SAD[c] Score Adjusted for Gender

SAD Score	Prevalence of SBS1		Risk Ratio[d]	Prevalence of SBS2		Risk Ratio[d]
	Men	Women	(95% C.I.)	Men	Women	(95% C.I.)
6 to 13[e]	22.2%	57.1%	2.2	33.3%	42.9%	2.4
0 to 2	3.5%	28.4%	(1.4-3.7)	7.0%	20.8%	(1.4-4.3)
3 to 13[f]	10.0%	46.3%	1.7	20.0%	39.0%	2.1
0 to 2	3.5%	28.4%	(1.1-2.7)	7.0%	20.8%	(1.3-3.4)

a SBS1 is defined by reporting building-related symptoms "often" or always" (1 nonspecific plus 2 irritative symptoms)
b SBS2 is defined by reporting building-related symptoms "sometimes," "often," or "always" (2 nonspecific plus 4 irritative symptoms)
c Seasonal Affective Disorder
d Risk of being a SBS case comparing each higher SAD score category with the corresponding lower category. Risk ratios are adjusted for effects of gender.
e Interval chosen to approximate 10% of respondents.
f Interval chosen to approximate the proportion of respondents expected to have subsyndromal seasonal affective disorder.

Table 39
Prevalance of Sick Building Syndrome by Two Definitions (SBS1[a] and SBS2[b]) and Lighting Level Adjusted for Gender
Toledo Municipal Building
HETA 89-065

Lighting Level	(N[c]) Men	Women	Prevalence of SBS1 Men	Women	Risk Ratio[d] (95% C.I.)	Prevalence of SBS2 Men	Women	Risk Ratio[d] (95% C.I.)
Low	20	68	10.0%	35.8%	1.2	10.0%	25.0%	0.9
High[e]	105	96	4.8%	30.5%	(0.8-1.9)	11.4%	26.3%	(0.6-1.5)

a SBS1 is defined by reporting building-related symptoms "often" or "always" (1 nonspecific plus 2 irritative symptoms).
b SBS2 is defined by reporting building-related symptoms "sometimes," "often," or "always" (2 nonspecific plus 4 irritative symptoms).
c Number of men or women in each lighting level category.
d Risk of being a SBS case for persons working in low lighting level areas compared to persons working in high lighting level areas (adjusted for gender).
e Defined by workstation location within 15 feet of a window with no intervening wall or partition.

Table 40
Prevalance of Depressive Symptomatology[a] by Lighting Level and SAD Score
Toledo Municipal Building
HETA 89-065

SAD Score	Lighting Level	Prevalence of Depression (N)	Risk Ratio (95% C.I.)
0 - 2	Low[b]	21.8% (55)	0.90
	High[c]	24.2% (128)	(0.50-1.62)
3 - 13	Low[b]	62.5% (24)	1.72
	High[c]	36.4% (44)	(1.03-2.88)

a CES-D score above 15.
b Workstation location more than 15 feet from a window or having a partion or wall between workstation and window.
c Workstation location within 15 feet of a window without an interviewing wall or partition.

Table 41
Prevalence of Depression by SAD Score and Lighting Level
Adjusted for Gender and Education Level
Toledo Municipal Building
HETA 89-065

SAD Score	Education Level	Lighting Level	Prevalence of Depression Men	Prevalence of Depression Women	Risk Ratio[d] (95% C.I.)
3-13	High school[a]	Low	100.0%	62.5%	
		High	25.0%	30.0%	
3-13	2 year[b] college	Low	50.0%	42.9%	1.9
		High	16.7%	66.7%	(1.1-3.2)
3-13	College graduate[c]	Low	100.0%	66.7	
		High	18.2%	33.3	
0-2	High school[a]	Low	0.0%	21.7%	
		High	33.3%	34.6%	
0-2	2 year college[b]	Low	0.0%	25.0%	0.7
		High	16.7%	25.0%	(0.4-1.4)
0-2	College graduate[c]	Low	20.0%	33.3%	
		High	17.4%	25.0%	

a High school graduate or less education.
b 2 years of college or associates degree.
c College graduate or more education.
d Summary statistic comparing prevalence of depression between low and high lighting levels, adjusted for education level and gender.

