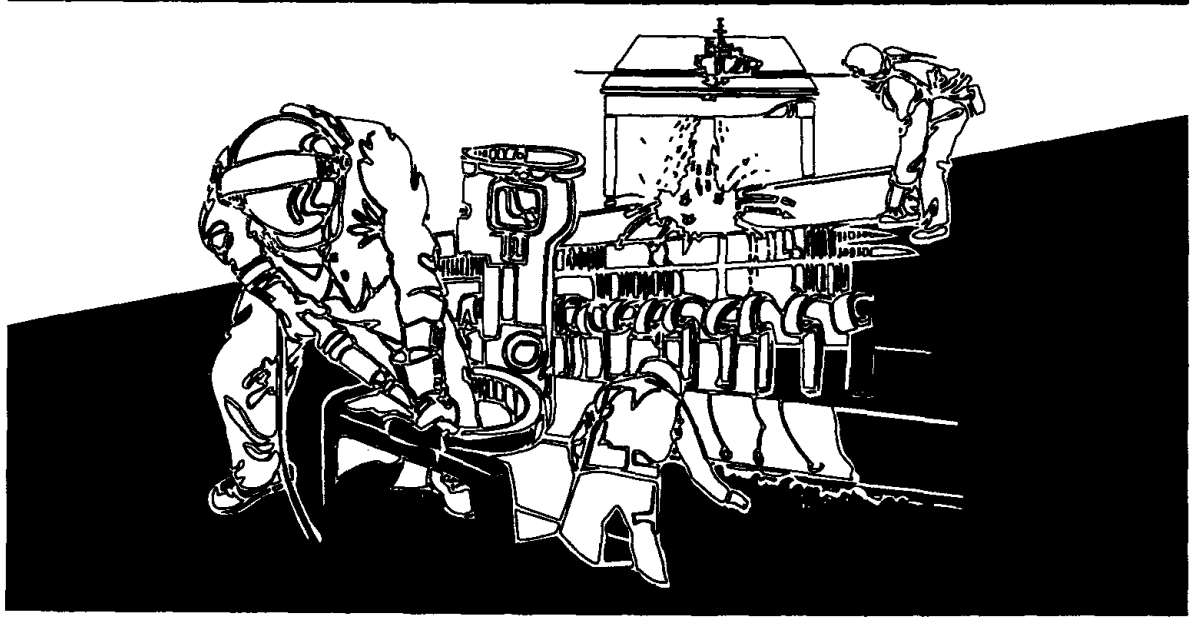
CDC
CENTERS FOR DISEASE CONTROL AND PREVENTION

NIOSH HEALTH HAZARD EVALUATION REPORT

HETA 92-217-2300
INTERNAL REVENUE SERVICE OFFICE
FLINT, MICHIGAN



U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

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.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

HETA 92-217-2300
INTERNAL REVENUE SERVICE OFFICE
FLINT, MICHIGAN
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I. SUMMARY

On October 29-30, 1992, industrial hygienists from the National Institute for Occupational Safety and Health (NIOSH) conducted a health hazard evaluation (HHE) at the Internal Revenue Service (IRS) Office in Flint, Michigan, in response to a National Treasury Employees Union request to evaluate indoor environmental quality concerns.

On October 30, temperature, relative humidity, carbon dioxide (CO_2), and particle count measurements were made throughout the office area three times during the day. The heating, ventilating, and air-conditioning (HVAC) unit that serviced the office areas was opened and visually examined. Questionnaires were distributed to the 28 employees present in the office during the site visit to obtain information regarding employees' symptoms and perceptions of the building environment.

All of the indoor CO_2 concentrations (range: 375 to 775 ppm) were lower than 1000 parts per million (ppm), a guideline suggested by American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE). The temperature (71 to 76°F) and relative humidity (34 to 40%) measurements were within seasonal limits suggested by ASHRAE. Inside particle counts inside ranged from approximately 119,000 to 558,000 particles per 0.1 cubic foot (ft^3) of air in the greater than or equal to ($\geq$) 0.3 micron range as compared to particle counts outside which ranged from approximately 95,000 to 176,000 particles per 0.1 ft^3 of air in the $\geq$ 0.3 micron range. A visual inspection found evidence of microbial growth in the lined condensate pan of the HVAC unit. The coils and filters appeared to be well maintained. The below ground outside air intakes were located adjacent to a parking lot; a potential source of vehicle exhaust. Smoking was allowed in a storage area which was part of the recirculating HVAC system that served the entire basement area.

