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NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH

ENVIRONMENTAL AND MECHANICAL SYSTEM ASSESSMENTS
25 SIGOURNEY STREET, HARTFORD, CT

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EH&E Report #11767
May 5, 2004

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LIST OF ABBREVIATIONS AND ACRONYMS

ACGIH	American Conference of Governmental Industrial Hygienists
ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc.
BASE	Building Assessment Survey and Evaluation
cfm	cubic feet per minute
cfu/g	colony-forming units per gram
cfu/m^3	colony-forming units per cubic meter
CO_2	carbon dioxide
CTOSHA	Connecticut Department of Labor, Occupational Safety and Health Administration
DPW	Connecticut Department of Public Works
DRS	Connecticut Department of Revenue Services
DSS	Connecticut Department of Social Services
EH&E	Environmental Health & Engineering, Inc.
EPA	U.S. Environmental Protection Agency
HVAC	heating, ventilating, and air-conditioning
IEQ	indoor environmental quality
in-H_2O	inches of water column
NIOSH	National Institute for Occupational Safety and Health
OA	outdoor air
ORCS	Occupational Risk Control Services
ppm	parts of vapor or gas per million parts of air by volume
RH	relative humidity
spores/m^3	spores per cubic meter
UCONN	University of Connecticut
VAV	variable air volume
VOC	volatile organic compound
°F	degrees Fahrenheit
ΔP	difference in pressure

1.0 EXECUTIVE SUMMARY

Environmental Heath & Engineering, Inc. (EH&E) is pleased to provide a summary of the investigative work completed by EH&E in response to occupant concerns and water intrusion at 25 Sigourney Street, Hartford, Connecticut. EH&E participated in a building investigation led by the National Institute for Occupational Safety and Health (NIOSH). The findings of the various parts of the investigation completed to date by EH&E are described in this report.

EH&E reviewed a compilation of indoor environmental quality (IEQ) investigations and remediation progress reports provided by the Connecticut Department of Public Works (DPW); collected and analyzed fungal samples throughout the building; analyzed the heating, ventilating, and air-conditioning (HVAC) systems; and evaluated the remediation and repairs to the building. In addition, EH&E administered a health questionnaire to occupants in June 2002. Each of these activities are summarized below.

In an attempt to understand IEQ conditions of the building prior to involvement by EH&E and NIOSH, EH&E obtained information from the reports of previous investigations of the indoor environment, including thermal comfort and microbiological agents. Information on the location and type of remediation work completed in the building was also obtained from the reports. Carbon dioxide (CO_2), temperature, relative humidity, and airborne fungi were measured in various locations of nearly every floor of the building, by several different investigators, on at least one occasion between August 1996 and April 2001. In addition to airborne fungi, carpet samples were collected in 2000 and early 2001. Overall, the measures were in the range of EH&E's experience with non-complaint office buildings and levels reported for a randomized sample of non-complaint office buildings that constitute the Building Assessment Survey and Evaluation (BASE) study sponsored by the U.S. Environmental Protection Agency (EPA).

To assess if current fungal contamination is an issue in the building, air and surface samples were collected from perimeter wall cavities, interior surfaces, and selected occupied areas of the building in July 2002 and March 2003. The measured fungal levels were examined for variation related to areas of historic water intrusion and also for variation among floors, sides of the building, and other spatial features. In addition, the results were compared to reference ranges of fungal levels reported for non-problem or non-complaint buildings in the United States. The preliminary conclusion of this portion of the investigation is that the results do not indicate elevated levels of fungal spores in the air or on surfaces in the building at the time of sampling.

As part of the HVAC investigation, EH&E assessed the adequacy of outdoor air delivery pressurization and exhaust airflow for the building in March 2003. EH&E also inspected the various mechanical rooms and air handling equipment. Overall, EH&E observed that the HVAC systems were clean and well maintained. Recent cleaning of the air handling units and upgrades to their filtration system appeared to restore the systems to very good condition. The airflow and building pressurization measurements indicate that the HVAC system was operating correctly at the time of EH&E's assessment.

EH&E also reviewed the original building envelope design and the repairs designed to eliminate water incursions into the building. In general, the repair program appears adequate to prevent future building leaks.

To evaluate the prevalence of potential building-related illness, EH&E administered a health questionnaire developed by NIOSH to building occupants in June 2002. A total of 248 individuals completed the questionnaire that included information on doctor-diagnosed asthma, asthma symptoms, other building-related asthma symptoms, allergic rhinitis symptoms, and non-specific building-related symptoms. The analysis of the questionnaire data is ongoing and will be the subject of future reports.

2.0 SUMMARY OF HISTORICAL BUILDING INVESTIGATIONS

2.1 SUMMARY

EH&E completed a review and interpretation of the investigative work completed prior to 2002 in response to occupant concerns and water intrusion at 25 Sigourney Street, Hartford, Connecticut. EH&E also reviewed a compilation of IEQ investigations and remediation progress reports provided by the DPW. EH&E obtained information from the reports on characteristics of the building IEQ, including thermal comfort and microbiological agents. Information on the location and type of remediation work completed in the building was also extracted from the reports.

CO_2, temperature, and relative humidity were measured in various locations of nearly every floor of the building, by several different investigators, on at least one occasion between August 1996 and April 2001. CO_2 levels were less than 900 parts per million (ppm), equivalent to approximately 20 cubic feet per minute (cfm) per person of outdoor air, indicating that an adequate amount of outdoor air was delivered to the spaces. Temperature, relative humidity, and CO_2 were in the range of EH&E's experience with non-complaint office buildings and that reported in EPA's BASE study.[1,2]

Indoor and outdoor air concentrations of viable fungi or fungal spores were measured on eight different occasions between October 1996 and April 2001. Total culturable fungi concentrations in indoor air were less than 200 colony-forming units per cubic meter (cfu/m^3) and levels of total fungi indoors were less than those in outdoor air. The types of fungi in the indoor and outdoor air samples were similar, typically *Cladosporium* and basidiospores that are mushroom-type spores. These levels of culturable fungi and fungal spores are typical of office buildings in the northeastern United States.[3]

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1 Ludwig JF, Baker BJ, and McCarthy JF. 2002. Analysis of ventilation rates for the BASE study: assessment of measurement uncertainty and comparison with ASHRAE 62-1999. In: *Indoor Air 2002: Proceedings of the 9th International Conference on Indoor Air Quality and Climate* Vol. 3. Levin H, ed. Santa Cruz, CA: Indoor Air 2002, pp.388-393.

2 Apte M, Fisk W, and Daisey J. 2000. Associations between indoor CO_2 concentrations and sick building syndrome symptoms in U.S. office buildings: an analysis of the 1994 – 1996 BASE study data. *Indoor Air* 10:246-257.

3 Shelton BG, Kirkland KH, Flanders WD, and Morris GK. 2002. Profiles of airborne fungi in buildings and outdoor environments in the United States. *Appl Environ Microbiol* 68:1743-53.

In 2000 and early 2001, fungal loading was measured in 20 surface dust samples as part of a series of studies designed to answer specific questions about the potential for mold growth in carpet that was repeatedly wet from water leaks or cubicle partitions, such stored outdoors prior to use inside the building. One dust sample from a repeatedly wet area of carpet from the 17th floor had an elevated level of culturable fungi dominated by *Ulocladium*, while the other "repeatedly wet" and "never wet" carpet samples both had loadings and species distribution similar to that reported for non-complaint office buildings.[4] Culturable bacteria levels were approximately 100 times greater in samples of "repeatedly wet" carpet than in samples of "never wet" carpet. *Pseudomonas* was the most abundant type of bacterium in the "repeatedly wet" carpet samples, while *Bacillus* and gram negative bacteria were predominant in samples of the "never wet" carpet.

Although several repair programs had been implemented over the years, the first major construction activity related to resolution of water intrusion began in 2000 with the repair of roof copings and brick caulking. This work was reported to have stopped 95% of the water intrusion associated with roof leaks.[5] Further remedial action was a mixture of cleaning, replacement of carpet and wallboard, upgrades to the air handling systems, and repairs to the building exterior. Water-stained wallboard and carpet was replaced along the perimeter of floors 16 – 19, as well as other locations, on several occasions between fall 2000 and fall 2003.

Ventilation ductwork on the upper floors of the building was inspected and cleaned in 2001. Also in 2001, exhaust fans were cleaned throughout the building and stained wallpaper was removed from bathrooms on certain floors. Higher efficiency filters were installed on every air handling unit in 2002.

Interim repairs began in 2001 and included caulking around windows associated with leaks during a heavy rain event. Permanent repairs on the building exterior designed to prevent water incursion began in April 2002. The schedule for the building envelope work was accelerated in October 2002. Building envelope repairs were completed on floors 17, 18, and 19 by January 14, 2003, except for fewer than five localized areas on

4 Chao HS, Milton, DK, Schwartz J, Burge HA. 2002. Dustborne fungi in large office buildings. *Mycopathologia* 154:93-106.

5 Connecticut Department of Public Works, minutes of meeting on January 19, 2001.

each floor, located primarily at building corners. Complete replacement of the roof system began in August 2003.

There was no evidence in the records reviewed by EH&E that building materials on floors 8, 9, 10, or 11 were damaged by water or replaced.

2.2 INTRODUCTION

Construction of the 20-story building at 25 Sigourney Street, Hartford, CT and known originally as the Xerox Centre was completed in 1985. The building has a steel reinforced concrete structure with a brick façade. Generally, the construction cross section on the exterior wall, from inside out, is gypsum board on metal studs or channels, attached to either reinforced concrete or concrete block; rigid insulation; air space; and 4" of brick face. There is substantial glass on the exterior in aluminum casings that abut the masonry. Twelve terraces that are accessible from inside the building ring the 17th and 18th floors. The 19th floor has thirteen balconies that are primarily located at corners of the building and are accessible from perimeter offices. The 20th floor penthouse is approximately 40% of the area of a typical floor.

The State of Connecticut assumed control of the building in the early 1990s. The interior space was reconfigured and personnel from the Department of Social Services (DSS) and Department of Revenue Services (DRS) were relocated to the building thereafter. DSS units occupy floors 6 through 14. DRS personnel occupy floors 15 through 20.

The building has a history of water intrusion in certain areas that has contributed to IEQ and health concerns expressed by the occupants. In response, the State of Connecticut has responded to these concerns by investigating the quality of the indoor environment in the building and addressing the water leaks through a series of renovation and improvement projects. The purpose of this report is to summarize the investigative and remediation work completed in response to occupant concerns and water intrusion.

2.3 APPROACH

EH&E reviewed a compilation of reports and other communications about the building written between 1996 and 2003 and provided to us by the DPW (Table 2.1). These documents include IEQ investigations conducted by the Connecticut Department of Labor, the University of Connecticut Health Center, and others, as well as two inspections of the building ventilation system, and the DPW newsletter distributed to building occupants and other interested parties.

Table 2.1 Documents Regarding Inspections Provided to EH&E and Reviewed for this Report

Reporting Organization	Type	Date
Wings Testing & Balancing, Inc.	Mechanical	February 1996
Connecticut Department of Labor	IEQ	October 1996
Connecticut Department of Labor	IEQ	December 1998
Mystic Air Quality Consultants, Inc.	IEQ	October 1999
Connecticut Department of Labor	IEQ	January 2000
University of Connecticut	IEQ	February 2000
H.L. Turner Group	IEQ	March 2000
Occupational Risk Control Services	IEQ	June 2000
Occupational Risk Control Services	IEQ	November 2000
Occupational Risk Control Services	IEQ	December 2000
Occupational Risk Control Services	IEQ	January 2001
Occupational Risk Control Services	IEQ	April 2001
Connecticut Department of Labor	IEQ	April 2001
Luchini, Milfort, Goodall & Associates, Inc.	Mechanical	May 2001
Air Technologies, Inc.	Boroscope	September 2002

IEQ indoor environmental quality

EH&E obtained information from the reports on characteristics of the building IEQ, including thermal comfort and microbiological agents. Information on the location and type of remediation work completed in the building was also extracted from the reports.

2.4 INDOOR ENVIRONMENTAL QUALITY

Results of the historical IEQ investigations are summarized in Table 2.2. A description of the investigations and their findings are presented in the following sections.

Table 2.2 Summary of IEQ Parameters Reported in Historical Reports from 25 Sigourney Street, Hartford CT

Date	Organization	Result	Benchmark/Comments
Thermal Comfort			
August 1999	Mystic Air, Inc.	Temp: 73 – 78 °F; RH: 30 to 34%	Thermal comfort envelope (ASHRAE 55-1992) Winter range: 68.5 °F – 75.5 °F, 30% RH 68.0 °F – 75.0 °F, 40% RH 68.0 °F – 74.5 °F, 50% RH 67.5 °F – 74.0 °F, 60% RH Summer range: 74.0 °F – 80.0 °F, 30% RH 73.5 °F – 80.0 °F, 40% RH 73.0 °F – 79.0 °F, 50% RH 73.0 °F – 78.5 °F, 60% RH
January 2000	UCONN	Temp: 72 – 77 °F; RH: 10 to 25%	
November 2000	ORCS	Temp: 71 – 75 °F; RH: 23 to 30%	
April 2001	ORCS	Temp: 72 – 80 °F; RH: 18 to 27%	
Outdoor Air Ventilation			
Fall 1996	CTOSHA	659<CO_2<966 ppm	Minimum recommended outdoor air ventilation rates (ASHRAE 62-2001): 20 cfm per person for offices. Corresponds to CO_2 concentrations less than 850 ppm assuming specific activity level for office workers, an outdoor air concentration of 300 ppm CO_2, and steady-state operating conditions.
December 1998	CTOSHA	1,312<CO_2<1,700 ppm	
August 1999	Mystic Air, Inc.	CO_2<800 ppm	
January 2000	CTOSHA	CO_2<740 ppm	
January 2000	UCONN	CO_2<900 ppm	
November 2000	ORCS	CO_2<900 ppm	
April 2001	ORCS	CO_2<900 ppm	
Airborne Fungal Material in Occupied Areas			
Fall 1996	CTOSHA	Indoor<35 cfu/m^3; outdoor=467 cfu/m^3	Indoor levels: • Viable fungi: 24 to 10,000 (Shelton et al. 2002) • Spores: 24 to 10,000 spores/m^3 (BASE)
December 1998	CTOSHA	Indoor<198 cfu/m^3; outdoor=222 cfu/m^3	
August 1999	Mystic Air, Inc.	Indoor<607 cfu/m^3; outdoor<750 cfu/m^3	
January 2000	CTOSHA	Indoor<35 cfu/m^3; outdoor=140 cfu/m^3	
November 2000	ORCS	Indoor<714 spores/m^3; outdoor=16,000 spores/m^3	
November 2000	ORCS	Indoor<28 cfu/m^3; outdoor<228 cfu/m^3	
April 2001	ORCS	Indoor<14 cfu/m^3; outdoor=121 cfu/m^3	
Fungal Material in Wall Cavities			
January 2000	Turner Group	Wall cavities ~200,000 spores/m^3	No known benchmark Sampled adjacent to visible mold growth

