HEALTH HAZARD EVALUATION REPORT

HETA 92-176-2328
COE MANUFACTURING, INC.
PORTLAND, OREGON

PREFACE

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

The Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial hygiene technical and consultative assistance (TA) to federal, state, and local agencies; labor; industry; and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

Mention of company names or products does not constitute endorsement by the National Institute for Occupational Safety and Health.

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SUMMARY

On February 12, 1992, the National Institute for Occupational Safety and Health (NIOSH) received a request for a Health Hazard Evaluation from employees of Coe Manufacturing in Portland, Oregon. The request concerned illness believed to be associated with exposures in the office areas at the plant. On November 3-5, 1992, NIOSH investigators visited the facility.

The medical evaluation included interviews with employees and a questionnaire survey. Reported symptoms included nasal congestion, tiredness, aggravation of existing asthma, sinus disease, headache and irritated eyes. Employees reported numerous perceived problems with the office environment. These included cigarette smoke, "stale air," insufficient air, excessive glare on computer screens, variable temperatures, and ammonia odors from a blueprint copying machine and dirty air vents.

The environmental evaluation included a physical inspection of the heating, ventilating, and air-conditioning (HVAC) system; measurement of carbon dioxide (CO_2), temperature, and relative humidity (RH); flow hood measurements of the air supply and return to the HVAC system; and analysis of bulk samples from the HVAC system for microbial contamination.

Insufficient outside air to the occupied space was reflected by increasing CO_2 levels throughout the facility over the course of the day, reaching as high as 2200 parts per million (ppm) in some areas. NIOSH investigators determined that the fresh air damper on the ventilation system servicing the Engineering Department was closed and that the ventilation system was in a non-operational mode (the thermostat was not calling for heating or cooling) in the area with the highest $C0_2$ concentrations (Software Engineering Department). NIOSH investigators recommended that Coe Manufacturing institute a no smoking policy, clean and repair the HVAC system, and address ergonomic issues among employees at the plant including providing computer glare screens to employees.

Reported symptoms at COE Manufacturing may be related to deficiencies (i.e., insufficient outside air) in the ventilation system, the presence of tobacco smoke in the work area, and poor work station design. NIOSH investigators recommended that COE Manufacturing institute a no smoking policy, clean and repair the HVAC system, and address ergonomic issues among employees at the facility including computer glare screens for employees.

KEYWORDS: SIC 3553 (Woodworking Machinery), indoor environmental quality, carbon dioxide, fungi, bacteria, thermoactinomycetes, ventilation.

INTRODUCTION

On February 12, 1992, the National Institute for Occupational Safety and Health (NIOSH) received a request for a Health Hazard Evaluation from employees of Coe Manufacturing in Portland, Oregon. The request concerned illness believed to be associated with exposures in the office area. On November 3-5, 1992, NIOSH medical and industrial hygiene investigators visited the facility.

The Coe facility contains both a manufacturing area and offices. Coe manufactures equipment used in sawmills and in the manufacture of plywood products. Personnel in the office area are divided into engineering, sales, accounting and purchasing areas. The engineering division is divided between the first and second floors of the office areas, with the Software Engineering unit located on the 1st floor. The request was from employees in the engineering area, located on the second floor of the facility, directly above an electronics and machine shop. Other factory jobs include welding, painting, machine assembly, and machine testing.

INDUSTRIAL HYGIENE EVALUATION

METHODS AND MATERIALS

Direct measurements for temperature, humidity, and carbon dioxide (CO_2) were collected at each sample location for four rounds of sampling beginning at approximately 7:00 a.m., followed by subsequent sampling rounds at 10:00 a.m., 1:00 p.m., and 3:00 p.m. Carbon dioxide was measured using a Gastech RI 411 CO_2 monitor (Gastech, Inc., Newark, California) that was calibrated before and after the day's samples were collected using 800 parts per million (ppm) CO_2 in nitrogen (Alphagaz, Division of Liquid Air Corporation, Cambridge, Maryland) as a calibrant. Temperature and RH were measured using a Vaisala HM 34 temperature and humidity meter (Vaisala Oy, Helsinki, Finland). The volume rate of air flow (cubic feet per minute [cfm]) was measured at the supply air diffusers and exhausts using a Shortridge Airdata™ Multimeter/Flowhood ADM Model 860/8405 with an Electronic Micromanometer.

Bulk samples (analyzed for microbial content) were collected from interior locations in the air handling unit and supply duct. Specifically, sample sites included the interior duct linings before and after the fan, two samples from the interior duct lining at the first supply diffuser, and two samples of debris on the first supply air diffuser.

EVALUATION CRITERIA

NIOSH investigators have completed over 1100 investigations of the occupational indoor environment in a wide variety of non-industrial settings. The majority of these investigations have been conducted since 1979.

The symptoms and health complaints reported to NIOSH by building occupants have been diverse and usually not suggestive of any particular medical diagnosis or readily associated with a causative agent. A typical spectrum of symptoms has included headaches, unusual fatigue, varying degrees of itching or burning eyes, irritations of the skin, nasal congestion, dry or irritated throats and other respiratory irritations. Typically, the workplace environment has been implicated because workers report that their symptoms lessen or resolve when they leave the building.

A number of published studies have reported a high prevalence of symptoms among occupants of office buildings.[1,2,3,4,5] Scientists investigating indoor environmental problems believe that there are multiple factors contributing to building-related occupant complaints.[6,7] Among these factors are imprecisely-defined characteristics of heating, ventilating, and air-conditioning (HVAC) systems, cumulative effects of exposure to low concentrations of multiple chemical pollutants, odors, elevated concentrations of particulate matter, microbiological contamination, and physical factors such as thermal comfort, lighting, and noise.[8,9,10,11,12,13] Indoor environmental pollutants can arise from either outdoor sources or indoor sources.

