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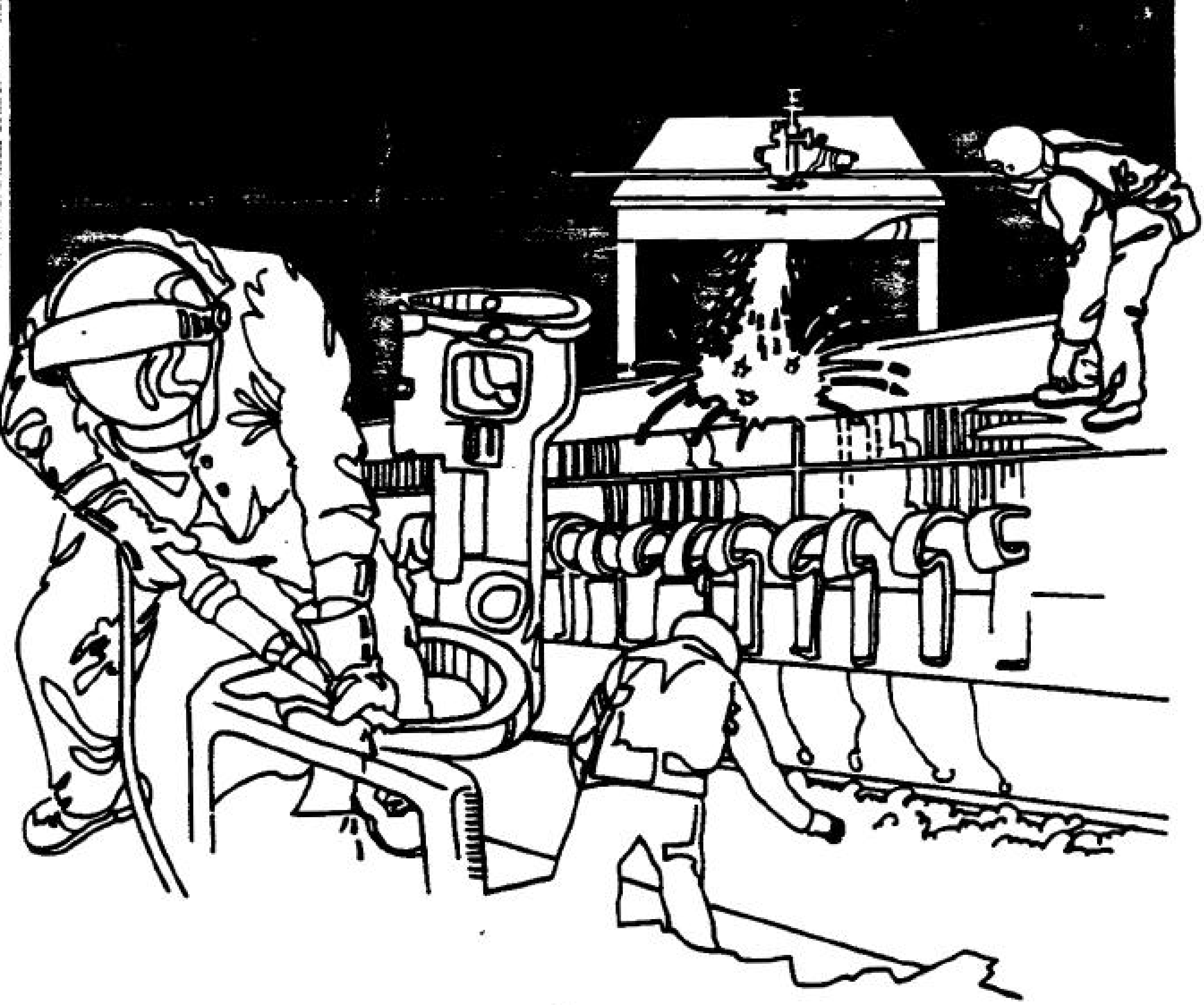

Health Hazard Evaluation Report

HETA 86-410-1772

HCFA-MEADOWS EAST BUILDING

BALTIMORE, MARYLAND

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 or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

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.

MHETA 86-410-1772
HCFA-MEADOWS EAST BUILDING
BALTIMORE, MD
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I. SUMMARY

On May 29, 1986, the Health Care Financing Administration (HCFA) requested the National Institute for Occupational Safety and Health (NIOSH) to investigate work-associated complaints of irritation of the eyes, mucosa, skin and respiratory tract among employees in the HCFA Meadows East Building (MEB). Additional health concerns were raised in July of 1986 involving three reported cases of fungal sinusitis and possible excess cancer at the MEB.

In July of 1986, NIOSH investigators conducted a walk-through evaluation and distributed a screening questionnaire to all MEB employees to assess the nature and frequency of the health/comfort complaints. Environmental surveys were done in August and September to assess indoor air quality (IAQ). Sampling was done for a number of environmental conditions/air contaminants including: ammonia, carbon dioxide, carbon monoxide, formaldehyde, nitrogen dioxide, organic compounds, ozone, sulfur dioxide, total airborne dust, viable fungi, and temperature/relative humidity. Evaluation of the building's ventilation system was also done. Medical telephone interviews were done in August to investigate potential cases of fungal sinusitis; medical records were requested and reviewed.

Fifty-nine percent (59%) of the 690 employees in the MEB completed the questionnaire survey; survey results indicated complaints of eye irritation/problems, headache, stuffy air, stuffy nose/sinus problems, uncomfortable temperatures, fatigue, and other complaints. A single case of fungal sinusitis was identified; however, this was not suggestive of a relationship to the building environment. (There was no evidence of excessive fungal growth and airborne fungal concentrations measured in the MEB during normal operations, were lower than ambient concentrations.) Thirteen cases of various types of cancer were reported in the MEB workforce over an 8 year period, but this is not unexpected by comparison to projections from the American Cancer Society statistics for the state of Maryland.

Environmental evaluations at the MEB indicated inadequate ventilation due to poorly adjusted or inoperative supply air terminals. Airborne dust, gas, and vapor concentrations measured inside the MEB were below the existing permissible exposure limits and exposure guidelines of The Occupational Safety and Health Administration (OSHA), The American Conference of Governmental Industrial Hygienists (ACGIH), The American Society for Heating Refrigerating and Air-Conditioning Engineers (ASHRAE), and NIOSH.

On the basis of the data obtained during the evaluation, the symptoms reported by this group of workers can most likely be explained by areas of local substandard ventilation in conjunction with low level indoor pollutants (e.g. tobacco smoke). Recommendations for prevention of these types of problems in the MEB are presented in section IX of this report.

Keywords: SIC 9441 OFFICE-BUILDINGS, INDOOR AIR POLLUTION, TIGHT BUILDING SYNDROME, VENTILATION

II. INTRODUCTION:

On May 29, 1986, the Division of Respiratory Disease Studies, National Institute for Occupational Safety and Health (NIOSH) received a technical assistance request to evaluate potential health/comfort problems in the Health Care Financing Administration (HCFA) Meadows East Building (MEB). The request, submitted by HCFA management, cited employee complaints of irritation of the eyes, mucosa, skin, and respiratory tract. NIOSH investigators conducted a walk-through evaluation at the MEB on July 8-9, 1986; during this evaluation, a standardized questionnaire on indoor air quality was distributed to all employees. Following this, NIOSH investigators were informed of reports concerning additional health problems at the MEB not detailed in the original HCFA request. These involved reports of fungal sinusitis in three workers and alleged excess cancer rates (several types) among MEB occupants. NIOSH investigators made a second site visit on August 5, 1986, to address employee health concerns raised over these additional reports. During this trip, NIOSH investigators met with HCFA management, the AFGE union representative, the HCFA Safety and Health Committee, and employees from the MEB. This visit was also used to make a request to MEB employees to submit their medical records for review. On August 11-13, 1986, NIOSH investigators conducted an environmental survey to assess indoor air quality in the MEB. An additional unannounced environmental survey was conducted on September 3, 1986, because some MEB employees felt that ventilation system operation and office conditions were much improved during the prearranged NIOSH surveys.

III. BACKGROUND:

The MEB, located in the Baltimore area, has four stories. The building is leased by the General Services Administration (GSA) for HCFA use from Equitable Real Estate Investment Management, Inc. The building, built during the early 1970's, was first occupied by the Social Security Administration (SSA). In 1979, HCFA moved employees into the building with SSA. HCFA became the sole building occupant in February, 1985, when the Health Standards and Quality Bureau of HCFA located offices on the 2nd floor. At that time, there were approximately 710 employees in the building. Approximately 690 employees occupied the MEB at the time of the NIOSH evaluation.

The MEB is of a modular construction, with about 108,040 square feet of area. The windows are sealed and do not open. The building is used predominately for office activities. It includes a cafeteria, computer rooms, some storage areas, and a small employee health clinic, in addition to office areas. A total ban on smoking has been in effect in the building since 8/5/86. The office areas are carpeted and furnished with systems furniture/partitions. Most of the building has an open bay design with 5-6 foot high partitions around individual work stations. The carpeting and furniture in most of the building (excluding the 3rd floor) have been added/replaced since about June of 1984.

Water incursions have been reported in several locations; however, damage has been limited to wet and stained ceiling tiles located under the loading dock or at various locations in peripheral offices.

The MEB has had several indoor air quality/health evaluations dating back to 1982. These evaluations were in response to employee complaints including: headaches, stagnant/stuffy air, irritation of the eyes and upper respiratory tract. The first of these evaluations was done by the Division of Federal Employee Occupational Health during March and December of 1982. Two additional indoor air quality evaluations were done in 1985 by Biospherics, Inc., and by Loss Control Inc.

IV. METHODS:

A. Indoor Air Quality Questionnaire

On July 8, 1986, a one-page, self-administered questionnaire (see Appendix A) was distributed to all building employees in order to initially assess the nature, frequency, and demographics of reported health complaints in the MEB. Employees were asked to complete the questionnaire and deposit it in a (NIOSH) collection box located in the 1st floor nurses station or return it by mail in the franked envelope provided with each questionnaire. The questionnaire data were analyzed by computer and used to help direct this evaluation.

B. Environmental

An industrial hygiene evaluation of the MEB was done to identify potential indoor air pollution problems related to the health/comfort complaints. This evaluation was done during three separate site visits in July, August, and September of 1986. The industrial hygiene evaluation included physical, chemical, and biological assessments of building conditions and indoor air quality.

Physical aspects involved evaluation of office areas for problem conditions including mold growth, flooding/water incursions, and other problems. Temperature and relative humidity measurements were taken and an evaluation of the ventilation system was done. Ventilation system flow rates were measured with a pitot tube/inclined manometer and a rotating vane anemometer.[1] A heated wire anemometer and a flowhood with a deflecting vane anemometer were used to take air flow measurements from ceiling air supply terminals.

Airborne sampling for several chemicals/substances was also done to assess the indoor air quality; these included ammonia, carbon dioxide, carbon monoxide, formaldehyde, ozone, organic gases/vapors, nitrogen dioxide, and sulfur dioxide. Samples were also taken to measure airborne total dust concentrations.

Ammonia concentrations were measured using a direct reading passive diffusion tube; full shift samples were taken. This sampling method has a detection limit (LOD) below 1.3 ppm for an 8 hour sample.(2)

Formaldehyde samples were taken with a midget impinger operated at 1 liter per minute (lpm). A sodium bisulfite collection media was used. Full shift samples were collected. The samples were analyzed by spectrophotometry. This method has a LOD of about 0.001 ppm for an 8 hour sample.(3)

Carbon dioxide, carbon monoxide, nitrogen dioxide, ozone, and sulfur dioxide were sampled using direct reading indicator tubes. These short term samples were collected over a time period of about 5 minutes.(2)

Bulk organic gas/vapor samples were collected on activated charcoal media at a sampling rate of 200 milliliters per minute. Full shift samples were taken and analyzed qualitatively for organic compounds by gas chromatography in conjunction with mass spectroscopy.(3)

Airborne total dust samples were collected on 37 millimeter diameter polyvinyl chloride (PVC) filter media at a sampling rate of 3 lpm. These samples were time-weighted over a 7 to 17 hour sampling period. The samples were analyzed gravimetrically using an electrobalance with a precision of about 0.01 milligrams (mg).(3)

Biological measures of indoor air quality involved sampling for both viable airborne fungi and viable fungi growing on the surface of ceiling tiles. Airborne fungi were collected using the Andersen (N6) biological sampler with rose bengal-streptomycin agar.(4) Partial period samples (3-20 minutes) were collected at a sampling rate of approximately 28 lpm. Fungal samples from ceiling tile surfaces were taken by pressing a piece of ceiling tile to the sampling agar surface; a rose bengal streptomycin agar was also used for these samples. The fungal samples were incubated at room temperature (about 72-74°F) and counted for fungal growth over a 4 day period using a microbiological plate counter. The genus of all fungi growing in these samples was identified; fungi of the genus Aspergillus were further identified to the species level, since Aspergillus flavus was identified as the organism involved in the documented case of fungal sinusitis.

The selection of environmental analytes for this evaluation was based on: (1) The screening questionnaire results from MEB; (2) past IAQ evaluations done in the MEB; and (3) NIOSH experience from IAQ evaluations in other office buildings. Area sampling was done at designated sampling stations located on each floor of the building. Sampling stations were selected in areas where workers reported health/comfort problems. One sampling station was also located outside the MEB to assess background (ambient) conditions for comparison purposes. Two of the sampling stations for airborne viable fungi were located in surrounding office buildings for comparison purposes.

C. Medical:

NIOSH investigators obtained a list of five possible cases of fungal sinusitis from the MEB employee health staff. A NIOSH medical officer conducted phone interviews with the listed individuals in order to obtain further clinical information. Personal medical records were subsequently obtained and reviewed for the two individuals with clinical conditions consistent with fungal sinusitis.

