(9)

University of Connecticut Health Center
Department of Medicine

Division of
Occupational
and
Environmental Medicine

The Ergonomic Technology
Center
of Connecticut

498-1570 Phone
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February 16, 2000

Mike Petosa
Office of the Chairman
State of CT Workers' Compensation Commission
Capitol Place
21 Oak Street/ 4th Floor
Hartford, CT 06106

Re: Industrial Hygiene Report
Department of Revenue Services
25 Sigourney Street (17th floor)
Hartford, CT

Dear Mr. Petosa,

Attached is the industrial hygiene report I have prepared at the request of the A&R union. The report focuses on several indoor air quality parameters at the Department of Revenue Services' 25 Sigourney Street (17th floor) office building in Hartford. It is my understanding that you will share this report with the appropriate personnel.

Please feel free to call me with any questions concerning the report. It has been a pleasure working with you on this project.

Sincerely,

Anne L. Bracker, MPH, CIH
(860) 679-2369 FAX: 679-1349
679-1000 operator ##

encl.

An Equal Opportunity Employer

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Industrial Hygiene Report

Department of Revenue Services
25 Sigourney Street (17th Floor)
Hartford, CT 06106

Report Prepared by:
Anne Bracker, MPH, CIH
February 16, 2000

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Background

The Department of Revenue Services (DRS) has had a history of Indoor Air Quality (IAQ) complaints from employees that work in its 25 Sigourney Street office building. The complaints began when the DRS occupied the building in 1994. The DRS occupies the 5th, 6th and 14th- 20th floors of the 20-story building. The first four levels of the building are used as a parking garage. At the request of the Administrative and Residual Employees union (A&R), I completed a focused Indoor Air Quality investigation. The focus of my investigation was on several IAQ parameters associated with "Zone 4" on the West Side of the 17th floor (see attached map).

This report addresses four parameters that can affect indoor air quality: bioaerosols, the ventilation system, thermal comfort and air pollutants. Information for this report was gathered during walkthrough surveys conducted on 12/21/99, 1/18/00, 2/1/00 and 2/14/00. Additional information was gathered through the review of relevant MSDSs, ventilation system design data and previous indoor air quality assessments. Mike Petosa, A&R union; Mark Thibedeau, DRS Business Manager and Vibha Buckingham and Maurice Halle of Tunxis Management played helpful roles throughout the site visit.

Overview of Symptoms

Employees who work near "Zone 4" of the building's 17th floor have complained of a constellation of symptoms. These employees temporally associate their symptoms with the building. The symptoms include dry cough, itchy eyes, sinus problems, rashes, headache, nausea, dizziness and lethargy. In addition, employees have reported intermittent foul odors. It is my understanding that some employees reported a worsening of symptoms in the fall of 1999 when the air handling system switched to a heating mode; construction activity began on exterior terraces and a partitioned office area was erected for Mr. Legault.

Overview of earlier IAQ Investigations

IAQ surveys of the Sigourney Street office building have been completed on several occasions since the building's occupancy in 1994. ConnOSHA's consultation and compliance staff and several private consultants have evaluated the 17th floor and other regions of the building. CO_2 levels, a surrogate for ventilation efficiency, were documented on repeated occasions. Bioaerosol levels inside and outside of the building were measured during different seasons. Air samples for selected chemical contaminants were collected during renovation and construction activities. Temperature and relative humidity measurements were recorded during each investigation. In addition visual observations and intervention recommendations were documented in these reports.

Bioaerosols

Bioaerosols are microorganisms or particles, gases, vapors, or fragments of biological origin that are in the air. Bioaerosols are everywhere in the environment. The most common microorganisms found indoors are fungi and bacteria. Some bioaerosols, when breathed in, can cause diseases. Microbial growth increases in dirty, moist environments. Therefore, porous materials should be removed if they become water damaged. Good housekeeping is essential.

25 Sigourney Street was constructed primarily from masonry and metal approximately fourteen years ago. The building has had a history of recurrent water damage. Following a rain, water frequently has entered the building around the perimeter- especially on the floors with Terraces (17 and 19) or the floors directly below the Terraces (16 and 18). A renovation project to abate the water incursion was initiated in the late spring of 1999. The project was completed in January 2000. The abatement work involved removing, repairing and replacing the coping.

Water-Damaged Wall and Microbial Contamination

The wall to the right of Terrace 9 showed visible water damage and possible mold growth. A bulk sample of what appeared to be compound was submitted to P&K's microbiology lab for analysis. The lab identified fungal levels of 19,000 and 17,000 CFU/g using CMA and MEA media (see attached results). *Acremonium* was the dominant fungus identified. *Stachybotrys chartarum* (= *Stachybotrys Atra*) was detected.

Acremonium is a moisture loving fungi that can grow when building materials become wet. *Acremonium* should be considered allergenic.

The presence of *S. chartarum* indicates that there have been chronic leaks or flooding in this area. *S. chartarum* is a greenish-black fungus that can grow indoors on water damaged building materials with cellulose content. *S. chartarum* can produce mycotoxins. Symptoms consistent with an allergic or toxic response to *S. chartarum* include respiratory illness, cold and flu symptoms, headaches, rashes and generalized malaise.

The New York City Department of Health proposed a guideline for evaluating and remediating microbial contamination involving *S. chartarum* (attached). In all cases, the cause of the water damage must be fixed or the problem will occur. Cleanup involves removal of all contaminated absorbent materials and disinfection of the surrounding area. Cleanup workers should be trained and wear protective equipment. The level of containment necessary depends on the extent of the contamination. The water-damaged wall should be removed according to the guidelines in the NYC document.

The extent of additional microbial contamination near Terrace 9 is unclear. During the site visit I used a Delmhorst Moisture Tester Model BD-2000 to test surfaces for percent moisture content. The wall to the right of the terrace showed no evidence of moisture. Although the wall to the left of the terrace showed no visible evidence of water damage, the meter detected 1.6-4.7% moisture content. Additional bulk samples of drywall sheetrock were collected on February 14, 2000 from the right and left sides of the terrace near the baseboard. The samples were submitted to P&K's analytical laboratory for analysis. A consultant should characterize the extent of interior water damage and potential microbial contamination (see attached list).

Water-Damaged Carpet and Potential Microbial Contamination

According to readings taken with the Delmhorst Moisture meter, the carpet beneath the filing cabinet in "Zone 4" of the 17th floor continues to be wet. These squares of carpet should be removed.

It is my understanding that the 2' x 2' removable squares of carpeting near Terrace 9 repeatedly have become saturated with water. After the carpet squares had dried, it is my understanding that some were reused in the building. As discussed in the other consultants' reports, water damaged porous materials often support microbial growth long after they appear dry. I am concerned that the carpeting may continue to represent an ideal environment for microbial growth. At a minimum, water-damaged carpet squares should be removed from the areas where employees have reported symptoms or the carpet gives off a musty odor. Carpet cleaning is rarely effective in removing microbial contamination.

On February 14, after a rainstorm, the carpet in front of the terrace was dry.

Interpretation of Historical Bioaerosol Sampling Results

The bioaerosol sampling results summarized in previous industrial hygiene reports have been unremarkable. Indoor concentrations have repeatedly been lower than outdoor concentrations. The hierarchy of microbial species detected indoors have been similar to the hierarchy of species detected outdoors. There is no government standard for a permissible bioaerosol level in indoor air. Although some quantitative values have been proposed, they are difficult to apply universally because of the difference in sampling protocols, sampling times, preparation of sampling media, incubation times and temperatures, and sampling strategy decisions. Although the bioaerosol results are unremarkable, remediation and continued evaluation is essential because microbial growth (*S. chartarum and Acremonium*) was confirmed in a bulk sample collected inside the building.

Summary of Recommendations Concerning Bioaerosols

- Better characterize the extent of interior water damage and potential microbial contamination.

- Remove water damaged porous materials including water-damaged carpet squares and drywall. Observe New York City Department of Health's Remediation Recommendations for area contaminated with *S. chartarum*.

- Insure that water incursion has been abated.

The Ventilation System

Ventilation systems supply and distribute conditioned air to occupants. Ventilation systems that supply and distribute an adequate volume of outside air can dilute the concentration of indoor contaminants. Ventilation systems should be maintained so that they do not become a reservoir for microbial growth.

System overview

Conditioned air is supplied to the 17th floor through a Variable Air Volume (VAV), multi-zone system. The windows on the floor do not open. Outside air from the building's roof-top penthouse travels through a duct and mixes with the 17th floor's recirculated air in the North and South mechanical rooms. A minimum of 20% outside air mixes with the returned air. After passing over a series of filters and heating or cooling coils, the conditioned air continues on through circular and fiberboard ducts until it is distributed to the occupied spaces through VAV boxes. The air is not humidified. Temperature control thermostats are located in each area served by a VAV box. The boxes are set to be open a minimum of 20 %. Perimeter VAV boxes have reheat coils. Air is returned to the mechanical rooms through a ceiling plenum. Air from the 17th floor does not mix with air from other floors of the building.