There are also reports describing results which show that occupant perceptions of the indoor environment are more closely related than any measured indoor contaminant or condition to the occurrence of symptoms.[14,15,16] Some studies have shown relationships between psychological, social, and organizational factors in the workplace and the occurrence of symptoms and comfort complaints.[16,17,18,19] Less often, an illness may be found to be specifically related to something in the building environment. Some examples of potentially building-related illnesses are allergic rhinitis, allergic asthma, hypersensitivity pneumonitis, Legionnaires' disease, Pontiac fever, carbon monoxide poisoning, and reaction to boiler corrosion inhibitors. The first three conditions can be caused by various microorganisms or other organic material. Legionnaires' disease and Pontiac fever are caused by *Legionella* bacteria. Sources of carbon monoxide include vehicle exhaust and inadequately-ventilated kerosene heaters or other fuel-burning appliances. Exposure to boiler additives can occur if boiler steam is used for humidification or is released by accident.

Problems that NIOSH investigators have found in the non-industrial indoor environment have included: poor air quality due to ventilation system deficiencies, overcrowding, volatile organic chemicals from furnishings, emissions from office machines, structural components of the building and contents, tobacco smoke, microbiological contamination, and outside air pollutants; comfort problems due to improper temperature and relative humidity (RH) conditions, poor lighting, and unacceptable noise levels; adverse ergonomic conditions; and job-related psychosocial stressors. In most cases, however, these problems could not be directly linked to the reported health effects.

Standards specifically for the non-industrial indoor environment do not exist. NIOSH, the Occupational Safety and Health Administration (OSHA) and the American Conference of Governmental Industrial Hygienists (ACGIH) have published regulatory standards or recommended limits for occupational exposures.[20,21,22] With few exceptions, pollutant concentrations observed in non-industrial indoor environments fall well below these published occupational standards or recommended exposure limits. The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) has published recommended building ventilation design criteria and thermal comfort guidelines.[23,24] The ACGIH has also developed a manual of guidelines for approaching investigations of building-related complaints that might be caused by airborne living organisms or their effluents.[25]

Measurement of indoor environmental contaminants has rarely proved to be helpful in determining the cause of symptoms and complaints except where there are strong or unusual sources, or a proven relationship between contaminants and specific building-related illnesses. The low-level concentrations of particles and variable mixtures of organic materials usually found are difficult to interpret and usually impossible to causally link to observed and reported health symptoms. However, measuring ventilation and comfort indicators such as CO_2, temperature and RH, has proven useful in the early stages of an investigation in providing information relative to the proper functioning and control of HVAC systems.

NIOSH and the Environmental Protection Agency (EPA) jointly published a manual on building air quality, written to help prevent environmental problems in buildings and solve problems when they occur.[26] This manual suggests that indoor environmental quality (IEQ) is a constantly changing interaction of a complex set of factors. Four of the most important elements involved in the development of IEQ problems are: 1) a source of odors or contaminants; 2) a problem with the design or operation of the HVAC system; 3) a pathway between the contaminant source and the location of the complaint; 4) and the building occupants. A basic understanding of these factors is critical to preventing, investigating, and resolving IEQ problems.

The basis for measurements made during this evaluation are listed below.

CARBON DIOXIDE

Carbon dioxide (CO_2) is a normal constituent of exhaled breath and, if monitored, may be useful as a screening technique to evaluate whether adequate quantities of fresh air are being introduced into an occupied space. The ANSI/ASHRAE Standard 62-1989, Ventilation for Acceptable Indoor Air Quality, recommends outdoor air supply rates of 20 cubic feet per minute per person (cfm/person) for office spaces and conference rooms, 15 cfm/person for reception areas, and 60 cfm/person for smoking lounges, and provides estimated maximum occupancy figures for each area.[23]

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.

TEMPERATURE AND RELATIVE HUMIDITY

The perception of comfort is related to one's metabolic heat production, the transfer of heat to the environment, physiological adjustments, and body temperatures. Heat transfer from the body to the environment is influenced by factors such as temperature, humidity, air movement, personal activities, and clothing. ANSI/ASHRAE Standard 55-1981 specifies conditions in which 80% or more of the occupants would be expected to find the environment thermally comfortable.[24]

MICROBIOLOGICAL CONTAMINANTS

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

indoor levels are expected to be below the outdoor levels (depending on HVAC system filter efficiency) with consistently similar ranking among the microbial species.[27,28]

Some individuals manifest increased immunologic responses to antigenic agents encountered in the environment. These responses and the subsequent expression of allergic disease is based, partly, on a genetic predisposition.[29] Allergic diseases typically associated with exposures in indoor environments include allergic rhinitis (nasal allergy), allergic asthma, allergic bronchopulmonary aspergillosis (ABPA), and extrinsic allergic alveolitis (hypersensitivity pneumonitis).[27] Allergic respiratory diseases resulting from exposures to microbial agents have been documented in agricultural, biotechnology, office, and home environments.[30,31,32,33,34,35,36,37]

Symptoms vary with the type of allergic disease: (1) allergic rhinitis is characterized by paroxysms of sneezing; itching of the nose, eyes, palate, or pharynx; nasal stuffiness with partial or total airflow obstruction; rhinorrhea with postnasal drainage; (2) allergic asthma is characterized by episodic or prolonged wheezing and shortness of breath due to bronchial narrowing; (3) ABPA is characterized by the production of IgE and IgG antibodies with symptoms of cough, lassitude, low grade fever, wheezing, and occasional expectoration of mucous.[27,38] Heavy exposures to airborne microorganisms can result in an acute form of extrinsic allergic alveolitis which is characterized by chills, fever, malaise, cough, and dyspnea (shortness of breath) appearing 4 to 8 hours after exposure. Onset of the chronic form of extrinsic allergic alveolitis is thought to be induced by a continuous low-level exposure, and onset occurs without chills, fever, or malaise but is characterized by progressive shortness of breath with weight loss.[39]