Table 42
Logistic Regression Model for Variables Associated with Sick Building Syndrome by Two Definitions (SBS1[a] and SBS2[b])
Toledo Municipal Building
HETA 89-065

Regression Model for SBS1

Variable	Risk Ratio	95% C.I.
Female Gender	7.5	3.0-18.7
Office Solvents[c]	4.3	1.5-12.0
Body Odor[d]	3.6	1.4- 8.7
Depressed Mood[e]	2.7	1.3- 5.6

Regression Model for SBS2

Variable	Risk Ratio	95% C.I.
Female Gender	3.0	1.3- 7.0
Tobacco Smoke[f]	3.7	1.6- 8.7
New Carpet Fumes[g]	4.7	1.0-21.3
Depressed Mood[e]	4.3	2.0- 9.0
Denser Population[h]	2.4	1.1- 5.2

a SBS1 is defined by reporting building-related symptoms "often" or "always" (1 nonspecific plus 2 irritative symptoms).
b SBS2 is defined by reporting building-related symptoms "sometimes," "often," or "always" (2 nonspecific plus 4 irritative symptoms).
c Office Solvents reported to cause eye, nose, throat or respiratory irritation at least sometime last year.
d Body odor noticed at least sometimes last year at workstation.
e Depressed Mood - Center for Epidemiologic Studies Depression Scale Score greater than 15.
f Tobacco Smoke reported to cause eye, nose, throat, respiratory irritation at least sometime last year.
g New Carpet Fumes reported to cause eye, nose, throat, or repsiratory irritation at least sometime last year.
h Denser Population - Workstation located near 11 or more workers.

Table 43
Prevalence of Current Building-Related Symptoms (CBRS*) by Gender
Toledo Municipal Building
HETA 89-065

Gender	Number (Proportion)	Prevalence of BRS	Risk Ratio (95% C.I.)
Male	124 (44.3%)	6.5%	4.37
Female	156 (55.7%)	28.2%	(2.35-8.15)

* Combination of one or more nonspecific work-related symptoms, each occurring 2 or more days in the previous week; plus, 2 or more irritative work-related symptoms, each occuring 2 or more days in the previous week.

Table 44
Prevalence of Current Building Related Symptoms (CBRS[a]) by
Industrial Hygiene Measurements Adjusted for Gender
Toledo Municipal Building
HETA 89-065

	Prevalence of CBRS		
	Men	Women	P-value[b]
Maximum CO^2 Concentration			
650 - 850 ppm	18.0%	33.3%	0.709
>850 - 1000 ppm	7.3%	41.5%	
1000 - 1250 ppm	28.1%	35.3%	
Average Respirable Particulate[c]			
0.011 - 0.018	16.7%	33.3%	0.735
>0.018 - 0.035	11.3%	40.8%	
>0.035 - 0.277	25.0%	35.3%	
Average Temperature			
71 - 73°F	10.8%	31.6%	0.368
>73 - 74°F	17.9%	42.0%	
>74 - 75°F	23.3%	31.9%	
Average Relative Humidity			
26% - 30%	16.3%	51.2%	0.194
>30% - ≤39%	19.1%	27.1%	
>39% - 48%	15.8%	35.2%	

a Combination of one or more nonspecific work-related symptoms, each occurring 2 or more days in the previous week; plus, 2 or more irritative work-related symptoms, each occuring 2 or more days in the previous week.
b Summary statistic for general association adjusted for gender.
c Respirable particulate levels expressed in micrograms per cubic meter.

Table 45
Prevalence of Current Building Related Symptoms (CBRS*) and Level of Current Depression Adjusted for Gender
Toledo Municipal Building
HETA 89-065

CES-D Score	Prevalence of CBRS Men	Women	Risk Ratio** (95% C.I.)
>15	34.6%	44.9%	1.54
0 - 15	12.4%	35.5%	(1.07-2.23)

* Combination of one or more nonspecific work-related symptoms, each occurring 2 or more days in the previous week; plus, 2 or more irritative work-related symptoms, each occurring 2 or more days in the previous week.
** Risk of having 'current building-related symptoms' for respondents in the high CES-D score category (adjusted for gender).