All twenty-eight questionnaires were returned and analyzed. The most common environmental concerns were temperature extremes, lack of humidity, and lack of air movement. The four most frequently self-reported symptoms were stuffy or runny nose, or sinus congestion; tired or strained eyes; unusual tiredness, fatigue or drowsiness; and dry, itching, or irritated eyes.

Environmental tobacco smoke (ETS) was identified as a health hazard in this building. The HVAC system inspection showed evidence of microbial growth in the lined condensate pan and the potential for entrainment of vehicle exhaust into the ventilation system. Recommendations for improving the work environment and eliminating ETS in the workplace can be found in Section VIII of this report.

Keywords: SIC 9311 (Public Finance, Taxation, and Monetary Policy), indoor environmental quality, IEQ, carbon dioxide, temperature, relative humidity, environmental tobacco smoke, ETS, microbial growth.

II. INTRODUCTION

On October 29-30, 1992, industrial hygienists from the National Institute for Occupational Safety and Health (NIOSH) conducted a health hazard evaluation (HHE) at the Internal Revenue Service (IRS) Office in Flint, Michigan. This site visit was made in response to a request from the National Treasury Employees Union (NTEU) to evaluate indoor environmental quality (IEQ) concerns. The request indicated that employees were experiencing sinus problems, cold-like symptoms, and headaches which the workers associated with the worksite.

III. BACKGROUND

The IRS offices are located in the basement of the Federal Building in Flint, Michigan. The brick building is 2 stories high with a full basement and was completed in 1930. Approximately 44 individuals are employed in the IRS offices.

The HVAC system serving the IRS area is located in the southwest quadrant of the basement. The HVAC system was installed in the early 1960s. The ventilation system is a constant air volume system. According to the facility manager, the HVAC system was balanced in October 1992 to meet ventilation guidelines recommended by ASHRAE. These guidelines specify outside air requirements of 20 cubic feet per minute (cfm) per person for office spaces.[1]

The HVAC system operates in the following manner. Outside air intakes are located below the first floor and adjacent to a parking lot. The outside air is mixed with the return air from the basement area. The return air is brought back to the HVAC system either through return ducting (as evident in the taxpayer service area) or through the hallways which act as a return air plenum for offices located adjacent to the hallways. The mixed air is filtered through the use of pleated, oil coated, fiberglass roll-type filters rated at 35% efficiency. These filters are reportedly changed out on a quarterly basis. Based on the temperature requirements of the basement offices, the air is either heated using a boiler or cooled using chiller water. The air is not humidified prior to being supply ducted throughout the basement.

In addition, convection heaters are used along the north face of the basement to provide additional heating. Additional heating is necessary due to the lack of insulation on the north wall. These heaters recondition the air supplied by the main HVAC system. Smoking was allowed in a storage area which had a particulate air cleaner ("smoke eater") and was part of the recirculating HVAC system that served the entire basement area.

IV. EVALUATION DESIGN

To evaluate thermal comfort, real-time temperature, and relative humidity measurements were made using a LCD Digital Hygrometer (Cole-Parmer Instrument Co.). Real-time carbon dioxide (CO_2) levels were measured using a Gastech Model RI-411A, portable CO_2 meter. Particle counts were collected using a Met One, Inc. Model 227 hand-held particle counter to qualitatively determine the presence of small particles in the different areas of the office for comparison between each area and the outside. To solicit information about IEQ issues, questionnaires were given out to all members of the staff and management present at the time of the site visit.

Temperature, relative humidity, particulate, and CO_2 measurements were made at 14 locations (13 inside and 1 outside) three times during the day of the site visit to determine changes in these parameters throughout the day. The outdoor measurements were taken near the north entrance. A diagram of the IRS office areas showing the 14 sample locations is included as Figure 1. Measurements were made at each location between 8:16-9:00 a.m. (beginning of the workshift), 1:10-2:08 p.m., and 3:22-3:55 p.m. (near the end of the workday).

With the assistance of maintenance personnel, the HVAC unit which served the basement area was opened and visually examined for microbial contamination, standing water, position of outside air intake dampers, general cleanliness, and particulate filter condition.