Supply of Outside Air

According to the "as built" design specifications (1994 prints), the VAV units are capable of supplying the recommended 20 cfm outside air per occupant[1]. 108 to 135 people occupy the 33,000 ft^2 17th floor. There may be periods of time, however, when the desired temperature in a given zone has been reached and some of the tempered air is diverted to other zones served by the system. At these times, minimal airflow will be detected through the given zone's diffusers because its damper will have closed to 20

[1] Total of minimum VAV set points: 6830 cfm or 1366 cfm outside air.
Total of maximum VAV set points: 33,930 cfm or 6796 cfm outside air.

percent capacity. Given the current occupancy of the floor, the air handling system may not always supply occupants with 20 cfm outside air. The VAV boxes have not been tested and balanced since 1994.

Historical CO_2 measurements appear to confirm that an adequate supply of outside air is distributed to the 17th floor on most days (Table 1). The data are difficult to interpret because occupancy data were not included in the reports. CO_2 is a normal constituent of exhaled breath. CO_2 measurements can be used as a screening technique to evaluate whether or not adequate quantities of outdoor air are being introduced into a building. Under steady state conditions, (7-occupants/1000 ft2 for several hours) if indoor CO_2 concentrations are more than 1000 ppm there may be inadequate dilution ventilation. (NIOSH: "Guidance for Indoor Air Quality Investigations- 1987")

Table 1: 17th floor: Historical CO_2 Air Monitoring Data

Date	Time	CO_2	Instrument	occupancy
3/3/98	9:00-5:00	500-620		
12/14/98	2:40-3:50	1312-1700	TSI, Q-Trak	
12/16/98	10:05-11:30	625-730	TSI, Q-Trak	
3/5/99	10:25-13:30	660-884	TSI, Q-Trak	

It is my understanding that the 12/14/98 CO_2 excursions above 1000 ppm may have been due to an "out-of-calibration" sampling instrument, faulty thermostats or high occupancy. It is possible, however, that on that date the majority of the VAV boxes only were open to their minimum set points resulting in an inadequate supply of outside air.

The CO_2 measurements recorded during my site visits are summarized in Table 2. The measurements suggest an adequate volume of outside air per occupant on the date and time the samples were taken.

Table 2: 17th floor, Zone 4: CO_2 Air Monitoring Data

Date	Time	CO_2	Instrument	Occupancy
1/18/00	11:00	900	Draeger Colorimetric	4-5/1000 ft^2
2/1/00	1:55	800	Draeger Colorimetric	5-7/1000 ft^2
2/14/00	3:50	650	Draeger Colorimetric	5-6/1000 ft^2

Air filtration: Outside and re-circulated air currently is filtered through Tri-Pleated extended surface pre-filters and Syn-Pac synthetic fiber pocket filters. According to the technical data sheets, the prefilters have an atmospheric efficiency rating of 25-30% per

ASHRAE 52-76. The pocket filters have an atmospheric efficiency rating of 80-85% efficiency per ASHRAE 52-76. The filters are changed on a routine maintenance schedule. In order to remove fungal and bacterial spores, filters should have a 50-70% efficiency rating for 2 um particles. A visual assessment of the ductwork was not possible because of the absence of access panels.

Air distribution: Because the partitions extend from floor to ceiling, Mr. Legault's newly constructed office does not receive a supply of outside air when the door is closed. There is no supply air diffuser in his room.

Summary of Recommendations Concerning the Ventilation System:

- Test and balance the VAV boxes to confirm that they operate as designed.
- Given current occupancy, evaluate whether or not the minimum set points of the VAV system supply the proper amount of outside air per occupant.
- Consider strategies to supply dilution ventilation to Mr. Legault's newly constructed office.

Thermal Comfort

ASHRAE Standard 55-1992 (Thermal Environmental Conditions for Human Occupancy) recommends that temperature be maintained in the range of 68-76°F during the heating season and that relative humidity be between 30-60%. During the winter months, the relative humidity has consistently been below 30%. Although low relative humidity is common in our region, some employees may experience eye and throat irritation and dry skin. Humidification is not recommended.

Humidity should be kept below 60% to prevent dust mite amplification and microbial growth.

Table 3: Temperature and Relative Humidity Measurements

Date	Temperature (°F)	Relative Humidity (%)
12/14/98	74.3-76.7	16.5-18.9
12/16/98	72-74	19-20
3/5/99	74-76	16-20
1/18/00	71.5	10.5
2/1/00	73.3	15.9-16.8
2/14/00	72.3	26.2

Air Pollutants

Renovation activity on the terraces was initiated to abate the ongoing problem of water leaks. In addition to replacing the coping stone, the construction activity involved a waterproofing process- sealing the brick openings, brushing the surface with primer, rolling out wall flashing and securing stainless steel water protection barriers over the wall flashing. The primer used by the subcontractor was "W.R. Grace Bituthene P 3000 Primer". According to the MSDS, the primer contains xylene, toluene, ethyl benzene and naphthenic oil. ConnOSHA did not detect these chemicals in the air samples collected on November 16, 1999. An outside contractor did not detect elevated levels of these chemicals or particulate (a surrogate for asphalt fume) when they collected air samples on November 17, 1999. Renovation activity was completed in January 2000.

Chemical contaminants associated with other point sources do not appear likely.

- The 17th floor has not had a history of pesticide applications.
- The office area is cleaned at night when the building is not occupied.
- Chemicals were not used to construct Mr. Legault's office- the partitions clipped together.
- 25 Sigourney Street is a non-smoking building.

Summary

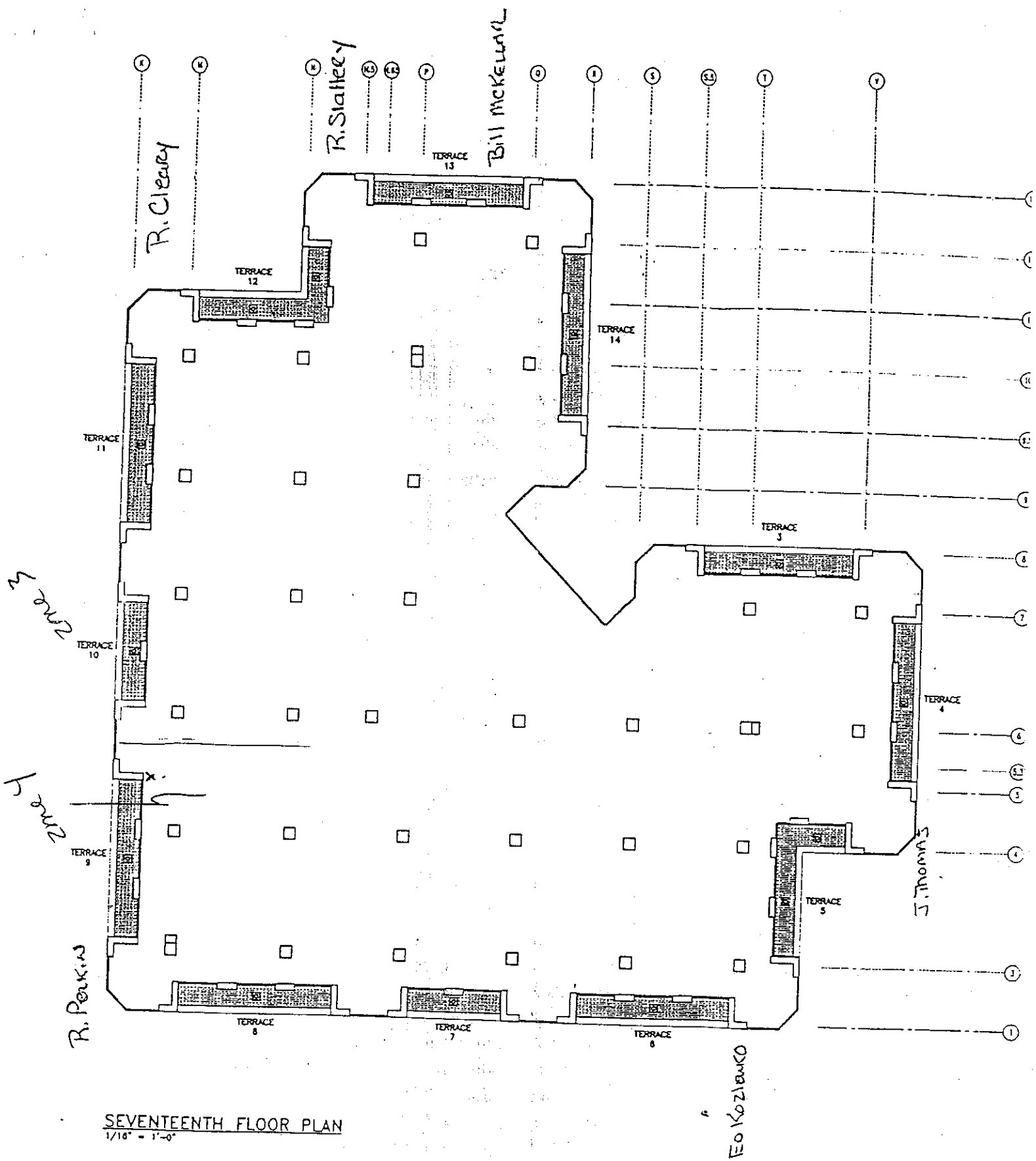
The removal of water-damaged porous materials from the interior of the building continues to be the most important IAQ intervention recommendation that can be made. The NYC Department of Health's Guidelines should be observed during the remediation of materials contaminated with *S. chartarum*.