During a meeting with HCFA employees on 8/5/86, and later via interdepartmental newsletter, NIOSH investigators requested that employees with known or suspected cancer and/or fungal infections identify themselves.

V. EVALUATION CRITERIA:

Evaluation criteria are used as guidelines to assess the potential health effects of occupational exposures to substances and conditions found in the work environment. These criteria consist of exposure levels for substances and conditions to which most workers can be exposed day after day for a working lifetime without adverse health effects. Because of variation in individual susceptibility, a small percentage of workers may experience health problems or discomfort at exposure levels below these existing criteria. Consequently, it is important to understand that these evaluation criteria are guidelines, not absolute limits between safe and dangerous levels of exposure.

Several sources of evaluation criteria exist and are commonly used by NIOSH investigators to assess occupational exposures. These include:

1. The U.S. Department of Labor (OSHA) Federal Occupational Health Standards; permissible exposure limits (PEL's);[5]

2. The American Conference of Governmental Industrial Hygienist (ACGIH) Threshold Limit (Exposure) Values (TLV's);[6]

3. NIOSH criteria documents and recommendations. (Recommended exposure limits.)

These criteria have been derived from industrial experience, from human and animal studies, and when possible, from a combination of the three. Consequently, due to differences in scientific interpretation of these data, there is some variability in exposure recommendations for certain substances. Additionally, OSHA considers economic feasibility in establishing occupational exposure standards; NIOSH and ACGIH place less emphasis on economic feasibility in development of their criteria.

The exposure criteria described below are reported as time-weighted average (TWA) exposure recommendations averaged over the full work shift; short term exposure limits (STEL) recommendations for a 10-15 minute exposure period; and ceiling levels (C) not to be exceeded for any amount of time. These exposure criteria and standards are commonly reported as parts contaminant per million parts air (ppm), or milligrams of contaminant per cubic meter of air (mg/m^3). Occupational criteria for the contaminants evaluated in this study are as follows:

Substance	NIOSH (REC.)	ACGIH (TLV)	OSHA (PEL)
Ammonia	50 ppm C	25 ppm	50 ppm
Carbon Dioxide	10,000 ppm	5,000 ppm	5,000 ppm
Carbon Monoxide	35 ppm	50 ppm	50 ppm
Formaldehyde[1]	LFL	1 ppm	3 ppm
Ozone	-	0.1 ppm	0.1 ppm
Nitrogen Dioxide	1 ppm (15 min C)	3 ppm	5 ppm-C
Sulphur Dioxide	0.5 ppm	2 ppm	5 ppm
Total Airborne Dust	-	10 mg/m^3	15 mg/m^3
Airborne Fungi	-	-	-

[1]Considered a potential human carcinogen by NIOSH and ACGIH.
-These standards/exposure levels refer to time-weighted averages (TWA) unless otherwise specified as Short term exposure limits (STEL), or ceiling values (C).
-ppm - Parts contaminant per million part air.
-mg/m^3 - Milligrams contaminant per cubic meter of air.
-LFL - Lowest feasible limit.

Some research suggests that industrial exposure criteria may be inappropriate for evaluating IAQ problems in office buildings.[7,8,9] The American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE) is one organization with environmental criteria designated to maintain acceptable IAQ in office building environments. They define acceptable IAQ as, "air in which there are no known contaminants at harmful concentrations and with which a substantial majority (usually 80%) of the people exposed do not express dissatisfaction."[7] ASHRAE recommends that outdoor air acceptable for ventilation (without treatment) meet the requirements established by the U.S. Environmental Protection Agency in the National Ambient Air Quality Standards and Additional Ambient Air Quality Guidelines.[7] These ASHRAE criteria for the contaminants evaluated in this study would include:

	Long Term		Short Term	
	level	time	level	time
Ammonia	0.7 ppm	1 yr	10 ppm	ceiling
Carbon Dioxide	-	-	-	-
Carbon Monoxide	-	-	35 ppm	1 hr
Formaldehyde	-	-	0.1 ppm	ceiling
Nitrogen dioxide	0.05 ppm	1 yr	-	-
Ozone	-	-	0.1 ppm	1 hr
Sulfur Dioxide	0.03 ppm	1 yr	0.1 ppm	24 hr
Total Airborne Dust	0.075 mg/m^3	1 yr	0.26 mg/m^3	24 hr

ppm - Parts per million parts air.
mg/m^3 Milligrams per cubic meter of air.
- Long term recommendations are averaged over a 1 year time period.

ASHRAE also recommends criteria[1] for indoor temperatures and ventilation rates for office buildings as detailed below:

Temp./Relative Humidity		Air Changes Per Hour	Minimum Outdoor Air
Winter	Summer		5 cu. ft. per min. (CFM)/person (non-smoking)
70-74°F	74-78°F	4 to 10	
20-30% RH	40-50% RH		20 CFM/person (smoking)

[1]ASHRAE is in the process of revising their recommendations on minimum outside air requirements for office buildings; however, the revisions are not final.

The ASHRAE estimated occupancy for offices is 7 persons per 1000 square feet (ft^2) or 143 ft^2 per person. This estimated occupancy is to be used only when design occupancy is not known.

Carbon dioxide (CO_2) concentrations in indoor air are often used as an indirect measure of a buildings capability to dilute indoor generated odors and irritants. The following CO_2 criteria have been used to assess indoor air quality in office environments: (10,11)

Carbon Dioxide (PPM)	Comments
Less than 600	Adequate outside air intake
600 - 800	There may be occasional complaints, particularly if the air temperature rises
800 - 1000	Complaints more prevalent
>1000	Insufficient make-up air, complaints are general

There are no established standards for occupational exposure to airborne fungi suitable to assess potential health effects. Consequently, fungal concentrations measured outdoors and in adjacent office buildings were used as a comparison to airborne fungal levels in the MEB.

VI. RESULTS:

A. Indoor Air Quality Questionnaire

Questionnaires were received from 406 of the 690 current MEB employees for a response rate of approximately 59% (Table 1). Nearly 60% of the employees reported experiencing discomfort believed to be work related. There was a statistically significant ($p<0.05$) difference among floors in the frequency of reports of work related discomfort: ground floor-69%; first floor-46%; second floor-60%; and third floor-53%. Although approximately one third of the employees reported work related medical illness, there was no statistically significant difference among floors.

The most prevalent symptom reported by MEB employees was eye irritation/eye problems (31%). Other symptom/problem conditions included headache (18%), stuffy building air (16.7%), and stuffy nose/sinus problems (14%). Some employees reported that it was often too hot inside the MEB (13.3%), while 8.9% reported that it was often too cold. Other symptoms/problem conditions include: too dusty (8.6%), fatigue (8.4%), allergy (6.4%), sore throat (5.4%), runny nose (5.2%), upper respiratory infections (5.2%), and other complaints.

B. Environmental:

Building Evaluation:

Some areas in the MEB had signs of water leaks -- mainly in perimeter offices on the 2nd and 3rd floors. Some office areas had water stains on the ceiling tiles near the perimeter walls of the building. There was no evidence of water damage to the carpet or office materials in these areas. Ceiling tiles in the ground floor area below the loading dock, a site of prior water incursion, were dry and there was no evidence of continued water problems in this area.

There were no areas of visible, identifiable mold growth observed in the building.

Ceiling tiles near the ventilation supplies in some areas were dirty with accumulated particulate.

Building occupancy was approximately 690 employees; while the area of the building (floors ground, first, second, and third) was about 108,040 square feet (ft^2). This represents an occupancy of about one employee per 157 ft^2. The occupancy rates by floor are presented in Table 4.

Temperature and Relative Humidity:

Forty-two temperature and relative humidity measurements were taken at the MEB in July, August, and September (Table 2). Indoor temperature ranged from a low of 70°F to a high of 78°F, and relative humidity ranged from 43% to a high of 58%.

Ventilation System Evaluation:

The MEB is a modern, relatively air-tight building; the windows do not open and the heating, ventilation, and air-conditioning (HVAC) is the primary source of outside air supply to building occupants. One large, HVAC system serves offices on all four floors. The system was installed in the early 1970's when the building was built. The system has heating and air-conditioning (cooling) capabilities but no humidification. Heating capacity is provided by a boiler located in the basement fan room; while cooling capacity is provided through a water cooling tower located on the roof. Air from the HVAC is delivered to office areas through ceiling supplies by a large fan, reported by building engineers to operate at a constant volume. These ceiling supplies (diffusers) are adjustable variable air volume (VAV) units (Appendix C). They provide variable amounts of supply air to office areas based on room air temperatures (dry bulb) in the offices being served. Each master VAV supply air terminal has a bimetal thermostat that allows an individual temperature setting separate from the other master units. The thermostats in these VAV supply air terminals are designed to sense room air temperature and adjust air flow through the supply air terminal accordingly. As room temperature increases/decreases from the thermostat setting, the supply air terminal is designed to increase supply air flow automatically to achieve room temperature according to the thermostat setting. Each VAV supply air terminal has a lever type thermostat adjustment; this lever adjustment can be used to reduce air flow to a minimum (cut off) discharge of approximately 24 cfm per diffuser. Each VAV supply air terminal is connected to several "slave" units[1] (supply air terminals) that are designed to operate according to the thermostat setting on the master VAV supply air terminal.

Air is exhausted from office areas into an open return plenum above the false ceiling. A large return fan is used for this. The outside air intake for the system is located below ground level on one side of the building and was observed to be free of accumulated debris. During the cooling mode of HVAC operation, MEB engineers report that the outside air intake louvers modulate to a minimum setting (opening) for outside air intake. During the heating season, outside air intake louvers automatically open from, or close to, this minimum louver setting to allow similar or increased outside air intake based on ambient air conditions.

The HVAC operates continuously from 5:00 a.m. to 9:00 p.m. on weekdays. The system does not run on the weekends. Following the weekend down time, start up is at 3:00 a.m. Monday morning.

Two types of filtration are used in the HVAC. A roughing filter is used on the exterior surface of the outside air intake. Roll type pre-filters are also used after the mixing chamber.

The HVAC system had some standing water in the collection trays below the cooling coils. There was a minimal amount of biological growth observed in the trays.

HVAC flow rates measured with a rotating vane anemometer are reported in Table 3. The volumetric flow rate of the supply fan was about 126,000 cubic feet per minute (CFM); the design flow rate for this supply fan (Appendix B) is 134,195 CFM. The return fan was operating at

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[1]The slave units are VAV supply air terminals without thermostats. They are connected to the master VAV supply air terminal thermostat and operate according to its setting.

approximately 85,500 CFM compared to a design flow rate of 106,930 CFM (Appendix B). Air flow through the outside air intake was measured at about 16,500 CFM. Outside air was also taken into the system through a large relief damper at a flow rate of about 257 CFM. (Note: the normal design function of this relief damper is to exhaust a portion of the return air from the building to compensate for the outside air intake). Total outside air supply for the system is approximately 16,700 CFM, or about 13 percent by volume. This would result in about 7.5 air changes per hour in the MEB if air distribution and supply were uniform.

Air flow rates for the MEB HVAC system measured during the NIOSH unannounced survey in September were unchanged from those measurements taken during the NIOSH survey in August.

The sum of HVAC air flow measurements taken by floor with a pitot tube and inclined manometer were lower than those taken with the rotating vane anemometer in the large supply ducts. (Note: The structure of the HVAC duct work in some areas did not provide good sampling locations for pitot tube measures, away from bends in the ducts and corresponding air turbulence. Consequently, this may have resulted in less accurate air flow measures with this sampling instrument). Table 4 presents the air flow measurements taken by floor with the pitot tube, The ground floor, which had the lowest number of employees, had the lowest air supply (approximately 17,000 CFM). The second floor, which had the largest population, had the highest air flow (approximately 25,000 CFM). The other floors had intermediate populations and flows.

Outside air intake for the HVAC system (in the cooling mode with the minimum louver setting) was about 16,700 CFM. (This estimate of outside air intake was made with a rotating vane anemometer since the pitot tube is designed to measure air flows inside HVAC ducts where the air velocities are higher). This reading was taken when the outside air louvers were set at about 65-70 degrees with individual slot openings ranging from about 1 3/4 inches to 2 3/4 inches. Approximately 690 people are employed in the MEB (July 9, 1986 Employee Lists); consequently, there is about 24 CFM of outside air taken into the building for each employee. This is approximately 13% outside air (rotating vane anemometer measurements).

The estimated amount of outside air supplied to each floor is reported in Table 4. These estimates are derived from HVAC flow measurements made with the pitot tube and the percent outside air intake measured with the rotating vane anemometer. Estimated outside air supplies per floor ranged from 2250 CFM for the 1st floor (134 employees) to 3300 CFM for the 2nd floor (217 employees). The estimated outside air supply per floor for the employees (CFM/employee) varied from 15 CFM/employee on the 2nd floor to 22 CFM/employee on the first floor. The ground and third floors had outside air supplies of 17 and 16 CFM/employee. These outside air supply estimates assume uniform distribution of supply air to all employees in the building or on a specific floor; however, imbalances in air flow from the ceiling supplies were measured. As discussed eariler, the ceiling air supply terminals are variable air volume units that adjust supply air flow based on temperature. The units receive minimal maintenance and many units were turned to cut off flow to accomodate building employees, blocked by employees, broken, or out of adjustment, thereby operating at flow rates well below design specifications for building supply air terminals. Building design flow specifications for the supply air terminals are:[1]

Air Terminal Type (#)	Design Flow CFM
1	170
2	220
3	225
4	230
5	235
6	245
7	250
8	255
9	260
10	265

Air flow measurements taken on the 3rd floor along the Zone 1 side of the building (air terminal type #4) ranged from 0 CFM of 180 CFM; none of the air supply terminals in this area were operating at the design flow rate, 230 CFM. Air flow measurements taken at other locations on the third and ground floors indicated similar problems. (Note: measurements were not taken from all of the supply air terminals on the third/ground floors, and no measurements were taken from supply terminals on the first or second floors). Many of the air supply terminals had no measurable air flow.