Table 46
Prevalence of Current Building Related Symptoms (CBRS*) and Level SAD Symptomatology Adjusted for Gender
Toledo Municipal Building
HETA 89-065

SAD Score	Prevalence of CBRS Men	Women	Risk Ratio** (95% C.I.)
3 - 13	30.0%	57.5%	2.0
0 - 2	10.6%	32.0%	(1.4-2.9)

* Combination of one or more nonspecific work-related symptoms, each occurring 2 or more days in the previous week; plus, 2 or more irritative work-related symptoms, each occurring 2 or more days in the previous week.
** Risk of having 'current building-related symptoms' for respondents in the high SAD score category (adjusted for gender).

Table 47
Prevalence of Irritative* and Nonspecific** Building-Related Symptoms by Levels of Current Depression and Seasonal Affective Symptomatology Adjusted for Gender
Toledo Municipal Building
HETA 89-065

CES-D Score	Prevalence of Irritative Symptoms* Men	Women	Risk Ratio (95% C.I.)
>15	22.2%	54.9%	1.7
0 - 15	4.5% (89)	38.1% (97)	(1.2-2.4)
SAD Score			
3 - 13	13.3%	53.7%	1.5
0 - 2	5.8%	39.2%	(1.0-2.1)

CES-D Score	Prevalence of Nonspecific Symptoms** Men	Women	Risk Ratio (95% C.I.)
>15	48.2%	68.6%	1.7
0 - 15	11.2%	51.0%	(1.3-2.2)
SAD Score			
3 - 13	23.3%	75.6%	1.5
0 - 2	17.4%	50.5%	(1.1-1.9)

* Defined by 2 irritative work-related symptoms 'often' or 'always' in the past year.
** Defined by 1 nonspecific work-related symptoms 'often' or 'always' in the past year.