Table 2.2 Continued

Date	Organization	Result	Benchmark/Comments
Fungal Material in Surface Dust			
June 2000	ORCS	12,000 to 630,000 cfu/g carpet dust	1,500 to 7,500,000 cfu/g carpet dust Chao et al. 2001
December 2000	ORCS	13,000 to 7,800,000 cfu/g partition dust	
February 2001	ORCS	4,700 to 410,000 cfu/g carpet dust	
Bacteria in Carpet Dust			
June 2000	ORCS	2,600,000 to 52,000,000 cfu/g carpet dust	No known benchmark
February 2001	ORCS	18,000 to 44,000,000 cfu/g carpet dust	Levels in "repeatedly wet" carpets were greater than in "never wet" carpets
Dust Mites in Surface Dust			
January 2000	CTOSHA	Mite fecal matter in ≤ 3 of 13 samples	No known benchmark
Volatile organic compounds, ozone, and nitrogen dioxide			
Fall 1996	CTOSHA	Non-detect (detection limit not reported)	ACGIH TLVs • Ozone—0.08 ppm • Nitrogen dioxide—3 ppm
August 1999	Mystic Air, Inc.	Non-detect (detection limit not reported)	

°F	degrees Fahrenheit
RH	relative humidity
ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc.
UCONN	University of Connecticut
ORCS	Occupational Risk Control Services
CTOSHA	Connecticut Department of Labor, Occupational Safety and Health Administration
CO_2	carbon dioxide
ppm	parts per million
cfm	cubic feet per minute
cfu/m^3	colony-forming units per cubic meter
spores/m^3	spores per cubic meter
BASE	Building Assessment Survey and Evaluation
cfu/g	colony-forming units per gram
ACGIH	American Conference of Governmental Industrial Hygienists
TLV	threshold limit value

2.4.1 Ventilation and Thermal Comfort

CO_2, temperature, and relative humidity were measured by various investigations at various locations of nearly every floor of the building on at least one occasion between August 1996 and April 2001. CO_2 levels were less than 900 ppm, equivalent to approximately 20 cfm of outdoor air delivery per person. The one exception is that CO_2 concentrations in a computer unit in December 1998 were in the range of 1,700 ppm. However, the accuracy of those measurements is in doubt because outdoor levels of CO_2 were reported to be 600 ppm—clearly an inaccurate value in comparison to global outdoor air CO_2 determinations (approximately 350 ppm).

2.4.2 Fungal Material

Indoor air concentrations of viable fungi or fungal spores were measured in more than 100 locations distributed over 15 floors of the building between October 1996 and April 2001. On each occasion, at least one corresponding outdoor air sample was also collected. As shown in Figure 2.1, total culturable fungi concentrations in indoor air were less than 200 cfu/m^3 and levels of total fungi indoors were less than those in outdoor air. The types of fungi in the indoor and outdoor air samples were similar, typically *Cladosporium* and basidiospores.

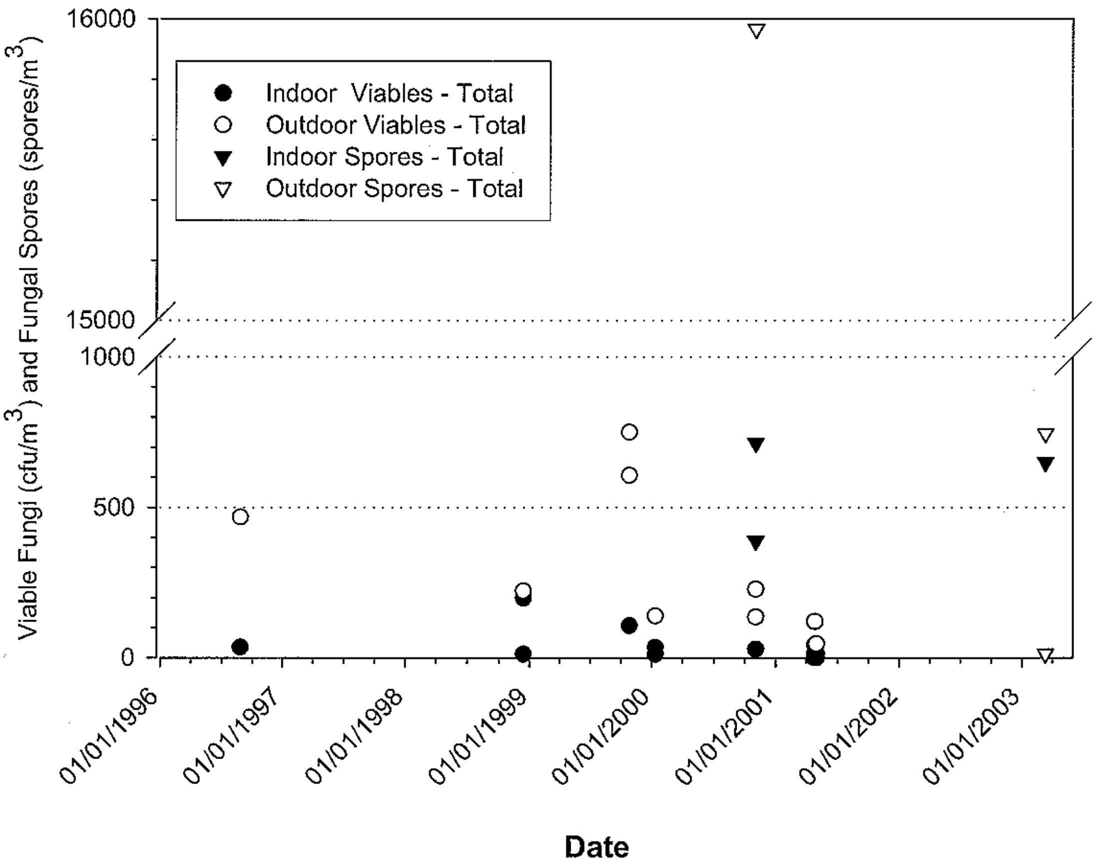

Figure 2.1 Minimum and Maximum Airborne Fungal Concentrations Measured during Eight Monitoring Periods at 25 Sigourney Street, Hartford, CT

In 2000 and early 2001, fungal loading was measured in 20 surface dust samples as a part of studies designed to answer specific questions about the potential for mold growth in carpet that was repeatedly wet from water leaks or cubicle partitions stored outdoors prior to use inside the building. One sample from a repeatedly wet area of carpet had 410,000,000 colony-forming units per gram (cfu/g) of culturable fungi, while the remaining repeatedly wet and never wet carpet samples had loadings less than 60,000 cfu/g. Concentrations in floor dust on the order of 250,000 cfu/g and as high as approximately 10^7 cfu/g have been reported for non-complaint office buildings.[6] *Ulocladium*, a fungus that has high moisture requirements, dominated the carpet sample with the highest loading. Surface dust collected from cubicle partitions formerly stored in the outdoor parking garage and later deployed on the 14th floor had fungal loading of

6 Chao HS, Milton, DK, Schwartz J, Burge HA. 2002. Dustborne fungi in large office buildings. *Mycopathologia* 154:93-106.

approximately 5,000,000 cfu/g compared to 20,000 cfu/g in the surface dust of 19th floor cubicle partitions that were not formerly stored in the garage.

2.4.3 Bacteria

In early 2001, culturable bacteria in three repeatedly wet carpet samples ranged from 1,100,000 – 44,000,000 cfu/g (mean 11,000,000 cfu/g), compared to 18,000 – 198,000 cfu/g (mean 60,000 cfu/g) for three never wet carpet samples. *Pseudomonas* was the most abundant type of bacterium in the repeatedly wet carpet samples, while *Bacillus* and gram negative bacteria were predominant in samples of the never wet carpet.

2.4.4 Mites

The presence of mites inside the building was characterized qualitatively based upon carpet and chair dust samples obtained in January 2000. The investigators concluded that active mite infestation was not evident.

2.4.5 Individual Reports

Twelve of the reports provided to EH&E described investigations of IEQ in the building that took place between Fall 1996 and Spring 2001.[7] Each of these reports is summarized in the remainder of this section.

In response to a request by a safety officer of the DSS, the Connecticut Department of Labor, Occupational Safety and Health Administration (CTOSHA) conducted a survey of the ninth floor of the building in August and September 1996.[8] The supply of outdoor air appeared to be adequate, as evidenced by short-term concentrations of CO_2 that were generally less than 800 ppm, although levels in a computer operations center were slightly less than 1,000 ppm.[9] Concentrations of a suite of volatile organic compounds (VOCs), ozone, and nitrogen dioxide were less than the method detection limit (not

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7 Follow-on investigations were conducted by the National Institute for Occupational Safety and Health and EH&E after that period and are described in other reports.

8 Connecticut Department of Labor. Consultation Report for State of CT Department of Social Services, 25 Sigourney Street, Hartford, CT 06106, January 24, 1997.

9 Outdoor levels of CO_2 were reported to be 457 ppm, suggesting inaccurate calibration of the CO_2 monitor, although local levels can be that high if sources are nearby.

specified in the report). Indoor air concentrations of total culturable fungi taken on August 26, 1996 were less than 35 cfu/m^3, compared to 467 cfu/m^3 (primarily *Cladosporium*) in the corresponding outdoor air sample.

Two years later, in December 1998, CTOSHA evaluated thermal comfort and mold exposure on the 17th floor of the building.[10] Concentrations of CO_2 ranged from 1,312 to 1,700 ppm indoors, although the validity of these measurements is questionable because outdoor CO_2 levels were reported to be 604 ppm. Culturable fungi in indoor air ranged from less than 12 to 198 cfu/m^3 among nine locations on the 17th floor in comparison to 222 cfu/m^3 outdoors. *Cladosporium* and *Aspergillus* species were the predominant fungi present in the indoor and outdoor air samples.

The ninth floor was the subject of an IEQ survey again in August 1999.[11] The results of this survey were similar to those from three years before in 1996. Specifically, VOC levels were less than the method detection limit, CO_2 concentrations were less than 800 ppm, and culturable fungi indoors (107 to 607 cfu/m^3 among eight locations) were less than the corresponding levels in outdoor air (607 and 750 cfu/m^3). Predominant fungi in both indoor and outdoor air were *Penicillium*, *Aspergillus*, *Fusarium*, and yeasts.

In January 2000, CTOSHA investigated two DRS areas on the 17th floor and a workstation on the 14th floor reported to be locations of recurrent water leaks for several years.[12] Temperature, relative humidity, and CO_2 levels indicated adequate thermal control and ventilation of the spaces. Concentrations of total fungi were less than 35 cfu/m^3 in the indoor locations, compared to 140 cfu/m^3 in outdoor air. A unique feature of this study was the characterization of "mold mites" and mite fecal material in samples of chair and floor dust. Two to three of the thirteen dust samples were reported to contain mold mites. CTOSHA reported that a "great deal" of mite fecal material was present in one chair dust sample. The amount of dust mite material in the samples apparently was not quantified. CTOSHA concluded that active mite infestation was not evident.

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10 Connecticut Department of Labor. Consultation Report for State of CT Department of Social Services, 25 Sigourney Street, Hartford, CT 06106, December 1998.

11 Mystic Air Quality Consultants, Inc. Limited and directed indoor air quality survey, Prepared for Tunxis Management, November 2, 1999.

12 Connecticut Department of Labor. Consultation Report for State of CT Department of Revenue Services, 25 Sigourney Street, Hartford, CT 06106, January 12, 2000.

The University of Connecticut Health Center conducted four walkthrough surveys of the building between December 1999 and February 2000.[13] Temperature and relative humidity ranged from 72 to 77 degrees Fahrenheit (°F) and 10% to 25%, respectively. CO_2 levels were less than 900 ppm. The inspectors noted water staining, water damage, and possible mold on areas of the 17th floor.

In January 2000, the H.L. Turner Group measured fungal concentrations within the cavity of exterior walls adjacent to locations of visible mold growth.[14] Spore counts in wall cavity air were as high as 300,000 spores per cubic meter (spores/m^3) and consisted primarily of *Penicillium/Aspergillus* types. Building pressure measurements indicated that wall cavities in those locations were positively pressurized with respect to the occupied space under certain conditions. A visual inspection of water intrusion on floors 17 through 19 documented evidence of leaks all along the inside of the exterior walls, especially near terraces and windows. The Turner Group recommended that action be taken to stop all known water leaks and to eliminate mold sources within the walls of the 17th, 18th, and 19th floors.

A small study was completed in June 2000 to test whether: (1) carpet repeatedly wetted by water intrusion had higher levels of fungi and bacteria than carpet that was not known ever to be wet and (2) carpet that is cleaned and dried within 24 hours of being wetted by a water leak has lower levels of fungi and bacteria than wet carpet that is not cleaned and dried.[15] Fungi and bacteria concentrations measured in dust collected from three carpet samples did not support either of the two hypotheses.

Occupational Risk Control Services evaluated ventilation, thermal comfort, and airborne fungi on seven floors of the building in November 2000.[16] Indoor concentrations of CO_2 were less than 900 ppm, temperature ranged from 71 to 75 °F, and relative humidity ranged from 23% to 30%. Airborne fungal spore concentrations on the 6th, 16th, 17th, and

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13 University of Connecticut Health Center, Industrial hygiene report, Submitted to State of Connecticut Workers' Compensation Commission, February 16, 2000.

14 H.L. Turner Group, Initial Wall Cavity Evaluation 17th, 18th, 19th Floors, Submitted to Tunxis Management Company, April 25, 2000.

15 Occupational Risk Control Services, Report for Carpet Sampling, Submitted to Tunxis Management, June 15, 2000.

16 Occupational Risk Control Services, Report for Fungal Air Sampling, Submitted to Tunxis Management, November 3, 2000.

19th floors were between 389 and 714 spores/m^3, compared to approximately 16,000 spores/m^3 outdoors. Airborne culturable fungi on floors 5, 6, 14, 17, 18, and 19 were less than 28 cfu/m^3, whereas the concurrent concentrations in outdoor air were 136 and 228 cfu/m^3. *Cladosporium* and basidospores dominated both the indoor and outdoor air spore and culturable fungi samples.

In December 2000, a study was conducted to examine whether surface dust on cubicle partition panels formerly stored in the parking garage of the building had different levels of fungi than panels that were not stored in the parking garage.[17] Culturable fungi levels in dust from three panels on the 14th floor and formerly stored in the garage ranged from 3,000,000 to 7,800,000 cfu/g and were exclusively *Cladosporium*. Concentrations from 13,000 to 34,000 cfu/g were found on three panels from the 19th floor that were not formerly stored in the garage. *Cladosporium*, *Rhodotorula*, and *Pithomyces* were the predominant molds on the partitions from the 19th floor. All cubicle partitions on DRS floors were cleaned in March 2001.

