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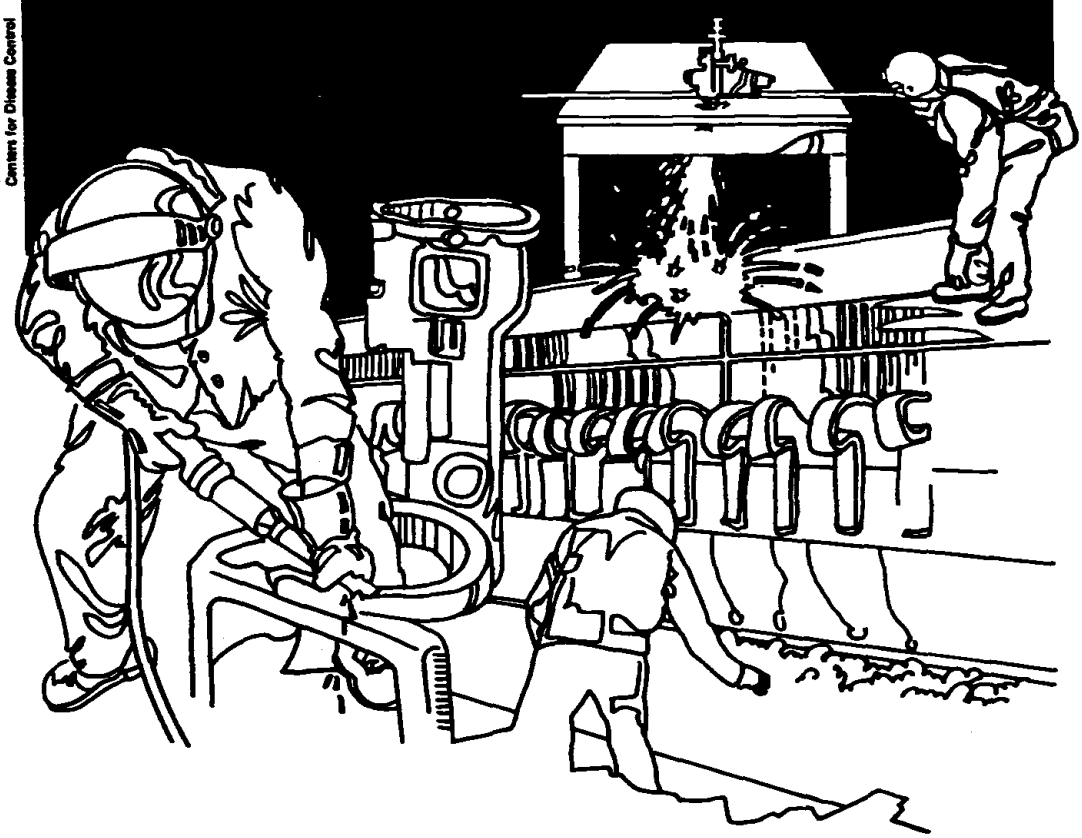

Health Hazard Evaluation Report

HETA 90-376-2106
U.S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
HATO REY, PUERTO RICO

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.

HAZARD EVALUATION AND TECHNICAL ASSISTANCE REPORT
HETA 90-376-2106
U.S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
HATO REY, PUERTO RICO
APRIL 1991

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SUMMARY

A health hazard evaluation (HHE) was conducted by the National Institute for Occupational Safety and Health (NIOSH) at the Caribbean Area Office of the U.S. Department of Housing and Urban Development (HUD) on December 11-12, 1990. Interviews with 16 HUD employees revealed the major complaints to be irritation from tobacco smoke and cold temperatures. Reviews of medical records for cases of asthma and pneumonia did not support a work-related cause for these illnesses, but did suggest that these conditions could be exacerbated by cold temperatures and exposure to tobacco smoke at work.

Environmental data tended to support employee concerns regarding cold temperatures, as measurements indicated temperature and humidity combinations falling outside of, or at the far ends of the ranges of temperature and humidity recommended by the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE). High relative humidity was measured on the second and third floors (63-71%), and ventilation deficiencies were observed which could promote microbial growth. Recommendations to correct the noted ventilation deficiencies and to prevent moisture incursion into the occupied space and within the air conditioning system are made in the Recommendations section of the report. Recommendations are also made to restrict smoking in occupied areas.

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

INTRODUCTION

On December 11-12, 1990, the National Institute for Occupational Safety and Health (NIOSH) conducted a health hazard evaluation (HHE) at the U.S. Department of Housing and Urban Development (HUD), Caribbean Area Office, Hato Rey, Puerto Rico. This evaluation was conducted in response to a joint request submitted by HUD management and the American Federation of Government Employees. The request concerned respiratory problems, pneumonia, allergies, and fungal growth on office walls, thought to be related to poor indoor air quality.

This report summarizes the activities, observations, and findings from the NIOSH evaluation, and comprises the final report of our investigation. Preliminary findings and recommendations were made at the closing meeting which was held with union and management representatives on December 12, 1990.

BACKGROUND

Employees have reported health concerns regarding the building since occupancy in November, 1986. At that time, floors 1-3 were completed; however floors 4-6 were still under construction. Although the number of health concerns has apparently decreased since construction was completed, employees remain concerned about the indoor air quality and its possible contribution to respiratory illnesses.

At the request of HUD management, the Occupational Safety and Health Administration (OSHA) conducted a consultation survey on December 16, 1989. The survey included an inspection of the ventilation system and the measurement of carbon dioxide (CO_2) concentrations and relative humidity (RH) in several work areas on the second and third floors. Additionally, air sampling was conducted for microbial contaminants (predominantly fungi) using an Andersen ambient air sampler. In a report dated August 10, 1990, the OSHA inspector reported low levels of fungi (5 to 37% of outdoor levels), CO_2 concentrations ranging from 600 to 800 parts per million (ppm), and RH ranging from 62 to 68%. Recommendations were made to clean the air conditioning units and associated ductwork, to increase the efficiency of the particulate filters in the air handling units, and to prevent moisture incursion into occupied space and within the air conditioning system.

During the week prior to our visit, it was reported that the supply air diffusers and exhaust grills were cleaned using a solution containing water and Fantastic®. Efforts were also made to wipe the inside surfaces of ducts to the point where a person's arm could reach. No other changes in cleaning or maintenance were reported in response to the recommendations made in the OSHA report.

BUILDING INFORMATION

The HUD offices are housed in a six-story building which was built in 1986. The building is constructed of concrete and has glass panels which do not open to the outside. The 115 HUD employees at this facility occupy all of the second and third floors and a portion of the first floor, encompassing an area of approximately 22,000 square feet. Floor plans for these areas are included in the Appendix. The remainder of the building is occupied by other governmental agencies, with the exception of the basement, which contains a parking garage. Office space is leased through the General Services Administration (GSA) which has a contract with an outside firm for building operation and maintenance. The building is located in the downtown Hato Rey area and is surrounded by other large office buildings.