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[1]These design flow specifications were obtained from mechanical buleprints for the building.

Airborne Gases/Vapors:

Formaldehyde concentrations inside the MEB ranged from 0.003 parts formaldehyde per million parts air (ppm) to 0.005 ppm (Table 5). The mean concentration from 8 samples taken inside the MEB was 0.004 ppm with a standard deviation (STD) of 0.0009. The mean formaldehyde concentration from two ambient samples taken outside the MEB was 0.003 ppm with a STD of 0.003.

Ammonia concentrations were all below detectable levels using a passive diffusion sampler (This sampling method has a detection limit below 1.3 ppm for an 8 hour sample). Eight full shift samples were collected over a two day period.

Bulk airborne samples taken for qualitative identification of organic gases and vapors contained 1,1,1,-trichloroethane, perchloroethylene, xylene and toluene. The samples also contained some unidentified aromatic and aliphatic hydrocarbons. Only trace amounts of these compounds were detected; there was no substantial difference between the spectra of the samples collected inside and outside the MEB. (Note: these bulk samples were collected during the walk-through survey for qualitative identification of any organic compounds present. Additional samples for subsequent quantitation of any airborne organic gases/vapors were not taken since the bulk samples contained only trace amounts of organic gases/vapors consistent with outdoor conditions).

Carbon dioxide (CO_2) measurements from short term detector tube samples are reported in Table 6. The 34 samples taken inside the MEB ranged from 500 ppm to 1000 ppm. The mean concentration from all floors of the building was 743 ppm with a standard deviation of 121. Mean concentrations by individual floors varied from 705 ppm (first floor) to 788 (2nd floor). The six ambient CO_2 samples collected outside the MEB had a mean of 433 ppm and a standard deviation of 108.

Short term detector tube samples for carbon monoxide, nitrogen dioxide, and sulfur dioxide were all below detectable levels. Ozone was detected in one of six detector tube samples at a concentration of about 0.03 ppm; this sample was taken outside the MEB by the transformer located on the side of the building. Ozone was not detected in any of the samples taken inside the MEB.

Airborne Dust:

Airborne total dust concentrations measured inside the MEB ranged from 0.03 milligrams of dust per cubic meter of air (mg/m^3) to 0.08 mg/m^3 (Table 7). The eight samples had a mean of 0.05 mg/m^3 with a standard deviation of 0.02. Airborne dust concentrations from the two dust samples taken outside the MEB had a mean of 0.08 mg/m^3 and a standard deviation of 0.06.

Fungal Sampling:

Airborne viable fungal concentrations measured inside the MEB during routine operations ranged from a low of 21 colony forming units per cubic meter of air (CFM/m^3) to a high of 172 CFU/m^3 (Tables 8 and 9). The mean concentration from the 23 samples collected inside this building was 75 CFU/m^3 with a standard deviation of 46. The ten samples collected outside the MEB had a higher mean fungal concentration, 435 CFU/m^3 with a standard deviation of 203. The four samples collected from nearby office buildings had a mean of 91 CFU/m^3 and a standard deviation of 59. Fungal concentrations in the MEB were the highest during filter changing operations; the eight fungal samples collected when filter changing was in process were overloaded with concentrations in excess of 2120 CFU/m^3. These elevated concentrations occurred only during filter changing operations and subsided once the new filters were in place.

The ground floor of the MEB had a mean fungal concentration of 115 CFU/m^3. The 1st and 2nd floor averages were 70 and 73 CFU/m^3 while the 3rd floor had an average fungal concentration of 57 CFU/m^3. These averages by floor were all lower than the airborne fungal concentrations measured outdoors and were similar to fungal concentrations measured in nearby buildings.

Surface fungal concentrations from water stained ceiling tiles exceeded the concentrations from non-stained ceiling tiles (Table 10). Two of the four samples from stained ceiling tiles had fungal concentrations that were too numerous to count (TNTC) while samples from the two non stained tiles had concentrations below 1 colony per square centimeter of agar surface area ($colony/CM^2$).

Eight different fungal genera were identified in the samples. These include: Alternaria sp., Aspergillus sp., Cladosporium sp., Epicoccum sp., Fusarium sp., Mycelia sp., Paecilomyces sp., and Penicillium sp. Only the Aspergillus fungi were speciated. Seven different Aspergillus species were identified in the samples including: A. flavus, A. fumigatus, A. glaucus, A. niger, A. nigrum, A. ustus, and A. versicolor.

C. Medical:

The HCFA health service provided an initial list of five persons who had known or suspected histories of fungal sinusitis. These persons were contacted by telephone. Two persons had previous sinusitis without evidence of fungal involvement and no evidence of current disease. One person had history suggestive of multiple allergies and recently normal sinus x-rays. The two cases described below were the primary cases of concern during the evaluation.

Case #1 is a female in the fourth decade of life and resident of MEB since about 1979. She had a one-year history of pain around the right eye. She had a significant past medical history for sinus disease and had had a previous surgical procedure with irrigation of the maxillary sinus. During her evaluation sinus x-rays demonstrated an abnormality in the left ethmoid sinus. She subsequently underwent surgery. Surgery demonstrated evidence of chronic sinusitis with inflammation and thickening of the sinus membranes. Fungal material which proved to be Aspergillus flavus was removed. The patient is under continuing medical therapy.

Case #2 is a female in the fourth decade of life who had been a resident of the MEB since about 1980. The patient had had previous sinus disease which resolved for several years after nasal septal surgery. The patient has suffered from an increase of sinus symptoms since 1984. She developed sudden onset hearing deficit in about June 1986. During the evaluation an abnormality was found in the left sphenoid sinus. Patient underwent surgery which revealed chronic bacterial sinusitis from hemophilis species, without fungal involvement. The patient is currently doing well.

Since a concern was raised regarding a possible cluster of cancer cases, a verbal and a second written request was made to the MEB employees to provide NIOSH investigators with the names of cancer patients so an evaluation of this concern could be addressed. One employee did provide a list of thirteen cases (because of the types of cancers listed, these were not verified, see discussion). These cases were of several different types of cancers occurring between 1978 and 1986 as listed below:

Cancer Cases -
6 female 7 male

Time

1 - 1978	1 - 1982	1 - 1984	1 - 1985	3 - 1986
	1 prior to 1983		5 - unknown	

Type
2 Breast
2 Lung
1 Leukemia
1 Liver
1 Brain
1 Thyroid
1 Lymphoma
1 Pancreas
1 Head and Neck
2 Unknown

No other individuals have provided information.

VII. DISCUSSION:

Fungal Sinusitis:

One of the primary health concerns raised during this health hazard evaluation involved fungal sinusitis. NIOSH investigators received reports suggesting that three cases of fungal sinusitis occurred among MEB employees; however, only one case was confirmed as fungal sinusitis. The occurrence of a single case of fungal sinusitis does not suggest a relationship to the MEB environment. Fungal sinusitis, though rare, is seen more commonly than was once thought. When fungal sinusitis occurs it usually affects persons due to an altered host response. The conditions which predispose to fungal sinusitis are trauma, diabetes, cancer patients undergoing treatment with chemotherapy, chronic cortico steriod treatment (excluding birth control pills), altered cellular immunity, or following antibiotic treatment for chronic bacterial sinusitis. These infections can also be seen sporadically in normal people with no identifiable risk factors as listed above. (12,13)

Acute and chronic bacterial sinusitis are common diseases, although only ten percent of those persons complaining of "sinus trouble" will prove to have true infection. Risk factors for bacterial sinusitis include low socioeconomic group, close quarters, increase exposure to nasal infections "colds", chronic mucosal irritation (e.g., cold dry air or cigarette smoke), nasal obstruction (e.g., tumors, deviated septum or polyps), and nasal allergies.(13)

There was no environmental evidence of fungal contamination problems at the MEB. Areas of excessive, obvious fungal growth were not observed in any of the offices at the MEB. The microbiological growth observed in the condensate pans for the HVAC was minimal. Flooding and water incursion into office areas can be a source of excessive fungal growth and exposure; however, there was no evidence of major flooding at the MEB. Some of the ceiling tiles along the perimeter of the building had some water stains indicating water leaks; however, this did not extend beyond the ceiling tiles to carpets/furnishings. The water stained ceiling tiles had higher surface concentrations of fungi than non-stained tiles. However, airborne fungal concentration measured at MEB during normal office operations were not high; they were lower than those measured outdoors and similar to those from nearby office buildings. The mean fungal concentration measured at the MEB (23 samples) during normal office operation was 75 CFU/m^3; outside fungal concentration (10 samples) were higher than normal indoor MEB concentrations with a mean of 435 CFU/m^3. Four fungal samples collected from nearby office buildings had a mean of 91 CFU/m^3. Airborne fungal concentrations were the highest during filter changing operation due to the release of fungal spores by filter agitation and removal during HVAC operation. The eight fungal samples collected during filter changing were all overloaded at concentrations in excess of 2120 CFU/m^3. Airborne fungal concentrations returned to normal levels once the new filters were in place. These airborne fungal concentrations measured during filter changing operations are high by comparison to levels found in office environments during normal operations; however, the health risk (if any) these exposures pose is not known. There are no adequate standards or guidelines to assess the health effects of occupational exposure to airborne fungi. Workers in other occupations (e.g. agriculture workers) are commonly exposed to fungal levels much higher than any of those measured in the MEB.(14) (NOTE: filter changing operations were not sampled at the other office buildings).

Eight different fungal genera, including seven different aspergillus species, were identified in the samples taken during this survey (Table 8). These were common fungi that could be found in most office environments. Some of the fungi identified in these samples are known to be potential human pathogens; however, these usually only cause infections in individuals who are immunocompromised.[12,13]

Cancer:

A second occupational health concern was raised regarding cancer. Reports given to NIOSH investigators suggested that MEB employees were concerned about the number of cancer cases which had occurred in recent years and the possibility of a relationship to the MEB. We received a list of thirteen cases as described in the results section. These cases had occurred over an eight year period and contained nine different types of cancer including common sites such as lung and breast to less common sites as liver and pancreas. Furthermore, cancer occurs with long (typically 10 years or more) latency periods (time between intial exposure and occurrence of disease). No uncommon or unusual cancers were listed. The age and sex distributions of the reported MEB cancer cases were typical of cancer occurrence in the general population. All of these factors suggest that no unusual cluster exists and do not suggest any relationship to the MEB.[15]

Over the past several years cancer has been increasing in prevalence and is now the second leading cause of death in the U.S. (Heart Disease is number one.) The American Cancer Society projects 17,500 new cases of cancer and 9,000 deaths from cancer in the state of Maryland for 1986. Cancer rates vary by type of cancer, sex, and age group. For the age groups who are employed in MEB the following table gives the over all mortality figures from 1983 for the United States.

Male

All Ages	Age 15-34	Age 35-54	Age 55-74
238,383 (100%)	3903 (1.6%)	25,450 (10.6%)	132,976 (55.8%)

Females

All Ages	Age 15-34	Age 35-54	Age 55-74
204,603 (100%)	3548 (1.7%)	26,497 (13%)	102,382 (50%)

Using the crude projections of 17,500 new cases and 9,000 deaths for the state of Maryland (approximate state population of about 4.2 million). Around 3.4 new cancers and 1.6 deaths per year would occur per 800 population. Also, given that the overall rate of cancer has been relatively stable over the last ten years, about 34 cancers and 16 deaths/800 population would be expected to have occurred in the last 10 years.[16] Given these estimates of morbidity and mortality from cancer, the list of cancers of various organ systems provided to us, and the lack of biologically plausible latency period, we conclude that neither an increased prevalence of cancer, nor building related cancer risk exists for the HCFA MEB employees.

Other Health/Comfort Concerns:

Other health and comfort problems were reported by MEB occupants. Among these, eye irritation/problems, headache, stuffy office air, stuffy nose/sinus problems, and uncomfortable temperatures were the most prevalent complaints. Additional health and comfort complaints included allergy problems, fatigue, runny nose, sore throat, dusty office conditions, upper respiratory tract infections, and others (Table 1). The questionnaire response rate (59%) is less than desirable but average. A low questionnaire response rate can often be weighted towards those individuals with complaints and thereby over state the problem. A majority of the questionnaire respondents (57.6%) from the MEB report experiencing work related discomfort; a smaller percentage reported work related medical problems (35.5%). (NOTE: Some of the work related medical problems included reports of cancer and fungal sinusitis just discussed).

Many of the health/comfort complaints of MEB employees have been commonly reported in similar airtight, multi-story buildings with central HVAC systems. Traditional industrial hygiene methods are often insensitive to these type of health/comfort problems reported in the office environment. In most instances, the reported symptoms can not be attributed to any specific environmental substance/exposure; hence the term 'tight building syndrome' has been used to describe these types of reported health/comfort problems.[8,10,11,17] This is consistent with the results of our evaluation, as well as past evaluations, of the MEB; the etiology of the health/comfort complaints at the MEB can not be directly attributed to overexposure to any particular environmental agent. None of the NIOSH industrial hygiene sampling results from the MEB exceeded existing OSHA PEL's or the exposure guidelines of NIOSH and ACGIH. Most of the environmental analytes sampled at MEB were substantially below these evaluation criteria.