In addition to insuring that moisture incursion has been abated, a consultant should characterize the extent of interior water damage and potential microbial contamination.

Ventilation systems that supply and distribute an adequate volume of outside air can dilute the concentration of indoor contaminants. The DRS should insure that when the VAV boxes operate as designed, they supply an adequate volume of outside air per occupant.

Respectfully Submitted,

Anne L. Bracker, MPH, CIH
Industrial Hygienist
UCHC/DOEM
(860) 679-2369



SEVENTEENTH FLOOR PLAN

1/16" = 1'-0"

P & K Microbiology Services, Inc.

Tel: 856-427-4044
Fax: 856-427-0232

The Environmental Microbiology Specialists

1950 Old Cuthbert Road Unit L, Cherry Hill, New Jersey 08034

Client: University of Connecticut Health Center, Farmington, CT
Project ID: 17th Fl - near Hunter
Date sampled: January 18, 2000
Date of inoculation: January 19, 2000
Samples submitted By: Anne Bracker
Date characterization completed: January 26, 2000
P&K Report No.: 011900-04

Fungal / Bacterial Analysis

Bulk Samples

Sample ID	Weight used (g)	Medium used	Dilution factor	Fungal / Bacterial ID	Colony counts	Conc. ** (CFU / g)	Percentage* (%)
				Fungi			
Bulk - 17th Fl.	0.107	CMA	100X	Acremonium	19	17,757	95
				Stachybotrys chartarum	1	935	5
						Total: 18,692	
				Fungi			
		MEA	100X	Acremonium	18	16,822	100
						Total: 16,822	

* Percentage of each group of fungi / bacteria in total population.

** Concentration is (CFU/Sample) if sample amount is NA.

Media types: Cellulose agar (CA), Czapek cellulose agar (CCA), cornmeal agar (CMA), 2% malt extract agar (MEA), 2% malt extract agar plus 20% sucrose (MEA+S), inhibitory mold agar (IMA), Pseudomonas isolation agar (PIA), rose bengal agar (RBA), tryptic soy agar (TSA), nutrient agar (NTA), Staphylococcus Medium 110 (Staphy).

Approved by: _____

Chin S. Yang, Ph.D., Microbiologist

Quality control checked by: _____

Consultants who bring expertise and experience to problems related to moisture incursion in buildings.

Joseph Lstiburek, PE
Building Science Corporation
273 Rossett Road
Chestnut Hill, MA 02167
(617) 323-6552

William A. Turner, PE
The H.L. Turner Group Inc.
RR1 Box 535A
Harrison, ME 04040
(207) 583-4572

Gil Cormier, CIH, CSP
Occupational Risk Control Services
103 Mansfield Ave.
New Britain, CT 06051
(860) 229-5352

The following is a list of Microbial Remediation Companies compiled by Gil Cormier. I do not have direct experience with their work

TechClean	516-454-9595
International Environmental Diagnostics	914-591-6651
Commercial Drying Technologies	516-739-0904
Steamatic of Central Connecticut	203-248-6073 ext. 11 for Vincent
Interior Maintenance Company	610-626-1300
Ramco Environmental	888-223-3323 Scott Rudder
Murdock Asbestos and Deleading	203-483-8000
ACES Asbestos and Lead Removal	860-828-3400 Stan Stachura Jr.

Source - Fungi & Bacteria in Indoor Environments

Johanning, Yang ed. 10/6-7/94

GUIDELINES ON ASSESSMENT AND REMEDIATION OF *STACHYBOTRYS ATRA* IN INDOOR ENVIRONMENTS

Sponsored by:

New York City Department of Health
New York City Human Resources Administration
Mount Sinai-Irving J. Selikoff
Occupational Health Clinical Center

Editorial note: Because of frequent requests we present here the consensus guidelines from a recent expert panel meeting related to the topic of assessment and remediation. Participants were, among others, Dr. P. Morey, Dr. B. Sorenson, Prof. B. Jarvis, Dr. D. Miller, Dr. C. Yang, and Dr. E. Johanning.

ENVIRONMENTAL ASSESSMENT

Criteria for Initial Inspection

Reports about potential *Stachybotrys atra* contamination in buildings should be followed up to ascertain whether a site inspection is warranted. The criteria for conducting an initial inspection include:

(1) presence of visible mold;
(2) evidence of water damage;
(3) symptoms which are consistent with an allergic or toxic response to *Stachybotrys atra* (e.g., respiratory illness, rashes and chronic fatigue) and are severe enough as judged by medical documentation to result in lost work days.

Inspection Procedures

If visible mold, water damage, and occupants exhibiting related symptoms serious enough to result in lost work days are present, a site inspection should be conducted. The results of all site inspections should be compiled into a written report, and made available to the building owner, employer and

Based on a panel discussion, May 7, 1993, District Council 37 AFSCME, 125 Barclay Place, New York, NY 10007.

employee representatives in the affected areas. Such an inspection should be conducted according to the following protocol:

Visual Inspection

Visual inspection is the most important initial step in identifying a possible contamination problem. Visual identification of black mold in chronically-wet areas is considered to be a possible indicator of *Stachybotrys atra*. Ceiling tiles, gypsum wall board, cardboard, paper, and other cellulosic surfaces should be given careful attention during visual inspection. The extent of any water damage and mold growth should be evaluated as this will be important in determining remedial strategies. Ventilation systems should also be visually checked, particularly for damp filters.

Bulk Sampling

a. If only a limited area is affected (i.e. all or part of an area that is approximately 30 square feet or less), the water damage is the result of a known occurrence, and no occupants are experiencing symptoms, then bulk (or other sampling) is not required. Remediation (as described under Remediation, Section A) should proceed without further evaluation, under the assumption that *Stachybotrys atra* or (other fungal contaminants) are present.

b. Bulk samples should only be used to document the presence and extent of *Stachybotrys atra* if extensive areas are affected, for example if visible mold occurs on areas larger than one wall board panel and water damage is a chronic problem, or if occupants are experiencing symptoms which may be related to *Stachybotrys atra* exposure.

c. When bulk sampling is required, designated personnel should collect bulk samples from appropriate areas (e.g. damp, moldy, cellulose-derived material) by scraping surface materials into a clean Ziploc plastic bag or by stripping the suspect surface with vinyl acetate tape.

Air Monitoring

a. Air sampling for *Stachybotrys atra* should not be part of a routine assessment. This is because air sampling methods for *Stachybotrys atra* are prone to false negative results and therefore cannot be used to rule out contamination. In addition, when the size of the affected area is small or moderate, decisions about appropriate remediation strategies can be made on the basis of visual inspection and bulk sampling.

b. Air monitoring may be required if there is evidence from visual inspection or bulk sampling that ventilation systems may be contaminated. The purpose of such air monitoring is to assess the extent of contamination throughout a building.

c. If air monitoring is conducted, personnel conducting the sampling must be trained in proper air sampling methods for microbial contaminants.

STATE OF CONNECTICUT

DEPARTMENT OF REVENUE SERVICES

TWENTY-FIVE SIGOURNEY STREET HARTFORD, CONNECTICUT 06106

DLB cc

MEMORANDUM

MAR 0 3 2000

TO: Donna Baisley, Assistant Director of Operations
DPW Facilities Management
165 Capitol Avenue
Hartford, CT 06106

FROM: Kevin G. Forsa, Director of Administration
Department of Revenue Services
25 Sigourney Street
Hartford, CT 06106

DATE: March 3, 2000

RE: Environmental Concerns - 25 Sigourney Street, Hartford, CT

Reference is made to the enclosed University of Connecticut Health Center Report dated February 16, 2000. This report was forwarded to the Department of Revenue Services (DRS) by the Administrative and Residual Employees Union.

As you may be aware, the employees of the Department of Revenue Services have had continuing concerns regarding air quality since the agency became a tenant at 25 Sigourney Street in 1994. To date, the majority of the effort and expense of investigating and, when necessary, taking corrective action has been borne by DRS.

Due to increasing service demands and a simultaneous decrease in available resources, DRS is no longer able to sufficiently reallocate personnel to address building environmental concerns. As such, the agency is requesting the health and safety component of DPW Facilities Management assume the role of investigating and resolving environmental issues at 25 Sigourney Street. It is our understanding that this is the usual arrangement for agencies housed in DPW owned buildings.