Acceptable levels of airborne microorganisms have not been established, primarily due to the varying immunogenic susceptibilities of individuals. Relationships between health effects and environmental microorganisms must be determined through the combined contributions of medical, epidemiologic, and environmental evaluation.[25] The current strategy for environmental evaluation involves a comprehensive inspection of the building to identify sources of microbial contamination and routes of dissemination. In those locations where contamination is visibly evident or suspected, bulk samples may be collected to identify the predominant species (fungi, bacteria, and thermoactinomycetes).

RESULTS

ENVIRONMENTAL

A single HVAC unit conditions the air in the Engineering Department; the unit is located on the roof directly above the ceiling. At the time of the survey, the fresh air dampers to the unit were closed thereby providing 100% recirculated air to the occupied space. A physical inspection of the unit did not reveal any visible evidence that would indicate a microbial contamination source: the filters appeared free of debris accumulation; the interior unit insulation was in good shape; and the heating/cooling coils, and the area directly beneath, were absent of standing water and/or "slime." The sound insulation lining the interior of the return air ducts appeared soiled, probably as a result of cigarette smoke residue and low efficiency filters in the HVAC unit. Smoke tubes were used to document the air flow patterns into the Engineering Department; the room was under negative pressure (air flow into the room) relative to other areas of the plant. The flow of air into the room may entrain chemical contaminants from the industrial areas of the building (i.e., the machine shop located next to the Engineering Department). In addition, one of the exhaust stacks from the machine shop was located approximately five feet from the fresh air intakes of the HVAC unit servicing the engineering offices. The proximity of the exhaust stack to the fresh air intake could result in the re-entrainment of cutting oil mists, welding fumes, solvent vapors, and/or other chemical agents emanating from machine shop operations.

The analytical results of bulk samples are presented in Table 1. All of the fungal taxa identified are normal constituents of the environment. The concentrations observed (ranging from 1500 to 112,500 CFU/gm) indicate the presence of small reservoirs of fungi but their existence may be more indicative of sedimentation from "normal" outdoor/indoor sources as opposed to flourishing fungal cultures. The predominance of yeast colonies in every bulk sample is characteristic of the presence of moisture - which is not unexpected considering the local climatic conditions in Portland, Oregon. The predominance of TA's (bacterial concentrations ranged from 1500 to 37,500 CFU/gm) may be the direct result of contributions from industrial areas of the plant, i.e., wood

Table 1

Microbiological Results of Bulk Samples

Sample Location	Fungi (CFU/gm)	Fungi Taxa Rank	Bacteria (CFU/gm)	Bacteria Taxa Rank
Duct lining before fan	4000	Yea>Pen=Alt=Asp	2000	TA=Cur
Duct lining after fan	1600	Yea>Pen	1600	TA
Duct lining behind Diffuser 1 - # 1	2000	Yea	2400	TA
Duct lining behind Diffuser 1 - # 2	1500	Yea	1500	TA>Bb
Debris on Diffuser # 1	25,600	Yea>Pen=Alt>Asp	7000	TA
Debris on Diffuser # 2	112,500	Yea>Cla>Pen=Alt=Asp=Epi	37,500	Bc>>TA

NOTE: Yea = Yeast
Pen = *Penicillium*
Cla = *Cladosporium*
Alt = *Alternaria*
Asp = *Aspergillus*
Epi = *Epicoccum*
TA = *Thermoactinomyces*
Cur = *Curtobacterium*
Bb = *Bacillus brevis*
Bc = *Bacillus coagulans*
ND = non-detectable

working operations. Although, there are no established criteria regarding "acceptable" concentrations of fungi and/or bacteria in ventilation system interiors, the concentrations observed do not indicate that there is a significant problem with regard to microbiological contamination.

The results of air flow measurements in the Engineering Department are presented in Figure 1. The measured air flow values are presented in the cubic feet per minute (cfm); the design air flow values are presented under the measured values in parentheses. Sample sites for CO_2, temperature, and humidity measurements are presented as starred locations. The measured air flow values conformed to the design specifications with the exception of the diffuser at sample location #2, the four diffusers at the end of the supply duct next to sample location #6, the diffuser on the opposite side of the duct from sample location #10, and the diffuser into the blue print storage vault (#8). The unbalanced nature of the system, however slight, will affect the perceived comfort of certain individuals in the occupied space (i.e., select occupants complained of too much air flow while others complained of too little air flow, both conditions correlated with the balance of the system). The return air vents for the HVAC unit are located directly above the segregated area for tobacco smoking employees. Slight adjustments to the diffusers can correct the system imbalance.