Carpet in areas obtained from the 17th floor known to be repeatedly wet from water leaks were analyzed for viable fungi and bacteria and the levels were compared to fungal and bacterial loading in carpet from the 6th and 17th floors known to have never been wet.[18] Total culturable fungi in four samples from repeatedly wet carpet ranged from 5,800 to 22,000 cfu/g, while one sample from repeatedly wet carpet had fungal loading of 410,000 cfu/g. In comparison, fungal loading in samples from never wet carpet ranged from 4,700 to 59,000 cfu/g. Yeasts, *Cladosporium*, and *Phoma* were the most abundant types of fungi present in both repeatedly wet and dry carpets, except for the predominance of *Ulocladium* in the repeatedly wet carpet with the highest total fungi loading. Culturable bacteria in repeatedly wet carpet samples ranged from 1,100,000 to 44,000,000 cfu/g (mean 11,000,000 cfu/g), compared to 18,000 to 198,000 cfu/g (mean 60,000 cfu/g) for never wet carpet samples. *Pseudomonas* was the most abundant type of bacterium in the repeatedly wet carpet samples, while *Bacillus* and gram negative bacteria were predominant in samples of the never wet carpet.

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17 Occupational Risk Control Services, Report for Vacuum Dust Sampling of Fabric Covered Partition Panels, Submitted to Tunxis Management, February 28, 2001.

18 Occupational Risk Control Services, Report for Carpet Sampling, Submitted to Tunxis Management, February 26, 2001.

In April 2001, environmental sampling was conducted to determine whether elevated levels of fungi were present in areas occupied by symptomatic individuals on floors 6 and 14 through 19.[19] CO_2 concentrations were less than 900 ppm, relative humidity ranged from 18% to 27%, and temperature was between 72 and 80 °F. Concentrations of airborne total culturable fungi were less than 14 cfu/m^3 in each of the 35 samples collected indoors. Total culturable fungi levels outdoors were 43 and 121 cfu/m^3.

Boroscopic inspections of 278 wall cavity locations on 14 floors of the building were conducted in September and October of 2002.[20] Conditions within the walls were classified as: (1) water staining, (2) rust or corrosion, or (3) spotting which could be mold. Rust was observed at least once on the 6th, 9th, 17th, and 18th floors. Mold was observed primarily on the 16th and 18th floors, and water staining was observed on nearly all floors, although the majority of stains were observed on the 18th floor.

2.4.6 Significance of Historical Data

The information presented in the reports of previous investigations indicates that the indoor environment of 25 Sigourney Street since 1996 was in the range of temperature, relative humidity, and delivery of outdoor air typical of EH&E's experience with non-complaint office buildings and consistent with that found in EPA's BASE study.

Airborne fungal levels also were in the range of EH&E's experience with non-complaint buildings. Thus, the historical information does not provide empirical evidence of elevated airborne concentrations of fungi inside the building despite the prevalence of documented water leaks on the 17th, 18th, and 19th floors and elevated fungal levels in wall cavities associated with areas of visible mold. However, it is possible that fungi resulting from water damage in wall cavities could cause sporadic localized exposures to fungal material in air, if the material was transported during building repairs or through a pressure differential between the wall cavity and occupied space.

The fungal measurements in surface samples could be interpreted as an indication that chronically wet carpets contain elevated levels of fungi that have high moisture

19 Occupational Risk Control Services, Report for Cultureable Fungal Sampling, Submitted to Tunxis Management, April 26, 2001.

20 Air Technologies Inc., Northford, CT reports.

requirements. However, the same data also suggest that such growth was limited to isolated locations because fungal loading in all but one of the chronically wet carpet samples was in the range reported for non-complaint office buildings.[21] Surface dust collected from cubicle partitions formerly stored in the outdoor parking garage and later deployed on the 14th floor had fungal loadings approximately 100 times greater than partitions that were not formerly stored in the garage. However, the significance of the cubicle partition data is limited by the small sample size (six samples in total) and limited potential for moisture to support fungal growth on panels relocated from the garage to indoors.

Chronically wet carpet contained levels of culturable bacteria that were approximately 100 times greater than never wet carpet. Bacteria populations in both chronically wet and dry carpets were dominated by gram negative bacteria, *Pseudomonas* and *Bacillus* spp., respectively. These opportunistic pathogens can cause infections in individuals with severely compromised immune systems or open wounds; however, these bacteria almost never infect uncompromised persons.[22] Gram negative bacteria are ubiquitous in nature and these areas could be a source of background levels of endotoxin. Although no reports were available that documented airborne or surface levels of endotoxin in the building, it is unlikely that the isolated areas of elevated bacterial growth noted would present a significant environmental exposure to occupants of the building.

2.5 REMEDIATION

According to the records reviewed by EH&E,[23] the first major construction activity related to water intrusion began in 2000 (Table 2.3). The repair of roof copings and brick caulking completed between March 2000 and November 2000 reportedly stopped 95% of the water intrusion associated with roof leaks.[24] Water-stained wallboard along the perimeter of floors 17 – 19 was replaced between September and October 2000. In December 2000, water-stained wallboard in zone 7 of the 16th floor was also replaced.

21 Chao HS, Milton, DK, Schwartz J, Burge HA. 2002. Dustborne fungi in large office buildings. *Mycopathologia* 154:93-106.

22 Tortora GJ, Funke BR, Case CL. 1998. *Microbiology: an introduction*. Menlo Park, CA: Benjamin/Cummings.

23 25 Sigourney Street—Progress Report Issues #1 through #37, prepared by the Department of Public Works.

24 Connecticut Department of Public Works, minutes of meeting on January 19, 2001.

Table 2.3 Chronological Listing of Remediation Activities Described in Progress Reports Issued by the Department of Public Works

Floor	Date	Material	Zone	Description
17	Mar. 11, 2000	Wallboard	Zone 4, right of balcony 9	Replaced wallboard sampled by Turner on Jan 18, 2000
Roof	Mar. 31, 2000	Roof	Exterior	Phase 1 coping repairs; Phase 2 to be completed by November 2000
17	May 27, 2000	Carpet	Perimeter	Carpet cleaning completed (per Turner recommendation)
18	May 27, 2000	Carpet	Perimeter	Carpet cleaning completed (per Turner recommendation)
19	May 27, 2000	Carpet	Perimeter	Carpet cleaning completed (per Turner recommendation)
Roof	Nov. 2000	Roof	Exterior	Repair of roof copings and brick caulking complete; 95% water intrusion stopped
17	~Oct. 15, 2000	Wallboard	Perimeter	Began early September; water stained wallboard on perimeter replaced
18	~Oct. 15, 2000	Wallboard	Perimeter	Began early September; water stained wallboard on perimeter replaced
19	~Oct. 15, 2000	Wallboard	Perimeter	Began early September; water stained wallboard on perimeter replaced
16	Dec. 30, 2000	Wallboard	7	Wallboard replaced
5	Mar. 26, 2001	Carpet	Balcony perimeter	Removed (no information about replacement)
17	Mar. 26, 2001	Partition walls	All; other DRS floors underway	Vacuumed
18	Mar. 26, 2001	Partition walls	All; other DRS floors underway	Vacuumed
19	Mar. 26, 2001	Partition walls	All; other DRS floors underway	Vacuumed
All	Mar. 26, 2001	Exhaust fans	Bathrooms	Cleaned
Not specified	Apr. 13, 2001	Wallpaper	Bathrooms	Removed stained wallpaper and eliminated at least one interior wall
Not specified	Apr. 21, 2001	Exterior	Around windows	Interim repairs begin; location not further specified; DPW Update #1
Not specified	Apr. 21, 2001	Interior	Around windows	Caulking interior at areas of water incursion during March 9, 2001 driving rainstorm
5	May 3, 2001	Sheetrock	Around a column	Replaced because of water staining
5	May 8, 2001	Sheetrock	Around a column	Replaced because of water staining
17	Jun. 4, 2001	Ductwork	Entire floor	Cleaned and filters changed
19	Jul. 2, 2001	Missing	Not specified	Repairs to stop leaks from penthouse; DPW update #1
6	Aug. 17, 2001	Air boxes	All	Inspection/filter change completed
14	Aug. 17, 2001	Air boxes	All	Inspection/filter change nearly complete
15	Aug. 17, 2001	Air boxes	All	Inspection/filter change in progress
16	Aug. 17, 2001	Air boxes	All	Inspection/filter change completed
17	Aug. 17, 2001	Air boxes	All	Inspection/filter change completed
19	Sep. 7, 2001	Wallboard	5 rooms	Wallboard replaced
All	Nov. 2, 2001	Carpet	All	Cleaning begins
All	Dec. 15, 2001	Carpet	All	Cleaning complete
17	Nov. 16, 2001	Carpet	2	Carpet replaced in floor/zone
17	Feb. 25, 2002	Carpet	All	Carpet replacement complete
All	Feb. 25, 2002	HVAC	All	Installed high efficiency filters
14, 15	Apr. 13, 2002	Walls	Bathrooms	Walls removed to remedy mold found beneath wallpaper at earlier date

Table 2.3 Continued

Floor	Date	Material	Zone	Description
All	Apr. 18, 2002	Exterior	All	Permanent repairs begin
19	Jul. 25, 2002	Wallboard	Perimeter	Reported in DPW progress report
17,19	Aug. 26, 2002	Wallboard	All water damaged	Removal complete; no visible mold; minimal water damage
19	Aug. 30, 2002	Carpet	Perimeter, localized	Carpet replaced after carpet sample positive for mold (DPW)
7	Sep. 3, 2002	Missing	Lunch and conference room	Leakage over lobby repaired and affected wallboard replaced
14	Sep. 7, 2002	Wallpaper	Bathrooms	Removed; walls repainted
18	Sep. 7, 2002	Carpet	Perimeter, localized	Carpet replaced after carpet sample positive for mold (DPW)
19	Sep. 24, 2002	Carpet	Perimeter	Carpet replaced after exterior sealed and wallboard replaced
All	Oct. 1, 2002	Exterior	Exterior	Accelerated schedule begins for repairs to building envelope
5	Oct .14, 2002	Wallboard	Around sliders	Replaced in conjunction with repair of the sliding glass doors
17	Jan. 14, 2003	Exterior	All	Repairs completed by this date, except for <5 localized areas
18	Jan. 14, 2003	Exterior	All	Repairs completed by this date, except for <5 localized areas
19	Jan. 14, 2003	Exterior	All	Repairs completed by this date
17	Feb. 28, 2003	Wallboard	In progress	Removal and replacement of water-damaged sheetrock
19	Feb. 28, 2003	Wallboard	Not specified	Replacement of removed materials completed
Unknown	May 1, 2003	Wallboard	Bathrooms	Remediation complete
18	Jul. 11, 2003	Wallboard	Water-damaged sheetrock	Removal complete
16	Jul. 11, 2003	Wallboard	Water-damaged sheetrock	Replacement in progress
Roof	Aug. 2003	Roof	Exterior	Complete replacement of roof system begins
18	Aug. 5, 2003	Wallboard	Water-damaged sheetrock	Replacement complete

ORCS Occupational Risk Control Services
DRS Connecticut Department of Revenue Services
DPW Connecticut Department of Public Works
HVAC heating, ventilating, and air-conditioning

Remedial action completed in 2001 was a mixture of cleaning, replacement of carpet and wallboard, upgrades to the air handling systems, and repairs to the building exterior. The ductwork on floors 6 and 14 through 19 was inspected and filters were replaced. The cubicle partitions on floors 17 through 19 were vacuumed. The carpet on each floor of the building was cleaned. Water-stained wallboard or carpet was replaced on floors 5 and 17. Exhaust fans were cleaned in bathrooms throughout the building and stained wallpaper was removed from bathrooms in certain floors. Finally, interim repairs, including caulking, began around windows associated with leaks during a heavy rain event in March 2001.

In early 2002, high efficiency air filters were reportedly installed in each floor of the building. Water-stained carpet was replaced on the 17^{th}, 18^{th}, and 19^{th} floors. Water-stained wallboard on the 5^{th}, 17^{th}, and 19^{th} floors was replaced as well. Wallpaper and underlying mold was removed from bathrooms on the 14^{th} and 15^{th} floor. Permanent repairs on the building exterior designed to prevent water incursion began in April 2002. The schedule for the building envelope work was accelerated in October 2002.

Building envelope repairs were completed on floors 17, 18, and 19 by January 14, 2003, except for fewer than five localized areas on each floor, located primarily at building corners. Water-damaged sheetrock was replaced on floors 17 and 19 in February 2003 and on floors 16 and 18 in August 2003. Complete replacement of the roof system began in August 2003.

There was no evidence in the records reviewed by EH&E that building materials on floors, 8, 9, 10, or 11 were damaged by water or replaced.

3.0 PRELIMINARY ANALYSES OF FUNGAL SAMPLES COLLECTED

3.1 SUMMARY

EH&E collected samples in July 2002 and March 2003 to characterize fungal conditions in perimeter wall cavities, interior surfaces, and the indoor air of selected areas in the building. The results indicated that, overall, the indoor spore concentrations on all floors of the building were low and in the range observed in non-complaint buildings. For example, the measured indoor total spore concentrations were similar to levels measured by EH&E for the EPA in its BASE study of buildings located throughout the United States. Wall cavity sampling conducted in July 2002 and March 2003 suggest that conditions in the wall cavities related to possible reservoirs of fungal growth had not changed substantially between the two time periods. Results of the 288 surface samples obtained in March 2003 suggested that high levels of airborne fungal spores had not been present in the selected floors since the most recent cleaning of these surfaces. Water stains on floors, walls, ceilings, and windows were not associated with total spore concentrations in the wall cavities on an individual sample basis or floor basis. In addition, visual evidence of water damage was not more likely in locations identified by the architectural consultant for remediation in 2000. The preliminary conclusions of the July 2002 and March 2003 sampling protocol are that the results do not indicate elevated levels of fungal spores in the air or on surfaces in the occupant spaces.

3.2 BACKGROUND AND METHODS

EH&E collected samples in July 2002 and March 2003 to characterize fungal conditions in exterior wall cavities, interior surfaces, and the indoor air of selected areas in the building.

The sampling protocol was designed to address the following two questions regarding the presence of fungal materials in the building:

- Is there evidence for current fungal growth in the building?
- Is there evidence for historical fungal growth in the building?

The fungal sampling conducted by EH&E in July 2002 included collection of air samples for fungal spores from the exterior wall cavities on all occupied floors in the building using the WallChek® sampling system. Each wall cavity sample was collected for five minutes using a sampling pump controlled by a timer and attached to an Air-O-Cell cassette. Approximately 30 samples were collected on each of the occupied floors; fewer samples were collected on floors 5 and 20 due to the smaller occupied areas on these two floors. Also in July 2002, visual inspections for mold growth and water damage on interior ceilings, walls, and floors were conducted on all occupied floors in the building. In addition to the sampling in July 2002, boroscope inspections were conducted in September and October 2002 at 278 locations on 14 floors of the building. A boroscope allows the investigator to identify water staining, rust or corrosion, or spotting which could be mold inside the walls.

The protocol implemented for the March 2003 evaluation was more extensive than the July 2002 protocol. It was conducted on seven floors of the building that were selected as representative of floors from both the DSS and the DRS. The protocol repeated the sampling of the exterior wall cavities using the WallChek® sampler; however, the samples were collected under two different conditions. Air samples were first collected under the quiescent conditions used in the July 2002 evaluation and then collected after the wall had been perturbed using a calibrated wall punch device. The objective of this perturbation sampling was to determine whether or not there were reservoirs of fungal growth within the wall cavities that could be detected only by perturbing the walls. Samples were collected from approximately half of the original July 2002 WallChek® sampling sites on each floor.