V. 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 high prevalences of symptoms among occupants of office buildings.[2-6] Scientists investigating indoor environmental problems believe that there are multiple factors contributing to building-related occupant complaints.[7,8] Among these factors are imprecisely defined characteristics

of 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.[9-14] 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 to the occurrence of symptoms than any measured indoor contaminant or condition.[15-17] Some studies have shown relationships between psychological, social, and organizational factors in the workplace and the occurrence of symptoms and comfort complaints.[17-20]

Less often, an illness may be found to be specifically related to something in the building environment. Some examples of potentially building-related illnesses are allergic rhinitis, allergic asthma, hypersensitivity pneumonitis, Legionnaires' disease, Pontiac fever, carbon monoxide poisoning, and reaction to boiler corrosion inhibitors. The first three conditions can be caused by various microorganisms or other organic material. Legionnaires' disease and Pontiac fever are caused by *Legionella* bacteria. Sources of carbon monoxide include vehicle exhaust and inadequately ventilated kerosene heaters or other fuel-burning appliances. Exposure to boiler additives can occur if boiler steam is used for humidification or is released by accident.

Problems NIOSH investigators have found in the non-industrial indoor environment have included poor air quality due to ventilation system deficiencies, overcrowding, volatile organic chemicals from furnishings, 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 conditions, poor lighting, and unacceptable noise levels; adverse ergonomic conditions; and job-related psychosocial stressors. In most cases, however, these problems could not be directly linked to the reported health effects.

Standards specifically for the non-industrial indoor environment do not exist. NIOSH, the Occupational Safety and Health Administration (OSHA) and the American Conference of Governmental Industrial Hygienists (ACGIH) have published regulatory standards or recommended limits for occupational exposures.[21-23] With few exceptions, pollutant concentrations observed in non-industrial indoor environments fall well below these published occupational standards or recommended exposure limits. The ASHRAE has published recommended building ventilation design criteria and thermal comfort guidelines.[1,24] 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 carbon dioxide (CO_2), temperature, and relative humidity, 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 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 outside 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.[1]

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 levels of 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 (see Figure 2).[24]

VI. RESULTS

A. Environmental

1. Measurements

The results of the environmental measurements are presented in Table 1. Indoor CO_2 concentrations ranged from 375 to 775 ppm. The outdoor CO_2 concentration was 350 ppm throughout the day. Indoor temperatures ranged from 71 to 76°F across all areas measured throughout the day. Outside temperatures were 49 to 57°F. Inside relative humidities ranged from 34 to 40% and outside relative humidities ranged from 48 to 58%. Particle counts inside ranged from approximately 112,000 to 558,000 particles per 0.1 cubic foot (ft^3) of air in the $\geq$ 0.3 micron range and outside particle counts outside ranged from approximately 95,000 to 176,000 particles per 0.1 ft^3 of air in the $\geq$ 0.3 micron range.

All of the indoor CO_2 concentrations were lower than 1000 ppm, a guideline suggested by ASHRAE.[1] The temperature and relative humidity measurements were within the acceptable ranges of operative temperature and humidity suggested by ASHRAE, as shown in Figure 2.[24] In general, acceptable winter temperature and relative humidities are 68.5°F-76.0°F at 30%-40% relative humidity. The temperature and relative humidity remained stable during the workday in the office areas.

The particle counts were highest in the area where smoking was allowed. The particle counts were similar inside and outside the building, except in the area where smoking was allowed and in the adjoining spaces. Higher particle counts are typically found in smoking areas. During the walk-through, it was observed that the return air intake for the hallway was located directly outside the smoking area. This return intake was part of

the recirculating system, creating the potential for smoke to be recirculated throughout the basement.

2. HVAC Inspection

The HVAC system was opened and visually examined. The outside air intakes were located below street level, directly adjacent to a parking lot. The potential for vehicle exhausts to become entrained into the outside air supply was apparent, especially for vehicles idling close to the outside air intakes. The filtration system was examined and appeared to be in good condition. There was no evidence of excess particulate buildup or air by-passing the filters. Some of the return grill work in the doors adjacent to the hallway had been blocked.

The condensate collection pans were also examined. Although the cooling system was not operating during the survey, there were signs of standing water accumulation. A foam material was used on the inside of the condensate collection pans, possibly to prevent corrosion of the metal and condensation from occurring outside of the HVAC system. The foam material was pitted and generally in poor condition. Microbial growth on the foam was evident from the visual inspection.