The office space includes both single perimeter offices and open areas. Four foot high partitions are present in some of the open areas. Carpet is present in some of the single offices, while floor tiles are present in the open areas. Most of the activities performed by HUD employees involve clerical tasks, including the use of personal computers, printers, and copy machines. At the time of this survey, smoking was allowed throughout the building.

On the second and third floors, there are two air handling units per floor, each rated at 8000 cubic feet per minute (CFM). These units have only cooling capacity and are part of a constant volume system. The units are located in separate mechanical rooms, adjacent to the elevators. We were not able to locate the outside air intakes for these units during our survey and could not confirm whether outside air was mechanically supplied to these units. The building manager has since reported that outside air is supplied to all air conditioning units from a supply fan connected via a duct system to the mechanical rooms and return air ductwork. No estimates of the amount of outside air supplied to the units were given. The system is in operation from 6:00am - 6:00pm, covering the time that the majority of the workforce spends in the building. One smaller air handling unit supplies conditioned air to the area on the first floor occupied by HUD auditors. This unit is rated at 4435 CFM and is located above the first floor ceiling.

EVALUATION DESIGN

MEDICAL EVALUATION

Medical interviews were conducted with 16 (approximately 14%) of the HUD employees, 10 from the second floor and six from the third floor. These employees had responded to a memo soliciting participation from anyone with building-related health complaints who wanted to talk with NIOSH representatives. Medical records, provided by workers, were reviewed for the pneumonia and asthma cases.

ENVIRONMENTAL EVALUATION

On December 12, 1990, environmental measurements were made to evaluate thermal comfort parameters (temperature and relative humidity) and CO_2 concentrations. Temperature and RH measurements were made using a Vista Scientific, Model 784, battery-operated psychrometer. Carbon dioxide measurements were made using the Draeger gas detection system with colorimetric detector tubes specific for CO_2. Environmental measurements were made at 12 locations on floors 1-3 and outdoors, at three times throughout the day. The purpose for the sequential measurements was to observe any fluctuations in these parameters throughout the day. The first set of measurements was made between 6:30 and 8:00am (prior to the arrival of the majority of the work force), the second set between 10:30 and 11:40am (when the building was fully occupied), and the third set between 2:00 and 3:00pm.

The ventilation portion of the survey included an inspection of the four air handling units serving the second and third floors. All of the units were opened and inspected for the presence of visible microbial contamination, standing water, general cleanliness, and condition of the particulate filters. The unit serving the first floor was not inspected due to time constraints and the fact that access to this unit was limited as a result of its location above the false ceiling.

EVALUATION CRITERIA

NIOSH investigators have responded to approximately 700 complaints of indoor air quality problems in a wide variety of settings. The majority of these investigations have been conducted since 1979, paralleling the "energy efficiency" concerns of building operators and architects.

Commonly, the symptoms and health complaints reported by building occupants have been diverse and not suggestive of any particular medical diagnosis or readily associated with a causative agent. A typical spectrum of symptoms has included headaches, varying degrees of itching or burning eyes, skin rashes, sinus problems, dry and irritated throats, and other respiratory irritations. The workplace environment has been typically implicated because workers' symptoms reportedly disappear when they are away from the office.

Less often the symptoms are more severe and are found to be specifically related to something in the building environment. Examples of these building-related illnesses (BRI) are environmental allergy (allergic rhinitis, allergic asthma, and hypersensitivity pneumonitis) caused by exposure to spores, organic dusts, animal "danders", bacteria and fungi, and bacterial pneumonia (Legionnaires' disease, and Pontiac fever). In previous NIOSH investigations, microbial contamination has resulted from water damage to carpets or furnishings, and standing water in ventilation system components.

The causes of comfort and health problems related to indoor air quality are typically multifactorial, which makes determination difficult. The investigations NIOSH has conducted have been classified by primary type of problem found: inadequate ventilation; contamination from inside the

building; contamination from outside the building; microbiological contamination; contamination from the building materials; and "unknown".

The predominant problems identified in the NIOSH indoor air quality investigations can be placed into the following three general categories listed in order of decreasing frequency: inadequate ventilation, chemical contamination, and microbiological contamination. Inadequate ventilation, a category which includes shortages of outside air, poor distribution, and short-circuiting of supply air, is reported most commonly in the NIOSH building investigations. These ventilation problems make it difficult to control heating and cooling, and allow the accumulation of contaminants in the occupied space. The resulting conditions may cause occupants to become uncomfortable or experience adverse health effects.

Scientists suspect 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, and work environments outside of comfort ranges. Standards for indoor air quality in office buildings do not exist. NIOSH, the Occupational Safety and Health Administration (OSHA), and the American Conference of Governmental Industrial Hygienists (ACGIH) have published regulatory standards and recommended limits for occupational exposures. With few exceptions, pollutant concentrations observed in the office work environment fall well below these published occupational standards or recommended exposure limits. The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) has published recommended building ventilation design criteria and thermal comfort guidelines as discussed below.[1,2]

The basis for monitoring carbon dioxide, temperature, and relative humidity is discussed below:

CARBON DIOXIDE (CO_2)

Carbon dioxide is a normal constituent of exhaled breath and, if monitored, can be used as a screening technique to evaluate whether adequate quantities of fresh air are being introduced into an occupied space. The ASHRAE Standard 62-1989, Ventilation for Acceptable Indoor Air Quality[1], recommends outdoor air supply rates of 20 cubic feet per minute per person (CFM/person) for office spaces and conference rooms, 15 CFM/person for reception areas, and 60 CFM/person for smoking lounges, and provides estimated maximum occupancy figures for each area.

Indoor CO_2 concentrations are normally higher than the generally constant outdoor 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. CO_2 concentrations in this range do not represent a health hazard. However, they do indicate that the air concentrations of other contaminants normally present in office environments may also be elevated and, in combination, may be contributing to employee health complaints.

TEMPERATURE AND RELATIVE HUMIDITY

The perception of thermal comfort is related to one's metabolic heat production, the transfer of heat to the environment, physiological adjustments, and body temperatures. Heat transfer from the body to the environment is influenced by factors such as temperature, humidity, air movement, personal activities, and clothing. ANSI/ASHRAE Standard 55-1981 specifies conditions in which 80% or more of the occupants would be expected to find the environment thermally comfortable.[2] The ASHRAE recommendations for acceptable ranges of temperature and humidity for summer and winter months are shown in Figure 1.