The March 2003 protocol also included collection of samples for airborne fungal spores in the occupant spaces and on surfaces in the occupant spaces. Air samples for fungal spores were collected every two hours during an eight-hour workday. Each sample was collected for five minutes using a sampling pump controlled by a timer and attached to an Air-O-Cell® cassette. A spore sampling station was also located on the roof of the building to obtain outdoor data for comparison to the indoor results. Tape samples were also collected from selected surfaces in the occupied spaces so that fungal components in surface dust could be identified by light microscopy. A primary focus of this sampling approach was to identify fungal materials that could be causes of contact dermatitis that had been reported by building occupants. Sites selected for sampling included areas that received minimal housekeeping, such as tops of filing cabinets and behind computers, and were likely reservoirs of material accumulated over an extended period of time.

3.3 RESULTS

Figure 3.1 presents the median values for measurements of total airborne fungal spores for samples collected at four time points during the day from the seven floors of the building and from two outdoor locations, the roof and the mezzanine located next to the cafeteria on the fifth floor, in March 2003. The results are reported as spores/m^3 of air; the error bars represent the 75^{th} percentiles for the data.

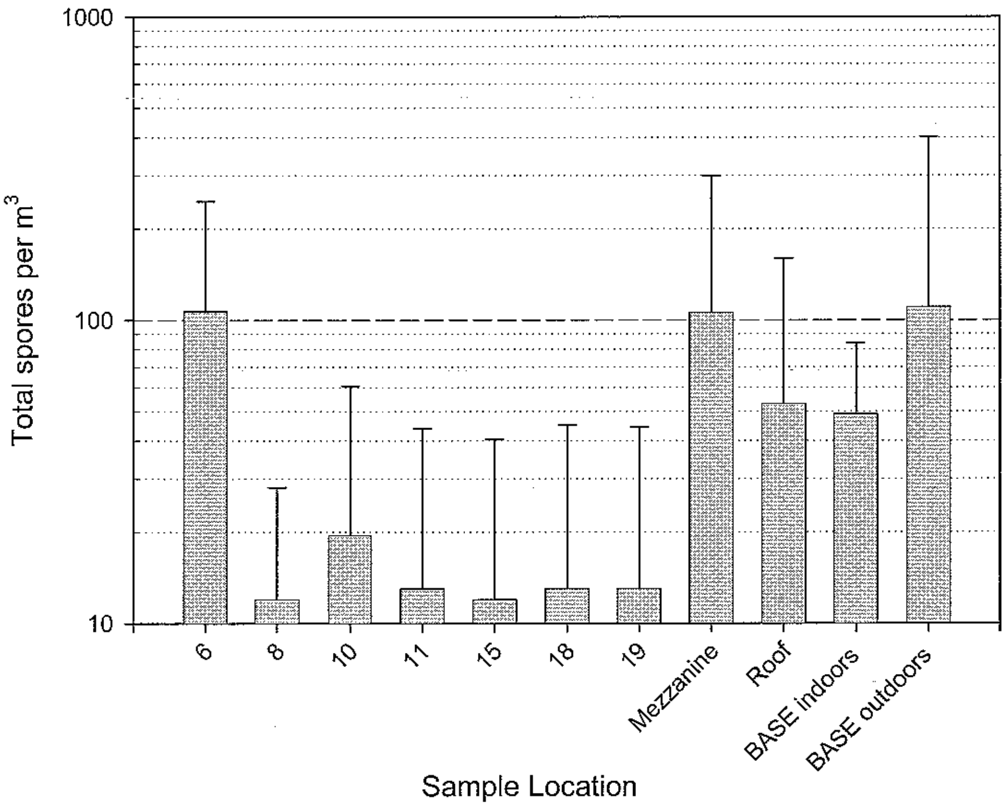

Figure 3.1 Median Total Spore Concentrations by Floor—March 2003

The results indicated that, overall, the indoor spore concentrations on all floors of the building were low and in the range observed in non-complaint buildings. Indoor concentrations were less than 20% of the values for corresponding outdoor concentrations, except on the sixth floor. Possible reasons for the elevated level on the sixth floor have not yet been determined. The types of spores identified in the indoor samples were the same as those identified in the outdoor samples, which indicated that no unusual sources of fungal growth were present in the indoor environment. The identified spore types primarily included *Penicillium/Aspergillus*, *Cladosporium*, basidiospores, and other small brown types of spores. All of these spore types are commonly found in air samples collected from indoor and outdoor environments. As shown in Figure 3.1, the measured indoor total spore concentrations were similar to levels measured by EH&E for the EPA in its BASE study of buildings located throughout the United States.

Figure 3.2 presents a summary of data from WallChek® samples collected in March 2003 by EH&E following perturbation of the wall. Data presented by the Turner Group from a wall cavity evaluation completed in 2000 are also shown in the chart.[25] The wall cavity samples from the Turner Group were collected adjacent to areas of visible mold growth and were also collected following wall perturbation. The data in this figure are reported as total spores/m^3 of air and plotted on a logarithmic scale.

25 Turner Building Science, LLC. 2000. *IAQ Evaluation: Initial Wall Cavity Evaluation 17th, 18th, and 19th Floors*. Danville, Vermont: Turner Building Science, LLC.

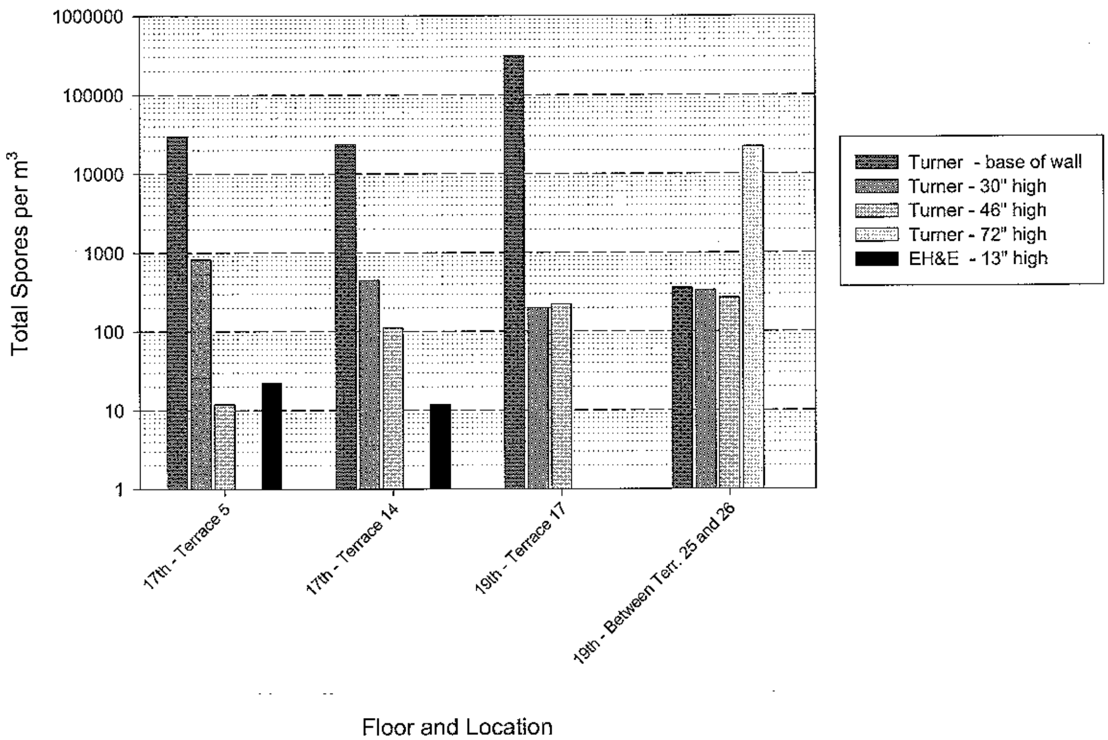

Figure 3.2 Wall Cavity Samples—March 2000 and July 2002

The Turner Group collected their samples from a series of heights at each sampling location to evaluate the spatial extent of potential fungal growth inside the wall cavity. The results from the report indicated high levels of spores in the wall cavities at their sampling locations on the 17th and 19th floors; the highest levels were measured at the base of the wall. The Turner Group concluded that the base of the wallboard on the 17th and 19th floors was supporting mold growth. Following this report, the wallboard along an entire exterior wall on the 17th floor was removed and replaced. This replacement may account for the much lower levels of spores measured on the 17th floor by EH&E in March 2003; EH&E did not collect samples on the 19th floor at the request of the DPW.

Figure 3.3 presents a summary of the data from the WallChek® samples collected by EH&E under quiescent conditions in July 2002 and March 2003. The results are median values reported as total spores/m^3 of air and plotted on a logarithmic scale; the error bars represent the 75th percentiles for the data.

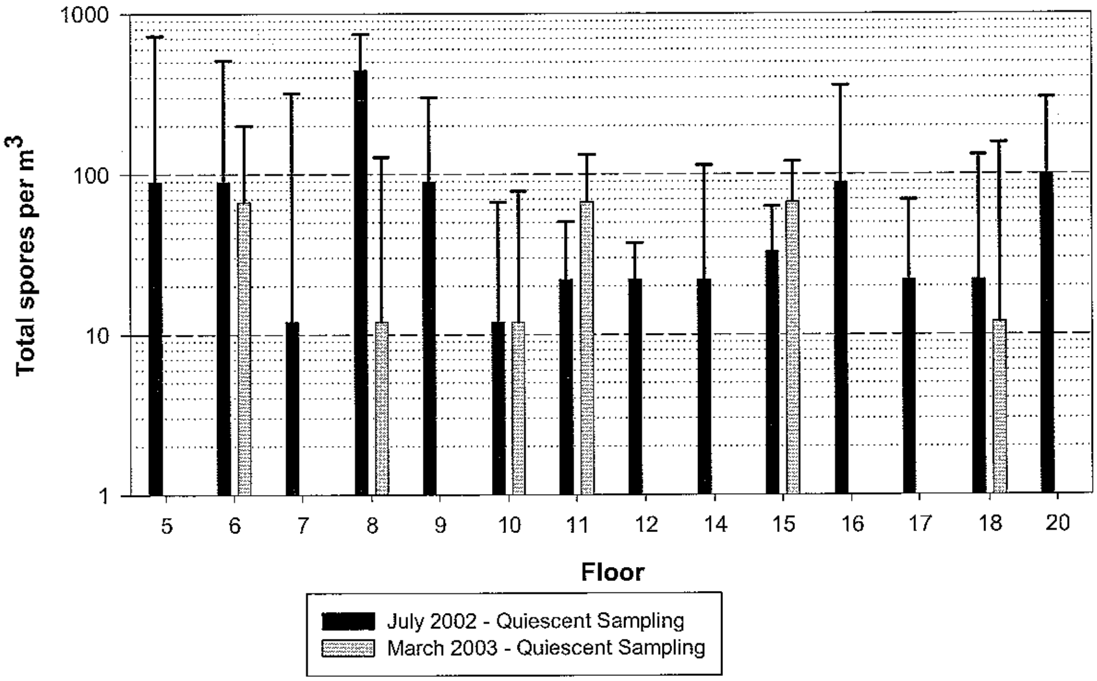

Figure 3.3 Wall Cavity Sampling—July 2002 and March 2003

One objective for comparison of these data was to determine whether conditions had changed in the wall cavities between the July 2002 and March 2003 sampling periods. The results indicated no statistically significant differences in the results between the two sampling periods. This suggests that conditions in the wall cavities related to possible reservoirs of fungal growth had not changed substantially between the two time periods.

Figure 3.4 presents a summary of the data from the WallChek® samples collected by EH&E under quiescent and perturbation conditions in March 2003. The results are median values reported as total spores/m^3 of air and plotted on a logarithmic scale; the error bars represent the 75th percentiles for the data.

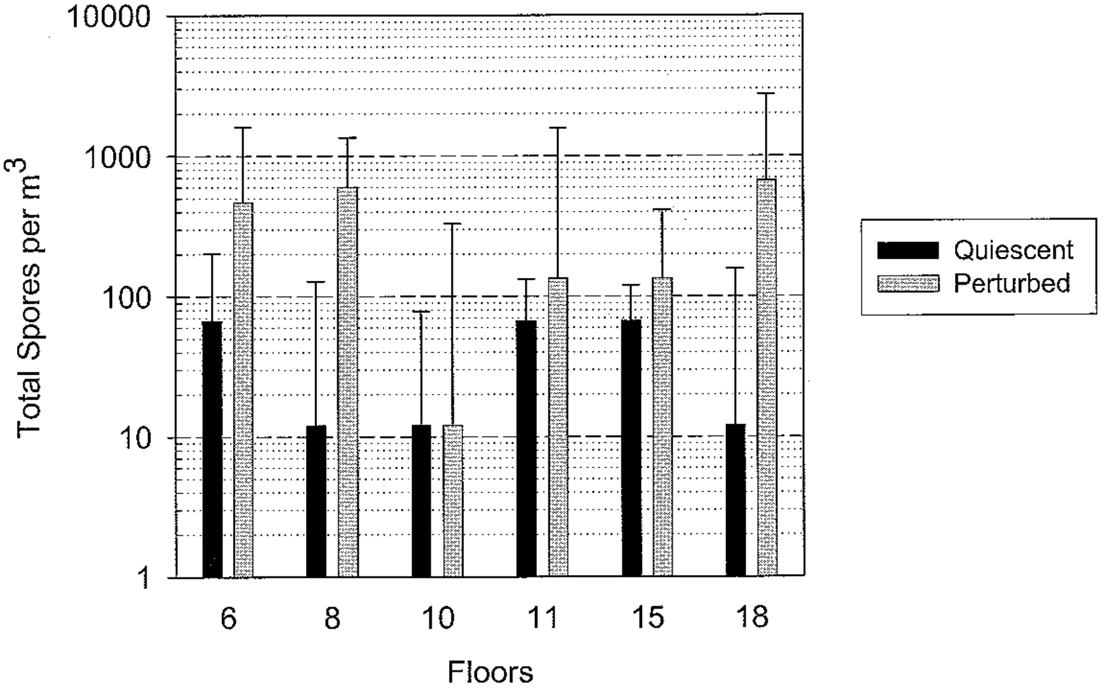

Figure 3.4 Wall Cavity Sampling—March 2003 Perturbed and Quiescent

Qualitatively, sampling of the wall cavities following perturbation yielded higher total spore concentrations than quiescent sampling. EH&E is in the process of conducting a careful quantitative analysis of the data to support interpretation of these results.