It is important to point out that this request for assistance should not be interpreted as any decline in commitment by DRS management to address health and safety issues raised by its employees. Rather, it is a deliberate action to ensure that employee safety concerns continue to be appropriately addressed in a timely manner. My office will remain the point of registration for DRS employee facility concerns, and it will actively monitor the progress made in resolving each issue forwarded to DPW for attention.

It is requested that you review the enclosed report and contact me regarding the actions that will be taken to implement the recommendations contained in it. If you should have any questions or require any additional information regarding this matter, please contact me at 297-5660.

KGF/v
Cc: R. Nicholson
M. Thibedeau
A. Alling

Evaluation of Environmental Data

Analysis

a. Documented quality control in the laboratories used for analysis of the bulk and air samples is necessary. *Stachybotrys atra* is easily missed if other species are present and microscopic identification of the spores requires considerable expertise. These services are not routinely available from commercial laboratories. The laboratory director should be familiar with the literature concerning *Stachybotrys atra*. A list of approved laboratories is available from the New York State Department of Health (518) 474-7413.

b. Samples should also be analyzed for the presence of other common indoor microbial contaminants.

c. Both indoor and outdoor air samples from nearby areas without signs of contamination should be collected and compared.

Evaluation criteria

a. Bulk sampling: Sampling results in excess of 1 colony forming unit per gram should be considered positive. Surfaces that were sampled and found to be contaminated with *Stachybotrys atra* need to be remediated, as described in Section III.

b. Air monitoring:

(1) Concentrations of mold in indoor air which exceed concentrations in outdoor air should be considered positive. Remediation of surfaces and general cleaning is required, as described in Section III.

(2) Airborne concentrations of 103-104 cfu/m3 or greater require immediate evacuation of all occupants.

REMEDIATION

Different levels of containment are necessary depending on the extent of the contamination problem. In all situations, the underlying cause of water accumulation must be rectified or the problem will recur. There must be a mechanism in place for ensuring an immediate response to these problems. Cleanup should be conducted when the affected area is unoccupied. In all remediations, a routine follow-up inspection at 6-12 months or sooner if visible mold contamination or water damage recurs should be conducted. Emphasis should be on ensuring proper repair of the building infrastructure, so that water damage and moisture buildup do not recur.

Four different levels of abatement, as described below, are identified, based on the extent of *Stachybotrys atra* contamination.

Level I: Small Isolated Areas (2 sq. ft. or less)

(1) Example: ceiling tiles

(2) Cleanup can be conducted by regular building maintenance staff. Such persons must receive training from a qualified individual on proper cleanup methods, protection, and potential health hazards, and should

be free from asthma, allergy and immune suppressive disorders. Gloves and a half face respirator should be worn. A full respiratory protection program, in accordance with 29 CFR 1910.134 is required.

(3) Contaminated absorbent material should be removed in a sealed plastic bag.

(4) Surrounding areas should be cleaned with household bleach.

(5) Special containment or evacuation measures are not necessary.

Level II: Larger Isolated Areas (2 - approximately 30 sq. ft.)

(1) Example: individual drywall panels.

(2) Cleanup can be conducted by regular building maintenance staff. Such persons must receive training from a qualified individual on proper cleanup methods, protection, and potential health hazards, and should be free from asthma, allergy and immune suppressive disorders. Gloves and a half face respirator should be worn. A full respiratory protection program, in accordance with 29 CFR 1910.134 is required.

(3) Surrounding material should be covered with plastic sheets and tape before removal.

(4) Contaminated absorbent material should be removed in a sealed plastic bag.

(5) Surrounding areas should be cleaned with household bleach.

Level III: Large Scale Remediations[1] (more than 30 square feet)

(1) Example: More than one wallboard panel in an area which cannot be isolated from personnel.

(2) Personnel trained in the handling of hazardous materials is necessary.

(3) Containment of the affected area is required.

a. Complete isolation of work area from occupied spaces using plastic sheeting sealed with duct tape (including openings, fixtures and HVAC components) is required.

b. A high efficiency particulate air (HEPA) exhausted negative air unit is required.

c. Airlocks and decontamination room are needed for exit from work area.

(4) Contaminated material should be removed in double-sealed plastic bags.

(5) The work area must be HEPA vacuumed prior to the removal of isolation barriers.

(6) Cleanup workers should wear:

a. Full-face respirators with HEPA cartridges or powered air purifying respirators.

b. Disposable protective clothing, head gear, foot covering, gloves.

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1910.134 is required.
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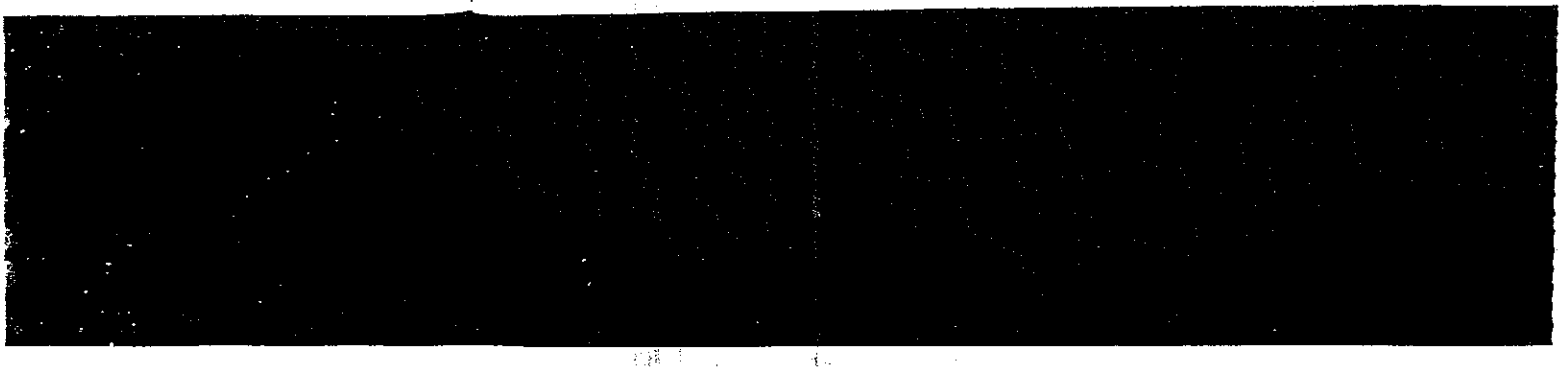
cartridges or powered air purifying

head gear, foot covering, gloves.

(7) Air monitoring:
   a. should be conducted during remediation to determine if spores are escaping during remediation and prior to removal of isolation barriers to assess the efficacy of the remediation.
   b. should be conducted after large scale remediation, to determine its effectiveness and whether an area is safe for symptomatic persons to reoccupy. If post-remediation air samples indicate the presence of SA, even in minor amounts, further investigation of possible sources is required.

Level IV: Remediation of HVAC Systems

(1) Personnel trained in the handling of hazardous materials are required for remediation of HVAC systems.
(2) Containment of the affected area is required.
   a. Complete isolation of work area from occupied spaces using plastic sheeting sealed with duct tape (including openings, fixtures and HVAC components) is required.
   b. A high efficiency particulate air (HEPA) exhausted negative air unit is required.
   c. Airlocks and decontamination room are needed for exit from work area.
(3) Contaminated material should be removed in double-sealed plastic bags.
(4) The work area must be HEPA vacuumed prior to the removal of isolation barriers.
(5) Cleanup workers should wear:
   a. full-face respirators with HEPA cartridges or powered air purifying respirators.
   b. disposable protective clothing, head gear, foot covering, gloves.
(6) If *Stachybotrys atra* is present in settled dust removal with a HEPA equipped vacuum and subsequent damp wiping is recommended.
(7) Air monitoring:
   a. should be conducted during remediation to determine is spores are escaping during remediation and prior to removal of isolation barriers to assess efficacy of the remediation.
   b. should be conducted after large scale remediation, to determine its effectiveness and whether an area is safe for symptomatic persons to reoccupy. If post-remediation air samples indicate the presence of *Stachybotrys atra*, even in minor amounts, further investigation of possible sources is required.
(8) Growth supporting material should be removed from ducts with a HEPA vacuum, where practical, if not removal of the affected component of the HVAC system is required.
(9) Contaminated material should be disinfected prior to removal. Decisions concerning the type of disinfection should be made by a qualified



individual, based on the extent of the growth supporting material. Decisions as to disinfection must be based on the extent of the growth substrate in the ducts. There are numerous "biocides" such as quaternary ammonium compounds (e.g. dimethylbenzyl ammonium chloride) that are employed routinely for disinfection and cleaning surfaces, particularly in hospitals and laboratories. Some of these biocides are recommended by manufacturers for use with cooling coils and condensation pans. In fact, the biocides are essential for maintaining the system. Household bleach is often recommended and can be used to clean coils. Chloorine dioxide or ozone are used for disinfecting inside of ducts.