Reduced ventilation rates, inadequate outside air supply, or altered air distribution are commonly associated with the 'tight building syndrome' problems.[8,10,11] It is well-recognized that fresh outside air must be added to closed-circuit building ventilation systems, in adequate amounts, to provide sufficient oxygen for respiration and to dilute the numerous low-level contaminants generated in occupied spaces. ASHRAE recommends a minimum of 5 cubic feet per minute (CFM) of outside air per occupant in a building without smoking; to compensate for increased indoor air pollution from smoking, ASHRAE recommends a minimum of 20 CFM per occupant in a building building where tobacco smoking occurs.[7] The reduction in outside air intake, or distribution, can result in occupant discomfort and complaints similar to many of those reported at MEB.[8,10,11,17,18]

Cigarette smoke is a major contributor to indoor air pollution and its components can cause many of the major complaints reported by MEB building occupants including eye, nose irritation, difficulty with wearing contacts, etc.[8,15] Cigarette smoke contains over four thousand chemicals, many of which are noxious irritants and/or carcinogens or co-carcinogens. Numerous scientific studies have shown a strong relationship between cigarette smoke and respiratory tract disease, heart disease, and cancer. Evidence is mounting for a relationship of cigarette smoke and these diseases in exposed non-smokers as well as smokers.[8,15]

Overcrowding can result in indoor air quality complaints; however, this was not a problem in the MEB. The occupant density in the MEB was approximately 157 ft^2 per employee. The ASHRAE estimated occupancy for use when design occupancy is not known, is about 143 ft^2 per employee.[7] Occupancy density per floor was highest on the 2nd floor (about 142 ft^2 per employee) and lowest on the 1st floor (about 192 ft^2 per employee).

Carbon dioxide (CO_2) concentrations are often used as a marker for adequate outside air intake and distribution. (CO_2 is generated in an office environment through human respiration, tobacco smoke, combustion processes, etc.). As the CO_2 concentrations increase above the normal ambient levels (approximately 330 ppm in non-polluted locations) there is evidence of reduced outside air intake. Increased CO_2 levels indicate insufficient outside air intake (with increased air recirculation) and have been associated with increased discomfort/complaints. Carbon dioxide concentrations in the 600-1000 ppm range are associated with occupant complaints. Carbon dioxide concentrations above 1000 ppm are associated with insufficient make-up air and widespread complaints.[10,11] Short term carbon dioxide concentrations measured in the MEB during the NIOSH surveys ranged from 500 ppm to 1000 ppm with a mean concentration of 743 ppm. CO_2 samples taken outside had a mean concentration of 433 ppm, somewhat higher than normal ambient levels. Consequently, CO_2 concentrations measured inside the MEB indicate some deficiency in outside air intake or its distribution. (Note: The NIOSH environmental surveys were done <u>after</u> the ban on smoking in the MEB).

The ventilation system characterization done at the MEB was an important component of this evaluation in assessing the indoor air quality related to employee complaints. As discussed earlier, the MEB is a modern, air-tight building. The windows in the building do not open and the HVAC is the primary source of outside air supply for building occupants. HVAC flow measurements indicated that the system was operating below design capacity. Measurements taken with a rotating vane anemometer indicated a supply fan flow rate of 126,000 CFM; the design flow rate for the supply fan is 134,195 CFM. Return fan measurements indicated a flow rate of 85,500 CFM compared to a design flow rate of 106,930. HVAC flow measurements taken with a second sampling device, the pitot tube and inclined manometer, were lower than the rotating vane measurements.

Outside air intake for the HVAC system (in the cooling mode with the minimum louver setting) was about 16,700 CFM. This is about 13% outside air intake. Approximately 690 people are employed in the MEB (7/9/86 employee lists); consequently there is about 24 CFM outside air taken into the building for each employee. Outside air supply estimates by floor derived from pitot tube measurements, were lower than those measurements taken with the rotating vane anemometer. Estimated outside air supply and distribution to individual floor includes: 17 CFM/person - ground floor; 22 CFM/person - 1st floor; 15 CFM/person - 2nd floor; and 16 CFM/person - 3rd floor.

The floors with the lower estimated outside air intakes ranging from 15-17 CFM/person (ground, second, and third) had a higher frequency of reported discomfort problems (53 to 69%). The first floor had the highest estimated outside air intake per employee (22 CFM/employee) and the lowest frequency of reported discomfort problems (46%). The first floor also had the lowest average CO_2 concentrations indicating higher outside air intake and distribution.

According to our measurements the outside air intake by floor meets the ASHRAE recommendations for a building where there is no smoking (5 CFM/person), assuming uniform/equal air distribution to all workers. [7] However, uniform air distribution through the variable air volume (VAV) ceiling supply terminals was a problem. (Using the lower air flow measurements taken by floor with the pitot tube, the ground, second, and third floors would <u>not</u> meet ASHRAE recommended outside air intake for a building where tobacco smoking is permitted.)

Many of the VAV ceiling air supply terminals were inoperative or out of adjustment. Most of the supply terminals evaluated on the ground and third floor were operating at flow rates less than design specifications and many were off with no measurable air supply. Consequently air distribution and mixing are suboptional at some locations inside the MEB. This problem was probably increased when smoking was allowed in the MEB in conjunction with other sources of low level air contaminants (off gassing from the addition of new furnishings and carpets, photocopying, cleaning, etc.)

VIII. CONCLUSIONS:

1. A single case of fungal sinusitis was identified among MEB employees; however, this is not suggestive of a relationship to the building environment. There was no evidence of abnormal fungal growth or contamination at the MEB during our evaluation. Airborne fungal concentrations measured during normal office operations were lower than those measured outdoors and not substantially different from concentrations measured in nearby office buildings.

2. There is no evidence (medical or environmental) to suggest an excess cancer rate among MEB employees.

3. Workers in the MEB report symptoms consistent with those commonly described as "tight building syndrome." These types of complaints, including eye irritation, stuffiness, tiredness, headache, nausea, muscle aches, upper respiratory tract irritation, and others are commonly associated with inadequate ventilation, in conjunction with low level indoor pollutants (e.g. tobacco smoke).[8,9,10,11,17]

4. According to our measurements the HVAC system at the MEB was taking in an adequate amount of outside air for a building with a non-smoking environment.[7] However, there were problems with the distribution and supply of this air to building employees. The VAV air supply terminals were the primary cause. Many of these units were had been adjusted to reduce flow to accomodate requests from building employees, had been blocked by employees, were broken, or were out of adjustment and thereby operating at flow rates well below design specification. Consequently, some building occupants are not receiving optimal amounts of outside air. The effects of this situation probably posed a greater problem prior to the smoking ban at MEB.

5. The carbon dioxide levels measured in the MEB were in a concentration range that has been associated with some indoor air quality complaints as determined from research in other offices.[10,11]

6. None of the gases/vapors sampled during the industrial hygiene survey exceeded the OSHA PEL's, ACGIH TLV's, NIOSH criteria, or ASHRAE standards. This is consistent with the findings from the previous evaluations in the MEB. Average airborne total dust concentrations measured inside the MEB were not in excess of ASHRAE recommendations.[7]

7. The temperature measurements taken at the MEB were all within the ASHRAE recommended levels for office environments; however, some of the relative humidity measurements exceeded ASHRAE recommendations.[7]

IX. RECOMMENDATIONS:

1. Rebalance (adjust) the HVAC system to insure that it is operating according to design specification and meeting ASHRAE standards for outside air intake and distribution, indoor temperature, and relative humidity. This rebalancing should include an operational evaluation of the entire HVAC system involving a physical inspection, air flow measurements, electrical measurements, and RPM tests. Special attention should be given to the VAV supply air terminals to insure that they are operating properly (supplying adequate amounts of air according to design specifications, at all times) and that the design specifications provide adequate outside air supply for the workers on each floor. Each VAV supply air terminal should be individually inspected and air flow measurements taken. Adjustments should be made to any HVAC system component as needed to insure the system (including the supply and return fans) meets design specifications and provides adequate amounts of outside air (20 CFM/person at a minimum). To insure proper rebalancing, we recommend that the rebalancing be done by an experienced, reputable HVAC engineer certified in rebalancing by the National Environmental Balancing Bureau, the Sheet Metal and Air Conditioning Contractors National Association, Inc., or a comparable ventilation system balancing authority.

2. Establish a mechanism (protocol) for routine maintenance and surveillance of the ventilation system to ensure ASHRAE standards are met. Special attention should be given to the VAV supply air terminals after they have been balanced to insure continued proper operation.

3. Consideration should be given to maintaining the no smoking policy in the MEB. Based on the evidence concerning cigarette smoke and its many health consequences, coupled with our survey findings and the myriad symptomatic complaints of irritative symptoms, it seems prudent to continue the smoking ban as a positive step toward improving air quality and related health/comfort complaints in the MEB.

4. Develop a more formal medical surveillance system using both the medical unit and the Health and Safety Committee. All employees should be made aware of the existence of the surveillance system and encouraged to report building related medical problems promptly. Having health care personnel confirm diagnoses can help avoid anxieties caused by unconfirmed diagnoses.

5. Rolling/changing of the HVAC roll filters should be done after work hours when the HVAC system is off.

6. The HVAC drain pans and cooling coils should be inspected at least monthly during the summer (cooling) season to prevent blockage, water stagnation, and the excessive biological growth. HVAC drain pans should drain freely without obstruction. Cleaning with detergents or biocides should be done periodically as needed; however, care should be taken to prevent the aerosolization of these substances into the HVAC system and occupied spaces.(19)

7. Repair all internal water leaks promptly and permanently. Water damaged ceiling tiles (or other water damaged materials) should be promptly replaced and discarded.(19)

8. Any recarpeting or refurnishing of large areas in the MEB should be done on the weekend and the HVAC system should be run for the entire weekend. The HVAC operating time should be increased as much as possible during the following work week in order to minimize any odors/irritation and related complaints.

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1. Office of Management and Budget, HFCA
2. Safety Manager, HFCA
3. AFGE Local 1923
4. GSA
5. Equitable Real Estate Investment Management, Inc.

For the purpose of informing affected employees, copies of this report should 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 QUESTIONNAIRE RESULTS
MEADOWS EAST OFFICE BUILDING
MHETA 86-410

RESPONSE: 406 - (59%)

SEX: Male (48%)
Female (52%)

BY FLOOR: Ground: 25%
First: 20%
Second: 29%
Third: 27%

Questions	Responses (%) Yes	No	No Response
Do you currently smoke tobacco products?	22.4	77.6	0
Are tobacco products smoked at your work area?	74.9	20.4	4.7
Have you experienced any significant discomfort related to your current work environment?	57.6	39.4	3.0
Have you changed your usual work activities because of this discomfort?	23.9	74.3	1.7
Have you changed your usual work location because of this discomfort?	9.4	89.3	1.3
Have you requested a change because of this discomfort?	12.4	85.9	1.7
Have you had a medical illness which you suspect is related to your current work environment?	35.5	62.3	2.2
Have you missed work because of this illness?	68.7	29.8	1.4
Have you seen a doctor for this illness?	72.2	26.4	1.4
Have you been treated for this illness?	69.4	29.2	1.4
Have you noticed a hazardous condition in your current work environment?	26.4	68.7	4.9
Have you changed your usual work activities because of this hazardous condition?	22.4	73.8	3.7
Have you changed your usual work location because of this hazardous condition?	2.2	94.3	3.4
Have you requested a change because of this hazardous condition?	16.8	80.3	2.8

TABLE 1 (cont)
INDOOR AIR QUALITY QUESTIONNAIRE RESULTS
MEADOWS EAST OFFICE BUILDING
MHETA 86-410

Symptoms	Percent (%)
Eye Irritation/Problems	31.0
Headaches	18.0
Stuffy Nose/Sinus Problems	14.0
Fatigue	8.4
Allergy	6.4
Sore Throat	5.4
Runny Nose	5.2
Upper Respiratory Infection	5.2
Skin Irritation	3.9
Nose Bleeds	3.7
Frequent Colds	3.2
Cough	3.0
Dyspnea	3.0
Dry Throat	2.0
Dizziness	2.0
Sneeze	2.0
Asthma	1.7
Nausea/Vomiting	1.2
Difficulty Concentrating	0.5
Blurred Vision	0.2
Chest Pain/Tightness	0.2
Confusion	0.2
Fever/Chills	0.2

Problem Conditions	Percent (%)
Stuffy	16.7
Too Hot	13.3
Too Cold	8.9
Too Dusty	8.6
Moldy Odor/Condition	3.4
Chemical Odor	1.7

TABLE 2
TEMPERATURE AND RELATIVE HUMIDITY MEASUREMENTS
MEADOWS EAST OFFICE BUILDING
MHETA 86-410

Time	Date	Location	Temperature (°F)	Relative Humidity(%)
1026	7/9/86	3rd Floor	74	50
1031	7/9/86	1st Floor	70.5	51
1037	7/9/86	1st Floor	70	55
1121	7/9/86	Ground Floor	74	50
1126	7/9/86	Outside	78.5	46
1133	7/9/86	2nd Floor	74	48
1420	8/11/86	1st Floor	74	48
1450	8/11/86	1st Floor	76	46
1500	8/11/86	1st Floor	75	48
1525	8/11/86	Ground Floor	75	48
1550	8/11/86	Ground Floor	74	48
1600	8/11/86	2nd Floor	78	43
1610	8/11/86	2nd Floor	75	48
1625	8/11/86	3rd Floor	76	48
1630	8/11/86	3rd Floor	76	51
1640	8/11/86	3rd Floor	77	48