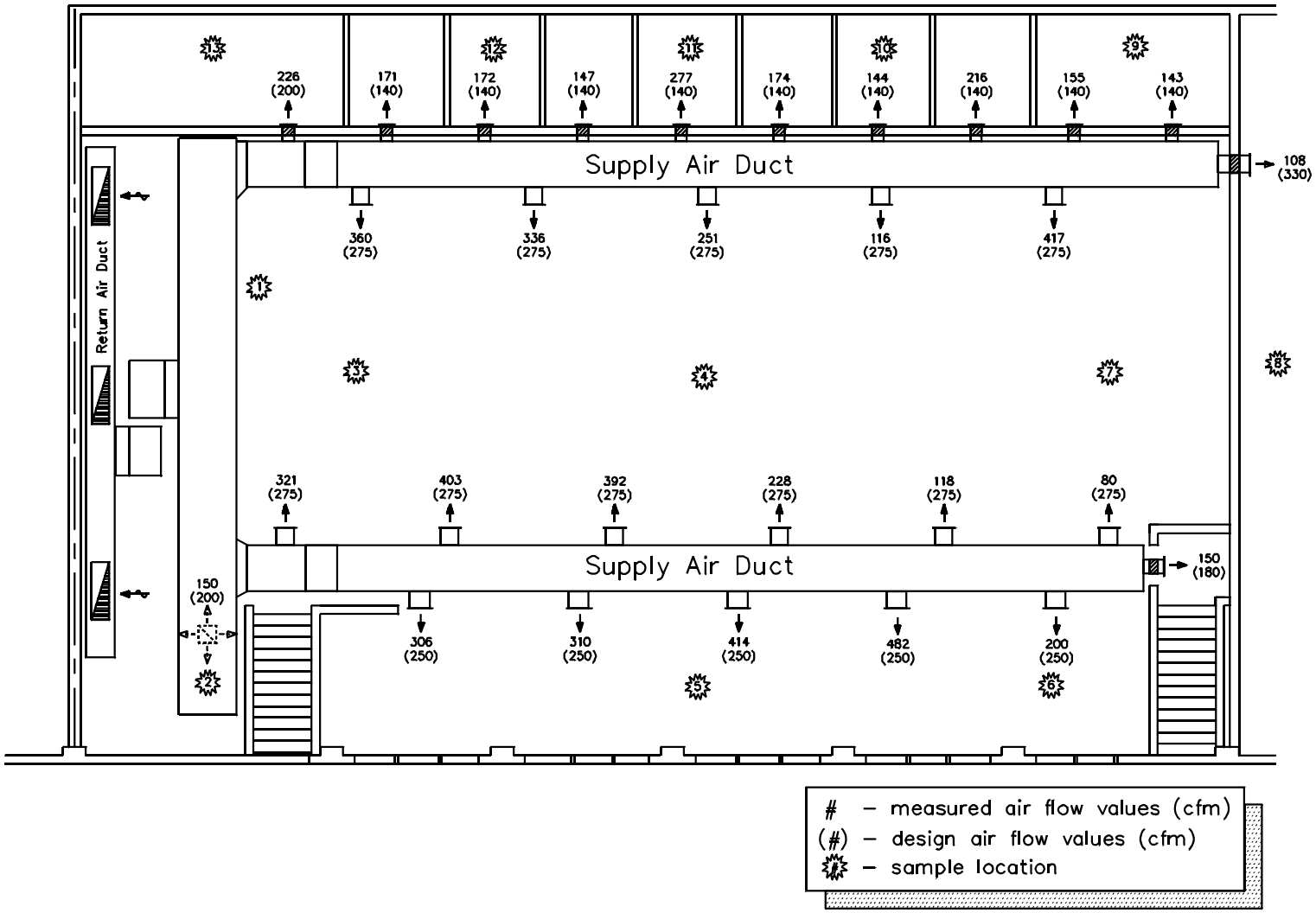

Figure 1. Engineering Department Floor Plan (with sample locations and flow hood measurements)