Results from analyses of fungal spores in surface tape samples collected from the occupant spaces on the seven floors studied during the March 2003 investigation were also evaluated. These samples were purposefully collected from dusty surfaces so that they would best represent airborne particles that had deposited on surfaces over time. This approach was selected to determine whether or not notable levels of fungal spores had been present previously in the air of the occupied spaces. The evaluation by light microscopy of 160 samples indicated that only one contained fungal spores; these results suggested that high levels of airborne fungal spores had not been present in the selected floors since the most recent cleaning of these surfaces. Surface tape samples were also collected from the mechanical rooms. Of the 128 samples collected, only nine samples contained fungal spores.

In the visual inspection in July 2002, water stains were observed at 14% of the wall locations, 4% of window locations, approximately 2% of the ceiling locations, and less than 1% of the floor locations. Water stains were observed on all 14 of the floors that were inspected and were most frequently (23% of wall locations) observed on floors 8 and 11. Relatively little or no staining was observed on the 18th floor, consistent with records from the building management that water-stained wallboard was replaced on at least one occasion in the 24-month period preceding the inspection. Water stains on floors, walls, ceilings, and windows were not associated with total spore concentrations in the wall cavities on an individual sample basis or floor basis. In addition, visual evidence of water damage was not more likely in locations identified by the architectural consultant for remediation in 2000.

Boroscopic inspections were conducted along the interior perimeter of the exterior wall of the building. Visible rust was observed at least once on the 6th, 9th, 17th, and 18th floors. Visual signs of mold growth were observed primarily on the 16th and 18th floors, and water staining was observed on nearly all floors, although the majority of stains were observed on the 18th floor. Detection of total fungal spore concentrations in wall cavities during 2002 or 2003 was not associated with the visual or boroscope inspection results. Although no significant relationships were detected between the boroscopic inspection and water staining visible from the visual inspection, boroscopic evidence of water damage was significantly more likely in locations identified for remediation in 2000.

3.4 CONCLUSIONS

The preliminary conclusions of the July 2002 and March 2003 sampling protocol are that the results do not indicate elevated levels of fungal spores in the air or on surfaces in the occupant spaces. Analysis of the WallChek® samples completed to date indicates that fungal conditions were relatively constant between July 2002 and March 2003, and that WallChek® results were dependent upon the degree to which walls are perturbed during sampling. A next step in the evaluation of the data is to combine historical information about the building with current environmental data to understand possible causes for health concerns reported by building occupants. Another step is to evaluate possible associations between the health survey data and the environmental data.

4.0 MECHANICAL SYSTEMS ASSESSMENT

4.1 SUMMARY

In March of 2003, EH&E reviewed the design, operation, and adjustment of selected HVAC systems in the 25 Sigourney Street Building in Hartford, Connecticut. In this investigation, EH&E measured the flow of outdoor air into selected floors during occupied operation conditions, measured the differential pressure between indoors and outdoors, and measured exhaust flows. EH&E also inspected the various mechanical rooms and air handling equipment serving the floors studied.

Overall, EH&E observed that the HVAC systems were clean and well maintained. Recent cleaning of the air handling units and upgrades to their filtration system appeared to restore the systems to very good condition. A review of air flows and building pressurization showed that the floors are operating at design flows relative to outdoor air delivery and that the floors are maintained at a positive pressure with respect to outdoors.

4.2 BUILDING HEATING, VENTILATING, AND AIR-CONDITIONING SYSTEMS

The following sections detail the design, operation, and observed maintenance of the HVAC systems for the building at 25 Sigourney Street in Hartford, Connecticut. This information was gained by a review of the original design drawings, a review of the various reports made by other entities concerning these systems, and measurements and inspections performed by EH&E in the course of performing its building evaluation.

To heat, ventilate, and air-condition each of the floors of the building, chilled or heated water generated from an off-site plant is supplied to two air handling units on each of the building's floors. Each air handling unit is located in a room which acts as a mixing plenum, mixing a fixed flow volume of outdoor air with return air from the space. Outdoor air is provided using fans and outdoor air inlets from the penthouse level of the building. During occupied time periods, the amount of outdoor air provided to each floor is constant and does not vary according to weather conditions. The outdoor air volume can be changed on a floor-by-floor basis in response to fire and smoke alarm conditions to purge and/or pressurize floors as needed. Exhaust air is removed from each floor through bathroom exhaust.

Each of the thermal control zones operates according to a variable air volume (VAV) control strategy. Using this strategy, each of the air handling units in the building will control the supply air discharge temperature to assure both adequate cooling and dehumidification to meet the cooling requirements of the space. The volume of this air is then varied based on the demands of the space, as sensed by local zone thermostats. For instance, in cooling mode, if the space temperature is getting lower than the zone thermostat's set point, this control strategy will lessen the amount of supply air discharged into the zone. By this strategy, the amount of supply air temperature to an individual zone will reduce to some predetermined minimum so as to assure adequate ventilation of the zone.

In the interior zones of the building, this strategy works in an occupied building and requires no heating even during the coldest weather, assuming that the space is occupied with normal lighting and office equipment usage. However, in the exterior zones, this strategy can be problematic during winter conditions if there is no local heat source to compensate for heat lost through the building skin and air leakage.

In this building, once the minimum flow value for an exterior zone is reached, a fan-powered reheat box will reheat supply air before introduction into the occupied space. The fan assures better distribution of heating air, which is always difficult to do from a ceiling mounted diffuser, and a hot water coil in the VAV box reheats the supply air to appropriate conditions to heat the zone.

The floor air handling units are also equipped with a preheat coil. This coil is generally used to perform a morning warm up of the space. There are no provisions to humidify indoor air in this building.

Figure 4.1 provides, in schematic fashion, a description of the HVAC strategy used in this building.

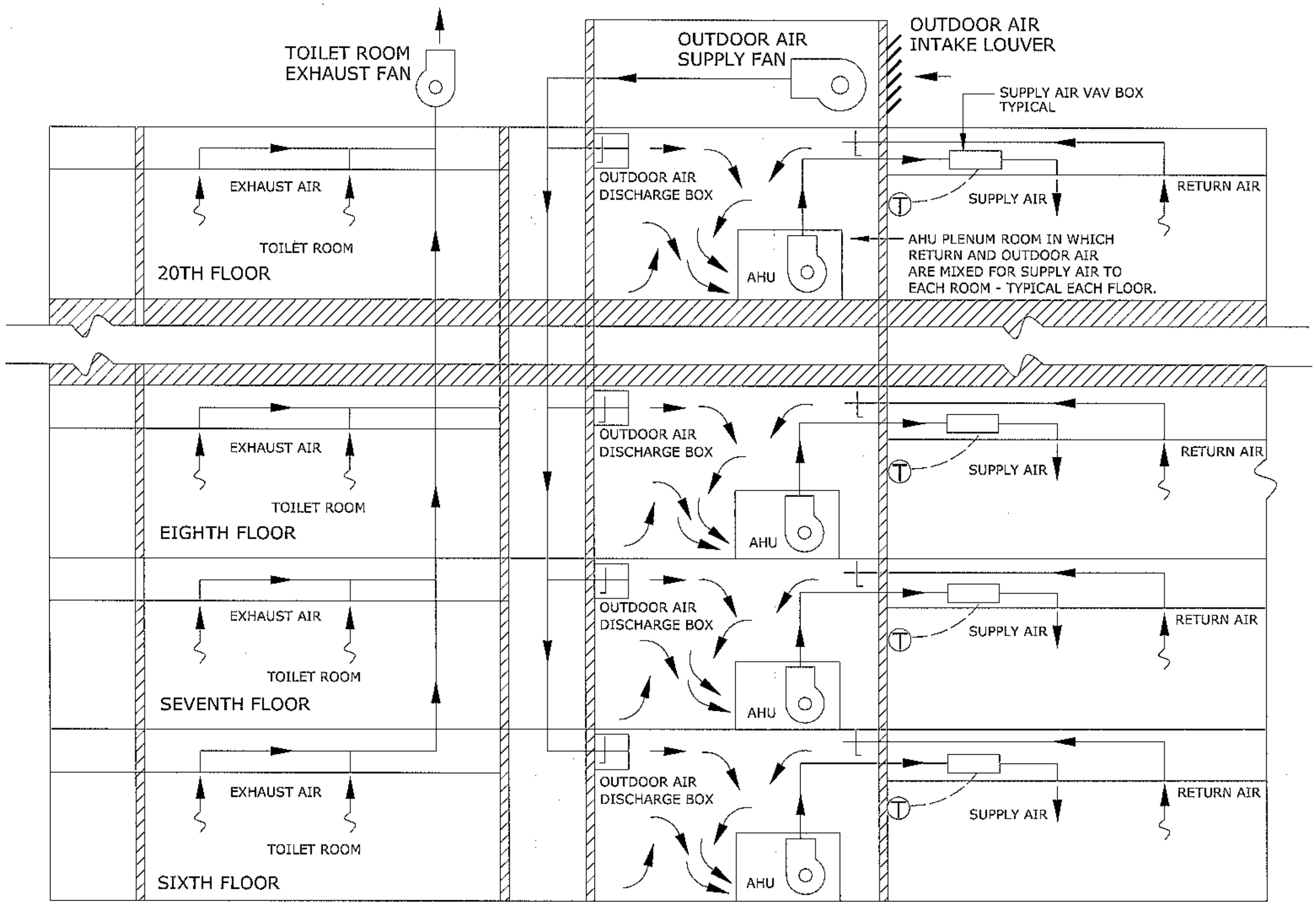

Figure 4.1 Schematic Depiction of the HVAC System of the 25 Sigourney Street Building

4.3 BUILDING HISTORY

The 25 Sigourney Street Building was built circa 1985 as an office building and was referred to as the Xerox Centre. In the early 1990s, Xerox relinquished control of the building to the State of Connecticut. The State of Connecticut accepted the property and chose to use it as office space for the DSS and DRS. It appears that the State of Connecticut performed some minor modifications to the building's HVAC systems in the form of a rezoning of floors 6 through 20 circa 1994.[26] However, from the original drawings to the current building, it appears that no radical changes were made to the design and operation of the building's HVAC systems.

In the late 1990s, mold was discovered on external walls of several floors. The source of water to enable this mold growth was thought to be water that was penetrating into the exterior of the walls. During the investigation of this problem, it was learned that, on some of the floors, the building was operating at a negative pressure with respect to outdoors. The fact that the building was operating at a negative pressure relative to outdoors was thought to exacerbate any leakage of water through the building envelope, as well as provide the transport mechanism for mold spores to move from their growth substrate into the occupied space.

Building pressurization issues, as well as various IEQ studies in which CO_2 was measured, called into question the relative performance of the building's outdoor air supply and exhaust systems. For a building of this type, it is common to mechanically supply more air to the building than is mechanically exhausted from each floor.

The rationale for this action is that it is better to have outdoor air enter the building in a controlled manner through the HVAC system. This assures that it is not contaminated by local pollutant source(s), and it can be appropriately filtered, thermally conditioned, and dehumidified prior to introduction into the occupied areas of the building.

26 As Built Drawings M-1 through M-6, prepared by Janazzo Heating & Air Conditioning, Inc. Contractors & Engineers, June 29, 1994.

4.4 HVAC ADJUSTMENTS

Apparently, in response to reports and observations of building pressurization issues and high CO_2 measurements, the building management contracted with an engineering firm to assess the building.[27] The engineer, in cooperation with an air balancing and controls firm, developed a refined control strategy to deliver outdoor air to the various floors of the building. This involved upgrading the building controls and then adjusting them to achieve the amount of outdoor air ventilation in the original building design.

4.5 EH&E MEASUREMENTS

In March of 2003, EH&E performed measurements of the building's mechanical systems on floors 6, 8, 10, 11, 15, 18, and 19 as a component of a larger building investigation led by NIOSH. In this investigation, EH&E measured the amount of outdoor air supplied to the study floors, measured the building pressurization with respect to outdoors as well as floor-to-floor, and measured exhaust on the study floors. The following paragraphs detail the results of these measurements.

4.5.1 Measured Outdoor Air Quantities

Outdoor air is supplied to each of the two mechanical rooms located on floors 6 through 20 at a constant rate during normal building operation. Each mechanical room functions as a mixing plenum, mixing outdoor air with return air from the space for distribution by an air handling unit located in the mechanical room.

To measure the volume of outdoor air supplied to each mechanical room, EH&E utilized the outdoor airflow measurement stations that were installed. EH&E attached its own pressure measurement device in parallel with the measurement devices installed to measure duct velocity in the outdoor air delivery duct. EH&E then multiplied this value by the effective discharge area reported on the flow measurement station to determine the volume of outdoor air delivered to each mechanical room. Outdoor airflow rates were measured in each mechanical room once each day over a four-day period. Table 4.1 reports the measurements performed for each of the floors studied.

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[27] Air Flow Study for 25 Sigourney Street, Hartford, CT., prepared by Luchini, Milfort, Goodell & Associates, Inc., May 29, 2001.

According to the balance report, for each floor, the target outdoor air flow delivery was 4,200 cfm. Based on EH&E's measurements, these targets were substantially achieved on all floors measured. Note also that the amount of outdoor air supplied to each floor measured was significantly more than the amount of air exhausted from the floor.

Table 4.1 Measured Outdoor and Exhaust Airflow Rates on Each of the Floors Studied by EH&E in March 2003

Floor	Minimum OA (cfm)	Average OA (cfm)	Maximum OA (cfm)	Bath Exhaust Totals	OA Less Exhaust (cfm)
6	4,464	4,695	4,819	309	4,386
8	4,036	4,531	4,761	602	3,929
10	4,119	4,458	4,697	959	3,499
11	4,387	4,553	4,728	771	3,782
15	4,402	4,501	4,599	405	4,096
18	3,813	3,949	4,229	470	3,479
19	3,776	3,976	4,084	633	3,343

OA outdoor air
cfm cubic feet per minute

4.5.2 Building Pressure Measurements

At various times prior to adjustments to the building's outdoor air control strategies, the building was observed to operate at a negative pressure with respect to outdoors. During March of 2003, EH&E measured pressure relationships of the various floors relative to outdoor air, as well as floor-to-floor relationships over the course of four days.

Tables 4.2 and 4.3 depict the observed pressure relationship between the various floors and outdoors, and floor-to-floor respectively.