Potentially toxic substances such as chlorine dioxide or ozone that are currently used for disinfecting duct work should not be used when the building is inhabited. Also, sufficient time should be allowed for the disinfectant to dissipate. These substances, however do have a short half life. As to whether they would be efficacious or not would depend upon the extent of the contamination and circumstances of application. As a safety factor it may be advisable to disinfect molded material within a duct system prior to cleaning.

(10) The causes of *Stachybotrys atra* accumulation and/or growth must be identified and corrective action taken.

Hazard Communication

When *Stachybotrys atra* is found, occupants in the affected area(s) should be notified of its presence by the building owner and the employer. Notification should include the description of the remedial measures to be taken and a timetable for completion. Group meetings held before and after remediation with full disclosure of plans and results can be an effective communication mechanism. Some individuals may require separate counseling. They should be encouraged to seek medical advice from a qualified occupational/environmental health practitioner if they are concerned about continuing health problems. Individuals seeking medical attention should be provided with a copy of all inspection results and interpretation to give to their medical practitioners.

CONCLUSION

In summary, prompt removal of contaminated material and infrastructural repair must be the primary response to *Stachybotrys atra* contamination in buildings. Emphasis should be placed on preventing contamination through proper building maintenance and prompt repair of water damaged areas.

Chronic exposure to airborne *Stachybotrys atra* poses a risk of debilitating health effects caused by irritative and allergic reactions. This risk is compounded by exposure to additional molds and other pollutants usually found in buildings contaminated by *Stachybotrys atra*. Laboratory tests for immune

markers associated with *Stachybotrys atra* exposure are not helpful at this time. Research should be pursued to refine such tests and characterize them more fully.

The simplest and most expedient remediation that properly and safely removes *Stachybotrys atra* from buildings should be used. This includes prompt removal, cleaning of contaminated sites and repair of the defects that led to water accumulation. Widespread contamination poses much larger problems that must be addressed on a case-by-case basis in accordance with published guidelines for remediation. Effective communication with building occupants is an essential component of all remedial efforts. Individuals with persistent health problems should be referred to physicians competent in evaluating health effects of microbial exposures.

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NEW JERSEY DEPARTMENT of HEALTH and SENIOR SERVICES

INDOOR BIOAEROSOLS

Division of Environmental and Occupational Health Services

Revised March, 1997

INTRODUCTION

This information bulletin was prepared because of the increasing awareness of bioaerosols in the indoor environment. It is intended to provide general information on indoor bioaerosols, how to identify bioaerosol contamination and its sources, and the control of bioaerosols in the indoor environment. The information bulletin focuses on bioaerosols that get into buildings from the outside environment.

WHAT ARE BIOAEROSOLS?

Bioaerosols are microorganisms or particles, gases, vapors, or fragments of biological origin (i.e., alive or released from a living organism) that are in the air. Bioaerosols are everywhere in the environment.

Some examples of bioaerosols are:

Living Source	**Examples of Bioaerosols**
Microorganisms (microbes):	
Bacteria	*Legionella, Actinomycetes*
Fungi	*Histoplasma, Alternaria, Pencillium, Aspergillus, Stachybotrys*, aflatoxins, aldehydes, alcohol
Protozoa	*Naegleria, Acanthamoeba*
Viruses	*Influenza* (flu)
Algae	*Chlorococcus*
Green plants	*Ambrosia* (ragweed) pollen
Arthropods	*Dermatophagoides* (dust mites) feces
Mammals	Horse or cat dander

Bioaerosols are always present in our environment and pose no problems in most cases when the quantity of them and the various types are kept within reasonable limits. However, some bioaerosols, when breathedin, can cause diseases including pneumonia, asthma, rhinitis (e.g., cold, hay fever), and respiratory infection.

In order for microorganisms to release indoor bioaerosols, they must get indoors, grow and multiply on some material and then get into the air. Microorganisms can get indoors through the heating, ventilation, and air conditioning system, doors, windows, cracks in the walls, the potable drinking water system, or be brought in on the shoes and clothes of people working or visiting in the building. Water, humidity, temperature, nutrients (e.g., dirt, wood, paper, paint), oxygen, and light determine whether microorganisms will grow in the indoor environment. The most common microorganisms found indoors are fungi and bacteria. Fungi produce spores that become airborne; some also produce mycotoxins (poisonous substances) or volatile organic compounds. Some of the most common fungi found indoors that can cause health problems are *Penicillium, Aspergillus,* and *Alternaria.* Some bacteria produce endotoxins (poisonous substances) and volatile organic compounds. Bioaerosols other than those from microorganisms (e.g., pollen, cat dander) get indoors in the same way as the microorganisms. These do not multiply but may become a problem if they accumulate.

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WHAT ARE THE DISEASES CAUSED BY INDOOR BIOAEROSOLS?

Bioaerosols enter the human body mostly through being breathed in. So, the diseases they cause usually affect the respiratory system.

The diseases caused by indoor bioaerosols fall into two categories: hypersensitivity diseases and infectious diseases.

Hypersensitivity Diseases

Hypersensitivity diseases (allergic diseases) result from exposure to materials in the environment called antigens (in this case, certain indoor bioaerosols) that stimulate an allergic response by the body's immune system. Some people are more susceptible than others. In other words, some of the people exposed may become ill and others may not. These diseases usually are diagnosed by a physician. Once an individual has developed a hypersensitivity disease, a very small amount of the antigen may cause a severe reaction. Hypersensitivity diseases account for most of the health problems due to indoor bioaerosols.

- Building-related asthma may result in complaints of chest tightness, wheezing, coughing, and shortness of breath. These symptoms may occur within an hour of exposure or 4-12 hours after exposure. Building-related asthma can be caused by airborne fungi such as *Alternaria*, glycoproteins from fungi, proteases (digestive enzymes that cause the breakdown of proteins) from bacteria, the algae *Clorococus*, ragweed pollen, dust mites, and dander from cats.

- Allergic rhinitis involves stuffiness of the nose, clear discharge from the nose, itchy nose, and sneezing. Itching and puffy eyes may also occur. All the indoor bioaerosols listed under building-related asthma except the bacteria proteases also cause rhinitis.

- Hypersensitivity pneumonitis (extrinsic allergic alveolitis) can be an acute, recurrent pneumonia with fever, cough, chest tightness, and fluids entering the lungs. Or, it can be a cough that progresses to shortness of breath, fatigue, weight loss and thickening and scarring of the lungs. The microorganisms associated with hypersensitivity pneumonitis are fungi such as *Penicillium* and *Sporobolomyces*, bacteria such as *Thermoactinomyces*, and protozoa such as *Acanthamoeba*.

- Humidifier fever results in fever, chills, muscle aches, and malaise (general feeling of being unwell), but no lung symptoms. The symptoms usually start within 4-8 hours of exposure and end within 24 hours without long-term effects.

Infectious Diseases

Infectious diseases are caused by the invasion of the body by a harmful organism. Some examples of infectious diseases caused by indoor bioaerosols follow.

- Legionnaire's disease, a bacterial pneumonia, is caused by *Legionella pneumophila*. It is a type of pneumonia that affects the lungs and may also affect the stomach and intestines, kidneys, and central nervous system. It can take 2-10 days after exposure to develop and frequently requires hospitalization. The source of the disease has been traced to aerosols from contaminated cooling towers, evaporative condensers, whirlpools, shower heads, faucets, and hot water tanks.

- Pontiac fever is also caused by *Legionella*. Pontiac fever is a "flu-like" illness with fever, chills, headache, myalgia (pain in the muscles), cough, nausea, and breathlessness. Pneumonia does not occur. It usually lasts 2-5 days. The sources are the same as for Legionnaire's disease.

- Histoplasmosis and Cryptococcosis, both fungal infections, may occur when contaminated bird droppings enter the indoor environment. Infection with *Histoplasma* often results in no symptoms or there may be mild respiratory illness (cough, fever, malaise). Rarely, a life threatening illness involving many parts of the body occurs. Infection with *Cryptococcus* results in inflammation of the brain and the membranes covering it and also can involve the lungs, kidneys, prostate gland, bones, or liver. The skin may also be affected with acne-like lesions, ulcers, or tumor-like masses.

HOW IS IT DETERMINED THAT AN INDOOR BIOAEROSOL IS THE CAUSE OF A BUILDING-RELATED ILLNESS?

Health complaints related to indoor air quality usually have a real basis, though it may sometimes be difficult to find the cause. Sometimes, bioaerosols are suspected of causing symptoms that are really caused by other agents. For example, detergent residues left in carpets after cleaning can cause cough and dry throat symptoms. Carbon monoxide poisoning can cause headache, fatigue, and nausea. These, and similar agents, should be ruled out before investigating for bioaerosols. For more information, see the Public Employees Occupational Safety and Health Program's information bulletin entitled "Indoor Air Quality."