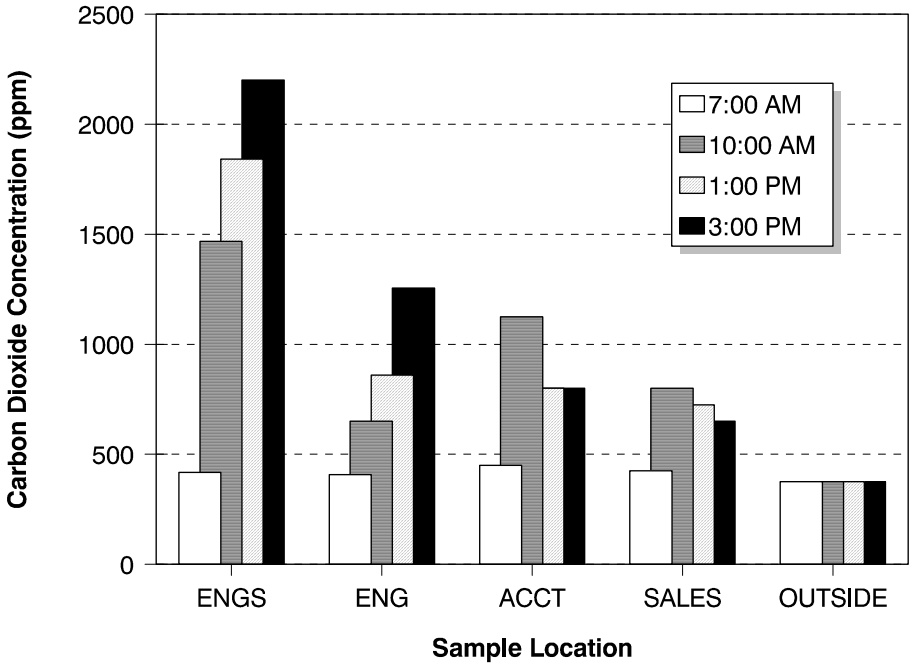

Figure 2 Mean Carbon Dioxide Concentrations at Various Locations

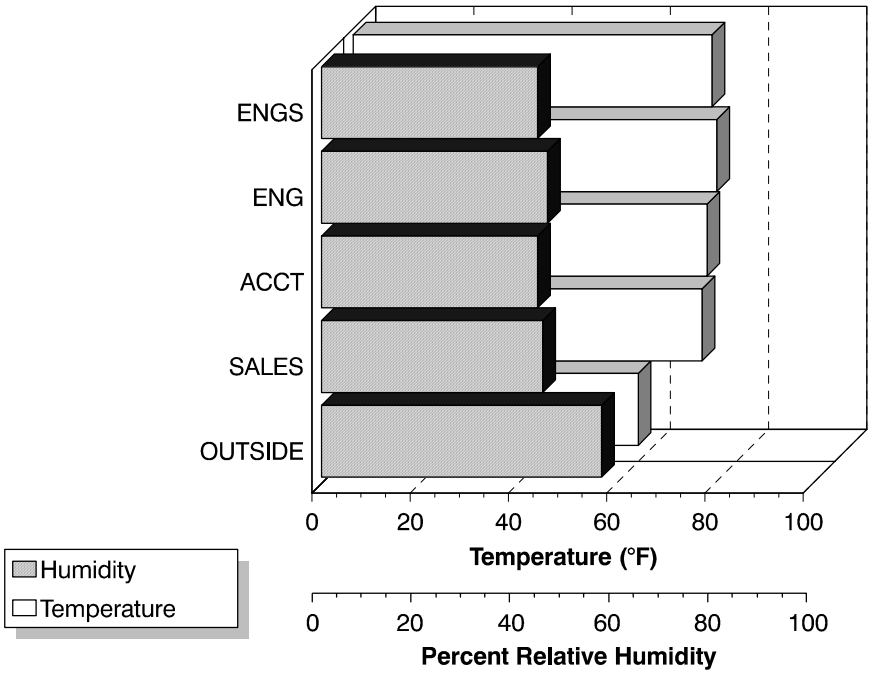

Figure 3. Mean Temperature and Humidity Concentrations at Various Locations

Air flow measurements were not conducted in the Software Engineering Department because the system was not operating at the time of the survey.

The effects of the closed fresh air damper for the HVAC unit servicing the Engineering Department were apparent in the CO_2 concentrations observed (refer to Figure 2). The mean CO_2 concentrations (ENG in Figure 2) ranged from 410 ppm at 7:00 a.m. to 1260 ppm at 3:00 p.m. The 3:00 p.m. concentration was above the ASHRAE recommended limit of 1000 ppm.[24] Three of the mean CO_2 concentrations (during the 10:00 a.m., 1:00 p.m. and 3:00 p.m. measurements) in the Software Engineering Department (ENGS in Figure 2) were above the ASHRAE recommended limit of 1000 ppm. Investigation into the cause revealed that the HVAC system servicing the Software Engineering Department offices only operates based on a "request" from the thermostat controlling that zone. Management explained that the unit only operates when the thermostat calls for conditioned (heat or cooling) air to the occupied space. This type of system will not be capable of meeting the ASHRAE recommendation of 20 cfm/person of outdoor air on a continuous basis.

Measurements of the Accounting Department revealed one time period, the 10:00 a.m. sample, when the mean CO_2 concentration was above the ASHRAE limit. Measurements collected in the Sales Department and outside had mean CO_2 concentrations below the ASHRAE limit. The results of monitoring for temperature and humidity are graphically presented in Figure 3. The mean temperature measurements ranged from 58°F at the sampling location outside of the building to 74°F in the Engineering Department. The mean RH measurements ranged from 44% in the Software Engineering and Accounting Departments to 57% at the outside sampling location. The temperature and RH mean values were very stable with standard deviations not greater than 2°F (Engineering Department) and 5% (outside sampling location), respectively. The indoor temperatures and RHs are within the limits recommended in the ASHRAE thermal comfort chart (Figure 4). This chart specifies the acceptable (at least 80% would be expected to feel thermally comfortable) ranges of operative temperature and humidity for persons clothed in typical summer and winter clothing, performing mainly sedentary activity.[24]

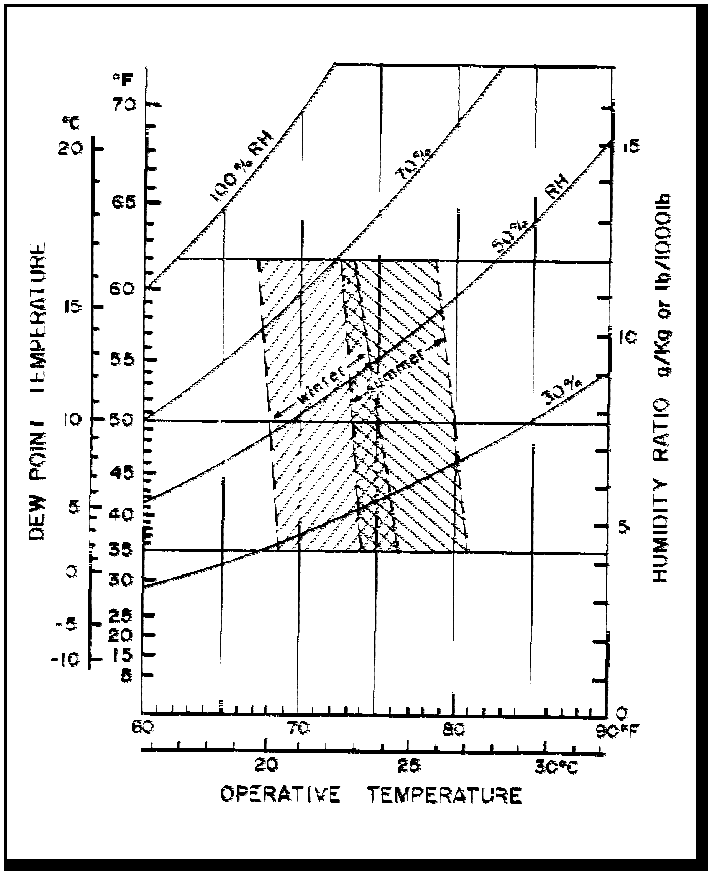

Figure 4. ASHRAE Thermal Comfort Chart

MEDICAL EVALUATION

METHODS

The medical evaluation consisted of interviews with employees and administration of a questionnaire. A questionnaire was administered to all office employees working in the accounting, sales, and engineering divisions of the company. Every employee present at work on November 4, 1992, was given a questionnaire at their workstation and asked to complete it during the day. NIOSH investigators were available on the

floor to answer any questions and assist the employees. The questionnaire was placed in sealed envelopes and collected at the end of the day. A copy of the questionnaire is in the Appendix.