Table 4.2 Measured Pressure Relationships between Various Floors of the Building and Outdoors Measured by EH&E in March of 2003

Date	Time	Floor	ΔP (in-H_2O)	± (in-H_2O)	Reference Point
3/11/2003	13:30	19	0.255	0.025	20th floor outdoors
3/11/2003	13:35	20	0.235	0.015	20th floor outdoors
3/11/2003	13:57	18	0.235	0.025	20th floor outdoors
3/11/2003	14:03	17	0.260	0.020	20th floor outdoors
3/11/2003	14:10	16	0.340	0.025	20th floor outdoors
3/11/2003	14:18	15	0.290	0.020	20th floor outdoors
3/11/2003	14:25	14	0.300	0.020	20th floor outdoors
3/11/2003	14:30	12	0.300	0.030	20th floor outdoors
3/11/2003	14:35	11	0.255	0.040	20th floor outdoors
3/11/2003	14:45	10	0.390	0.050	20th floor outdoors
3/11/2003	14:55	9	0.285	0.045	20th floor outdoors
3/11/2003	15:15	8	0.425	0.025	20th floor outdoors
3/11/2003	15:20	7	0.315	0.045	20th floor outdoors
3/11/2003	15:25	6	0.320	0.030	20th floor outdoors
3/11/2003	15:35	5	0.340	0.050	20th floor outdoors
3/11/2003	15:40	5	0.165	0.035	P4 outdoors
3/11/2003	15:45	5	0.200	0.020	P4 outdoors
3/12/2003	9:00	20	0.275	0.015	20th floor outdoors
3/12/2003	15:10	20	0.270	0.020	20th floor outdoors
3/12/2003	15:15	19	0.235	0.025	20th floor outdoors
3/12/2003	15:25	18	0.215	0.035	20th floor outdoors
3/12/2003	15:32	16	0.220	0.025	20th floor outdoors
3/12/2003	15:35	15	0.245	0.015	20th floor outdoors
3/12/2003	15:45	12	0.245	0.035	20th floor outdoors
3/12/2003	15:50	11	0.265	0.010	20th floor outdoors
3/12/2003	15:55	10	0.280	0.015	20th floor outdoors
3/12/2003	16:00	8	0.250	0.040	20th floor outdoors
3/12/2003	16:05	6	0.260	0.045	20th floor outdoors
3/12/2003	16:10	5	0.225	0.015	20th floor outdoors
3/12/2003	16:45	P4	0.155	0.015	20th floor outdoors
3/12/2003	16:50	P4	0.045	0.005	Ground level
3/13/2003	9:10	19	0.210	0.020	20th floor outdoors
3/13/2003	9:15	18	0.220	0.015	20th floor outdoors
3/13/2003	9:20	16	0.275	0.025	20th floor outdoors
3/13/2003	9:25	15	0.260	0.030	20th floor outdoors
3/13/2003	9:30	12	0.255	0.015	20th floor outdoors
3/13/2003	9:40	11	0.260	0.020	20th floor outdoors
3/13/2003	9:45	10	0.325	0.025	20th floor outdoors
3/13/2003	9:50	8	0.230	0.030	20th floor outdoors
3/13/2003	9:52	6	0.260	0.035	20th floor outdoors
3/13/2003	10:20	5 (M)	0.250	0.015	20th floor outdoors
3/13/2003	10:30	P4	0.075	0.015	P4 outdoors
03/13/03	10:33	P4	0.215	0.015	P4 outdoors
03/13/03	11:50	P4	0.120	0.010	P4 outdoors
03/13/03	11:55	M	0.025	0.015	P4 outdoors
03/13/03	12:05	6	0.055	0.010	P4 outdoors
03/13/03	12:12	8	0.065	0.005	P4 outdoors

Table 4.2 Continued

Date	Time	Floor	ΔP (in-H_2O)	± (in-H_2O)	Reference Point
03/13/03	12:15	10	0.065	0.015	P4 outdoors
03/13/03	12:20	11	0.055	0.015	P4 outdoors
03/13/03	12:25	14	0.050	0.010	P4 outdoors
03/13/03	12:35	15	0.055	0.015	P4 outdoors

ΔP difference in pressure
in-H_2O inches of water column

Table 4.3 Measured Floor-to-Floor Pressure Differences Measured by EH&E during March of 2003

Date	Time	Floor	Floor Referenced	Measured ΔP (in-H_2O)
3/14/2003	10:34	9	10	0.001
3/14/2003	10:32	10	11	0.001
3/14/2003	10:30	11	12	0.002
3/14/2003	10:27	12	14	0.001
3/14/2003	10:25	14	15	0.001
3/14/2003	10:22	15	16	0.002
3/14/2003	10:20	16	17	0.002
3/14/2003	10:15	17	18	0.004
3/14/2003	10:13	18	19	0.004
3/14/2003	10:10	20	19	0.004

ΔP difference in pressure
in-H_2O inches of water column

During the measurement period, winds were relatively brisk, ranging between 10 and 25 miles per hour, as measured at Bradley International Airport. This caused some differences in the reported pressure, depending upon whether the pressure was measured relative to the P4 ground level or the 20th floor level. However, regardless of the reference pressure location used, these measurements show that the building as operated at the time of the measurements was always positively pressurized with respect to outdoors. This is not surprising, given that, on all floors on which outdoor air and exhaust flows were measured, the outdoor air flows significantly exceeded the exhaust air flows.

Floor-to-floor pressure differences were generally small to not detectable.

4.6 EH&E OBSERVATIONS

During EH&E's Spring 2003 site investigation, EH&E inspected and sampled the building's mechanical systems. Generally, EH&E observed that the mechanical systems on the floors observed were well maintained and in a good state of cleanliness. The mechanical room in which the air handling units are located is a part of the return air plenum and EH&E observed that these rooms were kept clean and not used for storage of cleaning supplies or other inappropriate materials.

The air handling units were inspected inside and observed to have clean coils, clean linings, etc. According to building management, the systems had been recently cleaned. The units had been fitted with filters that fit in their racks in a manner that minimized the amount of air bypass that normally occurs in normal HVAC equipment.

Figures 4.2 through 4.6 show typical conditions observed in the building's mechanical rooms.

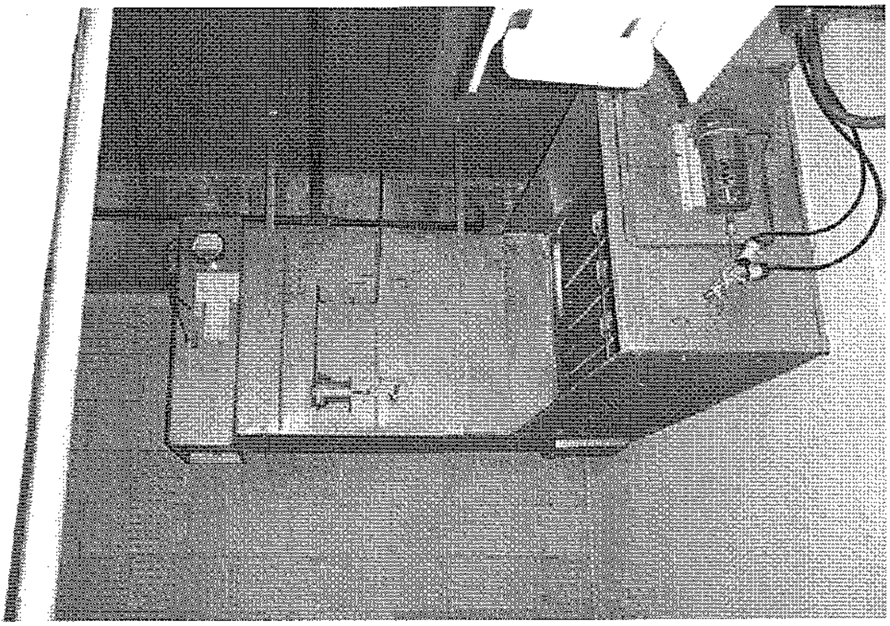

Figure 4.2 Photo of Outdoor Air Flow Measurement and Control Station Installed in a Typical Mechanical Room (DCP_0115.JPG)

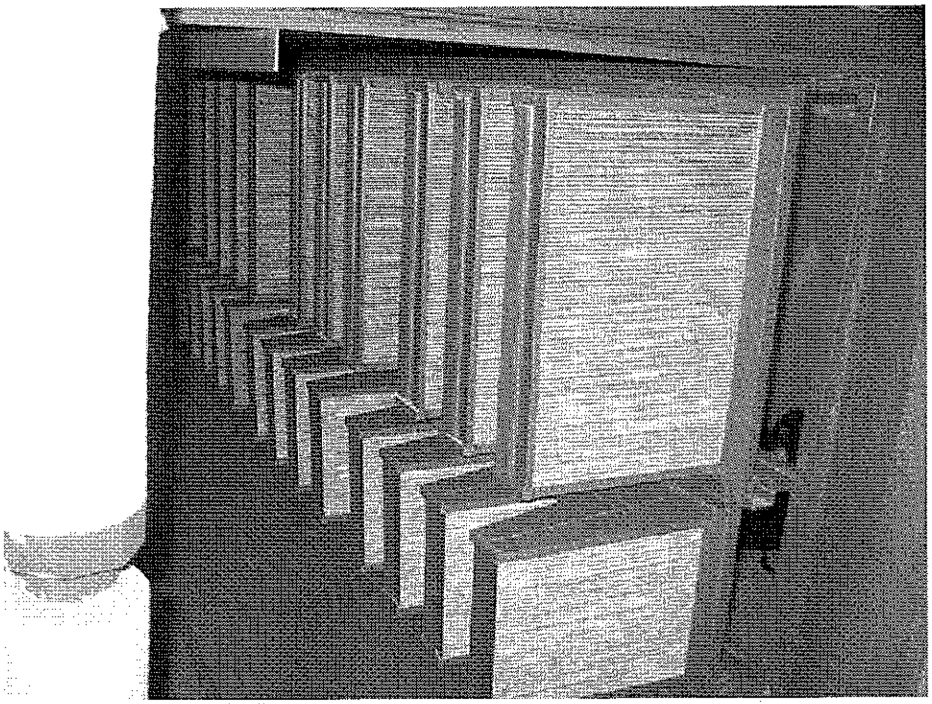

Figure 4.3 Photo of Typical Filter Installation in an Air Handling Unit (0109-0939_IMG.JPG)

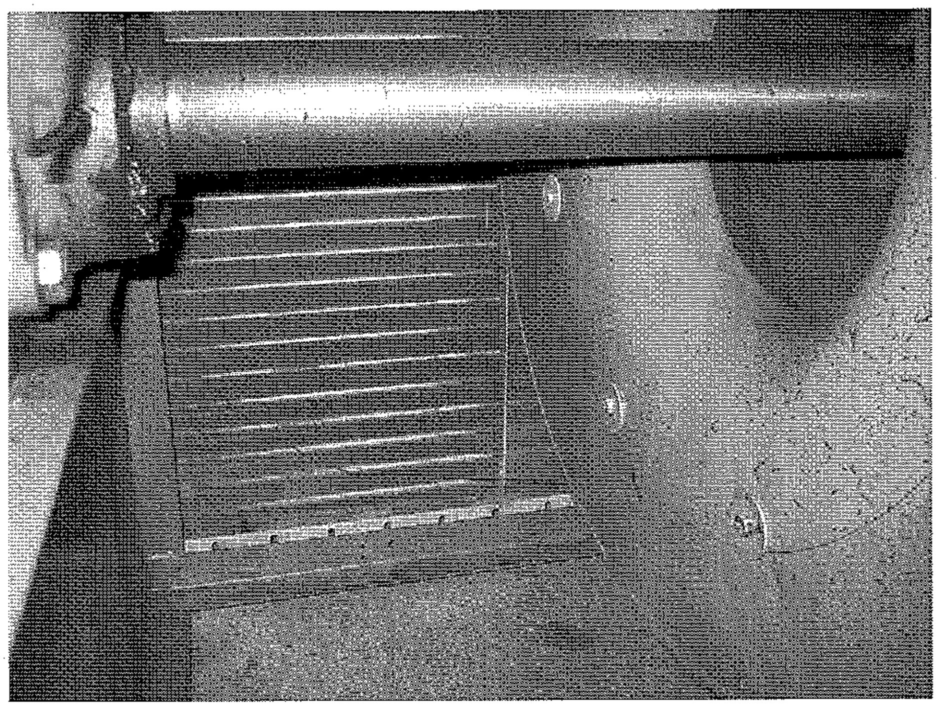

Figure 4.4 Photo Inside a Typical Air Handling Unit, Showing the Cleanliness of the Coils, Fan, and Bottom of the Drain Pan (109-0936_IMG.JPG)

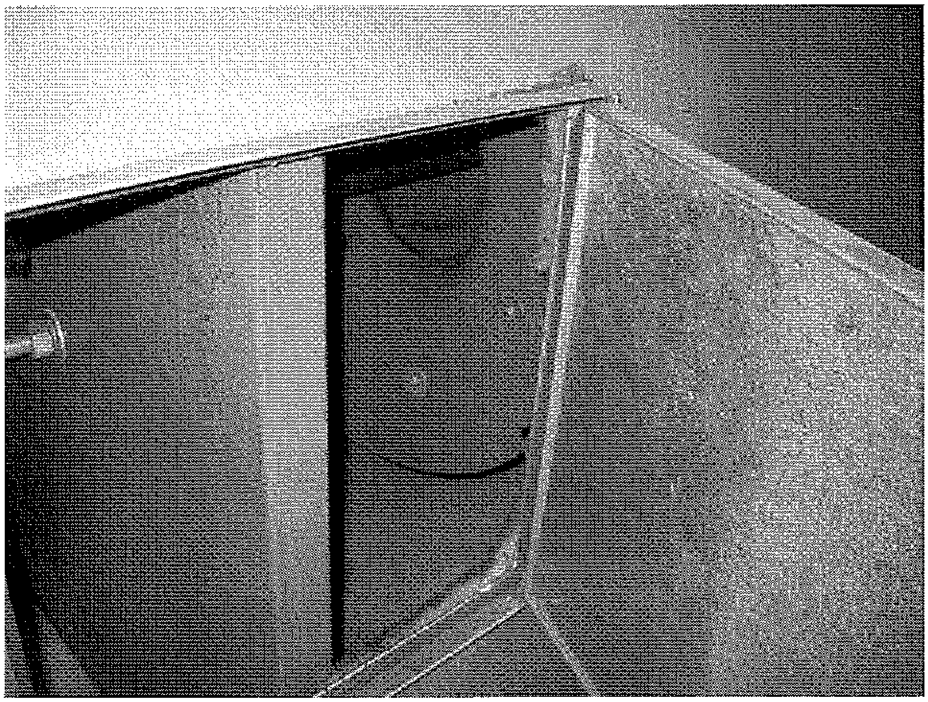

Figure 4.5 Photo of Cleaning and Inspection Access Panel in Typical Air Handling Unit (109-0948_IMG.JPG)

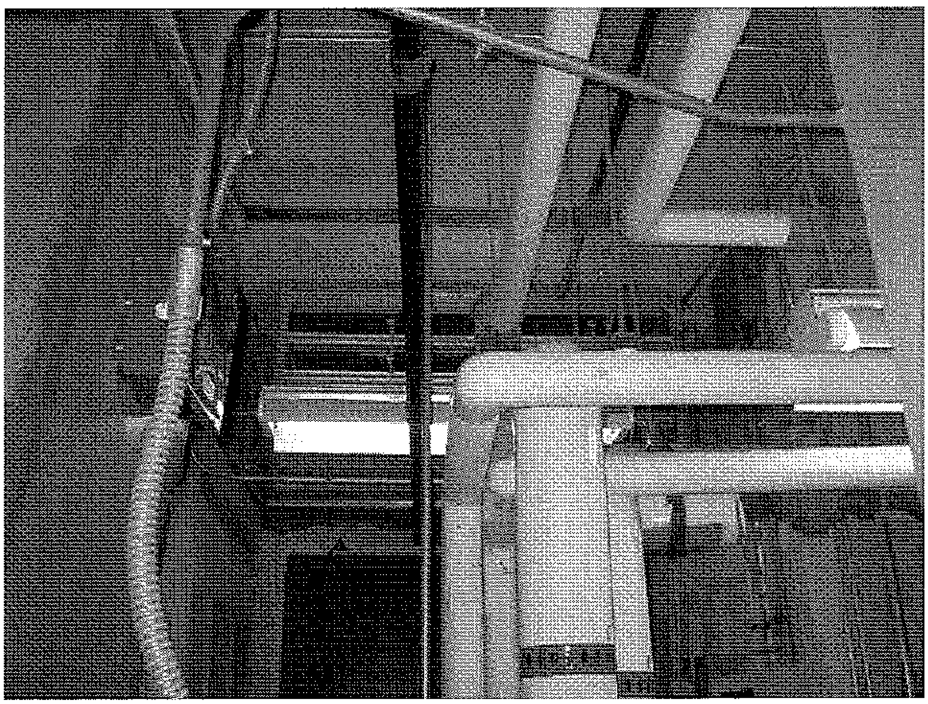

Figure 4.6 Photo of Return Air Inlet into a Typical Mechanical Room (109-0940_IMG.JPG)

5.0 REMEDIATION PLAN ASSSESSMENT

5.1 SUMMARY

EH&E completed a review of the remediation plan developed to address specific issues related to water incursion into 25 Sigourney Street, Hartford, CT and to identify moisture-damaged building materials to be removed. Water incursion pathways addressed in the remediation plan included repairs to the building envelope. The repair program appears to have been successful in stopping the relatively pervasive and persistent leaks that this building obviously had. A follow-up study performed after the completion of the repairs would provide additional feedback as to the effectiveness of the envelope repairs. As with any building of this size, small leaks are going to occur from time to time, and building management must adapt a program to monitor their frequency and persistence. Building materials that are wetted infrequently will not be a mold problem, unless some mechanism exists to keep the material persistently wet. These issues can be handled as they occur.