B. Questionnaires

All 28 questionnaires (100%) were returned and analyzed. The average age of the respondents was 44 years (range: 25-62). The population was 39% male (11/28) and 61% female (17/28). Twelve individuals (43%) had never smoked; eleven (39%) were former smokers; and five (18%) were current smokers. Twenty individuals (71%) wore glasses and/or contacts. Eleven individuals (39%) considered themselves to be sensitive to the presence of tobacco smoke.

A list of the self-reported symptoms that were perceived to be related to the building in the four weeks prior to the survey are given in Table 2. The most frequently reported symptoms were: stuffy or runny nose, or sinus congestion (20/28-71%); tired or strained eyes (20/28-71%); unusual tiredness, fatigue or drowsiness (18/28-64%); dry, itching, or irritated eyes (17/28-61%), headache (16/28-57%); and difficulty remembering things or concentrating (15/28-54%). One individual reported that her stuffy nose/sinus congestion, chest tightness, dry throat and shortness of breath symptoms had worsened in the last four weeks. The other respondents reported that their symptoms either stayed the same or improved during the four-week time frame.

On the day of the survey, the following symptoms were reported by the respondents (Table 3): stuffy or runny nose, or sinus congestion (14/28-50%); unusual tiredness, fatigue, or drowsiness (12/28-43%); dry, itching, or irritated eyes (11/28-39%); tired or strained eyes (10/28-36%); difficulty remembering things or concentrating (7/28-25%); headache (6/28-21%); and dry throat (9/28-15%).

Occupant perceptions of environmental conditions over the past four weeks were solicited (Table 4). The most common problems reported were: too little air movement (23/28-82%); air too dry (21/28-75%); temperature too cold (18/28-64%); and temperature too hot (18/28-64%). Photocopiers, laser printers, and facsimile (FAX) machines were frequently used by staff. Some employees (7/28-25%) reported some remodeling had been done in the last three months as well as water damage.

VII. DISCUSSION/CONCLUSIONS

Environmental tobacco smoke (ETS) was identified as a health hazard at this facility. Smoking was allowed in a storage area in the basement which was located next to a return for the recirculating HVAC system. NIOSH considers ETS to be a potential occupational carcinogen and recommends exposure be reduced to the lowest feasible concentration, either by eliminating smoking or restricting it to dedicated rooms ventilated directly to the outside. Recent epidemiologic studies have found that ETS can cause lung cancer and suggest a possible association between ETS and an increased risk of heart disease in non-smokers.[27]

All of the indoor CO_2 concentrations were lower than 1000 parts per million (ppm), a guideline suggested by ASHRAE. The CO_2 measurements suggested that the work areas were receiving adequate amounts of outside air on the day of the survey. The temperature and relative humidity levels during the site visit were within acceptable ranges of operative temperature and humidity suggested by ASHRAE.

Higher qualitative particle counts were obtained in the smoking area and surrounding offices. The HVAC system that was examined showed signs of microbiological contamination in the lined condensate pan but no standing water since the cooling system was not operating at the time of the survey. The filters and coils appeared to be well maintained.

Despite the fact that environmental measurements were within ASHRAE criteria on the day of the investigation, symptoms were reported by 50% of the occupants present. The most common occupant concerns regarding indoor environmental quality were temperature extremes, lack of humidity, and lack of air movement.

The four most frequently self-reported symptoms were stuffy or runny nose, or sinus congestion; tired or strained eyes; unusual tiredness, fatigue or drowsiness; and dry, itching, or irritated eyes.

VIII. RECOMMENDATIONS

1. Smoking should not be allowed in the work environment. If that is not possible, a separate smoking area should be designed to meet the current ASHRAE guidelines of negative pressure to the rest of the building, 60 cfm of supply air per person, and direct exhaust to the outside to prevent smoke from entering the ventilation system.[1] Suggestions to eliminate or restrict smoking in the workplace are found in the NIOSH "Current Intelligence Bulletin 54: Environmental Tobacco Smoke in the Workplace: Lung Cancer and Other Health Effects."[27]

2. To prevent microbial growth in the HVAC system condensate pan, the fiber lining should be removed and the condensate pan relined with an anticorrosive paint. The condensate pan angle should be increased to provide better drainage.

3. To prevent entrainment of vehicle exhausts into the outside air intakes, they should be relocated to at least 10 feet above the ground. If that is not possible, a policy of no idling on that side of the building should be implemented and no cars should be allowed to park next to the outside air intakes. No parking signs should be posted.