Figure 1

Environmental Sampling Locations
Toledo Municipal Building
HETA 89-065

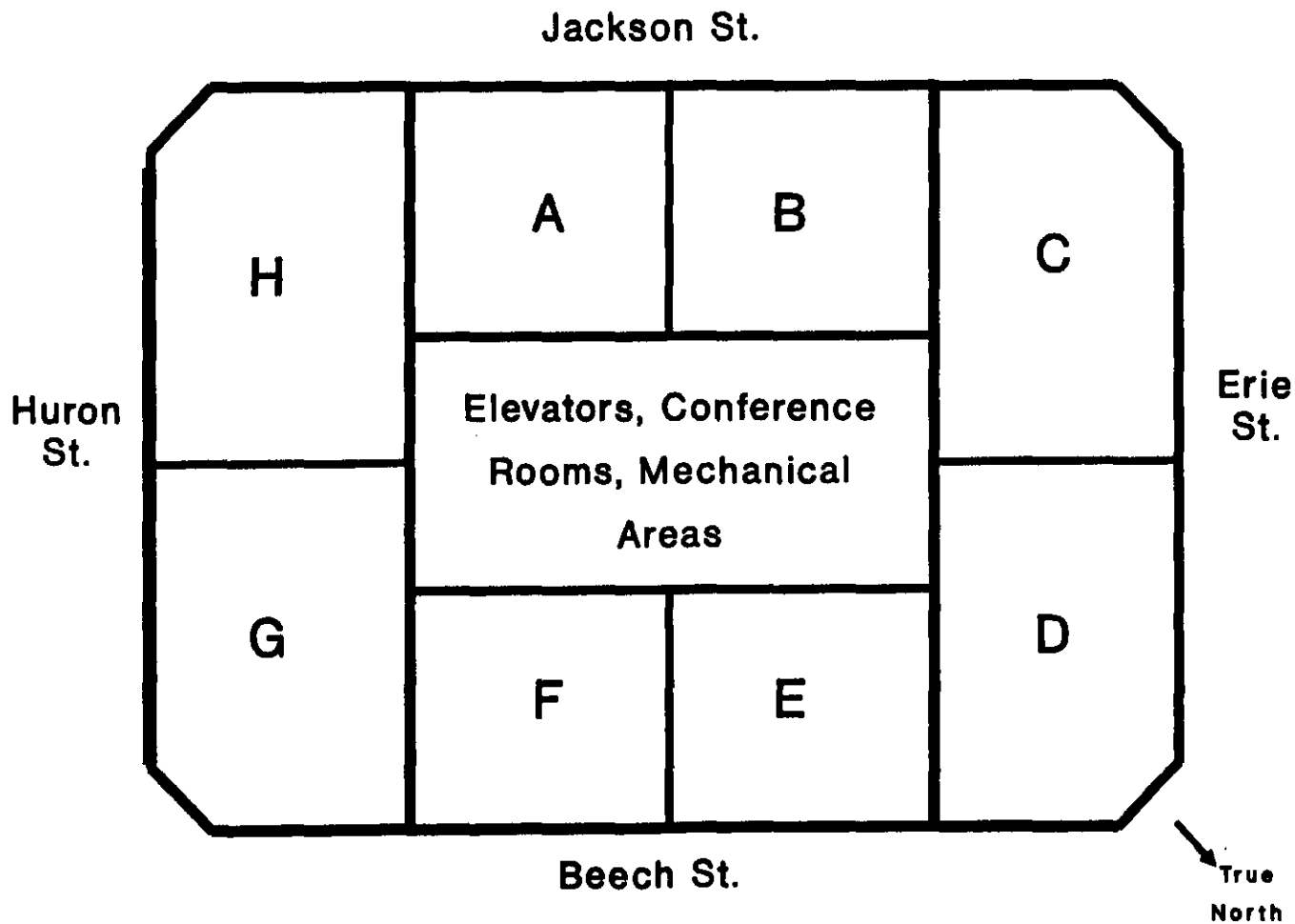
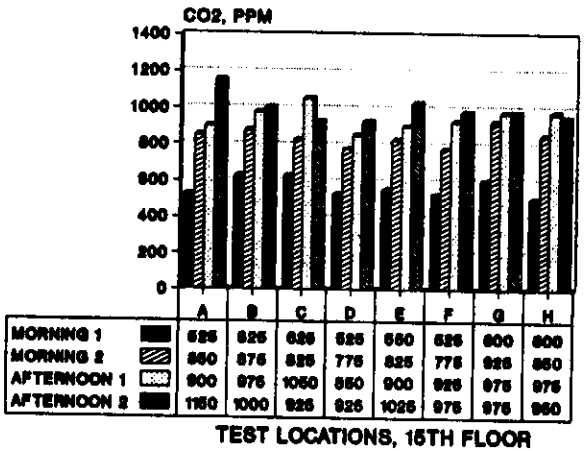
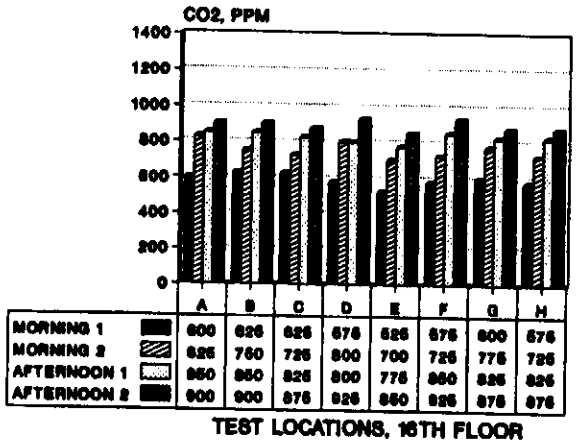