RESULTS

INTERVIEWS

Twelve interviews were conducted with employees who had notified NIOSH investigators that they wished to talk with them. During the course of the interviews, employees reported numerous environmental deficiencies and symptoms that they felt were related to the workplace. These deficiencies included variable temperatures, stale air, cigarette smoke odors, and excessive dust in the workplace. Reported symptoms included sinus infections, sinus polyps requiring surgery, stuffed nose, cough and burning eyes.

QUESTIONNAIRE

Sixty-eight questionnaires were distributed and 66 were returned for a participation rate of 97%. Location of the respondents is given in Table 2.

Employees were asked whether they had experienced symptoms while working in the building "every day," "1-3 days in the last week," "1-3 days in the last 4 weeks" or "not in the last 4 weeks." For the purpose of thedetermining prevalence rates, a positive response for the given symptom combined the responses "almost every day" and "1-3 days in the last week." A missing response on the questionnaire table concerning symptoms was considered a negative response. The most prevalent symptoms (with a

Table 2
Work Location of Respondents to Questionnaire

Location	Frequency	Percent
accounting	6	9
sales	15	23
engineering-1st floor	11	17
engineering-2nd floor	34	52

prevalence rate greater than 10%) included headache, eye irritation, nose/sinus problems, strained eyes, dry throat, and tiredness/fatigue. Results are given in Table 3.

Table 3
Reported Symptoms

Symptom	Percent reporting symptom "frequently" at work	Percent reporting symptom on day questionnaire was administered	Percent of employees reporting symptom "frequently" who improve away from work
dry, itching or	24	24	66
headache	17	18	67
tiredness/fatigue	24	9	62
nose/sinus problems	18	15	52
strained eyes	24	19	69
dry throat	14	8	52

Employees were questioned about their perceptions of various environmental conditions on their floor. Reported environmental deficiencies in the building included too little air movement, detecting cigarette smoke, thermal discomfort, and odors. Results of the questions concerning these workplace conditions are given in Table 4.

A similar percentage of employees experienced the work site as being too cold as experienced it being too hot, both "frequently" and on the day the questionnaire was administered (see Table 5 and 6). The data were analyzed by work area (accounting, engineering [1st or 2nd floor] and sales) to determine if differences in perceived temperature of one area was responsible for this finding. These data are presented in Table 5 and 6. Reports of employees being too hot or too cold did not appear to be related to one specific work area. This may be due to individual locations in the work area having markedly different conditions than others, possibly due to

Table 4

Perceived Environmental Conditions

Condition	Percent reporting condition	Percent reporting condition today
too much air movement	9	8
too little air movement	38	34
too hot	22	15
too cold	21	15
too humid	3	3
too dry	12	13
detect tobacco smoke	57	41
detect chemical odors	8	6
detect other odors	19	12

proximity to windows or ventilation ducts or because of improper balance of the HVAC system. The ASHRAE guideline is designed to maintain comfort for 80% of employees.[24] However, the engineering area (2nd floor) and the accounting area had more than 20% of the employees reporting thermal discomfort.

Table 5

Thermal Discomfort By Work Area Over The Last 4 Weeks
% of Employees

Area	Percent Reporting too hot at work	Percent Reporting too cold at work	Percent Reporting Both too hot and too cold at Work	Total percent of employees reporting thermal discomfort at work
accounting	17	33	0	50
sales	7	7	0	14
software engineering-1st	9	0	9	18
engineering-2nd floor	12	9	18	39

Questionnaire data were analyzed with regards to symptom prevalence in the various work locations (Table 7). Employees working in the Engineering Department on the second floor and the Engineering Department on the first floor tended to have higher symptom prevalence than those employees working in other areas. These differences were not statistically significant, but there were few employees in some locations. Employees in the second floor engineering office had the highest prevalence of nose/sinus problems, tiredness/fatigue and dry/irritated eyes. Employees in the first floor engineering office had the highest prevalence of headache and strained eyes.

Table 6

Thermal Discomfort By Work Area On Day Questionnaire Was Administered (11/4/92)
% of Employees

Area	Percent reporting too hot on day questionnaire was administered	Percent reporting too cold on day questionnaire was administered	Percent reporting both too hot and too cold on day questionnaire was administered	Total reporting thermal discomfort on day questionnaire was administered
Accounting	17	17	0	33
Sales	7	7	0	13
Software engineering-1st	0	9	9	18
engineering-2nd floor	12	9	9	30

Table 7

Prevalence of Symptoms by Work Location

	Dry, irritated eyes	Tiredness/ fatigue	Headache	Nose/sinus problems	Strained eyes	Dry throat
Accounting	33	17	0	17	0	33
Engineering-2nd	35	35	15	27	33	15
Sales	7	0	13	0	7	7
Software	9	27	36	18	36	9

Tobacco smoking was allowed in the office areas, and tobacco odors were a common complaint among interviewed employees. The office consisted of open partitions, and smoke was able to travel between partitions. Management had attempted to segregate smoking employees on one side of the floor but employees reportedly walked around the floor carrying lit cigarettes and it was not uncommon to have a smoking employee sitting next to a non-smoking one. Eighteen percent of the employees currently smoke. There was a difference between the location of the work area and reporting of tobacco smoke odors; 62% of employees in the Engineering Department (2nd floor) reported smelling tobacco smoke every day, while only 15% of employees in engineering (1st floor) and 12% of employees in accounting and sales reported smelling tobacco smoke. Employees who reported that they were sensitive to tobacco smoke were more likely to smell it in their environment ($p=0.0006$), and were more likely to report having headaches ($p=0.026$) and nose and sinus problems ($p=0.008$).