4. To improve air flow to the hallway return plenum, the material covering the grill work in doors should be removed.

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1. IRS Office, Federal Building, Flint, Michigan
2. National Treasury Employees Union
3. GSA Office, Federal Building, Flint, Michigan
4. OSHA, Region V

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

Table 1

Indoor Air Quality Data
IRS Office
Flint, Michigan
October 30, 1992

HETA 92-217

Location	Time	CO_2 (ppm)	Temp (°F)	RH (%)	Particle Count ($\geq$ 0.3 μm)*	No. of Occupants
Basement:						
Smoking Area-1	8:16	525	73	36	558000	0
	1:10	625	75	38	187000	1
	3:22	675	76	37	504000	1
Individual	8:20	400	71	34	379000	1
Office - 2	1:13	575	74	38	151000	1
	3:40	650	74	39	158000	1
Hallway - 3	8:23	375	71	35	262000	0
	1:16	600	73	39	134000	0
	3:24	575	74	39	263000	0
Criminal	8:25	525	71	37	139000	2
Investigation-	1:35	625	75	38	117000	0
Secretarial Area-4	3:35	725	74	40	146000	3
Criminal	8:26	475	71	37	128000	1
Investigation	1:37	600	74	38	125000	1
Section - 5	3:38	675	73	40	150000	0
Appeals	8:32	425	72	36	156000	0
Section-	1:45	575	72	40	147000	0
Secretarial Area-6	3:28	650	73	40	158000	0
Appeals Section	8:34	500	71	37	141000	1
Attorney's	1:47	575	72	40	146000	0
Office - 7	3:29	775	73	40	153000	0
Taxpayer	8:37	450	72	36	295000	0
Services-	1:51	650	74	39	129000	3
Reception Area-8	3:43	675	75	39	141000	4
Taxpayer	8:42	475	74	35	240000	1
Services	1:53	675	76	37	123000	1
Office - 9	3:46	650	76	38	125000	0
Taxpayer Services	8:44	475	74	35	144000	3
Collection and	1:56	625	76	37	123000	3
Exam Area-North-10	3:49	675	76	37	124000	2
Taxpayer Services	8:47	500	76	34	163000	2
Collection and	2:01	625	76	37	117000	2
Exam Area-South-11	3:50	675	76	38	112000	2
Taxpayer Services	8:51	475	75	34	279000	1
Public	2:08	625	76	37	112000	4
Relations - 12	3:45	675	76	38	130000	3
Break Area - 13	8:55	475	75	36	220000	2
	2:05	650	76	38	119000	0
	3:52	750	76	39	127000	1
Outside - 14	9:00	350	49	48	95000	0
North Side of	1:40	350	57	53	176000	0
Building	3:55	350	51	58	145000	0

* - μm - microns per 0.1 cubic foot of air

Table 2

Building-Related Symptoms
IRS Offices, Federal Building
Flint, Michigan

October 30, 1992

HETA 92-217

Symptoms	Experienced in the Past 4 Weeks
Tired or Strained Eyes	20 (71%)
Stuffy or Runny Nose, or Sinus Congestion	20 (71%)
Unusual Tiredness, Fatigue, or Drowsiness	18 (64%)
Dry, Itching, or Irritated Eyes	17 (61%)
Headache	16 (57%)
Difficulty Remembering Things or Concentrating	15 (54%)
Dry Throat	12 (43%)
Sore Throat	12 (43%)
Cough	11 (39%)
Dizziness or Lightheadedness	7 (25%)
Shortness of Breath	6 (21%)
Chest Tightness	2 (7%)
Wheezing	2 (7%)

Table 3

Building-Related Symptoms
IRS Offices, Federal Building
Flint, Michigan

October 30, 1992

HETA 92-217

Symptoms	Experienced in the Past 4 Weeks
Stuffy or Runny Nose, or Sinus Congestion	14 (50%)
Unusual Tiredness, Fatigue, or Drowsiness	12 (43%)
Dry, Itching, or Irritated Eyes	11 (39%)
Tired or Strained Eyes	10 (36%)
Dry Throat	9 (32%)
Difficulty Remembering Things or Concentrating	7 (25%)
Headache	6 (21%)
Cough	4 (14%)
Sore Throat	4 (14%)
Dizziness or Lightheadedness	3 (11%)
Shortness of Breath	2 (7%)
Chest Tightness	1 (4%)
Wheezing	0