RESULTS

MEDICAL EVALUATION

The results of the medical interviews are presented in Figure 2. The two most common complaints (smoke irritation and thermal discomfort) were mentioned by 50% or more of those interviewed and were felt by them to contribute to many of the other complaints including sinus problems, sneezing, allergies, asthma, eye irritation, colds, sore throat, and headaches. Thirteen of the 16 interviewed employees reported that their symptoms generally resolved within a few hours after leaving the building and on weekends.

Several employees expressed concern regarding the possible presence of fungi, molds, or other microorganisms in the building that might have been responsible for their symptoms. However, the symptoms associated with hypersensitivity pneumonitis -- which is the disease resulting from inhalation of a variety of organic dusts, including fungi, bacteria, and molds -- were not reported.

The medical histories for the asthma and pneumonia cases were not consistent with a work-related cause. These conditions were either pre-existing prior to beginning work at the HUD building or were attributable to causes other than exposures at work. However, both of these conditions could be exacerbated by exposure to cigarette smoke and cold temperatures at work.

ENVIRONMENTAL EVALUATION

Environmental Measurements

Figures 3a and 3b present the results of the CO_2 measurements made on floors 1-3. The test location designations correspond to sample locations identified on the floor plans which are included in the Appendix. (While the floor plans are not quality reproductions, the sample locations can be clearly seen.) As can be seen from Figures 3a and 3b, CO_2 concentrations ranged from 400-700 parts per million (ppm) on the first floor (location L), 450-1100 ppm on the second floor (locations F-K), and 300-1000 ppm on the third floor (locations A-E). It should be pointed out, however, that approximately six field investigators (out of eight total employees) from the first floor were not

present on the day that measurements were made; therefore the reported values may not be representative of conditions when all investigators are in the office. In most cases, the CO_2 concentrations were highest during the afternoon, indicating a build-up of CO_2 (primarily from exhaled breath) over the course of the day. Mean CO_2 concentrations for all locations combined were 450, 660, and 860 ppm, for measurements made in the early morning, late morning, and late afternoon, respectively. The relatively high CO_2 concentration measured in Location C (1000 ppm) may reflect the fact that an office luncheon was held in this area and was attended by approximately 20-30 people from surrounding areas, thus, contributing to an increase in the CO_2 concentration. In Location H, where the afternoon CO_2 concentration was measured at 1100 ppm, it was observed that there was no return air system present in this area, a situation which was not observed in the corresponding area on the third floor.

Air temperature measurements are shown in Figures 4a and 4b. While there was some temperature fluctuation throughout the day in all areas, this variation was generally on the order of a few degrees. For all indoor locations combined, the air temperatures ranged from 70-75.5 degrees Fahrenheit, while outdoor air temperatures ranged from 76 degrees in the morning to 79 degrees in the late afternoon. As shown in Figures 5a and 5b, relative humidity, an indication of the moisture content of the air, ranged from 52-56% on the first floor, 62-71% on the second floor, and 62-71% on the third floor. The outdoor air humidity ranged from 80-85% over the course of the day. While there was very little variation in RH between the second and third floors, the RH measured on the first floor was considerably lower. It should be noted, however, that the first floor space occupied by HUD employees was quite small in comparison to the areas occupied on the second and third floors, requiring a smaller air handling unit. It is unclear from the limited information available, however, whether factors such as the type of unit, chiller water temperature, or the amount of outside air entering or infiltrating the area were important factors influencing the RH.

On the second and third floors, most locations had a temperature and humidity combination falling outside of, or at the far ends of the operative temperature and humidity range recommended by ASHRAE, as shown in Figure 1.

Ventilation Assessment

The ventilation evaluation was performed with the assistance of the building superintendent. The air handling units serving the second and third floors were opened and inspected for the presence of microbial contaminants, filter condition, and overall cleanliness.

The four units serving the second and third floors appeared similar with respect to unit type and size, and type of filtration (metal mesh). The filters for all four units had reportedly been cleaned three weeks earlier and were all fairly clean. The superintendent indicated that the filters had been cleaned on a monthly basis for the past 10 months and were replaced every six months.

The PAC-4 unit serving the second floor had gaps in the filter bank, causing air entering the unit to preferentially flow through the unfiltered area. In addition, the filters were distorted and needed replacement. A hole approximately 18" X 18" was present in the mechanical room housing this unit, representing a potential safety hazard which should be addressed. The other unit serving the second floor, PAC-5, appeared to leak, as water was observed on the floor of the mechanical room and wet newspapers were present beneath the unit. In units PAC-6 and PAC-7, there was some slime and rust in the drain pans, indicating that, at times, there was some stagnation of the condensate water in these units. The condition of the filters in both units was good.

While we were not able to evaluate the air handling unit serving the first floor, employees noted that there were periodic water leaks from this unit. Due to complaints of odors in the second floor ladies room (by the elevator), this area was also inspected. The exhaust grills were found to be very dirty, and there was no movement of air through the exhaust duct.

DISCUSSION AND CONCLUSIONS

Of the 16 employees interviewed, the major health complaints and concerns reported by the employees included irritation from tobacco smoke and cold temperatures. Medical histories reviewed for the more serious health complaints noted in the health hazard evaluation request, such as asthma and pneumonia, were not consistent with a work-related cause of these illnesses; however, as previously noted, these conditions could be exacerbated by exposure to tobacco smoke and thermal comfort problems in the work area.

Management indicated that 20% of the current HUD work force are smokers. Smoking was observed throughout the building with and without the use of the desk top "smoke eaters" which are provided by HUD. Tobacco smoke is a potentially major contributor to indoor air quality problems. NIOSH investigators recommend that smoking should not be allowed in work areas, and that air cleaners should not be relied upon to remove these contaminants. Tobacco smoke contains several hundred toxic substances. The more important are the following: carbon monoxide, nitrogen dioxide, hydrogen cyanide, formaldehyde, hydrocarbons, ammonia, benzene, hydrogen sulfide, benzo(a)pyrene, tars, and nicotine. Tobacco smoke can irritate the respiratory system and, in allergic or asthmatic persons, often results in eye and nasal irritation, coughing, wheezing, sneezing, headache, and other related sinus problems. In addition, people who wear contact lenses often complain of burning, itching, and tearing eyes when exposed to cigarette smoke.