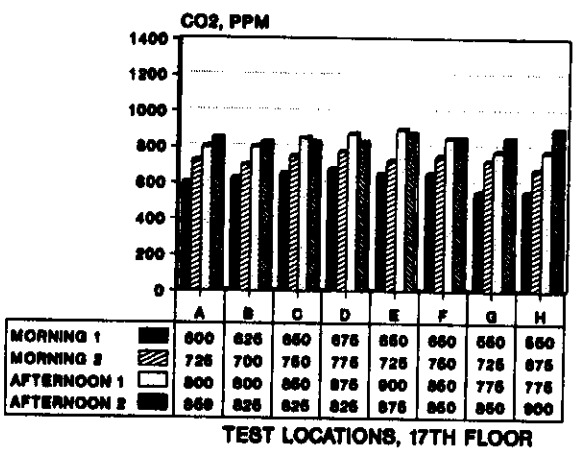
Figure 2

CO2 Concentrations - Toledo Municipal Building
HETA 89-065
March 20-23, 1989





Average CO2 Concentrations Outside = 300



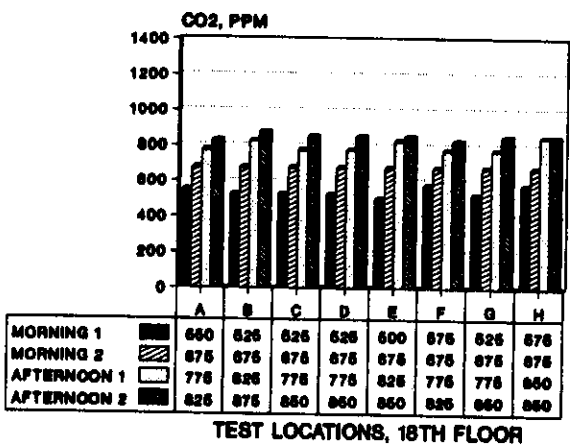
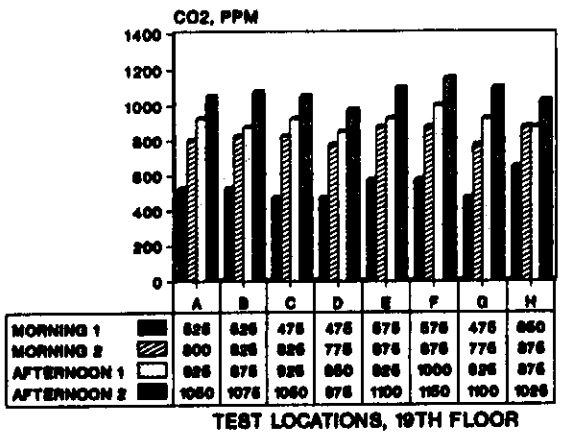
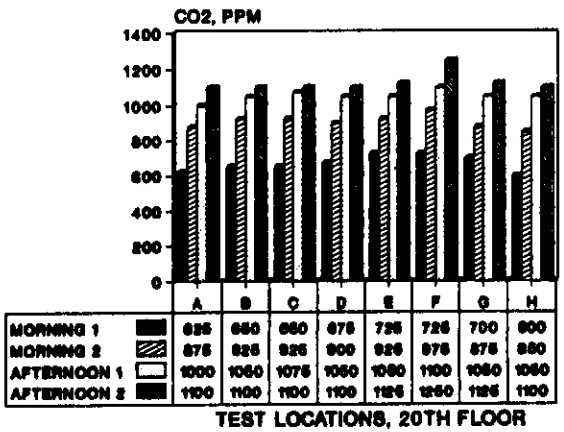