Employees who detected tobacco smoke at their work area reported statistically significantly-increased prevalence of nose/sinus problems, dry/irritated eyes, headache, tiredness/fatigue, and strained eyes. Dry throat and sinus infection prevalences were elevated among employees smelling cigarette smoke although the differences were not statistically significant. The data are presented in Table 8.

Table 8

Prevalence Rates Related to Detection of Tobacco Smoke

Symptom	% of Employees Who Detected Tobacco Smoke Frequently at Work and Reported Symptom	% of Employees Who Did Not Detect Tobacco Smoke at Work and Reported Symptom
tiredness/fatigue	39	7
headache	28	3
dry/irritated eyes	39	7
nose/sinus problems	30	3
strained eyes	39	7
dry throat	19	7
sinus infection	34	20

Deficiencies in ergonomic design of employee workstations were noted by NIOSH investigators. To reduce glare from sunlight and overhead fluorescent lights, employees taped home-made cardboard hoods to their terminals. No window shades or blinds were available to block the sun. Since the office faced east, the problem with the sun was most acute in the morning. Computer desks were not adjustable and wrist rests were not provided to most of the employees. The high percentage of employees reporting eye strain, tiredness, fatigue and headache is consistent with poor workstation design. Eye strain was reported more frequently in the Engineering Department (2nd floor), where 18.8% of the employees reported experiencing eye strain every day, compared with 0% experiencing eye strain every day in other work areas. Although NIOSH investigators did not do a formal ergonomic analysis, the Engineering Department (2nd floor) was the work area where the homemade cardboard glare screens were observed.

CONCLUSION

Measured deficiencies in the indoor environment were noted at Coe Manufacturing that may be related to both symptoms and comfort complaints. Carbon dioxide levels in excess of ASHRAE recommendations were observed at numerous locations in the building, indicating a lack of fresh air in the facility. Inspection of the HVAC unit servicing the Engineering Department revealed closed fresh air dampers. This resulted in the Engineering Department being under negative pressure with respect to industrial areas of the building with the possibility that factory emissions could enter the office workspace. The HVAC unit servicing the Software Engineering Department was not operational at the time of the survey. Both the Engineering Department and the Software Engineering Department tended to increased symptom prevalence compared to other areas. In addition, smoking in the office environment may have been related to some of the symptoms and comfort complaints.

RECOMMENDATIONS

1. Coe Manufacturing should institute a smoking policy that provides a smoke free environment for all employees. This recommendation is in accordance with NIOSH guidelines which recommend a smoke free environment in the workplace. Reports from the Surgeon General and the National Research Council (NRC) 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.[40,41,42,43,44,45] NIOSH has concluded that ETS may be related to an increased risk of lung cancer and possibly heart disease in occupationally-exposed workers who do not smoke themselves.[46]

   If smoking is permitted in the building, it should be restricted to designated smoking areas. These areas should be provided with a *dedicated exhaust system* (room air directly exhausting to the outside), an arrangement which eliminates the possibility of re-entrainment and recirculation of any secondary cigarette smoke. In addition, *the smoking area should be under negative pressure relative 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. This air can also be obtained from the surrounding spaces (transfer air) if it is relatively uncontaminated, that is, does not contain pollutants from production areas.

2. The fresh air damper providing fresh air to the Engineering Department should be opened sufficiently to provide a minimum of 20 cfm per employee, in accordance with ASHRAE guidelines.

3. The HVAC system air-handling units should not be turned off while employees are working in the building. Specifically, this includes modification to the HVAC system that serves the Software Engineering offices. The modification should entail a continuous supply of outside air; the thermostat should only be responsible to the treatment of the air (i.e., heating or cooling) and not the operation of the fan.

4. The preventive maintenance program for the HVAC systems should be re-evaluated to assure proper cleanliness and operation.

5. Shades on the windows and glare screens on computers should be installed to relieve eyestrain among employees who work on computers.

6. Wrist rests and adjustable desks should be provided to employees working on computers to prevent the development of musculo-skeletal injury and cumulative trauma disorders.

7. Local exhaust ventilation should be provided to the ammonia-based blue-print copying machine that sits in the middle of the work floor or the machine should be re-located to a site that will not expose employees to the volatiles. In addition, an exhaust system should be installed in the blue-print vault room to remove residual odors from stored blue-prints.

8. Communication between management and employees should be increased to facilitate the exchange of concerns about environmental conditions at the building. Employees should be made aware of the problems with the building and decisions made by management to address those problems.

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November, 1992

APPENDIX

NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH

INDOOR AIR QUALITY AND WORK ENVIRONMENT

SYMPTOMS SURVEY

THE COE MANUFACTURING COMPANY SURVEY - PORTLAND, OREGON (HE 92-176)

The National Institute for Occupational Safety and Health (NIOSH) is part of the United States Public Health Service and the division of the Centers for Disease Control (CDC) that is concerned with workplace health and safety. We are here at the request of the employees, to evaluate the environment of your workplace and any possible health concerns. Measurements of a variety of environmental conditions are being taken in your work area throughout the day.