TABLE 2 (cont)
TEMPERATURE AND RELATIVE HUMIDITY MEASUREMENTS
MEADOWS EAST OFFICE BUILDING
MHETA 86-410

Time	Date	Location	Temperature (°F)	Relative Humidity(%)
0832	8/12/86	Outside	68	64
0905	8/12/86	Ground Floor	74	51
0938	8/12/86	3rd Floor	74	48
1002	8/12/86	1st Floor	73	55
1027	8/12/86	2nd Floor	74	51
1138	3/12/86	Outside	72	54
1430	8/12/86	Outside	76	52
1440	8/12/86	Ground Floor	75	52
1445	8/12/86	1st Floor	74	51
1500	8/12/86	3rd Floor	75	52
0810	8/13/86	Outside	66	66
0847	8/13/86	Ground Floor	73	51
0921	8/13/86	1st Floor	75	48
1000	8/13/86	1st Floor	72	50
1015	8/13/86	1st Floor	74	48
1103	8/13/86	2nd Floor	74	48
1127	8/13/86	2nd Floor	73	51

TABLE 2 (cont)
TEMPERATURE AND RELATIVE HUMIDITY MEASUREMENTS
MEADOWS EAST OFFICE BUILDING
MHETA 86-410

Time	Date	Location	Temperature (°F)	Relative Humidity(%)
1150	8/13/86	3rd Floor	76	46
1212	8/13/86	3rd Floor	75	45
1339	8/13/86	Outside	78	40
1130	9/03/86	2nd Floor	76	55
1136	9/03/86	2nd Floor	74	58
1144	9/03/86	2nd Floor	75	54
1158	9/03/86	Outside	72	73
1231	9/03/86	1st Floor	76	51
1240	9/03/86	Ground Floor	74	54

TABLE 3
HVAC VOLUMETRIC FLOW MEASUREMENTS
MEADOWS EAST BUILDING
MHETA 86-410

LOCATION	VOLUMETRIC FLOW (CFM)[1]
Supply Duct	126,000
Return Duct	85,500
Outside Air Intake	16,500
Relief Damper	257 (Net Incoming)

[1] CFM - Cubic Feet Per Minute

Measurements Made With a Rotating Vane Anemometer

TABLE 4
HVAC VOLUMETRIC FLOW MEASUREMENTS BY FLOOR
MEADOWS EAST BUILDING
MHETA 86-410

FLOOR	NO. BRANCHES SAMPLED	VOLUMETRIC FLOW (CFM)	OUTSIDE AIR (CFM)[1]	NO. EMPLOYEES	AREA SQ. FEET	CFM OUTSIDE AIR/EMPLOYEE	SQ FEET OFFICE AREA/ EMPLOYEE
Ground	2	17,300	2250	134	19,650	17	147
First	2	23,300	3030	139	26,634	22	192
Second	3	25,400	3300	217	30,880	15	142
Third	3	24,900	3240	199	30,880	16	155

CFM - Cubic Feet per Minute
- These measurements were taken with a pitot tube and inclined manometer
- Outside air supply was estimated from percentages determined by rotating vane anemometer

TABLE 5
FORMALDEHYDE CONCENTRATIONS
MEADOWS EAST OFFICE BUILDING
MHETA 86-410

Concentrations in PPM

Sample	Date	Location	Concentration (PPM)
1	8/12/86	Ground Floor	0.005
2	8/12/86	1st Floor	0.005
3	8/12/86	2nd Floor	0.004
4	8/12/86	3rd Floor	0.005
5	8/12/86	Outside MEB	0.001
6	8/13/86	3rd Floor	0.003
7	8/13/86	2nd Floor	0.004
8	8/13/86	1st Floor	0.005
9	8/13/86	Outside MEB	0.005
10	8/13/86	Ground Floor	0.003

Health Standards/Guidelines

OSHA Standard (TWA) - 3 ppm
ACGIH Recommendation (TWA) - 1 ppm
NIOSH* Recommendation - LFL
ASHRAE Standard (C) - o.1 ppm

PPM - Parts Per Million Parts Air
OSHA - Occupational Safety and Health Administration
ACGIH - American Conference of Governmental Industrial Hygienists
TWA - Time Weighted Average
LFL - Lowest Feasible Limit
C - Ceiling Exposure Level

TABLE 6
CARBON DIOXIDE CONCENTRATION BY AREA
MEADOWS EAST OFFICE BUILDING
MHETA 86-410

Concentrations in PPM

Location	Samples	Mean	STD	Range Low	Range High
Outside MEB	6	433	108	300	600
MEB - All Floors	34	743	121	500	1000
Ground Floor	7	757	53	700	800
1st Floor	10	705	142	500	900
2nd Floor	8	788	69	700	900
3rd Floor	9	733	104	500	1000

PPM - Parts Per Million Parts Air
STD - Standard Deviation

TABLE 7
AIRBORNE TOTAL DUST CONCENTRATIONS
MEADOWS EAST OFFICE BUILDING
MHETA 86-410

Concentrations in Mg/m^3

Sample	Date	Location	Concentration (Mg/m^3)
15650	8/12/86	Ground Floor	0.03
15654	8/12/86	1st Floor	0.05
15662	8/12/86	2nd Floor	0.04
15658	8/12/86	3rd Floor	0.04
15666	8/12/86	Outside MEB	0.04
15646	8/13/86	3rd Floor	0.04
15651	8/13/86	2nd Floor	0.06
15652	8/13/86	1st Floor	0.08
15656	8/13/86	Outside MEB	0.12
15655	8/13/86	Ground Floor	0.07

mg/m^3 - Milligrams Per Cubic Meter of Air

TABLE 8
AIRBORNE FUNGAL CONCENTRATIONS
MEADOWS EAST OFFICE BUILDING AND SURROUNDING LOCATIONS
MHETA 86-410

Concentrations in CFU/m^3

Sample	Date	Location	Concentration	Fungal Genera
1	8/12/86	Outside MEB	672	Aspergillus flavus Aspergillus niger Fusarium sp. Penicillium sp.
2	8/12/86	Outside MEB	756	Aspergillus glaucus Alternaria sp. Fusarium sp. Penicillium sp.
3	8/12/86	Ground Floor	113	Alternaria sp. Penicillium sp.
4	8/12/86	Ground Floor	172	Alternaria sp. Fusarium sp. Penicillium sp.
5	8/12/86	3rd Floor	71	Alternaria sp. Mycelia sterilia
6	8/12/86	3rd Floor	35	Alternaria sp. Aspergillus versicolor Penicillium sp.
7	8/12/86	1st Floor	127	Alternaria sp. Penicillium sp.
8	8/12/86	1st Floor	68	Alternaria sp. Penicillium sp.
9	8/12/86	2nd Floor	162	Penicillium sp.
10	8/12/86	2nd Floor	156	Alternaria sp. Penicillium sp.
11	8/12/86	3rd Floor Filter Changing	>2120	Penicillium sp. Fusarium sp
12	8/12/86	2nd Floor Filter Changing	>2120	Aspergillus versicolor Penicillium sp.

CFU/m^3 - Colony forming units per cubic meter of air

TABLE 8 (cont)
AIRBORNE FUNGAL CONCENTRATIONS
MEADOWS EAST OFFICE BUILDING AND SURROUNDING LOCATIONS
MHETA 86-410

Concentrations in CFU/m^3

Sample	Date	Location	Concentration	Fungal Genera
13	8/12/86	1st Floor Filter Changing	>2120	Aspergillus ustus Aspergillus versicolor Fusarium sp.
14	8/12/86	Ground Floor Filter Changing	>2120	Aspergillus glaucus Aspergillus versicolor Penicillium sp.
15	8/12/86	Ground Floor Filter Changing	>2120	Aspergillus glaucus Penicillium sp.
16	8/12/86	1st Floor Filter Changing	>2120	Paecilomyces sp. Penicillium sp.
17	8/12/86	2nd Floor Filter Changing	>2120	Alternaria sp Penicillium sp.
18	8/12/86	3rd Floor Filter Changing	>2120	Alternaria sp. Epicoccum nigrum Penicillium sp.
20	8/13/86	Outside MEB	544	Aspergillus niger Fusarium sp. Penicillium sp.
21	8/13/86	Outside MEB	445	Aspergillus niger Aspergillus ustus Aspergillus glaucus Fusarium sp. Penicillium sp.
22	8/13/86	Outside MEB	415	Aspergillus versicolor Aspergillus niger Fusarium sp. Penicillium sp.
23	8/13/86	Ground Floor	71	Alternaria sp. Penicillium sp.
24	8/13/86	Ground Floor	105	Aspergillus niger Penicillium sp.

CFU/m^3 - Colony forming units per cubic meter of air

TABLE 8 (cont)
AIRBORNE FUNGAL CONCENTRATIONS
MEADOWS EAST OFFICE BUILDING AND SURROUNDING LOCATIONS
MHETA 86-410

Concentrations in CFU/m^3

Sample	Date	Location	Concentration	Fungal Genera
26	8/13/86	1st Floor	56	Alternaria sp. Aspergillus flavus Epicoccum nigrum
27	8/13/86	1st Floor	28	Cladosporium herbarium
28	8/13/86	1st Floor	37	Alternaria sp. Cladosporium sp.
29	8/13/86	1st Floor	113	Aspergillus flavus
30	8/13/86	1st Floor	61	Aspergillus flavus Epicoccum nigrum Fusarium sp.
31	8/13/86	2nd Floor	35	Aspergillus flavus Cladosporium sp.
32	8/13/86	2nd Floor	40	Aspergillus flavus Cladosporium sp.
33	8/13/86	2nd Floor	21	Aspergillus fumigatus Cladosporium sp.
34	8/13/86	2nd Floor	21	Cladosporium sp. Penicillium sp.
35	8/13/86	3rd Floor	64	Cladosporium sp. Penicillium sp.
36	8/13/86	3rd Floor	54	Aspergillus versicolor Alternaria sp. Cladosporium sp.
37	8/13/86	3rd Floor	64	Penicillium sp.
38	8/13/86	3rd Floor	54	Aspergillus flavus Aspergillus niger
39	8/13/86	Outside MEB	210	Cladosporium sp. Fusarium sp. Penicillium sp.

CFU/m^3 - Colony forming units per cubic meter of air

TABLE 8 (cont)
AIRBORNE FUNGAL CONCENTRATIONS
MEADOWS EAST OFFICE BUILDING AND SURROUNDING LOCATIONS
MHETA 86-410

Concentrations in CFU/m^3

Sample	Date	Location	Concentration	Fungal Genera
40	8/13/86	Outside MEB	184	Aspergillus niger Fusarium sp. Penicillium sp.
41	8/13/86	Outside MEB	181	Cladosporium sp. Fusarium sp. Penicillium sp.
1B	8/13/86	Lyon Building	85	Aspergillus fumigatus Alternaria sp. Penicillium sp.
2B	8/13/86	Lyon Building	19	Alternaria sp. Cladosporium sp.
3B	8/13/86	Outside East Low Rise Building	375	Alternaria sp. Aspergillus flavus Penicillium sp.
4B	8/13/86	Outside East Low Rise Building	572	Alternaria sp. Aspergillus flavus Aspergillus niger Fusarium sp. Cladosporium sp. Penicillium sp.
5B	8/13/86	East Low Rise Building	162	Aspergillus flavus Aspergillus glaucus Aspergillus niger Alternaria sp. Penicillium sp.
6B	8/13/86	East Low Rise Building	97	Alternaria sp. Cladosporium sp. Penicillium sp.

CFU/m^3 - Colony forming units per cubic meter of air

TABLE 9
AIRBORNE FUNGAL CONCENTRATIONS BY AREA
MEADOWS EAST OFFICE BUILDING AND SURROUNDING LOCATIONS
MHETA 86-410

Concentrations in CFU/m^3

Location	Samples	Mean (CFU/m^3)	STD	Range Low	Range High
Outside MEB	10	435	203	181	756
MEB - All Floors	23	75	46	21	172
Ground Floor	4	115	42	71	172
1st Floor	7	70	37	28	127
2nd Floor	6	73	67	21	162
3rd Floor	6	57	13	35	71
MEB - Filter Change	8	ALL >2120 (ALL SAMPLES OVERLOADED)			
Surrounding Building	4	91	59	19	162

CFU/m^3 - Colony forming units per cubic meter of air

STD - Standard deviation

TABLE 10
FUNGAL CONCENTRATIONS FROM CEILING TILE SAMPLES
MEADOWS EAST OFFICE BUILDING
MHETA 86-410

Concentrations in Colonies/CM^2

Sample	Type	Location	Concentration	Fungal Genera
261	Stained tile	2nd Floor	12.5	Alternaria sp. Cladosporium sp.
342	Stained tile	3rd Floor	TNTC	Alternaria sp.
3A2	Stained tile	3rd Floor	7	Cladosporium sp. Epicoccum sp.
2H2	Stained tile	2nd Floor	TNTC	Cladosporium sp.
A3	Non-Stained tile	2nd Floor	<1	Aspergillus niger
A4	Non-Stained tile	3rd Floor	<1	Cladosporium sp.

TNTC - To Numerous to Count

APPENDIX A

NIOSH INDOOR AIR QUALITY QUESTIONNAIRE

July 8, 1986
MHETA 86-410

Dear Employee:

The National Institute for Occupational Safety and Health (NIOSH) has been requested to evaluate a possible health hazard which may be related to your office building environment.

This evaluation will be done by NIOSH personnel. As a first step, it is necessary to get an idea of the type and frequency of problems experienced by workers in your building. Therefore, it is important for you to fill out the enclosed questionnaire. Information will be treated confidentially by NIOSH.

After completing the questionnaire, seal it in the enclosed envelope and return it to the nurses station (The Health Unit) on the first floor of the Meadows East Building by 3:00 p.m., July 9th. As an alternative, you may mail the questionnaire directly to NIOSH in the enclosed envelope as soon as possible. NIOSH will base subsequent steps in the evaluation upon review of the completed preliminary questionnaires.