5.2 BUILDING ENVELOPE REPAIRS

EH&E's review of the repair specifications for the building developed by Hoffmann Architects in December of 2001[28] shows that most of the water leaks that were observed in the building could be attributed to the sliding doors and terraces on the upper floors of the building. Secondary damage was observed in areas associated with the "zipper greenhouse enclosure," as well as the corners of the building.

In this specification, the Architect evaluated the building envelope and specified repairs to stop penetration of water in the areas with observed envelope leaks. It is EH&E's understanding that, even prior to the repairs outlined in this project, the State of Connecticut had modified the coping on top of the parapet walls by sealing them with metal, and installed new flashings between the base of the parapet walls and the rooftop.

28 Drawings and specifications for Exterior Repairs—Building Envelope, 25 Sigourney Street, Hartford, CT, Project No. BI-2B-033, prepared by Hoffmann Architects, North Haven, CT, December 2001.

5.2.1 Background

The evolution of curtain wall design, as currently practiced, can be traced back to the mid-1960s. In 1978, the Brick Institute of America issued *BIA Technical Notes on Brick Construction 28 Revised.*[29] This note details the use of a brick veneer attached to a backing wall separated by a 1" airspace. With the exception of flashings around lintels, etc., the note did not recommend that the wall be covered by a water resistant material.

In 1987, The Brick Institute of America issued *BIA Technical Notes on Brick Construction 28B Revised II.*[30] The details on this note were similar to the earlier note with the exception that the airspace had been increased from 1" to 2" in thickness, and a water resistant membrane was now covering the entire backing wall. Details concerning the flashing and weep holes for water to leave the airspace between the brick and backing wall were more carefully spelled out. The increase from 1" to 2" airspace was probably because it is quite difficult to assure that excess mortar does not bridge between the veneer and backup wall without careful supervision of the construction process. In fact, the 1978 Technical Note cautions that the 1" airspace between the veneer and backup be kept clean and free of all mortar droppings, so that the wall assembly will perform as a drainage wall. "If mortar blocks the air space, it may provide a bridge for water to travel to the interior."

5.2.2 Review of Original Envelope Design

The building was originally constructed circa 1985. A review of the envelope details shows that it was originally constructed in a manner more closely resembling the practice from BIA Technical Note 28 issued in 1978, rather than the later 1987 edition. The backup wall specified is either concrete masonry unit blocks or an insulated gypsum sandwich. In both cases, the exterior of these walls was covered by a 1" thickness of ridged insulation, with an airspace of approximately 1 3/8" between this and the brick veneer. Other than the flashings at the lintels, there were no provisions for a water resistant membrane.

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29 Brick Institute of America. 1978. *BIA Technical Notes on Brick Construction 28 Revised, Brick Veneer New Construction*. McLean, VA: Brick Institute of America.

30 Brick Institute of America. 1987. *BIA Technical Notes on Brick Construction 28B Revised II, Brick Veneer Steel Stud Panel Walls*. McLean, VA: Brick Institute of America.

The original parapet walls had masonry caps. It is EH&E's understanding that the parapet walls on the building had a metal cap installed on them, even before the current rehabilitation project had begun. This would make this detail more forgiving to the normal cracking and deterioration that could be expected with a wall capped with masonry materials.

5.2.3 Review of Building Envelope Repairs

EH&E reviewed the building envelope repair specifications prepared by Hoffman Architects, dated December 2001. In these specifications, EH&E observed some specifications and details that were judged to be very good and appropriate for this building. Other details were less than ideal, in that they rely too much on some detail elements and offer little tolerance for either workmanship defects, or materials defects, degradation, differential element movement, etc. The less than ideal details offer little of the redundancy that would be designed into a building of new design and construction.

On July 24, 2003, EH&E interviewed Steve Babola of the DPW. Mr. Babola served as clerk of the works for this project on behalf of the DPW. According to Mr. Babola, the project was nearing completion and, so far, the results were good. In a couple of places where leaks were observed after the work, it was because the rehabilitation contractor had missed details. When these missed details were corrected, the leak problems were solved. According to Mr. Babola, the project was scheduled to be complete by the end of August 2003. Mr. Babola also mentioned that a new roof was planned for the building, with completion scheduled by the beginning of December 2003.

Mr. Babola mentioned that an inspection performed in the fall of 2002 using infrared cameras was invaluable. This study found a number of defects of the original construction, such as missing backer rods, caulking details, etc., that were part of the original building details. The project architect (Hoffman) has updated the rehabilitation project details as a result of this study.

EH&E discussed planned or ongoing follow-up testing with Mr. Babola. Mr. Babola mentioned that, at the completion of the curtain wall repair program, a follow-up inspection would be conducted to determine the effectiveness of the repairs. Mr. Babola also mentioned that, before the scaffolding was removed from any section of the building, the entire area was washed with a power washer. The act of power washing provides a test of the repairs.

According to Mr. Babola, in addition to his monitoring of the project, there has been an engineering consultant on-site throughout this work. The Architect visits the site at least once per week and often every other day.

5.2.4 The Prognosis for Future Building Leaks

Repairs to the building's walls and roof will be completed by the end of 2003. The repair program appears to have been successful in stopping the relatively pervasive and persistent leaks that this building obviously had. A follow-up study performed after the completion of the repairs will provide additional feedback as to the effectiveness of the envelope repairs.

As with any building of this size, small leaks are going to occur from time to time, and building management must adapt a program to monitor their frequency and persistence. Building materials that are wetted infrequently will not be a mold problem, unless some mechanism exists to keep the material persistently wet. These issues can be handled as they occur.

5.3 VISUAL ASSESSMENT OF REPAIRS

As part of the March 2003 site visit, a visual inspection of select areas[31] of the building was conducted to assess the extent of current moisture damage that could be associated with fungal growth in the building. This included an assessment of building materials such as ceiling tiles, gypsum wallboard, window frames, and carpets. Visual inspection of non-occupied spaces was also conducted including mechanical rooms, air handling equipment, and ceiling plenum spaces.

With the exception of isolated water incursion at the building roof, there was no visual evidence of moisture-damaged building materials that would suggest pervasive or

[31] Denote floors inspected where sampling occurred.

persistent leak sources. Ceiling tiles on the floors inspected were visually dry with no evidence of staining. Gypsum wallboard on the floors inspected was also dry, as evidenced by visual inspection and moisture meter readings. At the time of the site inspection, windows appeared to be adequately sealed and showed no visual evidence of water incursion through the frames.

Inspection of building mechanical spaces and air handling equipment showed them to be in good condition with no signs of moisture damage that would suggest pervasive or persistent leak sources. Mechanical rooms on the floors inspected were clean and dry, with only minor isolated water leaks occurring at valve stems of a few heating and cooling pipes. In a few locations, it appeared that condensation had occurred on chilled water pipes during the summer. Overall, the chilled water pipes appeared to have adequate insulation and only isolated signs of condensation occurring on occasion. There were no visual signs of moisture damage to air handling unit components or to interior air handling unit surfaces. At the time of the site visit, air handling unit condensate drain pans were clean and dry.

6.0 PROTOCOL FOR THE JUNE 2002 HEALTH QUESTIONNAIRE

In June 2002, EH&E administered a health questionnaire developed by NIOSH to occupants of 25 Sigourney Street. A copy of the questionnaire is included as Appendix B of this report. EH&E created an electronic data entry form and accompanying Microsoft Access® database to facilitate acquisition and management of the questionnaire data.

Prior to the visit to the building, EH&E staff members received instruction on administering the questionnaire and on entering responses directly into the electronic database during training sessions held at EH&E. The use of personal interviews by trained personnel was selected as the optimal approach to standardize responses provided by the building occupants. The direct entry of data using pull-down menus also minimized both variability in coding of responses and potential errors associated with transfer of information from hardcopy forms into a database. The EH&E data coordinator was then able to easily review the data entered into the database for quality assurance/quality control purposes.

A total of 248 building occupants completed the questionnaire during the weeks of June 3 to 7 and June 10 to 14, 2002. The questionnaire data were used to evaluate the prevalence of doctor-diagnosed asthma, asthma symptoms, other building-related asthma symptoms, allergic rhinitis symptoms, and non-specific building-related symptoms.

APPENDIX A

LIMITATIONS

LIMITATIONS

1. Environmental Health & Engineering, Inc.'s (EH&E) indoor environmental quality assessment described in the attached report number 11767, *YY-Title of Report* (hereafter "the Report"), was performed in accordance with generally accepted practices employed by other consultants undertaking similar studies at the same time and in the same geographical area; and EH&E observed that degree of care and skill generally exercised by such other consultants under similar circumstances and conditions. The observations described in the Report were made under the conditions stated therein. The conclusions presented in the Report were based solely upon the services described therein, and not on scientific tasks or procedures beyond the scope of described services, nor beyond the time and budgetary constraints imposed by the client.

2. Observations were made of the site as indicated within the Report. Where access to portions of the site was unavailable or limited, EH&E renders no opinion as to the condition of that portion of the site.

3. The observations and recommendations contained in the Report are based on limited environmental sampling and visual observation and were arrived at in accordance with generally accepted standards of industrial hygiene practice. The sampling and observations conducted at the site were limited in scope and, therefore, cannot be considered representative of areas not sampled or observed.

4. When an outside laboratory conducted sample analyses, EH&E relied upon the data provided and did not conduct an independent evaluation of the reliability of these data.

5. The purpose of the Report was to assess the characteristics of the subject site as stated within the Report. No specific attempt was made to verify compliance by any party with all federal, state, or local laws and regulations.

APPENDIX B

JUNE 2002 HEALTH QUESTIONNAIRE

ID________

Sigourney Street June 2002 Questionnaire

Identification and Demographic Information

Name: 1.____________________ 2.____________________ 3.____
(Last Name) (First Name) (MI)

Home Address: 4.____
(Number, Street, and/or Rural Route)

5. ______________________ 6. _____ 7.__________
(City) (State) (Zip Code)

Home Telephone Number: 8. (__ __ __) __ __ __ - __ __ __ __

9. Date of Birth __ __ / __ __ / __ __ __ __
(Mo.) (Day) (Year)

10. Are you: __ female __ male

11. Race (Select one or More):
1.________ American Indian or Alaska Native
2.________ Asian
3.________ Black or African-American
4.________ Native Hawaiian or other Pacific Islander
5.________ White

12. Are you of Hispanic or Latino origin? _______Yes _______No

Work Information

13. Which Agency do you work for? ____DRS ___DSS

14. When did you first begin work with this Agency? _____Month _____Year

15. When did you begin working in the Sigourney Street Building _______Month_____Year

16. Where do you now work most of the time _____Sigourney Street_____Farmington Ave.

If Farmington:

16a. When did you move to Farmington Avenue ____Month ____Year

17. Have you moved to a different work-area since April 2002 (the last 2 months)?

1._______Yes 2._______No

If Yes:

17a. When did you move ______Month ____Date.

The following questions concern your health during the last 4 weeks:

18. If you run, or climb stairs fast do you ever:

cough?	___ No	___ Yes	___ Don't know
wheeze?	___ No	___ Yes	___ Don't know
get tight in the chest?	___ No	___ Yes	___ Don't know

19. Is your sleep ever broken by . . .

wheeze?	___ No	___ Yes	___ Don't know
difficulty with breathing?	___ No	___ Yes	___ Don't know

During the last 4 weeks:

20. Do you ever wake up in the morning (or from your sleep if a shift worker) with . . .

wheeze?	___ No	___ Yes	___ Don't know
difficulty with breathing?	___ No	___ Yes	___ Don't know

21. Do you ever wheeze . . .

if you are in a smoky room?	___ No	___ Yes	___ Don't know
if you are in a very dusty place?	___ No	___ Yes	___ Don't know

22. During the last 4 weeks, how often did you have any of the following symptoms?

Cough	____Never	___1/week or less	___2 to 3 times/week	___4 to 6 times/week	___Every day	__Don't know
Wheezing	____Never	___1/week or less	___2 to 3 times/week	___4 to 6 times/week	___Every day	__Don't know
Shortness of Breath	____Never	___1/week or less	___2 to 3 times/week	___4 to 6 times/week	___Every day	__Don't know
Chest tightness	____Never	___1/week or less	___2 to 3 times/week	___4 to 6 times/week	___Every day	__Don't know

***If any of cough, wheezing, shortness of breath or chest tightness 1/week or less, 2 to 3 times/week, 4 to 6 times/week, everyday*:**

23. In what *month* and *year*, during your lifetime, did any of these respiratory symptoms first begin?

___/ _____
(Mo.) (Year)

24. When you are away from work on weekends, days off, or vacations, are your respiratory symptoms:

_______Same _______Worse _______Better

25. During the last 4 weeks, how often were you awakened from sleep by any one or more of; cough, wheezing, shortness of breath or chest tightness?