Several steps can be taken to make the determination that an indoor bioaerosol is the cause of a building-related illness. These steps include epidemiologic investigation and on-site investigation. Each of these steps is discussed below.

Epidemiologic Investigation

An epidemiologic investigation sometimes can clarify whether or not there is a building related illness, if it is due to an indoor bioaerosol(s), and, if so, how to deal with it. An epidemiologic investigation includes:

- definition of a case of disease;
- review of possible other non-building diseases that may be causing the problem;
- selection of controls (people without the disease) to compare to the cases;
- questionnaires for the cases and controls which include questions about the disease (e.g., symptoms, date started); and
- ordering of diagnostic tests, obtaining the results of physician evaluations, or arranging for one physician or clinic to evaluate all the employees with serious health complaints.

Sometimes the epidemiologic investigation is not necessary because it is obvious that a bioaerosol is causing the problem. For example, if mold is growing on a carpet or wall, an on-site investigation can begin without the epidemiologic investigation.

On-site Investigation

If it is believed that an indoor bioaerosol is the cause of the health complaints, an assessment of the bioaerosol status of the building should be undertaken. The investigators should study the structure, maintenance, and occupancy patterns of the building, look for possible sources of the indoor bioaerosol, and make recommendations about additional investigation or how to control the indoor bioaerosol. Sometimes bulk, wipe, or air sampling is part of the on-site investigation. The sampling strategy, laboratory analysis, and interpretation of the sampling results are complicated and require a high level of training and expertise. Industrial hygienists and/or other trained personnel (e.g., mycologist, engineer), building management, and maintenance personnel should be involved in the investigation. Areas that should be included in the on-site investigation are listed below.

- Outdoor investigation – Any disturbance that has recently occurred such as agricultural activity or construction work should be noted. Outdoor sources of bioaerosols can be stirred up during these activities. A sample of the outdoor air should be taken for comparison with the indoor air samples only if indoor air sampling is done (see the section on "Recommendations for Control"). The outdoor air sampling should be done at the same time and in the same way as the indoor air sampling. In general, the types of bioaerosols indoors should be similar to those outdoors and the amounts should be lower. If not, this indicates a potential problem.

- Heating, ventilation, and air conditioning (HVAC) system investigation – Generally a building's HVAC system mixes outdoor air with recirculated air, filters the air mixture, heats or cools the air mixture, and distributes it via ductwork throughout the building. Places to look within the HVAC system are the outdoor air intakes, filters, heat exchanger, air supply plenum and ductwork (including insulation), fan-coil and induction units, and return air. These parts of the system and the potential bioaerosol sources are described in more detail below.

- Outdoor air intakes – excessively contaminated outdoor air can be brought indoors through the intakes. Potential bioaerosol sources are cooling towers and evaporative condensers located close to or directly upwind from the outdoor air intakes, especially for Legionnaire's disease. Slime, foam, standing water, and other indicators of poor maintenance suggest microbial growth. Water samples and slime scrapings can be collected and analyzed in the laboratory. This is most helpful when a specific building-related disease such as Legionnaire's disease or Pontiac fever has been identified in the epidemiologic investigation. Sanitary vents located near the outdoor air intakes can contaminate the indoors with intestinal bacteria. Stagnant water, leaves, soil, or vegetable material near or in the intake can allow growth of bacteria and fungi which then enter the building. Birds may use the intakes to roost and nest. Their droppings can harbor fungi such as *Histoplasma* and *Cryptococcus* and bacteria.

- Filters – most buildings' filters are not efficient enough to remove small (1-2 microns) fungal and bacterial spores. Filters that contain organic dusts may become moist during the air conditioning season, allowing microbial growth on the filter itself. Filters are usually changed when there is a noticeable pressure drop in the HVAC system. By this time, many microorganisms can be growing on the filter. The dirt that has accumulated on the filters can be collected and analyzed to see if microorganisms are growing on the filter.

- Heat exchanger – the heat exchanger, with heating and cooling coils, adds or removes heat and moisture. Potential bioaerosol sources include stagnant water from drain pans that do not drain properly. The presence of slime or foam in standing water is an indicator of microbial growth. Water samples can be taken for analysis. Fungi and bacteria may grow in the porous insulation next to the cooling coils and drain pan. Microbial growth may be seen and/or bulk samples of insulation can be taken for analysis. Air washers and humidification devices are almost always contaminated with microorganisms. Bulk samples can be taken to confirm contamination.

- Air supply plenum and ductwork – this moves the filtered, conditioned air to the occupied rooms of the building. The reservoirs (the water supply) of humidification devices in the ductwork may be contaminated, and the ductwork next to these devices can become contaminated if water condenses on it. Reservoir water samples can be taken, the ductwork can be looked at for microbial growth, or bulk samples of the duct liner or accumulated debris can be collected. Ductwork usually has some dirt, but it should not contain a thick layer of deposited material. If dirt and debris collect in the ductwork and moisture becomes excessive, microbial growth can occur. If microbial growth can be seen, swab or bulk samples can be taken to confirm their identity.

- Fan-coil and induction units – heating and cooling for the building may also take place in these units which are located in enclosures. These units can become contaminated with microorganisms in the same way other parts of the ventilation system can become contaminated.

- Return air – air exits from the occupied space of the building in various ways. Bioaerosols from the occupied space can enter the return air system and settle on duct or plenum surfaces. Back-flow through the return air system could cause the settled microorganisms to get in the air again.

- Occupied space – the most important potential microbial source in occupied space is water from leaks, high relative humidity, humidifiers, floods, and spills. Microbes can multiply within a short time after water has gotten inside the building. Water-damaged ceiling tiles, sheetrock, wall coverings, wickerware, and wood are good places for microorganisms to grow. They also can grow on water-damaged chair fabric, modular furniture, and in carpets. Usually water damage and microbial growth are obvious, but water-damaged materials can support microbial growth long after they appear dry.

If the relative humidity in the occupied space is over 70 percent, materials containing carbon may absorb enough moisture to support microbial growth. Musty or moldy odors are associated with excess

relative humidity and indicate that contamination exists. Condensation can occur on exterior walls and the building envelope (the area between the exterior and interior walls), especially in humidified buildings during the cold, winter months. Visible microbial growth is an indication of contamination, and swab or bulk samples can be taken to confirm the identity of the organisms. Microorganisms are abundant in portable cool mist and ultrasonic humidifiers unless they are cleaned and disinfected daily. People are sources of viruses such as influenza and measles, and bacteria such as *Staphylococcus*, *Streptococcus*, and *Mycobacterium tuberculosis*. People can also bring in contaminants on their clothes, such as cat dander, that become airborne. The number of people occupying the building affects the potential for transmission of diseases, as does inappropriate use of occupied space.

Recommendations for Control

As a result of the epidemiologic and/or on-site investigations, one or more potential bioaerosol sources may be identified, and there may be enough information to make recommendations for the control of the bioaerosols. Additional information may be needed to identify the bioaerosols and to determine if they are causing the problem. The results of the wipe and bulk samples collected during the on-site investigation may provide the additional needed information. Air sampling may be appropriate. If no apparent sources for bioaerosol contamination are found during the investigation, nonbioaerosol causes for building-related complaints should be investigated. Sometimes, it is not possible to determine for sure what is causing the building-related complaints. Control recommendations still may be made based on the findings of the on-site investigation.

WHAT ARE THE POSSIBLE CONTROLS FOR BIOAEROSOLS?

Actions to control indoor bioaerosols are of three types:

- design buildings and HVAC systems so that indoor contamination does not occur;
- maintain indoor conditions so that contamination does not occur and reoccur; and
- clean-up existing contamination.

Each of these actions is discussed in more detail below.

Building and HVAC System Design

Buildings and HVAC systems can be designed to prevent the entry of outdoor bioaerosols and to maintain conditions within the building that do not help microbial growth. Preventing the entry of bioaerosols from outdoors involves the appropriate location of air intakes and good air filtration. Design factors that help to prevent microbial growth are:

- Dilution – Adequate fresh air is needed to dilute human-source bioaerosols. For example, outdoor air should be provided at a rate of 20 cubic feet per minute (cfm) per person working in an office building.

- Maintenance – Good maintenance is necessary to eliminate areas where microorganisms can grow and multiply. Air handling units and ductwork should allow easy access for inspection and cleaning. The drain pan below the cooling coils should be designed and placed so that the collected water can drain easily, preventing the water from accumulating and becoming stagnant.

- Minimize and Protect Substrates – Substrates are any materials that trap dirt and moisture, thus providing a good place for microorganisms to grow. Acoustical/thermal fibrous glass insulation on the inside surface of the housing of the air handling, fan-coil, and induction units should be smooth-surfaced, or insulation should be placed on the outside. Fibrous glass lining should not be used in ductwork where there is high relative humidity or within ten feet of either side of the cooling coils. Carpeting should not be used where there is persistent moisture (e.g., buildings built on a slab with no basement).