Table 4

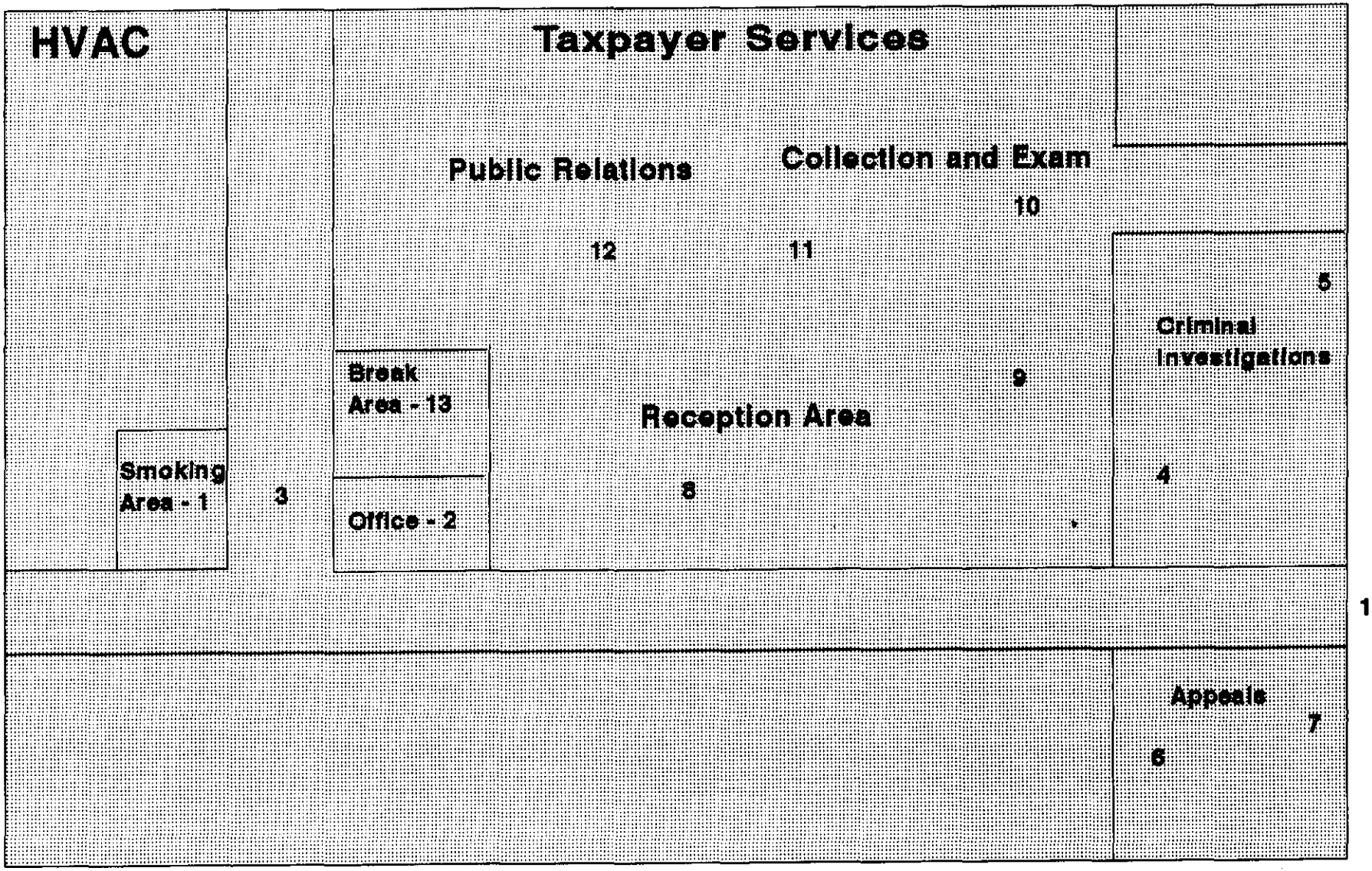
Workplace Conditions
IRS Offices, Federal Building
Flint, Michigan

October 30, 1992

HETA 92-217

Workplace Conditions	Experienced in the Past 4 Weeks
Too little air movement	23 (82%)
Air too dry	21 (75%)
Temperature too cold	18 (64%)
Temperature too hot	18 (64%)
Other unpleasant odors	11 (39%)
Chemical odors	9 (32%)
Tobacco smoke odors	9 (32%)
Too much air movement	9 (32%)
Air too humid	2 (7%)