Employee and management representatives will be kept informed of the non-confidential aspects of the NIOSH evaluation and subsequent recommendations. If you have any questions, please feel free to contact me by phone (304-291-4203) or letter (Health Hazard Evaluations, NIOSH, 944 Chestnut Ridge Road, Morgantown, WV 26505).

Sincerely,

Greg J. Kullman, C.I.H.

Enclosures

OFFICE BUILDING EVALUATION QUESTIONNAIRE NIOSH MHETA #86-410

PLEASE COMPLETE THIS QUESTIONNAIRE AND RETURN IT IN THE ACCOMPANYING ENVELOPE

PLEASE PRINT!

Name: ______________________ Date: __________

Age: _____ Sex: _______ Job Title: ______________________

Office Location: Floor _____ Room Number ______ Office Phone # ____________

Years Employed in Current Office: ___________; in Current Building: ________

PLEASE CHECK APPROPRIATE BOXES

A. 1. Do you currently smoke tobacco products? ☐ Yes ☐ No
2. Are tobacco products smoked at your work area? ☐ Yes ☐ No

B. 1. Have you experienced any significant discomfort related to your current work environment? ☐ Yes [answer B.2,3,4] ☐ No [skip to C]
(IF "YES", GIVE DETAILS ON BACK.)

2. Have you changed your usual work activities because of this discomfort? ☐ Yes ☐ No

3. Have you changed your usual work location because of this discomfort? ☐ Yes ☐ No

4. Have you requested a change because of this discomfort? ☐ Yes ☐ No

C. 1. Have you had a medical illness which you suspect is related to your current work environment? ☐ Yes [answer C.2,3,4] ☐ No [skip to D]
(IF "YES", GIVE DETAILS ON BACK.)

2. Have you missed work because of this illness? ☐ Yes ☐ No

3. Have you seen a doctor for this illness? ☐ Yes ☐ No

4. Have you been treated for this illness? ☐ Yes ☐ No

D. 1. Have you noticed a hazardous condition in your current work environment? ☐ Yes [answer D.2,3,4] ☐ No [stop]
(IF "YES", GIVE DETAILS ON BACK.)

2. Have you changed your usual work activities because of this hazardous condition? ☐ Yes ☐ No

3. Have you changed your usual work location because of this hazardous condition? ☐ Yes ☐ No

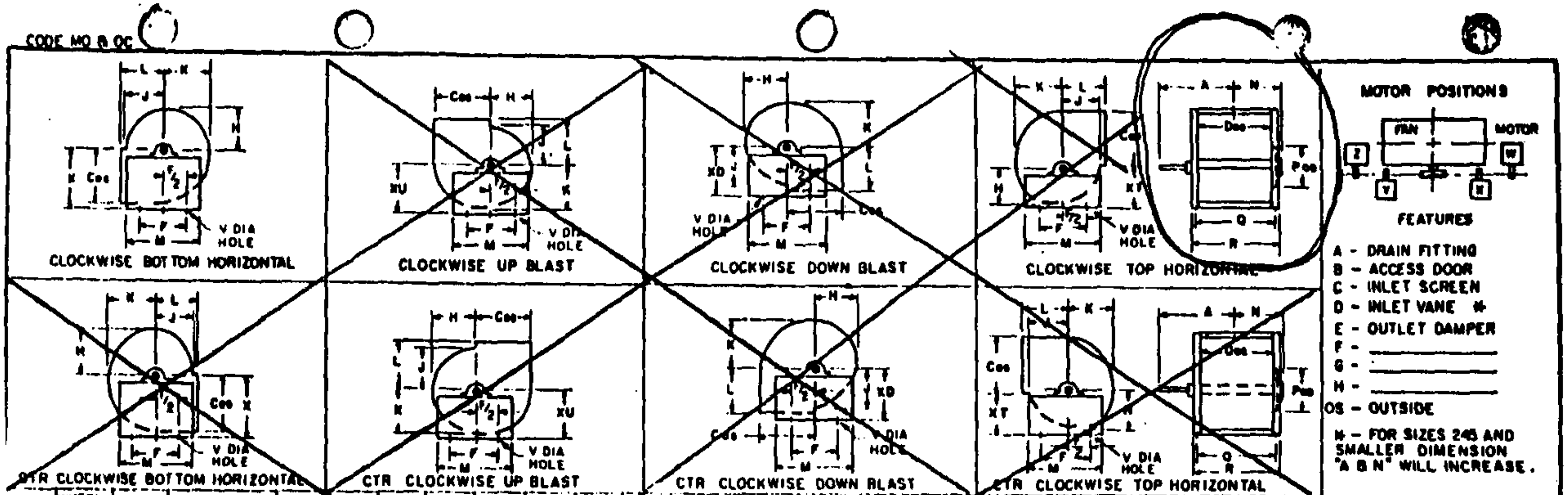
4. Have you requested a change because of this hazardous condition? ☐ Yes ☐ No

FURTHER DETAILS MAY BE WRITTEN ON BACK OF PAGE

APPENDIX B

HVAC FAN DESIGN DATA

CODE MO & OC



SIZE	WHEEL DIA	SHAFT DIA	KEYWAY	A	C	D	F	H	J	K	L	M	N	P	Q	R	V	NO OF V HOLES	X	XT	XU	XD
270	27	2	x x 6	20	29	21	30	22	18	25	21	36	12	29	23	25		4	32	23	26	18
300	30	2	x x 7	24	32	23	33	24	20	28	23	41	13	32	26	28		4	35	26	29	20
330	33	2	x x 7	27	35	25	36	27	22	31	25	44	15	35	28	30		4	38	28	31	22
365	36	2	x x 7	28	39	28	39	30	25	34	28	49	16	39	32	34		4	42	31	35	25
402	40	2	x x 8	31	43	31	44	33	27	37	30	53	18	43	35	37		4	46	34	39	27
445	44	3	x x 8	33	47	39	48	36	30	41	33	56	20	47	40	43		4	50	37	42	30
490	49	3	1 x x 9	37	52	38	53	40	33	45	37	61	21	52	43	46		4	55	41	47	33
542	54	3	1 x x 10	40	58	42	59	44	37	50	40	66	24	57	47	50		4	60	47	52	37
600	60	4	1 x x 11	44	64	46	65	49	41	56	44	73	26	63	51	54		4	67	51	58	41
660	66	4	1 x x 12	48	70	52	72	54	45	61	48	82	30	70	59	64		4	73	56	64	45
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807	80	4	1 x x 14	56	88	62	88	68	55	75	61	99	35	85	69	74		6	89	69	76	55
~~[illegible]~~	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
982	98	5	1 x x 16	64	105	76	105	80	67	91	75	116	42	104	84	92	1	6	108	83	94	67
097	108	6	1 x x 18	71	116	84	116	89	74	101	83	127	46	115	92	100	1	6	119	92	104	74
200	120	7	1 x x 18	76	128	93	128	98	82	112	91	140	51	127	103	113	1	6	131	101	115	82

NOTE: APPROX. WEIGHT W/200 HP MOTOR 4,500#

AN NO	LOCATION	SIZE	CL	ROT	DISCH	MOTOR POS	CFM	OV	SP	BHP	RPM	FEATURES	MOTOR HP	MOTOR RPM	MOTOR V/PH/HZ
S.A.	FAN Room	807	III	CW	BH	W	134195	3570	6.0"	180	645	A,B,E	200	1750	480/3/60

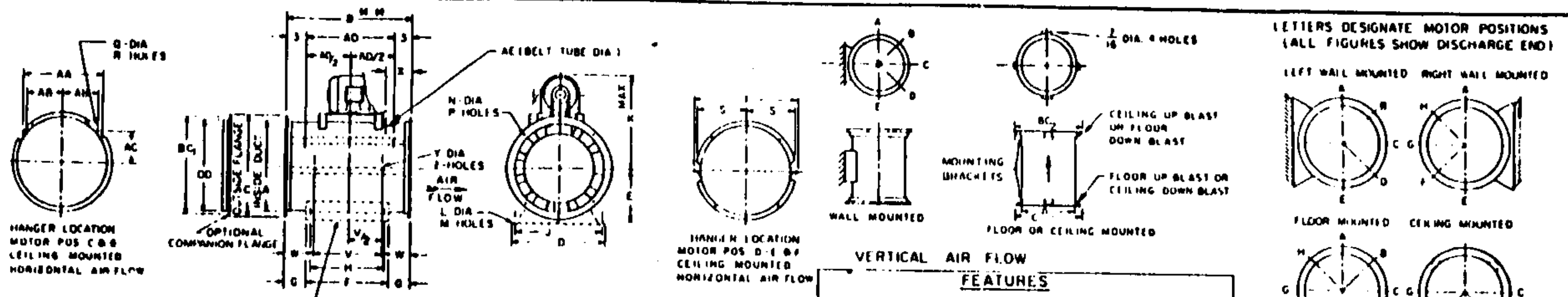
JOB NAME MEADOWS EAST OFFICE BLDG
JOB LOCATION 6300 BLOCK SECURITY BLVD.
BUYER POOL AND KENT CO.
BUYER NO. S-8830-E CARRIER NO. 2230D6017
DIMENSIONS CERTIFIED BY WWW DATE 6/6/72

DATE	SUPERSEDES				
0-7-71	27CC-202-9, REV. A, DATED 1-19-71	ARRANGEMENT NO. 3	27CC CENTRIFUGAL FAN SWSI	CLASS III	27CC-202-9 REV. B

Carrier

27CC

CODE: MO & OC



FEATURES

A - BELTGUARD
B - ACCESS DOOR
C - INLET SCREEN
D - INLET VANE
E - ______
F - ______

NOTE: APPROX. WGHT W/ 75HP MTR 8,500#

** INLET VANE ON SIZES 105 THRU 165 INCREASE DIMENSION "B"

SIZE	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R	S	T	V	W	X	Y	Z	AA	AB	AC	AD	AE	BC_1	BC_2	SHAFT DIA CL I	SHAFT DIA CL II	OD
105	14 1/8	18 1/2	17 1/4	14 3/8	9 1/2	12	3 3/8	9	12 1/8	19 1/4	3/16	4	1/8	8	1/2-13	4	7 1/2	17 1/4	9 1/2	4 1/2	4 5/8	9/16	4	11 3/8	5	6 1/2	12 1/2	5	15 1/2	20 3/8	3/4	1	14 1/2
122	16	21 3/8	19 11/16	16 11/16	11 1/2	14	3 13/16	11	14 11/16	22 3/8	3/16	4	3/16	8	1/2-13	4	9 1/2	19 3/4	12 3/8	4 1/2	4	9/16	4	12	4 1/4	8	15 3/8	5	18	22	1	1 3/16	17
135	18	24	21 1/2	18	12	16	4	13	16	23 1/2	3/16	4	3/16	8	1/2-13	4	10	21 1/2	15	4 1/2	5	9/16	4	14 1/4	5 1/2	8	18	6	20	24	1	1 3/16	18
150	20 3/4	26	23	20 1/2	12 1/2	17 1/2	4 3/4	14 1/2	18 1/2	24 1/2	3/16	4	3/16	8	1/2-13	4	11	23	17	4 1/2	5	9/16	4	17	7 1/4	8 1/2	20 3/8	6 5/8	22 1/2	26 1/2	1	1 3/16	18
165	22	29	25 1/2	22 1/2	14	19	5	16	20 1/2	27 1/2	3/16	4	3/16	8	1/2-13	4	12	25	20	4 1/2	6	9/16	4	18 1/2	8	9	23	7	24	28	1	1 3/16	20
182	24	32	27	24	15	21	5	18	22	29	3/16	4	3/16	8	1/2-13	4	13	27	23	4	7	9/16	4	19	8	9	26	8	26	30	1	1 3/16	22
200	27	35	30	27	16 1/4	24	5	21	25	30	3/16	6	3/16	8	1/2-13	4	14 1/2	30	26	4	8	9/16	4	22	9	10	29	9	29	33	1	1	24
222	30	39	34	30 1/2	18 1/8	26	6 1/4	23	28 1/2	31 1/2	5/16	6	3/16	8	1/2-13	4	16	33	30	4 1/2	8	9/16	4	24	10	12	33	10	32	37	1	1	27
245	33	43	37 1/2	33	19	29	7	26	31	32	1/4	6	3/16	8	1/2-13	4	18	38 1/2	33	5	9	11/16	4	26	11	13 1/4	37	11	35	40	1	1	30
270	36	40	40	36	21 1/2	32	8	29	34	34 1/2	1/4	6	1/16	8	1/2-13	4	19 11/16	41	38	5	10	11/16	4	29	13 1/4	14	42	12	39	43	1	1	37
300	40	45	44	40	23	35	9	32	38	38	1/4	6	1/16	8	1/2-13	6	21 1/4	46	43	5	11	11/16	6	32	14	16	47	13	43	47	1	1	44 3/4
330	44	50	49	45	26	39	9	36	43	44	1/4	6	1/16	8	1/2-13	6	23	50	48	5	12	11/16	6	34	15	17	52	14	47	52	1	1	45
365	49	64	53	49	28	43	10	40	47	46	1/4	4	1/16	8	1/2-13	4	26	54	54	5	14	11/16	4	38	17	19	58	16	52	56	2	2	50
402	54	71	59	54	31	47	12	44	52	49	1/4	4	1/16	8	5/8-11	4	28	59	60	5 1/2	15	1/4	4	42	11	21	65	17	57	*62	2	2	55
445	60	79	65	60	33 1/2	53	13	50	50	51	1/4	4	1/16	16	5/8-11	4	31	65	68	5 1/2	16	1/4	4	45	21	22	73	19	63	*70	2	2	61
490	66	87	71	66	36	58	14	55	64	54	1/4	4	1/16	16	5/8-11	4	34	71	76	5 1/2	18	1/4	6	50	23	25	81	21	69	*	2	2	67
542	73	96	78	73	40 1/2	64	16	61	71	58	1/4	6	1/16	16	5/8-11	6	38	78	85	5 1/2	20	1/4	6	55	26	27	90	24	76	*	2	2	74
600	81	106	86	81	44	71	17	68	79	62	1/4	6	1/16	16	5/8-11	6	42	86	95	5 1/2	22	1/4	6	61	29	30	100	26	84	*	2	3	82
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730	99	129	105	99 1/2	53 3/4	87	21	84	97	75	1/4	6	3/16	16	5/8-11	6	51	105	117	6	27 1/2	1/2	6	74 1/4	35 1/4	37	123	32	102	*	(3)	[illegible]	100
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890	120	150	128	121	65	105	26	102	119	87	1/4	6	1/16	16	5/8-11	6	62	128	145	6 1/2	33	1/4	6	89	42	44	152	39	124	*	3	4	121
902	133	172	141	133	71	116	28	113	131	104	1/4	6	1/16	32	3/4-10	6	68	141	158	7	36	1/4	6	98	47	49	166	48	138	*	4	5	131
1087	147	190	156	147	79	129	30	126	145	111	1/4	6	1/16	32	3/4-10	6	75	155	176	7	40	1/4	6	108	52	54	184	48	152	*	5	6	148
1200	162	209	171	163	86	142	33	139	161	119	1/4	6	1/16	32	3/4-10	6	83	171	195	7	44	1/4	6	119	57	59	203	54	167	*	6	7	165