- Humidification – Humidifiers provide moisture to the air, usually in the dry, winter months. Humidifiers should, if possible, use clean steam. Cold water humidifiers should use potable (drinkable) water that should be run to a drain line after passing through the humidifying device. Humidifiers using recirculated water are not recommended because

they can become good sites for microbial growth. The use of console humidifiers or vaporizers should be discouraged in the building. The use of water spray humidifiers or air washers as components of HVAC systems is not recommended because these units almost always provide a good place for microorganisms to grow. They have been associated with outbreaks of humidifier fever and hypersensitivity pneumonitis.

- Dehumidification – Moisture in the interior building must be controlled. Relative humidity in the occupied space should be maintained below 60 percent throughout the year. To accomplish this, most HVAC systems remove moisture or heat from the air through the use of a cooling coil section. Another approach to control humidity is to have reheat coils or desiccant dehumidification immediately after the heat exchanger. It is difficult and expensive to do this in an HVAC system already in place.

- Filtration – The location of the filters in the HVAC system is very important in protecting building occupants from bioaerosols. In order to remove fungal and bacterial spores, filters should have a 50-70 percent efficiency rating. In most air handling units, filters are located before the heat exchanger section. Consequently, building occupants will not be protected from bioaerosols produced in areas beyond the heat exchanger section, such as cooling deck coils, humidifiers, and water spray systems.

Maintenance

Preventive maintenance is probably the single most important method to control bioaerosols in existing buildings. Maintenance involves keeping the indoor environment clean by removing dirt and water and maintaining equipment so that conditions that help microbial growth do not occur. Cleaning includes the routine prevention of the build-up of dirt and moisture and immediate attention to unusual situations that could result in bioaerosol problems.

- Routine cleaning – A maintenance schedule must be established to remove dirt and debris from the internal components of air handling units, fan-coil units, and induction units. Carpeting should be maintained dry and free of accumulated dirt. Steam or other water-based carpet cleaning adds moisture to the environment and must be used with extreme care. The carpet should be dried with heat and fans within 24 hours. Duct cleaning (vacuuming) is necessary only when so much dirt has collected that the duct surfaces are no longer visible. Careful attention to proper filter selection and maintenance can reduce the need for duct cleaning.

- Heat exchange systems – Stagnant water should not be allowed to collect in drain pans or air handling and fan-coil units.

- Humidifiers – Cold water humidifiers should have a fastidious preventive maintenance program, including regular inspection of mechanical components and removal of stagnant water and slime.

- Dehumidification – Moisture levels in the air must be low enough so that condensation on cold interior surfaces such as cold water pipes does not occur. Protection of filters against moisture damage and scheduled replacement of filters is required for acceptable filter maintenance.

- Emergency situations – Prompt repair and prevention of leaks that cause floods are essential. If a flood is due to potable water, wet vacuums should be used to remove as much water as soon as possible, preferably within 24 hours. Water-damaged materials such as ceiling tiles, and insulation should be removed and replaced. Water-soaked carpeting and carpet padding should be replaced if it is not completely dried within 48 hours. Water-damaged papers should be discarded unless they are essential, in which case they should be spread out to dry as soon as possible. If microbial growth becomes visible, the papers should be discarded. Contaminated items can be frozen to stop microbial growth until drying can occur. A diluted bleach solution (1 part bleach to 10-50 parts water) may be used to disinfect hard surfaces when necessary. If the flood is due to dirty water such as sewage, the clean-up procedures are different. All contaminated porous materials, including carpets, should be removed. Other floor covering, such as tiles, can be disinfected with a diluted bleach solution, rinsed with clean water, and allowed to dry. Dehumidifiers can be used to dry water-damaged areas. All clean-up personnel should be protected using appropriate personal protective equipment such as respirators, gloves, and protective suits. Only trained individuals should

perform the clean-up. If respirators are used, the Occupational Safety and Health Administration's (OSHA) or Public Employees Occupational Safety and Health (PEOSH) Program's Respiratory Protection Standard (29 CFR 1910.134) must be followed.

Clean-up of Existing Contamination

Potential sources of bioaerosols found during the on-site investigation, or following a more intensive investigation, should be removed and/or cleaned. Contaminated cooling towers should be cleaned and decontaminated to prevent the microorganisms from returning. Air intakes and/or cooling towers should be moved so that contaminants from the cooling towers or other places cannot enter the air intakes. Within the HVAC system, mechanical or detergent cleaning may be required to remove dirt and debris, and microorganisms before decontamination. Steam can be used for cleaning if that treatment does not damage the heat exchanger. Chlorine-generating materials or hydrogen peroxide may be used for disinfection. It is not clear that biocides (substances that kill living cells) are effective over the long term. HVAC system mechanical components should be turned off during cleaning and people should not be in the building. Cleaning chemicals and disinfectants should be removed from the HVAC system prior to its being restarted. Otherwise, the chemicals from the cleaning could become airborne and cause health problems for the people in the building.

Microbial contamination on hard surfaces may be removed with a vacuum cleaner that has a high-efficiency particulate air (HEPA) filter. Any porous material in a building that is contaminated with microorganisms should be discarded. Contaminated ceiling plenums are almost impossible to clean and contaminated insulation must be removed.

If the problem is due to bird droppings, the best approach is to isolate the affected area, and treat and remove the bird droppings. The bird droppings must be wet down and treated with a bleach solution before removal. The surrounding area should also be disinfected with a bleach solution. Personnel doing the removal should use personal protective equipment such as respirators, gloves, and protective clothing. All clean-up should be performed by trained individuals. If respirators are used, the OSHA or PEOSH Program's Respiratory Protection Standard (29 CFR 1910.134) must be followed.

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NEW JERSEY DEPARTMENT of HEALTH and SENIOR SERVICES

INDOOR AIR QUALITY

Division of Environmental and Occupational Health Services

Revised July 1996

INTRODUCTION

The average person spends approximately 90% of their time indoors. Recent studies have indicated that indoor air is often dirtier and/or contains higher levels of contaminants than outdoor air. Because of this and increased awareness regarding poor indoor air quality (IAQ), it is not surprising that the number of reported employee complaints of discomfort and illness in nonindustrial workplaces is increasing.

WHEN DID POOR INDOOR AIR QUALITY BECOME A PROBLEM?

Beginning in the mid-1970s, IAQ complaints increased for two reasons. The main reason is the impact of the energy crisis. To reduce heating and cooling costs, buildings have been made "airtight" with insulation and sealed windows. In addition, the amount of outside air introduced into buildings has been reduced. The second reason is that more chemical containing products, office supplies, equipment, and pesticides have been introduced into the office environment increasing employee exposure. These changes created IAQ health problems known as Sick Building Syndrome (SBS) or Building Related Illnesses (BRI).

WHAT IS SICK BUILDING SYNDROME?

A workplace is characterized with SBS when a substantial number of building occupants experience health and comfort problems that can be related to working indoors. Additionally, the reported symptoms do not fit the pattern of any particular illness, are difficult to trace to any specific source, and relief from these symptoms occurs upon leaving the building.

WHAT ARE THE SYMPTOMS OF SICK BUILDING SYNDROME?

Employee symptoms of SBS may include headaches, eye, nose, and throat irritation, dry or itchy skin, fatigue, dizziness, nausea, and loss of concentration.

WHAT ARE BUILDING ILLNESSES?

A workplace is characterized with BRI when a relatively small number of employees experience health problems. Symptoms associated with BRI are generally different than those associated with SBS and are often accompanied by physical signs that are identified by a physician and/or laboratory findings. Relief from the illness may not occur upon leaving the building. BRI are caused by microbial contamination and/or specific chemical exposures that can result in allergic and/or infectious responses. Microbial contamination occurs when viruses, bacteria, or molds accumulate in heating, ventilation and air conditioning (HVAC) systems, water damaged ceiling tiles and carpets, hot water heaters, and humidifiers. Chemical exposures can be generated from specific sources within the workplace, such as formaldehyde emitted from newly installed carpets.

WHAT ARE THE SYMPTOMS OF BUILDING RELATED ILLNESSES?

Employee symptoms of BRI may include eye, nose, throat, and upper respiratory irritation, skin irritation or rashes, chills, fever, cough, chest tightness, congestion, sneezing, runny nose,

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muscle aches and pneumonia. Examples of BRI include asthma, hypersensitivity pneumonitis, multiple chemical sensitivity, and Legionnaires' Disease.

WHAT ARE THE SPECIFIC CAUSES OF SBS AND BRI?

The IAQ problems that cause SBS and/or BRI may include:

1. Lack of fresh air:

   If insufficient fresh air is introduced into occupied spaces, the air becomes stagnant and odors and contaminants accumulate. Lack of fresh air in occupied areas is the number one cause of SBS.