The environmental measurements indicated that many of the work areas had a temperature and RH combination falling outside of, or at the far ends of, the range recommended by ASHRAE. If the ASHRAE recommendations for summer are used as criteria (since the local climatic conditions create the need for air conditioning all year), air temperatures tended to be cooler than those recommended. The mean temperature for all locations combined was 72.5

degrees. This condition is consistent with the complaints of cold temperatures mentioned by 50% of the workers interviewed. In addition, during the walk-through survey, the NIOSH investigator talked with one employee who indicated that the air supplied to his work station was very cool and that the airflow through the diffuser created a lot of noise. This was substantiated by air temperature measurements of 66 degrees at this work station (in the vicinity of Location K between the two exit doors) and a very noticeable increase in the noise level at this work station due to the velocity of the air supplied by the diffuser above. The conditions noted suggest the need for balancing the air distribution system. ASHRAE recommends that average air movement in the occupied zone should not exceed 50 feet per minute (fpm) during the summer, and 30 fpm during the winter.[2]

The relative humidity on the second and third floors was quite high, ranging from 63-71%. Due to concerns regarding the potential for microbial contamination within the building and the possibility that this contamination can result in building-related illnesses, such as the hypersensitivity diseases or infections, the RH should be maintained below 60% throughout the year.[3] Preventive maintenance of the air distribution system and keeping the environment clean by removing dirt and water are also important factors for controlling microbial contamination in buildings. This survey documented problems which could promote microbial growth, such as leaks in the air handling units, condensate drain pans overflowing, and slime in condensate drain pans. In addition, fungal contamination was observed on two walls on the second floor. Although the NIOSH investigators did not evaluate conditions within the ventilation system ducts, the OSHA report noted that there was dust buildup and other debris located in some of the ducts. This situation should be further evaluated and the ducts cleaned, if necessary, to prevent a substrate for microbial growth.

A number of other ventilation deficiencies were noted during this survey which should be corrected. These problems are addressed below in the Recommendations section.

RECOMMENDATIONS

1. Smoking should not be allowed in work areas. If smoking is to be allowed in the building, a separate smoking room should be provided. This room should be provided with 60 CFM of outside air per person, in accordance with ASHRAE standard 62-1989.[1] Room air should be exhausted directly to the outside, with no recirculation of room air into other occupied areas.

2. The ventilation deficiencies identified during this survey should be corrected. This would include repairing the exhaust ventilation in the second floor ladies' room, adding exhaust air ducts in Location H, preventing cold air drafts in Location K, eliminating gaps in air handling unit filter banks, replacing damaged filters, repairing leaks in the PAC-5 unit, and ensuring proper drainage angle for the condensate drain pans for all units. Ideally, the ventilation systems serving these areas should be balanced by a ventilation engineering firm, particularly when making changes or additions to the existing system. Attention

should also be given to routine inspection of the filters, general cleaning of the units, calibration of thermostats, and ensuring an adequate supply of outdoor air at all times, in all areas of the building. ASHRAE recommendations outlined in standards 62-1989 and ANSI/ASHRAE standard 55-1981 should be followed.

3. Moisture incursion into occupied space and within the air handling system should be prevented. The relative humidity in the building should be maintained below 60%, and if possible, filters having a moderate dust spot efficiency of 50-70% should be incorporated to adequately remove particulate material from the air.[3] Pre-filters can be used to prolong the life of the higher efficiency filters. Stagnant water and slime should be removed from drain pans, and a chlorine disinfectant should be added on a routine basis. Visible contamination present on the two office walls on the second floor should be cleaned. Porous furnishings which have become wet, such as ceiling tiles, should be discarded and replaced.

4. Management should continue to be sensitive to employee health complaints and concerns. Written complaints should be forwarded to the appropriate agency representative so that they can be addressed on a timely basis.

REFERENCES

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

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

3. American Conference of Governmental Industrial Hygienists. Guidelines for the assessment of bioaerosols in the indoor environment. Cincinnati, OH: ACGIH (1989).

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2. AFGE
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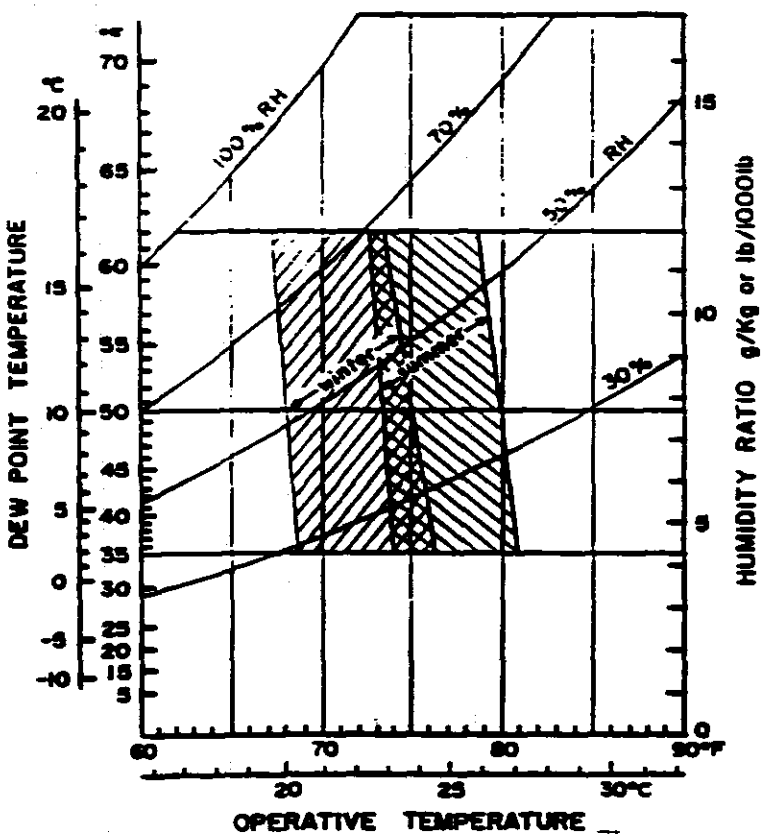


Figure 1 — Acceptable ranges of operative temperature and humidity for persons clothed in typical summer and winter clothing, at light, mainly sedentary, activity. (ASHRAE 55-1981)