Figure 3

CO2 Concentrations - Toledo Municipal Building
HETA 89-065
March 20-23, 1989

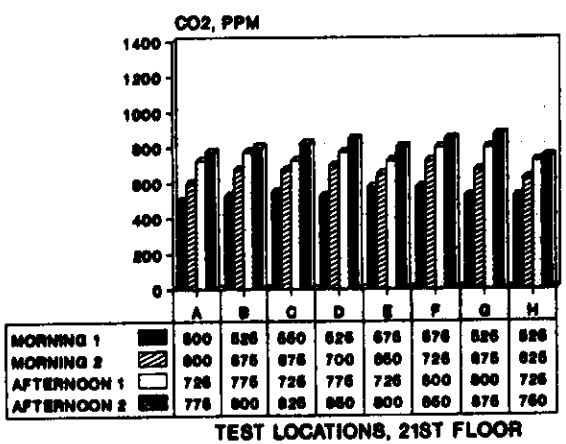


TEST LOCATIONS, 19TH FLOOR

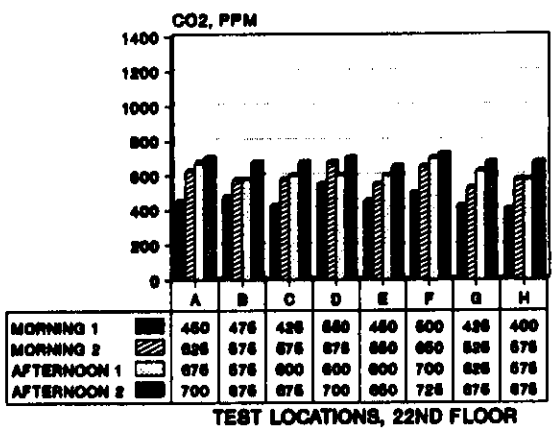


TEST LOCATIONS, 20TH FLOOR

Average CO2 Concentration Outside - 300 ppm



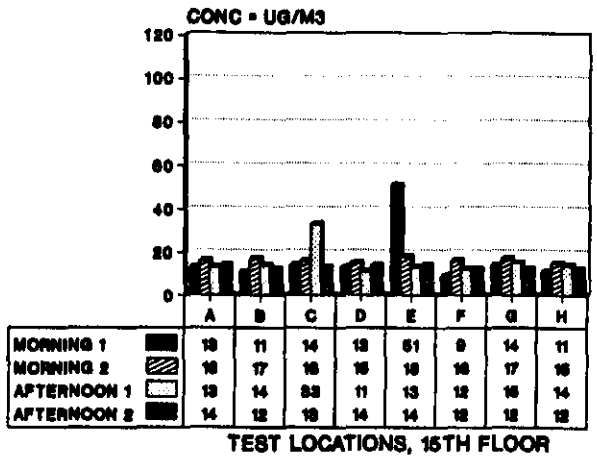
TEST LOCATIONS, 21ST FLOOR



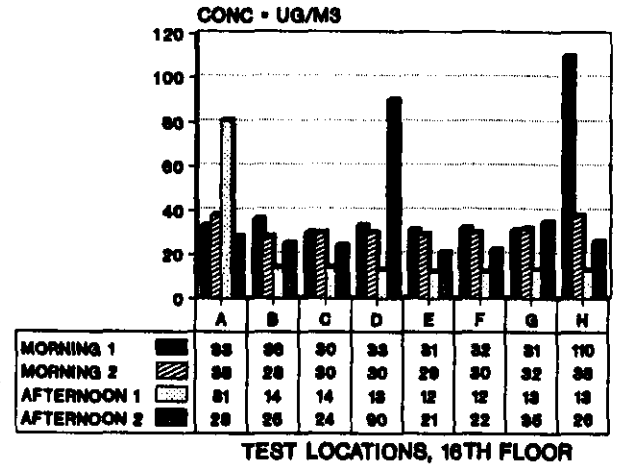
TEST LOCATIONS, 22ND FLOOR

Figure 4

Particulate Concentrations - Toledo Municipal Building
HETA 89-065
March 20-23, 1989