2. Poorly maintained or operated ventilation systems:

   Mechanical ventilation systems must be properly maintained and operated based on the original design or prescribed procedures. If systems are neglected, their ability to provide adequate IAQ decreases. One problem associated with poorly maintained systems is missing or overloaded filters. This can cause higher levels of dust, pollen, and cigarette smoke to enter occupied spaces. Another problem is clogged condensate drain pans and drain lines in HVAC systems which allow water to accumulate. The accumulation of water can lead to microbial contamination. Poorly maintained ventilation systems can cause both SBS and BRI.

3. Disruption of air circulation throughout occupied spaces:

   The quantity of air depends on the effectiveness of air distribution. If the air circulation is disrupted, blocked, or otherwise does not reach occupied areas, it can become stagnant. File cabinets, bookshelves, stored boxes, dropped ceiling tiles, added office walls, cubicles, and partitions can block or divert the supply of air to occupied spaces.

4. Poorly regulated temperature and relative humidity levels:

   If the temperature and/or relative humidity levels are too high or too low, employees may experience discomfort, loss of concentration, eye and throat irritation, dry skin, sinus headaches, nosebleeds and the inability to wear contact lenses. If relative humidity levels are too high, microbial contamination can build up and can cause BRI.

5. Indoor and outdoor sources of contamination:

   Chemical emissions can contribute to BRI and SBS. Chemical contaminants in an office environment either originate from indoor sources or are introduced from outdoor sources. Common sources include emissions from office machinery or photocopiers, cigarette smoke, insulation, pesticides, wood products, synthetic plastics, newly installed carpets, glues and adhesives, new furnishings, cleaning fluids, paints, solvents, boiler emissions, vehicle exhaust, roof renovations, and contaminated air from exhaust stacks. Contaminants found in indoor environments can include radon, ozone, formaldehyde, volatile organic compounds, ammonia, carbon monoxide, particulates, nitrogen and sulfur oxides, and asbestos.

WHAT IS CONSIDERED ACCEPTABLE IAQ?

The American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE) defines acceptable IAQ as:

> "air in which there are no known contaminants at harmful concentrations as determined by cognizant authorities and with which a substantial majority (80% or more) of the people exposed do not express dissatisfaction."

WHAT CAN BE DONE IF THE AIR QUALITY IS UNACCEPTABLE?

In order to understand and resolve IAQ problems and concerns, standard investigative procedures should be followed. Investigating IAQ complaints, however, can be very complicated due to employee concerns, unknown sources of contamination, and the complexities of buildings and their ventilation systems. The New Jersey Department of Health and Senior Services, Public Employees Occupational Safety and Health (PEOSH) Program recommends following general investigative procedures such as:

1. Conducting employee interviews to obtain pertinent information regarding what symptoms are being experienced, how many employees are affected, when they are affected, where they work, what they do, etc. This information may identify possible IAQ problems.

2. Reviewing building operations and maintenance procedures to determine when and what type of chemicals are being used during cleaning, floor waxing and stripping, painting, gluing, pesticide spraying, roofing operations, renovation and construction activities, etc. Also determine when deliveries, which may generate vehicle exhaust, occur, or if furniture, drapery, and office equipment has been recently installed.

3. Conducting a walk-through inspection to evaluate possible sources that may contribute to IAQ complaints.

4. Inspecting the HVAC system, window air conditioners, office dehumidifiers, etc., in order to determine if the systems are working properly and are in good condition.

5. Reviewing the building blueprints of the ductwork and ventilation system to determine if the system is adequately designed.

6. Conducting air sampling, if necessary, to determine if specific contaminants are present or if adequate fresh air is being supplied.

HOW CAN IAQ PROBLEMS BE CORRECTED AND/OR PREVENTED?

1. ENSURE ADEQUATE FRESH AIR SUPPLY

   This has been shown to be the single most effective method for correcting and preventing IAQ problems and complaints. To ensure that adequate fresh air is supplied to occupied spaces, the following is recommended:

   A. A preventive maintenance schedule must be developed and followed in accordance with the manufacturer's recommendations or with accepted practice to ensure that the ventilation systems are properly checked, maintained, and documented.

   B. The preventive maintenance schedule should include the inspection and maintenance of ventilation equipment and/or system, making sure that:

      - outdoor air supply dampers are opened as designed and remain unobstructed,

- fan belts are properly operating, in good condition, and replaced when necessary,
- equipment parts are lubricated,
- motors are properly functioning and in good operating condition,
- diffusers are open and unobstructed for adequate air mixing,
- the system is properly balanced,
- filters are properly installed and replaced at specified intervals,
- components that are damaged or inoperable are replaced or repaired as appropriate, and
- condensate pans are properly draining and in good condition.

C. To achieve acceptable IAQ, outdoor air should be adequately distributed to all office areas at a minimum rate of 20 cubic feet per minute (cfm) per person **OR** the concentration of all known contaminants of concern be restricted to some specified acceptable levels as identified in ASHRAE's "Ventiliation for Acceptable Indoor Air Quality" Standard.

D. To determine if the ventilation system is effectively providing adequate fresh air, carbon dioxide (CO_2) levels should be measured. ASHRAE sets the standard (ASHRAE 62-1989) of 1000 ppm of CO_2 as the maximum recommended level for acceptable IAQ. CO_2, a byproduct of human respiration, is an indicator of the lack of fresh outdoor air and is not harmful at this level.

E. If possible, gauges should be installed to provide information on air volumes delivered by supply and return fans, and maintenance staff should be trained to read them and respond appropriately.

F. A sufficent supply of outside air should be provided to all occupied spaces. An insufficient supply can cause the building to be at negative pressure, allowing untreated air and/or contaminants to infiltrate from outside. This can be determined by observing the direction of air movement at windows and doors. In order to prevent this problem, the air supply and exhaust system must be properly balanced.

G. If the office layout is changed (e.g., by erecting partitions or new walls), ensure that adequate air flow and distribution is maintained.

H. Ventilation system filters should have a moderate efficiency rating (60% or more), as measured by the ASHRAE atmospheric dust spot test, and be of an extended surface type. To determine if the filters have the appropriate efficiency rating, check with the manufacturer. Prefilters (e.g., roll type) should be used before air passes through higher efficiency filters.

I. Avoid overcrowding of employees and make sure that the proper amount of outdoor air is provided based on the number of occupants.

2. ELIMINATE OR CONTROL ALL KNOWN AND POTENTIAL SOURCES OF CONTAMINANTS, BOTH CHEMICAL AND MICROBIAL

<u>To Control Chemical Contamination:</u>

A. Hazardous chemicals should be removed or substituted by less hazardous or non-hazardous chemicals, where possible.

B. Properly store all chemicals to minimize exposure hazards.

C. Use local exhaust ventilation to capture and remove contaminants generated by specific processes where appropriate. Local exhaust

does not recirculate the contaminated air, but directly exhausts the contaminant outdoors. Check to see if the manufacturer of your office machines can provide guidance on ventilation requirements for their equipment.

D. Check to be sure that HVAC fresh air intakes or other building vents or openings are not located in close proximity to potential sources of contamination (e.g., places where motor vehicle emissions collect, downwind of exhausts, cooling towers). If necessary, raise stacks or relocate intakes or exhausts.

E. Isolate areas of renovation, painting, carpet installation, etc., from occupied, nonconstruction areas, through use of physical barriers and isolation of involved ventilation systems. If possible, perform this type of work in the evening or on weekends. Supplying the maximum amount of fresh air to these areas can assist in the dispersion of contaminant levels.

F. When pesticides are being applied, refer to the label instructions for the proper application, employee occupation, and ventilation information.

G. Eliminate or reduce cigarette smoke. Smoking restrictions or designated smoking areas should be considered. The air from designated smoking areas must not be recirculated to non-smoking areas of the building.

To Control Microbial Contamination:

A. Promptly detect and permanently repair all areas where water collection or leakage has occurred.

B. Maintain relative humidity at less than 60% in all occupied spaces and low air-velocity plenums. During the summer, cooling coils should be run at a low enough temperature to properly dehumidify conditioned air.

C. Check for, correct, and prevent further accumulation of stagnant water by maintaining proper drainage of drain pans under the cooling coils.

D. Due to dust or dirt accumulation or moisture-related problems down stream of heat exchange components (as in ductwork or plenum), additional filtration downstream may be necessary before air is introduced into occupied areas.

E. Heat exchange components and drain pans should be accessible so maintenance personnel can easily inspect and clean them. Access panels or doors should be installed where needed.

F. Non-porous surfaces where moisture collection has promoted microbial growth (e.g., drain pans, cooling coils) should be properly cleaned and disinfected. Care should be taken to ensure that these chemical cleaners are removed before ventilation systems are reactivated.

G. Porous building materials contaminated with microbial growth, such as carpets and ceiling tiles, must be replaced or disinfected to effectively eliminate contamination. Note that the American Conference of Governmental Industrial Hygienists (ACGIH) recommends that miocrobial contaminated porous materials should be discarded.