* VARIES PER ISOLATION

FAN NO	LOCATION	SIZE	CL.	MTG	MTR POS	CFM	OV	SP	BHP	RPM	FEATURES	MOTOR HP	MOTOR RPM	MOTOR V/PH/HZ
RA	FAN ROOM	730	I	FL	–	106,930	2000	2.0	70	600	AB,D	75	1750	480/3/60

JOB NAME MEADOWS EAST OFFICE BLDG
JOB LOCATION 6300 BLOCK SECURITY BLVD
BUYER POOL AND KENT CO.
BUYER NO S-8830-E CARRIER NO 223006017
DIMENSIONS CERTIFIED BY WWW. DATE 5/31/72

Carrier

DATE	SUPERSEDES		
11-2-71	27GA-202-1, REV. A DATED 6-6-70	27GA IN-LINE CENTRIFUGAL (CLASS I & II) ARRANGEMENT 9	27GA-202-1 REV B

27GA

APPENDIX C

OPERATING AND MAINTENANCE INSTRUCTIONS FOR SUPPLY AIR TERMINALS

Dual Moduline® Weathermaster® Air Terminals

INTRODUCTION

37AC DUAL MODULINE WEATHERMASTER'S (see Fig. 1) are ceiling terminal diffusers with self-contained, system-powered control sections. Available in three control arrangements (slave, constant volume, and variable volume), they have a cfm per slot delivery that ranges between 20 and 120 cfm thru a duct static pressure range of 0.50- to 5.0-in. wg.

- **Slave Units** (D configuration) are designed for interconnection with constant and variable volume units.
- **Constant Volume Units** (C configuration) provide constant volume regardless of changing duct pressures.
- **Variable Volume Units** (B configuration) provide complete room temperature control with cold air supply.

The 37AC consists of a plenum, cutoff assembly, and removable center diffuser assembly. The plenum is insulated to reduce heat gain and to attenuate fan or regenerated noise in the air stream. The cutoff assembly is comprised of two internal felted cutoff edges, side panels, and side diffusers. To further reduce air noise, the side panels are provided with additional insulation. The center diffuser assembly is made up of two neoprene-coated fabric bellows, bonded to the center plate, exposed center diffuser bar, and the control retainer assembly.

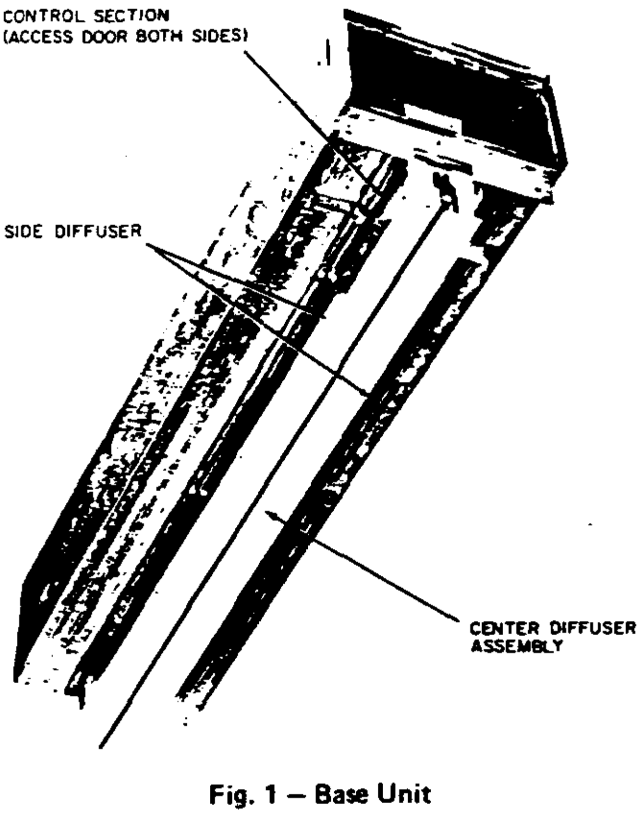


Fig. 1 — Base Unit

Access to the control area of a 37AC unit can be accomplished by removing the control compartment access door located on the side panels or by removing the center diffuser assembly itself. (See Gaining Access To Control Area.)

By familiarizing himself with the following, the system operator will ensure the proper functioning of these units.

OPERATION

Unit Operation

The 37AC units control space temperature by metering cold supply air thru an adjustable bellows. Air flowing thru the 37AC plenum is uniformly distributed along the length of the unit by the distribution baffle (see Fig. 2). Air is then directed to the center of the unit, passed between the bellows and cutoff edges, and discharged thru the slots formed by the center and side diffusers into the room.

The rate of air flow is controlled by varying the width of the slot formed by the bellows and cutoff edges. Each side of a 37AC unit can be controlled independently of the other, or they can be controlled by a common control to provide equal side-to-side air flow.

Constant air delivery is maintained as long as plenum pressure is within the limits specified in Table 1. As plenum pressure increases, bellows pressure also increases resulting in constant air delivery. The reverse action is true with a decrease in plenum pressure.

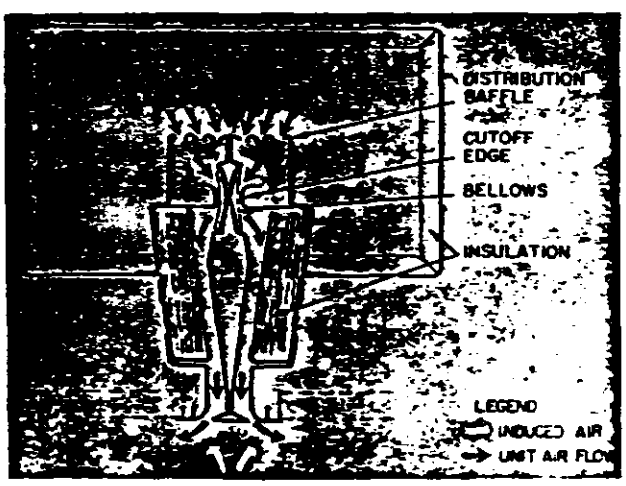


Fig. 2 — Air Flow

Table 1 — Duct Pressures At Specified Air Quantities

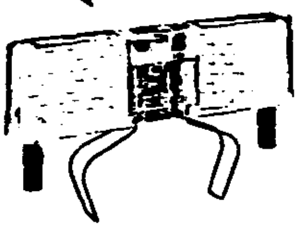
AIR QUANTITY (Cfm/Slot)	DUCT PRESSURE (in. wg)	
	Minimum	Maximum
20 to 50	0.50	
60	0.60	
70	0.75	
80	1.00	5.00
90	1.10	
100	1.30	
110	1.40	
120	1.60	

ntrol Operation

The following paragraphs apply to control :ration of one of two bellows in a 37AC unit. : second bellows can be controlled by the same ıtrol components or by an independent set of ıtrols located in another unit.

AVE UNIT — This unit includes a bellows :mbly which is regulated by control air pressure ıplied from another unit. The bellows is com- ;ed of a neoprene-coated fabric. Increase in ssure inflates the bellows, causing it to auto- tically adjust toward the felted cutoff edge, thus ucing the width of the air slot and reducing air w to the conditioned space.

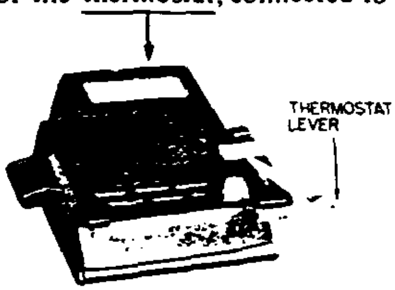
NSTANT VOLUME UNIT — In addition to a s assembly, this unit contains a filter and a uıator. The filter ensures complete filtration of



main air supply to the controls. Control air passes thru the filter and into the regulator. (See Fig. 3.) The regulator supplies control air to position the

ows for desired air flow into the conditioned ce. Any change in duct pressure produces a :esponding change in bellows pressure to main- ı ıstant air flow from the unit. The regulator vıdes constant cfm delivery regardless of the t pressure. (See Table 1.) Cfm per slot delivery be set by adjusting the translucent edge of the rled adjustment dial to the desired cfm on the e. (See Fig. 4.)

RIABLE VOLUME UNIT — This unit operates does a constant volume unit. However, the addition of the thermostat, connected to the bleed



port (orifice cap removed) of the regulator (see Fig. 3) imposes a variable back pressure to the bellows, resulting in a variable air discharge to maintain room temperature.

As the bimetal senses a rise in room tempera- ture, it tends to open the bleed port of the regulator. More control air is then allowed to bleed to the atmosphere, which results in a decrease in bellows pressure and a corresponding increase in unit air delivery. The bimetal responds to changes within a range of 65 F to 85 F with a midpoint of approximately 75 F. An internal asperator in the unit assures constant room air flow over the thermostat bimetal. A lever on the thermostat can be used to vary air into the conditioned space from maximum (as set on the regulator) to a minimum discharge of approximately 12 cfm per slot (cutoff).

NOTE: Adjusting lever toward blue area causes cooler space temperature; adjusting it toward red area, warmer space temperature. Only a slight movement of the lever in either direction is neces- sary to change the temperature several degrees.

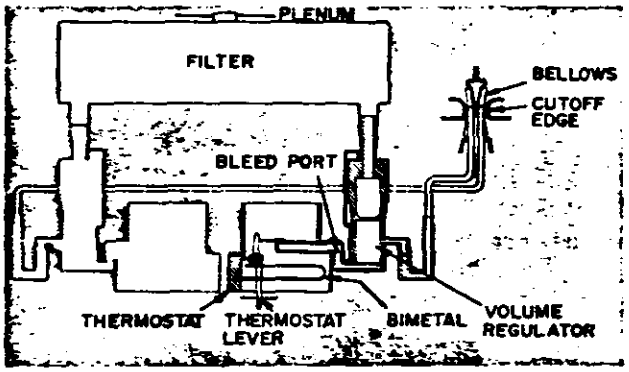
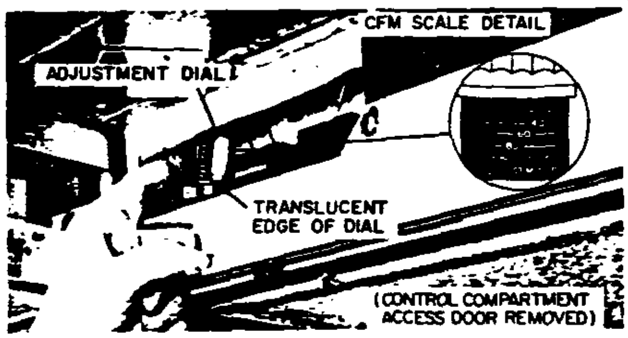


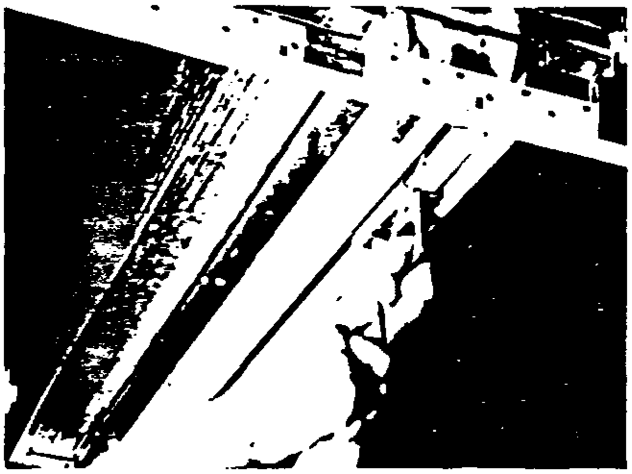
Fig. 3 — Control Arrangement



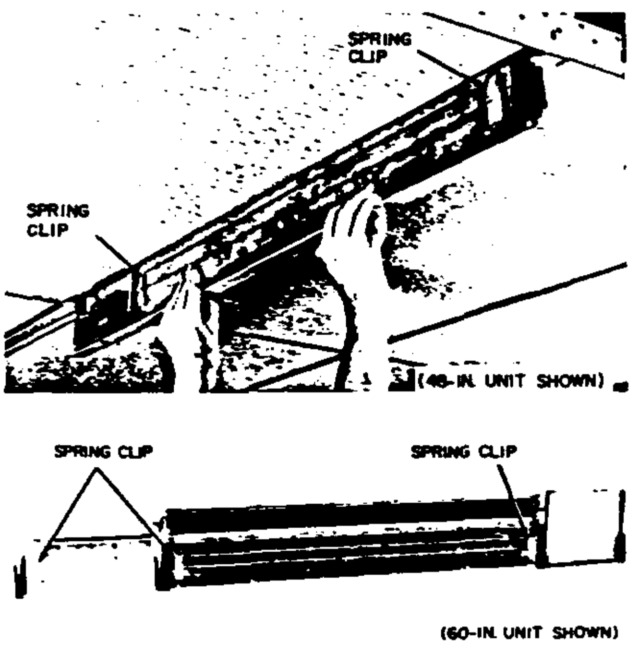
NOTE: Turn adjustment dial until translucent edge of dial reaches desired cfm reading on scale.