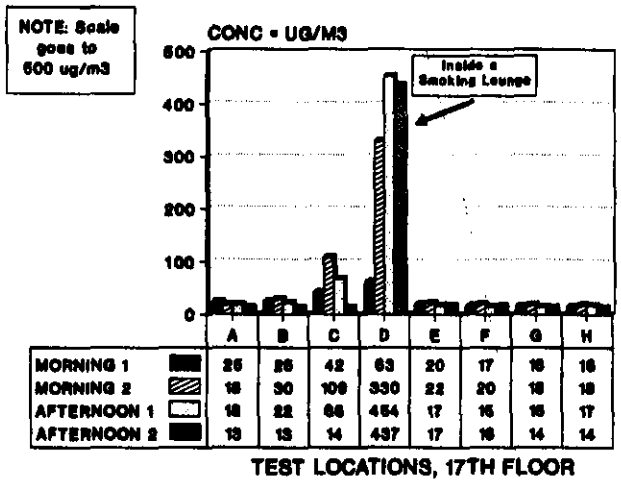


TEST LOCATIONS, 15TH FLOOR

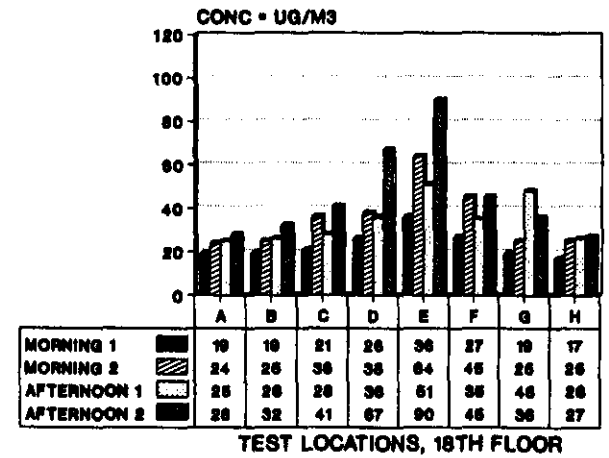


TEST LOCATIONS, 16TH FLOOR

Average Particulate Concentration Outside • 9 ug/M3

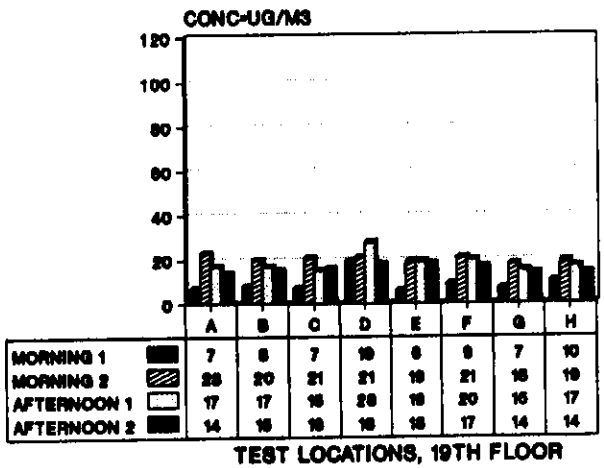


TEST LOCATIONS, 17TH FLOOR

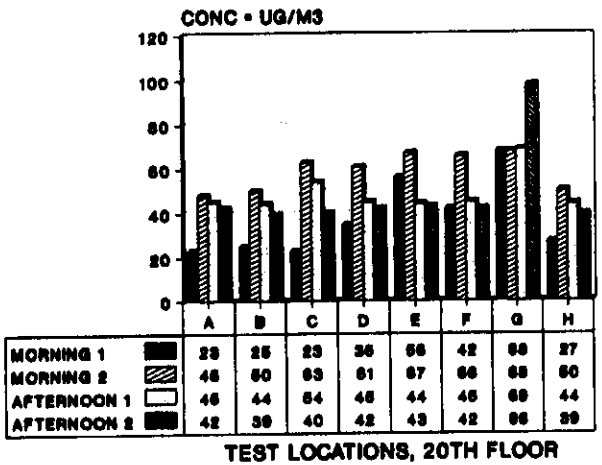


TEST LOCATIONS, 18TH FLOOR

Figure 5
Particulate Concentrations - Toledo Municipal Building
HETA 89-065
March 20-23, 1989