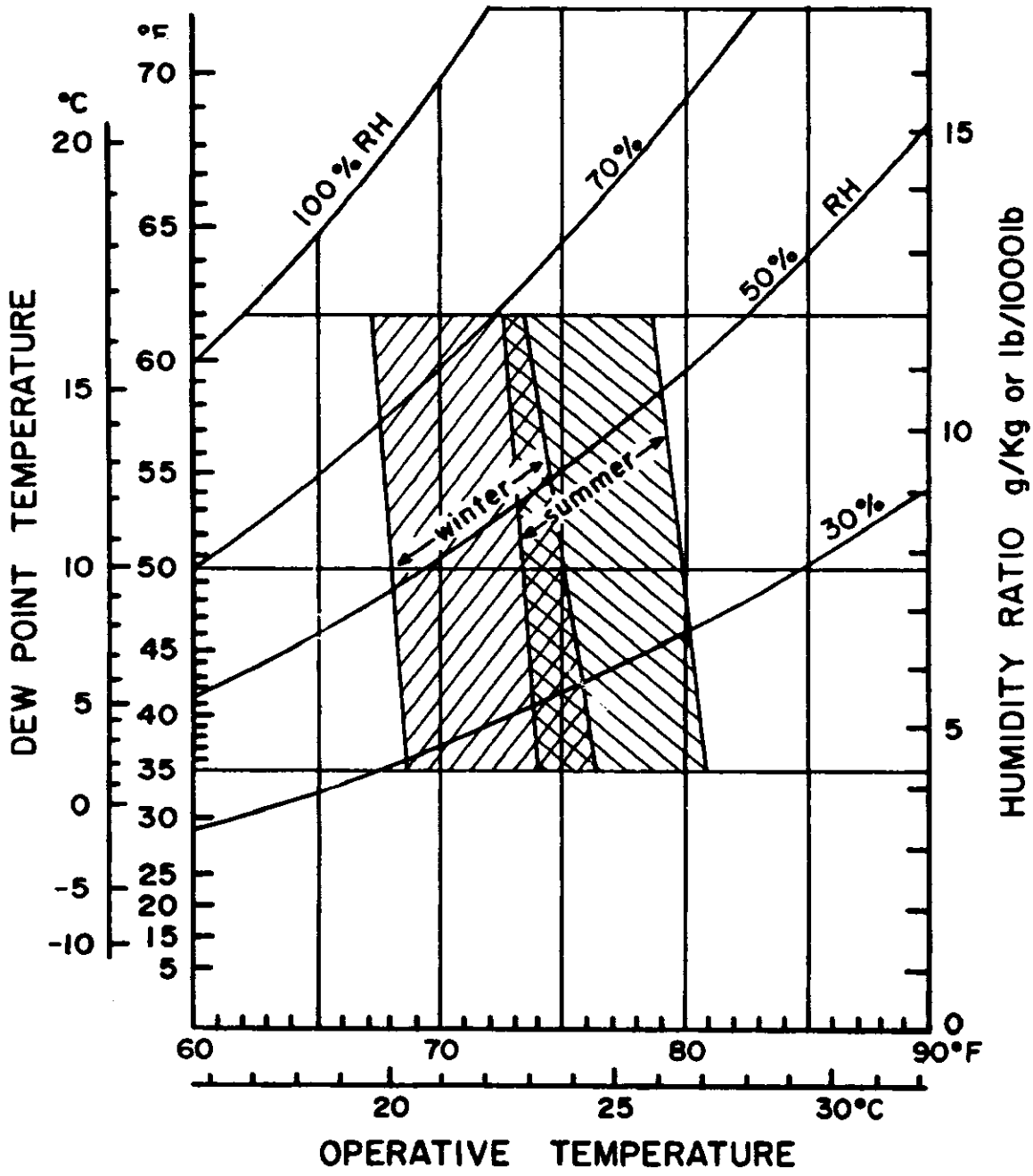
Figure 1
IRS Offices Flint, MI
HETA 92-217



Sample Sites

Figure 2

IRS Offices
Flint, MI
HETA 92-217



Acceptable ranges of operative temperature and humidity for persons clothed in typical summer and winter clothing, at light, mainly sedentary, activity.

Figure courtesy of the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), Thermal Environmental Conditions for Human Occupancy (55-1981).