____Never ___Twice/month or less ___Between 2/month and 1/week ___1 to 3 times/week ___4 or more times/week ___Don't know

Shortness of breath when walking

26. Are you troubled by shortness of breath when hurrying on level ground or walking up a slight hill?
_______Yes _______No

27. Do you get short of breath walking with other people of your own age on level ground?
_______Yes _______No

28. Do you have to stop for breath when walking at your own pace on level ground?
_______Yes _______No

Cough and Phlegm from the Chest

29. Do you usually have a cough first thing in the morning? _______Yes _______No

30. Do you usually cough during the day or at night? _______Yes _______No

If yes to 29 or 30:

30a. Do you cough like this on most days for as much as three months each year?
_______Yes _______No

30b. In what *month* and *year*, during your lifetime, did you *first* start having this cough?
__ __ / __ __ __ __
(Mo.) (Year)

31. Do you usually bring up phlegm from your chest first thing in the morning
_______Yes _______No

32. Do you usually bring up phlegm from your chest during the day or at night?
_______Yes _______No

If yes to 31 or 32:

32a. Do you bring up phlegm like this on most days for as much as three months each year?
_______Yes _______No

32b. In what *month* and *year*, during your lifetime, did you *first* start having this phlegm?
__ __ / __ __ __ __
(Mo.) (Year)

Nasal and Sinus Conditions

33. Please think how much you have been disturbed by the following nasal symptoms ***during the last 4 weeks:***

Itchy nose
______None ______Trivial _____Mild ______Moderate ______Severe

Sensation of fullness, congestion, or blockage of the nose
______None ______Trivial ______Mild ______Moderate ______Severe

Sneezing
______None ______Trivial ______Mild ______Moderate ______Severe

Discharge or runny nose
______None ______Trivial ______Mild ______Moderate ______Severe

If yes to any of nasal symptoms:

34. In what *month* and *year*, during your lifetime, did any of these nasal symptoms begin on a recurring basis that is now continuing? ___/ _____
(Mo.) (Year)

35. When you are away from work on weekends, days off, or vacations, are your nasal symptoms:
_______Same _______Worse_______Better

36. Please think how much you have been disturbed by the following symptoms ***during the last 4 weeks:***

Headache or pain in face
______None ______Trivial ______Mild ______Moderate ______Severe

Blowing out thick mucus
______None ______Trivial ______Mild ______Moderate ______Severe

Postnasal drip in back of throat
______None ______Trivial ______Mild ______Moderate ______Severe

Throat clearing or hoarseness of voice ______None ______Trivial ______Mild
______Moderate ______Severe

If yes to any of these symptoms:

37. In what *month* and *year*, during your lifetime, did any of these symptoms begin on a recurring basis that is now continuing? ___/ _____
(Mo.) (Year)

38. When you are away from work on weekends, days off, or vacations, are your sinus symptoms:

____Same ____Worse ______Better

39. General symptoms and conditions

In the last 4 weeks, how often have you had...	Same as in 40 below			What happened to this symptom or condition at times when you were away from work? (e.g. weekends, vacations)			When did this symptom begin
	Never	Less than every week	Every week	Stayed Same	Got Worse	Got Better	Month/Year
A. Fever?							
B. Chills?							
C. Night-sweats							
D. Flu-like achiness?							
E. Unusual tiredness or fatigue?							
F. Joint pains?							

Dermatitis

40. Have you experienced any of the following skin conditions in the last ***4 weeks***?

Skin Condition	No	Yes			Location (check all that apply)				
	Never	Rarely	Weekly	Daily	Arms/ Hands	Neck	Face	Legs/ Feet	Other
Acne									
Hives									
Rash w/small, red bumps									
Raised rash on									

shins									

If yes to any of Acne, Hives, Rash w/small,red bumps, Raised rash on shins:

40a. In what *month* and *year*, during your lifetime, did any of these skin conditions begin on a recurring basis that is now continuing? ___/_____ (Mo.) (Year)

Asthma

41. Have you ever had asthma? _______Yes _______No

If yes:

41a. How old were you when you first had asthma ? _______Years old

41b. Was this confirmed by a doctor? _______Yes _______No

If Yes to 41b:

41b.1 Date of Diagnosis ___Month _____Year

41c. Did you have asthma during the year before you began working in this building? _______Yes _______No

41d. Do you still have asthma? _______Yes _______No

If Yes to 41d.

41d.1. When you are *away* from work on weekends, days off, or vacations, are your asthma symptoms the ____Same ____Worse ______Better

41e. In the last 4 weeks, how many asthma attacks did you have? _______

41f. In the last 12 months, how many times did you get treatment for an acute asthma attack at a doctor's office, urgent care facility, or emergency department (ER)? ______ times

41g. In the last 12 months, how many times were you hospitalized overnight for asthma _______ times

If 41g: 1 or more times:

41g.1. When was your last overnight hospitalization for asthma ____Month ___Year

42. In the last 12 months, how many days have you missed work because of respiratory health problems? __________Number of days

43. In the last 12 months, how many days have you missed work because of health problems other than respiratory? __________Number of days

Medications for Breathing Problems

44. In the last 4 weeks have you used any prescription or over-the-counter medications for breathing problems? _______Yes _______No

If No, go to question 45.

If Yes:

44a. In the past 4 weeks, have you used any inhaled beta-agonists (quick-relief medicine, such as Albuterol, Proventil, or Maxair) for breathing problems? _______Yes _______No

If yes:

44a. 1. Have you used your beta-agonist inhaler on a daily basis in the last ***4 weeks***?

_______Yes_______No

44b. In the last 4 weeks, have you used any over-the-counter inhalers or pills (*e.g. Primatene*) for breathing problems? _______Yes_______No

If yes to 44a AND/OR 44b:

44c. In the last 4 weeks, was your use of beta-agonist inhalers or over-the-counter medications different on weekends, days off, or vacations as compared to workdays?

_______Yes______No

If yes:

44c.1. Did you use these inhalers or pills more or less on weekends, days off, or vacations ? _______Less _______More

44d. Over the past 4 weeks, have you used any inhaled steroids or corticosteroids for breathing problems? _______ Yes_______ No

If yes:

44d.1. This question consists of two parts. First, we would like to know which inhaled steroids or corticosteroids you are currently using. (Check all that apply.) Second, how many puffs or inhalations per day have you taken over the last 4 weeks?

Drug	• •	**Number of puffs or inhalations per day, on average, taken in the last 4 weeks**
Beclovent (*beclomethasone*) 42 mcg		
Beclovent (*beclomethasone*) 84 mcg		
Vanceril (*beclomethasone*) 42 mcg		
Vanceril (*beclomethasone*) 84 mcg		
Pulmicort (*budesonide*) 200 mcg		
Dexacort (*dexamethasone*) 84 mcg		
Aerobid (*flunisolide*) 250 mcg		
Flovent (*fluticasone propionate*) 44 mcg		
Flovent (*fluticasone propionate*) 110 mcg		
Flovent (*fluticasone propionate*) 220 mcg		
Flovent Rotadisk (*fluticasone propionate*) 50 mcg		
Flovent Rotadisk (*fluticasone propionate*) 100 mcg		
Flovent Rotadisk (*fluticasone propionate*) 250 mcg		
Advair Diskus (*fluticasone propionate/salmeterol*) 100 mcg		
Advair Diskus (*fluticasone propionate/salmeterol*) 250 mcg		
Advair Diskus (*fluticasone propionate/salmeterol*) 500 mcg		
Azmacort (*triamcinolone acetonide*) 100 mcg		
QVAR (beclomethasone) YY mcg		

Other (*please specify*______________________)		

44e. In the last 4 weeks, have you used any other medications for breathing problems?
_______ Yes _______ No

If yes:
44e.1. What other medications have you used in the last 4 weeks? (*check all that apply*)

Drug	• •
Atrovent (ipratropium)	
Serevent (salmeterol)	
Combivent (albuterol/ipratropium)	
Intal (cromolyn sodium)	
Tilade (nedocromil sodium)	
Duraphyl, Slo-bid, Slo-phyllin, Theo-24, Theobid, Theo-dur, Uniphyl (theophylline)	
Choledyl (oxitriphylline)	
Aminodor, Dura-Tabs (aminophylline)	
Singulair (montelukast sodium)	
Accolate (zafirlukast)	
Zyflo (zileuton)	
Other (please specify______________________)	

45. In the last 12 months, have you used steroid or corticosteroid pills such as Prednisone, Medrol, or Decadron for your breathing problems?
___ No ___ Yes ___ Don't Know

If "yes" to 45:
45a. Have you used steroid or coticosteroid pills every day or every other day for the **entire** last 12 months? ___ No ___ Yes ___ Don't Know

If "no" to 45a:
45b. In the last 12 months, have you used a short course, or "burst," of oral steroids or corticosteroids? ___ No ___ Yes ___ Don't Know

If "yes" to 45b:

45c. In the last 12 months, how many times did you use a short course or "burst" of oral steroids or corticorsteroids? __ __ times

46. Have you *ever* been told by a physician that you had any of the following conditions?

IF AYES@: What year were you first diagnosed?

Conditions	Told by MD you had it?	Month and Year of first diagnosis?
Hayfever or nasal allergies	Yes __ No __	
Sinusitis or sinus infections	Yes __ No __	
Eczema, dermatitis, or skin allergy	Yes __ No __	
Acute bronchitis	Yes __ No __	
Chronic bronchitis	Yes __ No __	
Emphysema	Yes __ No __	
Pneumonia	Yes __ No __	
Hypersensitivity Pneumonitis	Yes __ No __	
Sarcoidosis	Yes __ No __	
Heart Disease	Yes __ No __	

47. Has any of your immediate biological family (parents, brothers or sisters, or children) ever had the following:

A. Nasal allergies or hay fever? _______Yes _______No

B. Eczema? _______Yes _______No

C. Asthma? _______Yes _______No

The next set of questions asks for your views about your health.

48. In general, would you say your health is:
__Excellent ___Very good ___Good ___Fair ___Poor

49. Does your health now limit you in….

49a. Moderate activities, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf.
__Yes, Limited a Lot ___Yes, Limited a Little ___No, Not Limited at All

49b. Climbing several flights of stairs.
__Yes, Limited a Lot ___Yes, Limited a Little ___No, Not Limited at All

50. During the last 4 weeks, as a result of your physical health have you.....

50a. Accomplished less than you would like ___Yes ___No

50b. Been limited in the kind of work or other activities ___Yes ___No

51. During the last 4 weeks, as a result of your emotional health (such as feeling depressed or anxious) have you...

51a. Accomplished less than you would like. ___Yes ___No

51b. Been limited in the kind of work or other activities ___Yes ___No

52. These questions are about how you feel and how things have been with you during the last 4 weeks. For each question, please give the one answer that comes closest to the way you have been feeling.

How much time during the last 4 weeks....

	All of the Time	Most of the time	A good bit of the time	Some of the time	A little of the time	None of the time
Have you felt calm and peaceful?	___	___	___	___	___	___
Did you have a lot of energy?	___	___	___	___	___	___
Have you felt downhearted and blue?	___	___	___	___	___	___

53. During the last 4 weeks, how much of the time has your physical health or emotional health interfered with your social activities (like visiting with friends, relatives, etc.)?

__All of the time __Most of the time __Some of the time __A little of the time __None of the time

Home Environment

We are now going to ask you a few questions about your home.

54. Is gas used for cooking? ___ No ___ Yes ___ Don't know

55. Is an exhaust fan that vents to the outside used regularly when cooking in your kitchen?
___ No ___ Yes ___ Don't know

56. Are unvented gas logs, an unvented gas fireplace, or an unvented gas stove used in your home?
___ No ___ Yes ___ Don't know

57. Is a wood burning stove or fireplace used in your home? ___ No ___ Yes ___ Don't know

58. In the ***last 12 months***, have you used a humidifier or vaporizer in your home? (Include any humidifier built into the heating system) ___ No ___ Yes ___ Don't know

59. During the last 12 months, has a dehumidifier been regularly used to reduce moisture inside your home? ___ No ___ Yes ___ Don't know

60. Do you use an outside exhaust fan in your bathroom?
___ No ___ Yes ___ Don't know

61. During the ***last 12 months***, has there been mold or mildew on any surfaces (other than food) inside your home?
___ No ___ Yes ___ Don't know

62. During the ***last 12 months***, have you smelled moldy or musty odors inside your home?
___ No ___ Yes ___ Don't know

63. During the ***last 12 months***, has there been water damage to your home or its contents, for example from broken pipes, leaks, or floods?
___ No ___ Yes ___ Don't know

64. Do you have carpeting or rugs in your bedroom? ___ No ___ Yes ___ Don't know

65. Do you have a dog, cat, other furry pets, or a bird in your home?
MARK ALL THAT APPLY
___ Dogs
___ Cats
___ Pet mice, rats, hamsters, gerbils
___ Other furry pets: ____________
___ Birds

66. In the ***last 12 months*** have you seen cockroaches? ___ No ___ Yes ___ Don't know

67. In the ***last 12 months***, have any of your hobbies or projects involved exposure to dust, smoke, gas, or chemical fumes (for example, wood dust, glue, or paint)?
___ No ___ Yes ___ Don't know

68. Does anyone, not including yourself, smoke inside your home on a regular basis?
____Yes ____No

Smoking

69. Have you *ever* smoked cigarettes? _______Yes _______No
(Answer >No= if less than 20 packs of cigarettes in a lifetime or less than 1 cigarette a day for 1 year)

If yes:

69a. How old were you when you *first* started smoking regularly?
_______Years Old

69b. Over the entire time that you have smoked, what is the average number of cigarettes you smoked per day?
_______Cigarettes/Day

69c. Do you still smoke cigarettes?
_______Yes_______No

If no:

69c1. How long has it been since you have stopped smoking?
_______Years _______Months

Characteristics of your job

How satisfied are you with the following aspects of your work station?

70. Conversational privacy	71. Freedom from distracting noise
__ Very satisfied (1) __ Somewhat satisfied (2) __ Not too satisfied (3) __ Not at all satisfied (4)	__ Very satisfied (1) __ Somewhat satisfied (2) __ Not too satisfied (3) __ Not at all satisfied (4)

72. What is your job category?	73. All in all, how satisfied are you with your job?
__ Managerial (1) __ Professional (2) __ Technical (3) __ Secretarial or Clerical (4) __ Other (please specify) ____________ (5)	__ Very satisfied (1) __ Somewhat satisfied (2) __ Not too satisfied (3) __ Not at all satisfied (4)

74. The next series of questions asks HOW OFTEN certain things happen at your job. (Check the appropriate box for each question.)

	Rarely (1)	Occasionally (2)	Sometimes (3)	Fairly often (4)	Very often (5)
How often does your job require you to work very fast?					
How often does your job require you to work very hard?					
How often does your job leave you with little time to get things done?					
How often is there a great deal to be done?					
How often are you clear on what your job responsibilities are?					
How often can you predict what others will expect of you on the job?					
How much of the time are your work objectives well defined?					
How often are you clear on what others expect of you on the job?					

75. In order to better understand your responsibilities outside your normal working day, the next series of questions deals with other significant aspects of your life.

RESPONSIBILITY	Yes (1)	No (2)
Major responsibility for child care duties		
Major responsibility for housekeeping duties		
Major responsibility for care of an elderly or disabled person on a regular basis		
Regular commitment of 5 hours or more per week, paid or unpaid, outside of this job (include educational courses, volunteer work, second job, etc.)		