Medical Interview Data
HUD-Caribbean Area Office, HETA 90-376

December 12-13, 1990

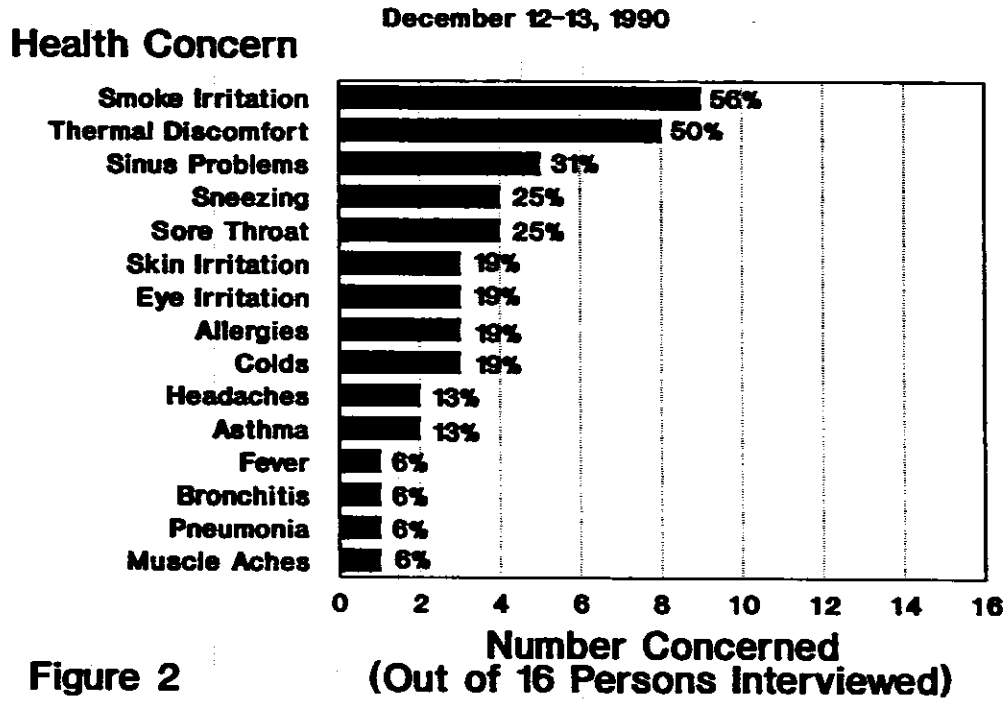


Figure 2

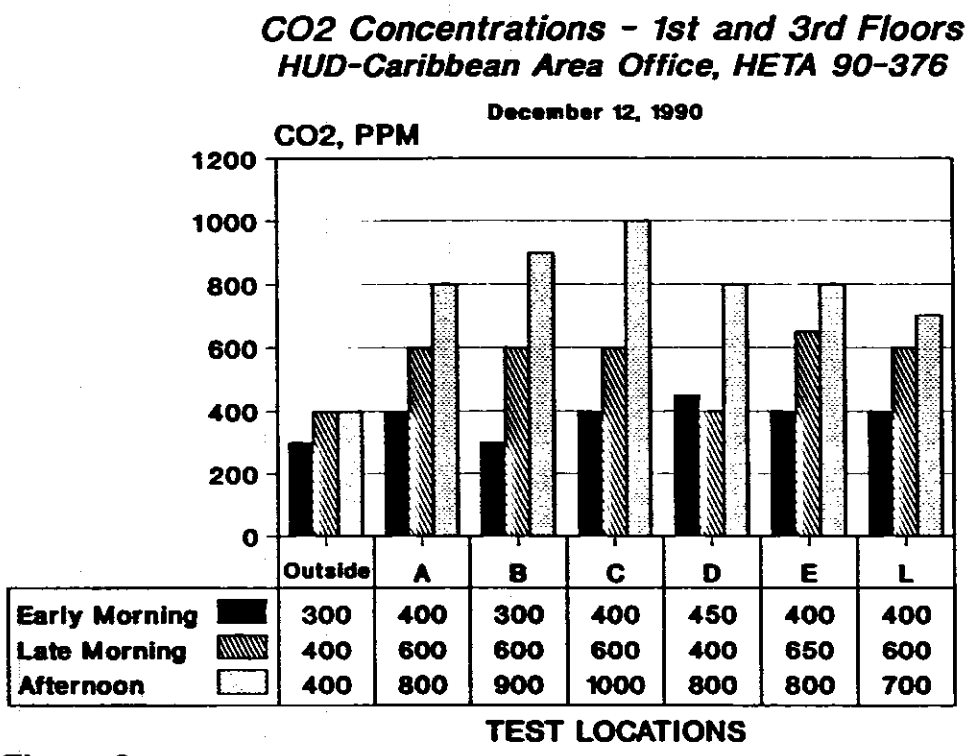


Figure 3a

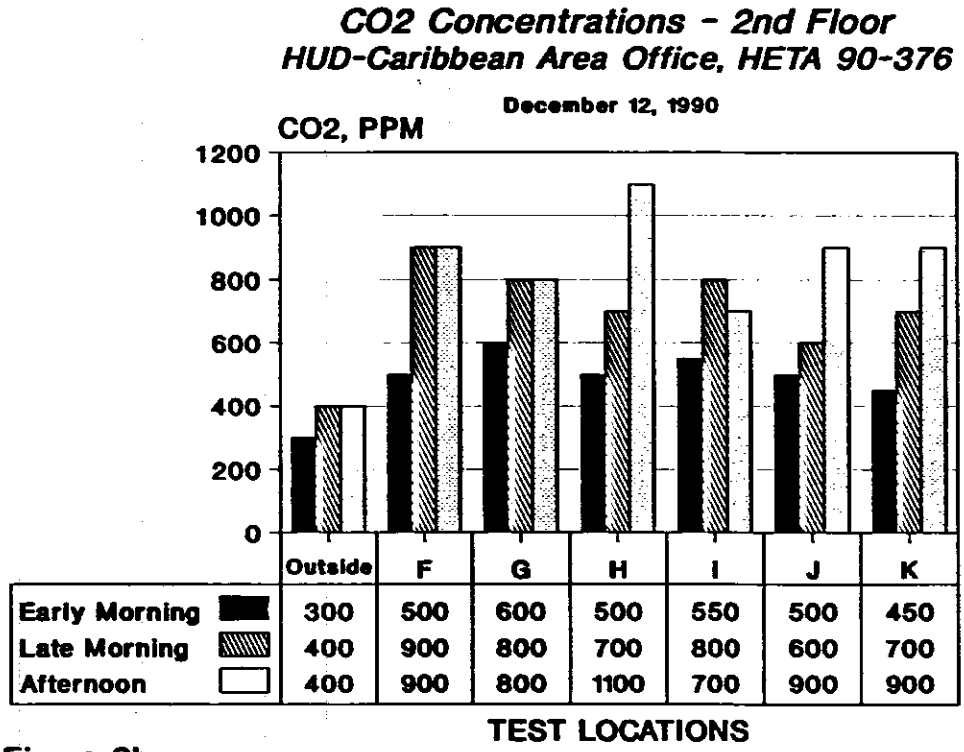
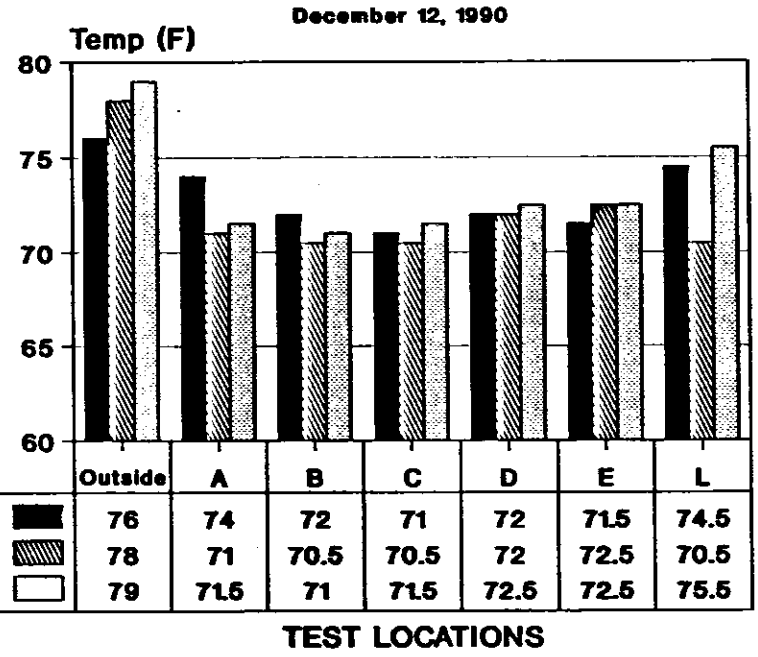