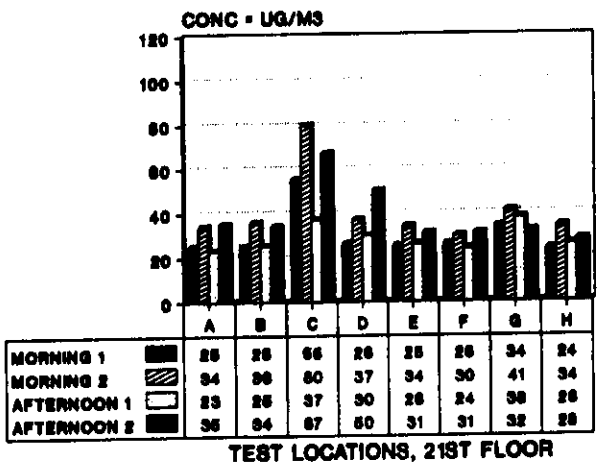


TEST LOCATIONS, 19TH FLOOR

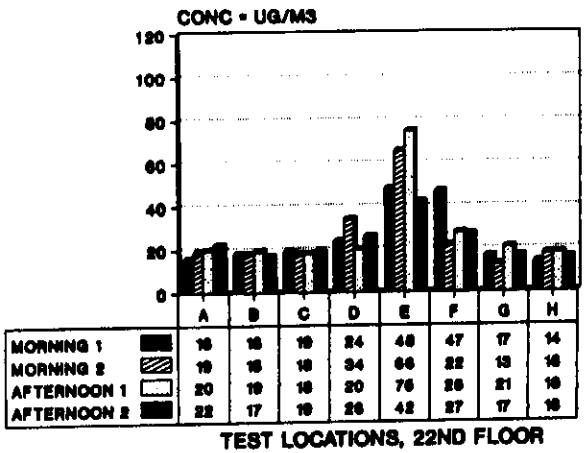


TEST LOCATIONS, 20TH FLOOR

Average Particulate Concentration Outside = 9 ug/M3

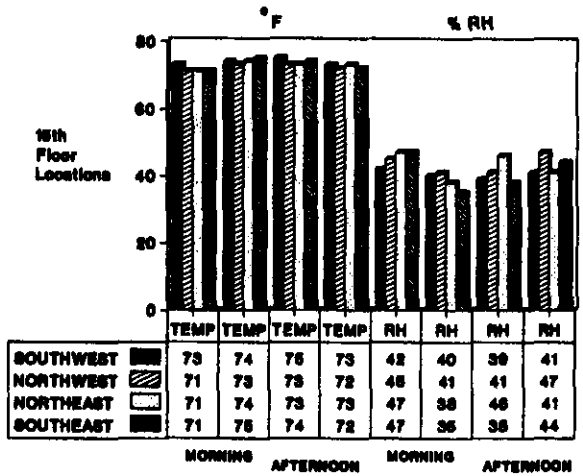


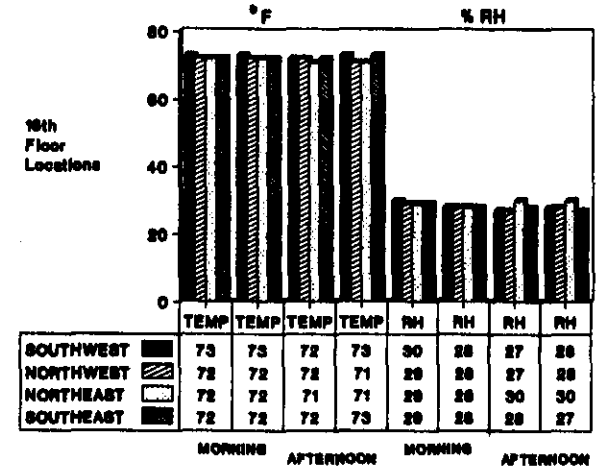
TEST LOCATIONS, 21ST FLOOR

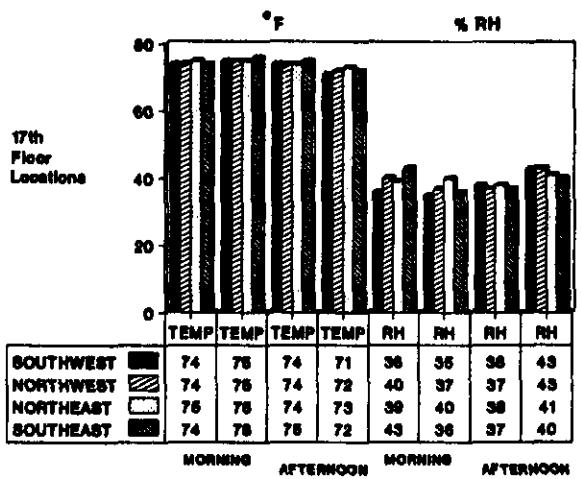


TEST LOCATIONS, 22ND FLOOR

Figure 6
Temperature and Relative Humidity Measurements
Toledo Municipal Building - HETA 89-065
March 20-23, 1989







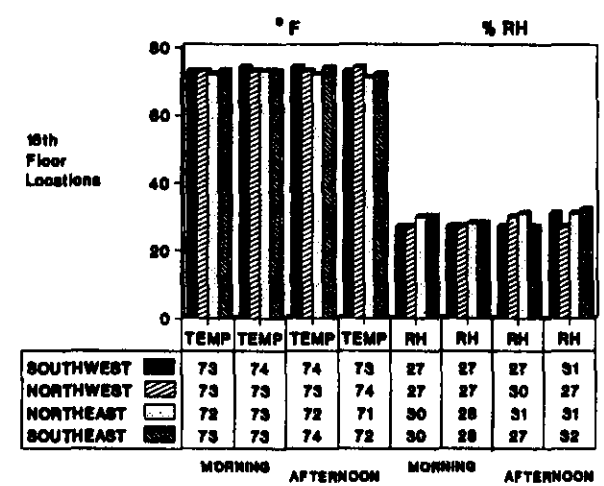


Figure 7
Temperature and Relative Humidity
Toledo Municipal Building - HETA 89-065
March 20-23, 1989