To help determine how these measurements relate to your comfort and health, please complete the attached questionnaire. Your participation in this part of the evaluation of this building is voluntary, but very important. Your completed questionnaire will be collected and analyzed by NIOSH investigators and your responses WILL NOT BE SEEN BY MANAGEMENT OR UNION REPRESENTATIVES.

We would prefer you place your name on the questionnaire in the event further questions or follow-up may be necessary. HOWEVER, THIS IS OPTIONAL ON YOUR PART.

After completing the questionnaire, please place and seal it in the attached envelope and place the envelope in a prominent spot on your desk and it will be collected from you, or return it to a study investigator.

YOUR FULL NAME-Optional (Please Print):_____

"BY COMPLETING THIS QUESTIONNAIRE, I INDICATE MY CONSENT TO PARTICIPATE IN THIS STUDY. I UNDERSTAND CONFIDENTIALITY WILL BE MAINTAINED."

THANK YOU FOR YOUR PARTICIPATION IN THIS STUDY.

NIOSH INDOOR ENVIRONMENTAL QUALITY SURVEY
(HETA 92-166)

I.D. Number _ _ _ _ (1-4)
Location Code _ _ _ _ (5-8)
(leave blank)

Today's Date: _____/_____/_____ (9-14)

This survey is being conducted to determine the environmental quality of your office building. This questionnaire asks about how you think your office environment affects you. Please answer the questions as accurately and completely as you can, regardless of how satisfied or dissatisfied you are with conditions in the office.

ALL OF YOUR ANSWERS WILL BE TREATED IN THE STRICTEST CONFIDENCE.

I. WORKPLACE INFORMATION

1. How long have you worked *in this BUILDING*?

_ _ years _ _ months (15-18)

2. How long have you worked at your *PRESENT LOCATION* in the building?

_ _ years _ _ months (19-22)

3. On average, how many hours per week do you work *in this building*?

_ _ hours per week (23-24)

4. On what floor do you work?

_ _ floor (25-26)

5. Which best describes the space in which your current workstation is located?

1_ Private office
2_ Open space with partitions
3_ Open space without partitions
4_ Other (specify) _____ (27)

6. How many people work in the room in which your workstation is located (including yourself)?

1_ one
2_ two to five
3_ six to ten
4_ eleven or more
(28)

7. How long, per day, do you work with a computer or word processor?

_ _ hours _ _ minutes per day (29-32)

II. INFORMATION ABOUT HEALTH AND WELL-BEING

1. Have you ever been *TOLD BY A DOCTOR* that you have or had any of the following?

	YES (1)	NO (2)	
Migraine			(33)
Asthma			(34)
Eczema			(35)
Hay fever			(36)
Allergy to dust			(37)
Allergy to molds			(38)
Sinus infections			(39)

2. Do you consider yourself more sensitive than most people to the presence of tobacco smoke?

1__ Yes (40)
2__ No

3. Do you consider yourself more sensitive than most people to the presence of chemicals in your work environment (e.g., fumes from office machines, carpets)?

1__ Yes (41)
2__ No

4. What is your tobacco smoking status?

1__ never smoked (42)
2__ former smoker
3__ current smoker

5. What type of corrective lenses do you usually wear at work?

1__ none (43)
2__ glasses
3__ contact lenses
4__ both (glasses and contacts)

6. How old were you on your last birthday?

__ __ years (44-45)

7. Are you:

1__ male (46)
2__ female

During the **LAST FOUR WEEKS YOU WERE AT WORK**, how often have you experienced each of the following symptoms while working **in this building**? Check **only one** column for each symptom.					During the **LAST FOUR WEEKS YOU WERE AT WORK**, what happened to this symptom at times when you were away from work? (eg, holidays, weekends) Check **only one** column for each symptom.			While at work **TODAY**, did you experience this symptom?	
SYMPTOMS	Not in Last 4 Weeks (1)	1-3 days in last 4 weeks (2)	1-3 days *per wk* in last 4 wks (3)	Every or Almost Every Workday (4)	Got Worse (1)	Stayed Same (2)	Got Better (3)	**YES** (1)	**NO** (2)
dry, itching, or irritated eyes									(47-49)
wheezing									(50-52)
headache									(53-55)
sore throat									(56-58)
unusual tiredness, fatigue, or drowsiness									(59-61)
chest tightness									(62-64)
stuffy or runny nose, or sinus congestion									(65-67)
cough									(68-70)
tired or strained eyes									(71-73)
difficulty remembering things or concentrating									(74-76)
dry throat									(77-79)
dizziness or lightheadedness									(80-82)
shortness of breath									(83-85)
sneezing									(86-88)

III. DESCRIPTION OF WORKPLACE CONDITIONS

During the **LAST FOUR WEEKS YOU WERE AT WORK**, how often have you experienced each of the following environmental conditions while working in this building? Check **only one** column for each symptom.					**TODAY**, while working at your usual workstation, did you experience this environmental condition?		
CONDITIONS	**Not in Last 4 Weeks (1)**	**1-3 days in last 4 weeks (2)**	**1-3 days *per wk* in last 4 wks (3)**	**Every or Almost Every Workday (4)**	**YES (1)**	**NO (2)**	
too much air movement							(89-90)
too little air movement							(91-92)
temperature too hot							(93-94)
temperature too cold							(95-96)
air too humid							(97-98)
air too dry							(99-100)
tobacco smoke odors							(101-102)
chemical odors (e.g., paint, cleaning fluids, etc.)							(103-104)
other unpleasant odors (e.g.. body odor, food odor, perfume)							(105-106)