Figure 3b

Air Temperatures-1st and 3rd Floors
HUD-Caribbean Area Office, HETA 90-376

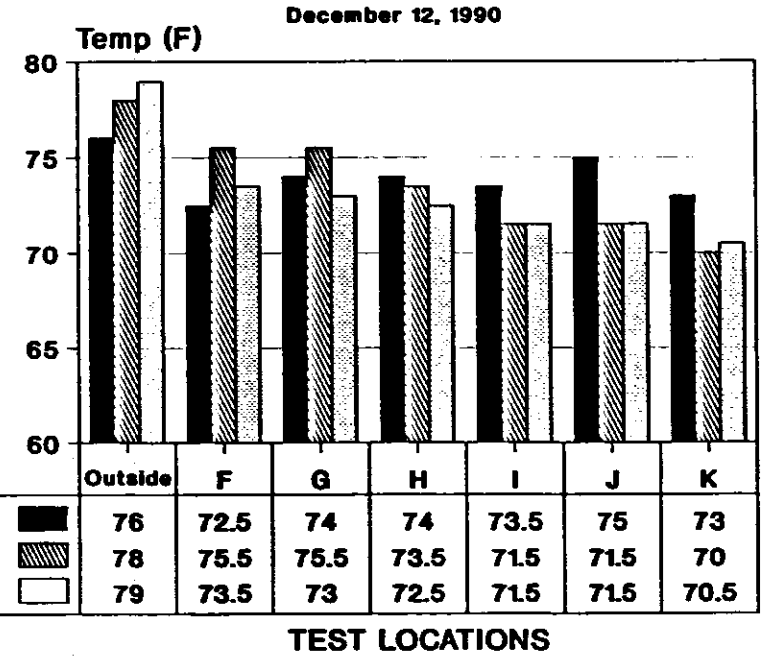


	Outside	A	B	C	D	E	L
Early Morning	76	74	72	71	72	71.5	74.5
Late Morning	78	71	70.5	70.5	72	72.5	70.5
Afternoon	79	71.5	71	71.5	72.5	72.5	75.5

TEST LOCATIONS

Figure 4a

Air Temperatures-2nd Floor
HUD-Caribbean Area Office, HETA 90-376

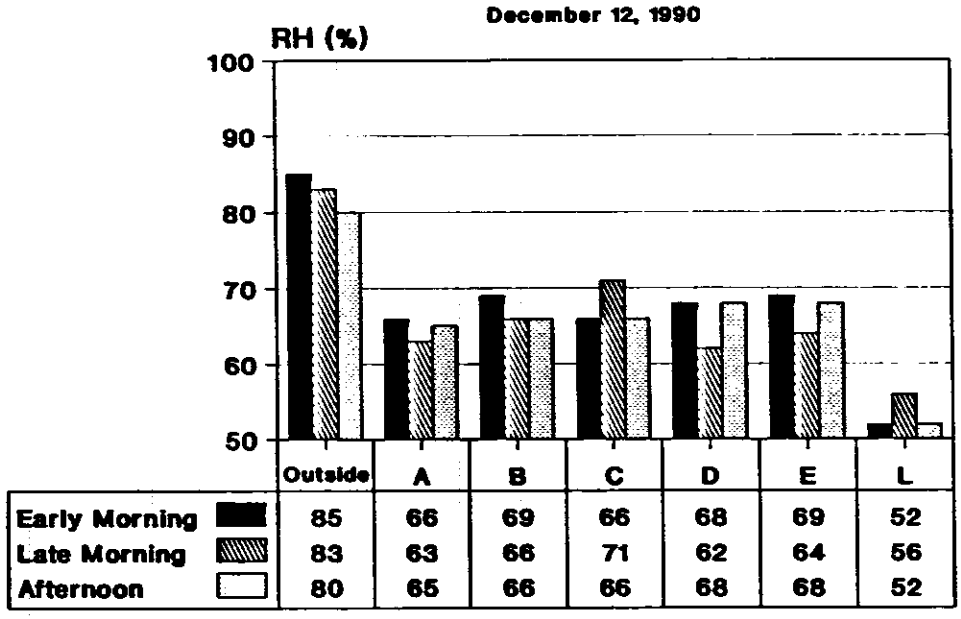


	Outside	F	G	H	I	J	K
Early Morning	76	72.5	74	74	73.5	75	73
Late Morning	78	75.5	75.5	73.5	71.5	71.5	70
Afternoon	79	73.5	73	72.5	71.5	71.5	70.5