Fig. 4 — Setting Volume Regulator

THRU CONTROL ACCESS DOOR



NOTE: To avoid damage to the side diffusers, use long thin screwdriver with protected shank.



THRU CENTER DIFFUSER ASSEMBLY

Fig. 5 — Gaining Access to Control Area

MAINTENANCE

Gaining Access To Control Area

Access to the control area of a 37AC unit can be accomplished in either of two ways: by removing the control compartment access door or by removing the center diffuser assembly. (See Fig. 5.)

Removal of the control compartment access door on the side of the unit is the *preferred* method of access. If this is not possible, however, access thru the center diffuser assembly as follows:

1. Face the right-hand side of the *installed* unit (control section on your left side) and use the accessory center diffuser removal tool and a screwdriver to disengage the center diffuser assembly.
   NOTE: To avoid damage to side diffusers, use a long thin screwdriver with a protected shank.
2. On 48-in. units, affix the removal tool in the area of the left-hand spring clip on the center diffuser assembly. (See Fig. 5.) Locate spring clip (approximately 11 in. from left-hand end of center diffuser assembly), insert screwdriver, and depress spring. Simultaneously, pull removal tool until left-hand side of center diffuser assembly is disengaged (approximately 1/2 in.).
3. Slide removal tool to the area of the right-hand spring clip and affix to center diffuser assembly. Locate spring clip (approximately 2 1/2 in. from right-hand end of center diffuser assembly), insert screwdriver, and depress spring. Simultaneously, pull removal tool until right-hand side of center diffuser assembly is disengaged (approximately 1/2 in.).
4. On 60-in. units, three spring clips must be depressed to remove center diffuser assembly. Refer to Fig. 5 for the spring clip locations.
5. After disengaging center diffuser assembly, start to pull assembly *evenly* from unit. (Assembly, in effect, slides out on a track. Uneven pulling or sudden jerking will cause it to bind in the track.) After assembly has been pulled from unit approximately 5 in., disconnect interconnecting tubing (if applicable).
6. Remove center diffuser assembly from unit.

Component Removal and Replacement

When component replacement becomes necessary, remove the control components in the following order:

- Thermostat
- Regulator
- Filter

The following component removal and replacement instructions are for a left-hand variable volume/right-hand slave unit (BD configuration). When performing these procedures on other models (see Fig. 6), select the instructions applicable for the components contained in that unit.

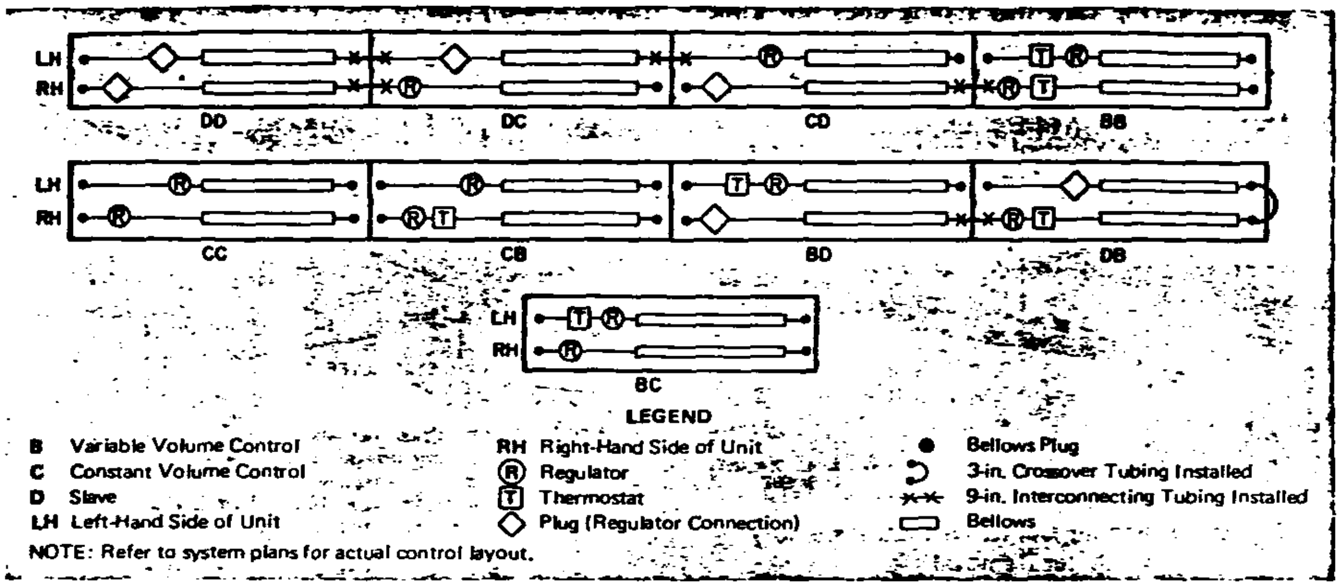


Fig. 6 — Control Arrangements

THERMOSTAT REMOVAL

1. Dislodge thermostat support (see Fig. 7) from groove on top of thermostat and remove baffle.
2. Unseat thermostat port from regulator port by pulling upward.
3. Remove thermostat from unit.

REGULATOR REMOVAL

1. Unseat regulator base assembly port from control block port by sliding regulator upwards (see Fig. 7).
2. Dislodge regulator tapered end (with O-ring) from filter port by pulling downward.
3. Remove regulator from unit.

FILTER REMOVAL

1. Dislodge control air filter from retainer by sliding downward.
2. Remove filter from unit.

When replacing components, replace them in the following order:

- Filter
- Regulator
- Thermostat

FILTER REPLACEMENT

1. If applicable, make sure filter plug is in place for slave side of unit.
2. Insert control air filter in the retainer as shown in Fig. 7.

REGULATOR REPLACEMENT

1. Make sure plug has been removed from the side of the filter in which regulator is to be inserted.
2. Insert tapered end (with O-ring) of regulator into filter port. Seat port on base assembly of regulator into control block port. *Make sure that brass orifice cap remains on the thermostat port connection of the regulator if a thermostat will not be used. If installing a thermostat, remove this orifice cap.*

IMPORTANT: Adjust regulator so that it is seated within the width restrictions of the retainer.

3. Set regulator to design cfm. (See Fig. 4.)

THERMOSTAT REPLACEMENT

1. Make sure brass orifice cap has been removed from thermostat port connection of the regulator. *Make sure that thermostat is fully seated.*
2. Position thermostat support (see Fig. 7) into groove on top of thermostat.
3. Reinstall baffle if applicable.
4. Adjust thermostat lever for desired comfort. (See insert, Fig. 7.)
5. Reinstall control compartment access doors or center diffuser assembly as applicable. If diffuser assembly was removed, reapply putty (3M Synthetic Putty Type 1279 or equivalent) as shown in Fig. 8. When reinstalling center diffuser assembly, push diffuser into slot *evenly*. If applicable, reconnect interconnecting

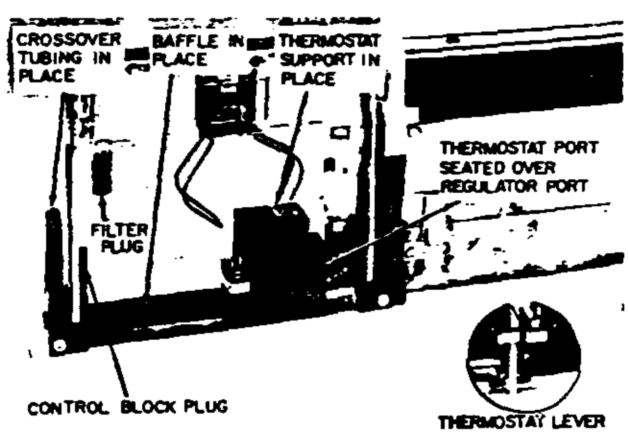


Fig. 7 — Left-Hand Variable Volume/Right-Hand Slave Unit Control Combination

tubing, taking care that tubing does not kink while diffuser assembly is being repositioned. (Diffuser assembly is in place when spring clips catch.)

NOTE: For Control Conversions, refer to 37AC Installation Instructions.

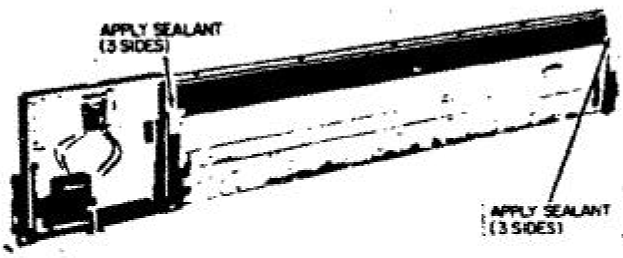
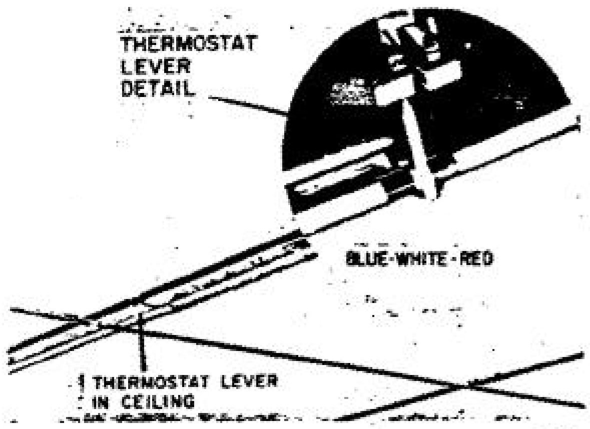


Fig. 8 — Resealing Center Diffuser Assembly After Removal



NOTE: Reading when thermostat lever is set at extreme of *blue* area is approximately 65 F, at *white* area (lever perpendicular) approximately 75 F; and at extreme of *red* area approximately 85 F. *When adjusting thermostat lever, a slight movement results in a change of several degrees.*

Fig. 9 — Locating Thermostat Lever

TROUBLESHOOTING

SYMPTOM	POSSIBLE CAUSE	CORRECTIVE PROCEDURE
ROOM TOO COLD	Thermostat setting Incorrect	Check thermostat setting – *move thermostat lever slightly toward red area. If unit shuts off, leave lever in this (or in an intermediate) position. (See Fig. 9.)*
	Regulator Setting Incorrect	Check actual regulator setting versus design cfm – *readjust regulator setting.*
	Supply Air Temperature Too Low	Check actual temperature of supply air versus design supply air temperature – *if required, raise supply air temperature.*
	Controls Improperly Seated	Check connections between: filter and plenum, regulator and filter, thermostat and regulator – *secure connections as required.*
	Tubing Loose or Kinked; Control Plugs Not Properly Installed	Check interconnecting or crossover tubing; caps on end of bellows; refer to job drawings; check control arrangement – *secure as required.*
	Unit Controlled By More Than One Set of Controls	Check job drawings for proper control arrangement – *make changes as required.*
	Filter Clogged	Visually check filter media – *replace only if excessively dirty. (Normally, filter will not require replacement.)*
	Air Flow To Filter Obstructed or Bellows Punctured	Remove center diffuser assembly and visually inspect – *replace center diffuser assembly.*
	Duct Pressure Incorrect	Measure duct pressure – *verify per Table 1.*
	Regulator Defective	Check regulator operation with thermostat lever set at extreme blue area – *replace regulator if unit air flow does not decrease when regulator cfm setting is decreased.*
	Thermostat Defective	Check thermostat operation – *replace thermostat if temperature at thermostat is below 75 F and air flow does not shut off when lever is at extreme red area.*
ROOM TOO WARM	Thermostat Setting Incorrect	Check thermostat setting – *move thermostat lever slightly toward blue area. If air is discharged from unit, leave lever in this (or in an intermediate) position. (See Fig. 9.)*
	Regulator Setting Incorrect	Check actual regulator setting versus design cfm – *readjust regulator setting.*
	Supply Air Temperature Too High	Check actual temperature of supply air versus design supply air temperature – *if required, reduce supply air temperature.*
	Duct Pressure Incorrect	Measure duct pressure – *verify per Table 1.*
	Unit Controlled By More Than One Set of Controls	Check job drawings for proper control arrangement – *make changes as required.*
	Regulator Defective	Check regulator operation with thermostat lever set at extreme blue area – *replace regulator if unit air flow does not increase when regulator cfm setting is increased.*
	Thermostat Defective	Check thermostat operation – *replace thermostat if temperature at thermostat is above 69 F and cfm is not per design when lever is at extreme blue area.*

For replacement items use Carrier specified parts.

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