TEST LOCATIONS

Figure 4b

Relative Humidity-1st and 3rd Floors
HUD-Caribbean Area Office, HETA 90-376

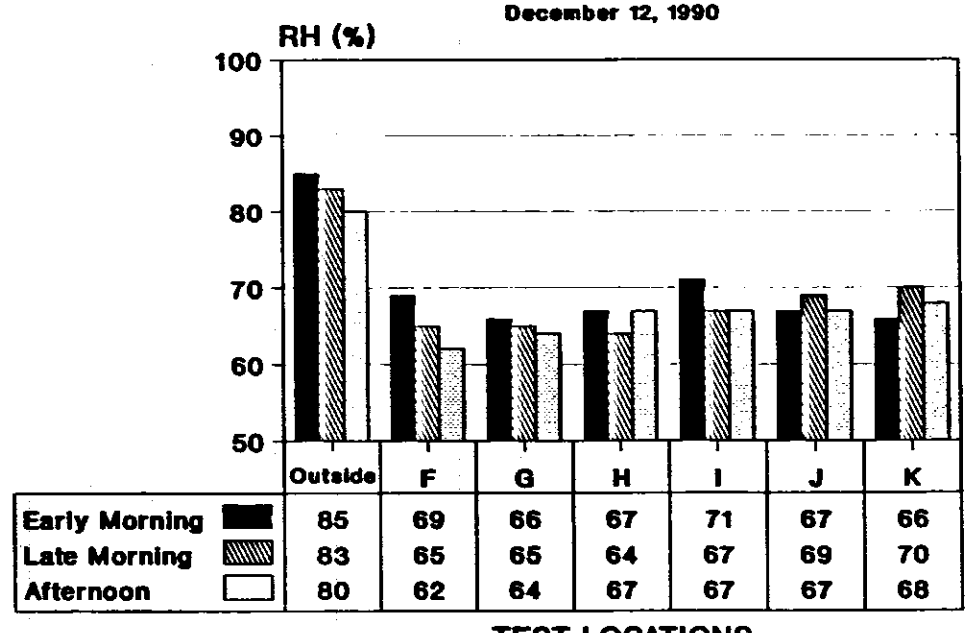


	Outside	A	B	C	D	E	L
Early Morning	85	66	69	66	68	69	52
Late Morning	83	63	66	71	62	64	56
Afternoon	80	65	66	66	68	68	52

TEST LOCATIONS

Figure 5a

Relative Humidity-2nd Floor
HUD-Caribbean Area Office, HETA 90-376

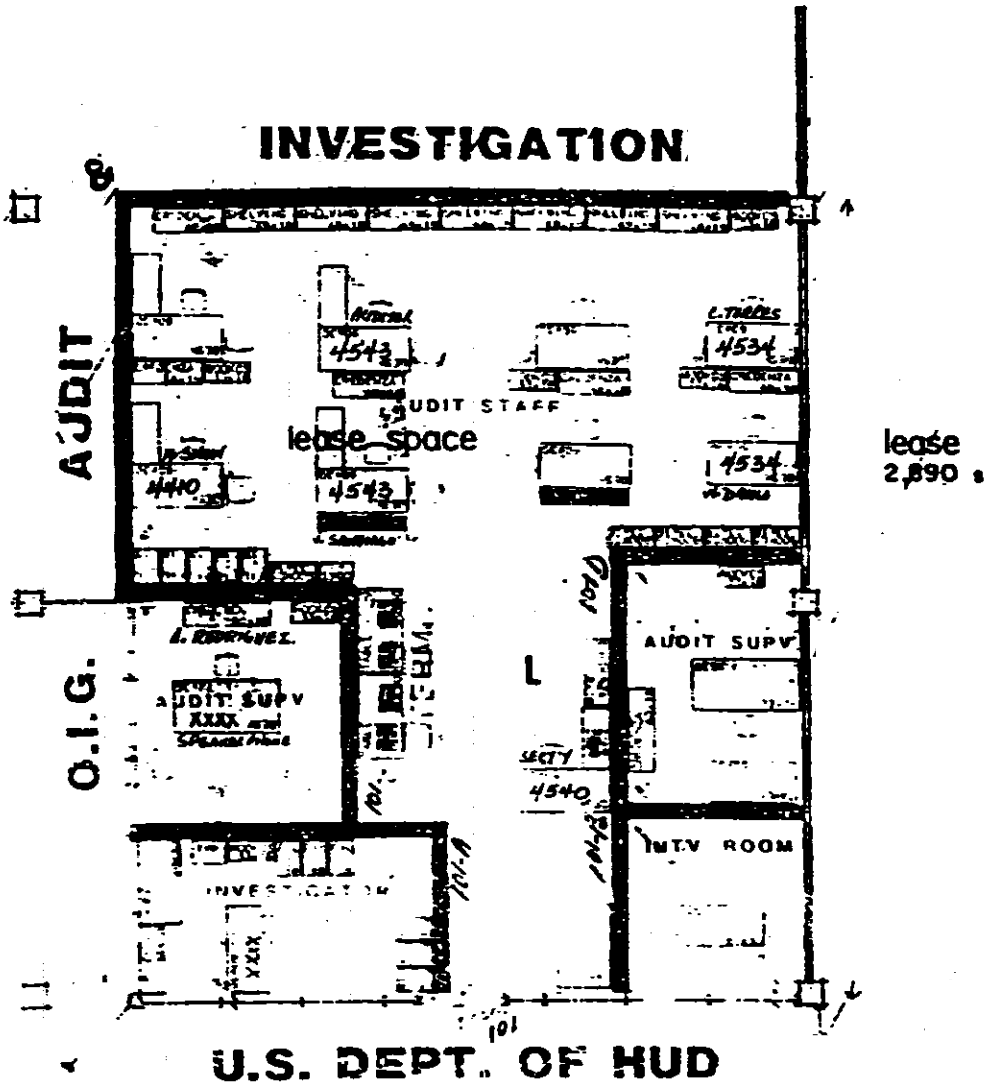


	Outside	F	G	H	I	J	K
Early Morning	85	69	66	67	71	67	66
Late Morning	83	65	65	64	67	69	70
Afternoon	80	62	64	67	67	67	68

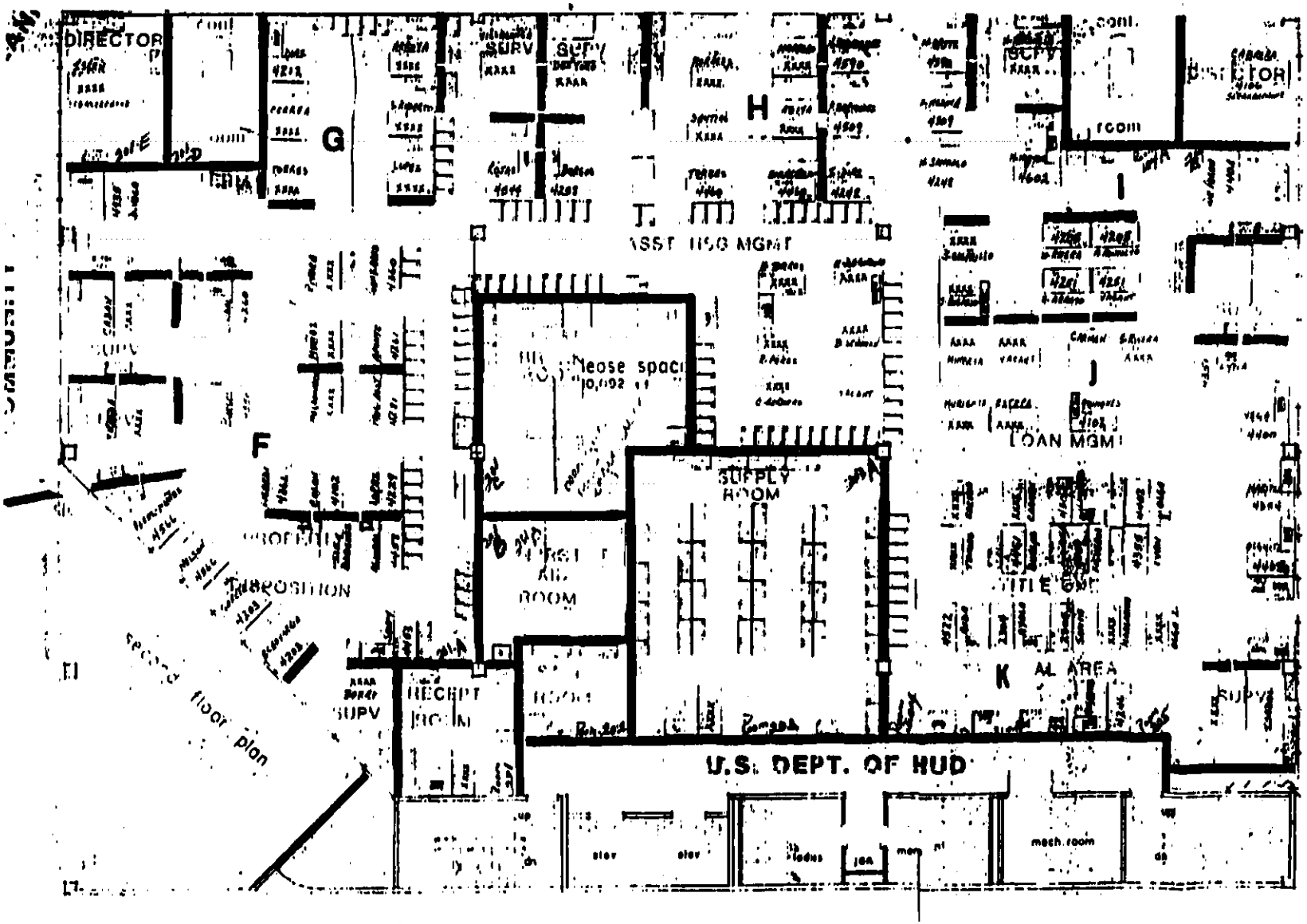
TEST LOCATIONS

Figure 5b

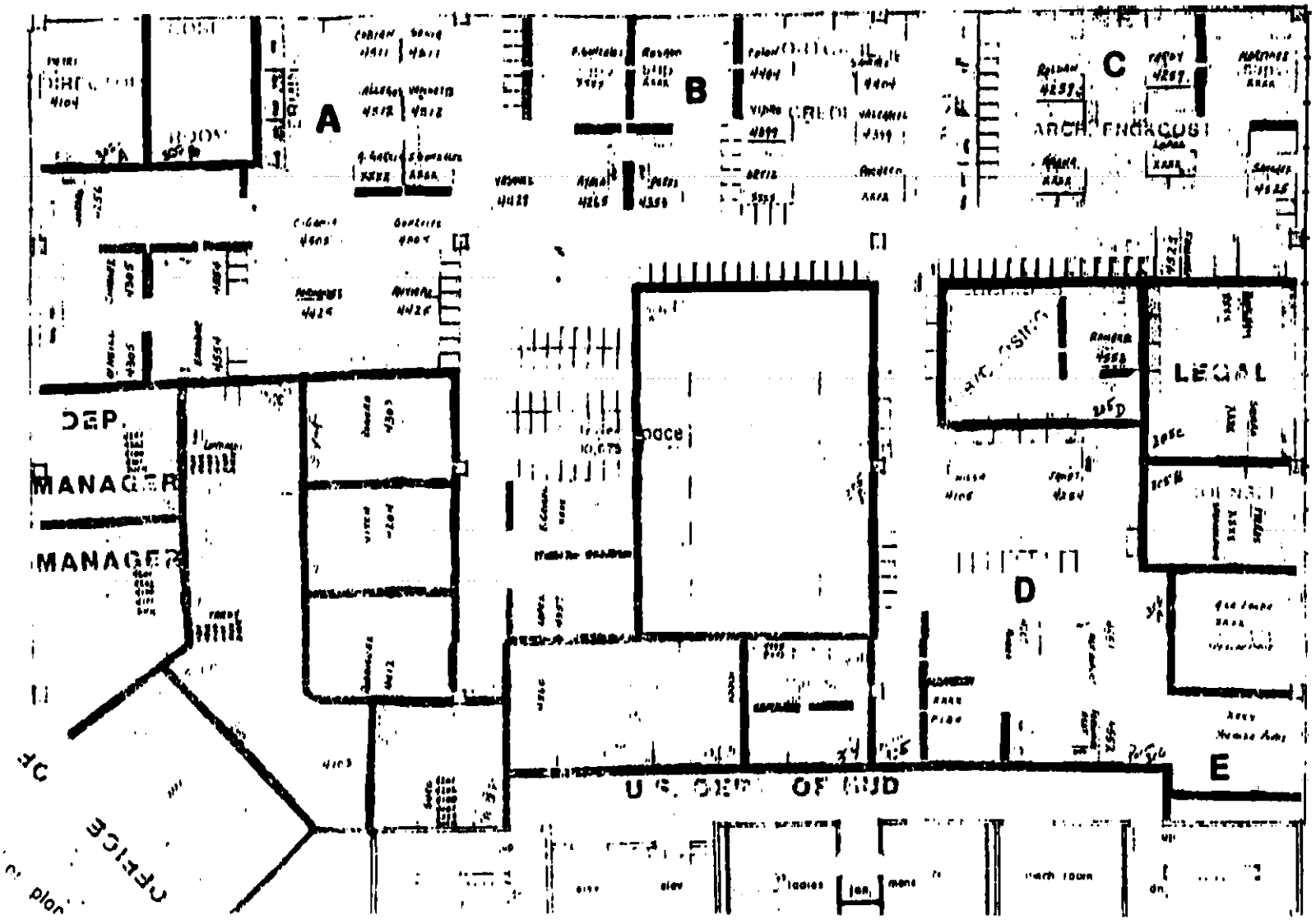
APPENDIX



Floor Plan for HUD-CAO, 1st floor



Floor Plan for HUD-CAO, 2nd floor



Floor Plan for HUD-CAO, 3rd floor