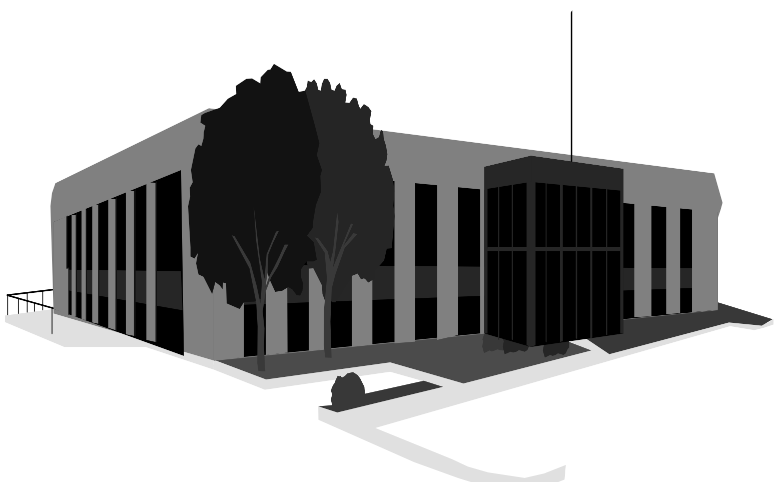
INDOOR AIR QUALITY ASSESSMENT

Department Social Services
Hyde Park Office
1530 River Street
Boston, Massachusetts



Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
January, 2001

Background/Introduction

At the request of Rosemary Sammarco, Director, Office of Facilities Management of the Massachusetts Department of Social Services (DSS) and a building occupant, an indoor air quality assessment was done at the DSS Hyde Park office 1530 River Street, Boston, Massachusetts. This assessment was conducted by the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA). Complaints of upper respiratory symptoms and temperatures prompted this request. On May 31, 2000, a visit was made to this building by Michael Feeney, Chief of Emergency Response/Indoor Air Quality (ER/IAQ), and Cory Holmes, Environmental Analyst of the ER/IAQ program. A follow-up visit was made on September 29, 2000, to take a second set of air samples to ascertain if carbon dioxide, temperature and relative humidity levels would be altered after several months of operation of the ventilation system over the summer.

The DSS resides in a one-story, graded-slab, brick building built in the 1950's. The floor of the building has a slight tilt downward from the front towards the back. The tilt of the floor is the result of the building's former use as the Empire Lanes Bowling Alley. The interior was converted into office space by renovation in 1999-2000. The property is bordered on the southwest by River Street, on the northwest by a building occupied by Bell Atlantic, to the southeast by the employee parking lot and to the northeast by the Neponset River. The DSS moved into the building during the winter of 2000 from their former office at 45 Morton Street in Jamaica Plain.

Methods

Air tests for carbon dioxide were taken with the Telaire, Carbon Dioxide Monitor and tests for temperature and relative humidity were taken with the Mannix, TH Pen PTH8708 Thermo-Hygrometer.

Results

The building has a population of approximately 95 employees and an estimated 20-40 other individuals who visit the building on a daily basis. The tests were taken under normal operating conditions. Test results appear in Tables 1-7. Air sampling results are listed in the tables by location that the air sample was taken. Each location was assigned a number as listed on the floor plan provided to BEHA staff by DSS personnel (see Appendix A).

Discussion

Ventilation

It can be seen from the tables that carbon dioxide levels were slightly above 800 parts per million parts of air [ppm] in four of forty-eight areas sampled throughout the building during the May 31 visit. The DSS building is divided into private offices and a large open work area that was subdivided into smaller work areas by floor dividers. Each work area contains fresh air supply diffusers and exhaust vents (see Pictures 1 & 2) that are connected to rooftop air handling units (AHUs), which provide fresh air (see Picture 3). Heating in the building is divided into zones controlled by thermostats. The thermostat in each zone controls a damper within the supply duct. The thermostats are centrally controlled by a computer network that operates the HVAC unit in the appropriate heating, cooling and/or ventilation mode. Restroom ventilation is provided by ceiling-mounted local exhaust vents. These vents were also operating during both assessments.

On return to this building on September 29, all areas tested (16 of 16) were above 800 ppm carbon dioxide. These 16 general areas were chosen to be reflective of the overall adequacy of fresh air supply throughout the office space, since each location tested on September 29 is supplied by the same rooftop AHUs as non-tested areas. Although the system was operating during both site visits, elevated levels of carbon dioxide were more prevalent during the September 29th visit, which may indicate that the outside air intake louvers on the AHUs were minimally opened or shut. BEHA staff were unable to gain access to the roof to observe the AHUs.

In order to have proper ventilation with a mechanical supply and exhaust system, the system must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air. The date of the last servicing and balancing of the HVAC systems was not available at the time of the visit.

The Massachusetts Building Code requires a minimum ventilation rate of 20 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week based on a time weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches.

Temperature measurements were within the BEHA recommended comfort range for both visits. Temperature measurements ranged from 71^{o} F to 77^{o} F on May 31 and from 71^{o} F to 73^{o} on September 29. The BEHA recommends that indoor air temperatures be maintained in a range of 70 ^{o} F to 78 ^{o} F in order to provide for the comfort of building occupants. A number of complaints of uneven heating and cooling were expressed to BEHA staff. As previously mentioned, the building is divided into five thermostat zones and is adjusted by digital wall-mounted thermostats (see Picture 4). In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

The relative humidity in this building ranged from 31 to 43 percent on May 31, and from 36 to 38 percent on September 29, which was close to the BEHA recommended comfort range for most areas (see Tables). The BEHA recommends a comfort range of 40 to 60 percent for indoor air relative humidity. Relative humidity levels would be expected to drop during the winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

Plants were noted in several areas. Plants can be a source of pollen and mold, which can be a respiratory irritant to some individuals. Plants should be properly maintained and be equipped with drip pans. Plants should also be located away from the air stream of mechanical ventilation to prevent aerosolization of dirt, pollen or mold.

Several areas contained water-stained ceiling tiles (see Picture 5), which are evidence of historic roof or plumbing leaks. BEHA staff removed ceiling tiles in areas 30 and 31 (see Appendix A) to observe conditions within the ceiling plenum. Several plastic buckets were observed hanging from fixtures in the ceiling plenum apparently to collect rainwater from roof leakage (see Picture 6). Water-damaged ceiling tiles can provide a source of mold and mildew. If the roof leakage has been fixed, these buckets should be removed; ceiling tiles should be inspected for mold growth and be replaced as necessary.

A number of cracks in the exterior brickwork were noted on the southwest (front) and southeast (parking lot) sides of the building (see Pictures 7 & 8). These conditions are breaches of the building envelope and can provide a means for water entry into the building. Repeated water penetration can result in the chronic wetting of building materials and the potential for mold growth.

Also noted on the southwest (front) side of the building were plants growing between the tarmac and the foundation/exterior wall of the building (see Picture 9). The growth of plants against the exterior walls of the building can bring moisture in contact with wall brick and eventually lead to cracks and/or fissures in the foundation below ground level, which can subsequently breach the integrity of the building envelope.

Building downspouts on the southeast walls were missing elbow extensions to divert rainwater away from the building. Picture 10 shows that the system empties approximately 10-12 inches above ground level, which allows back-splashing rainwater to impact on the ground below resulting in chronic wetting of the exterior wall. Downspouts should be designed to direct rainwater away from the base of the building to prevent the chronic wetting of exterior walls which can result in damaged brickwork and/or mold growth.

Other Concerns

Several photocopiers were noted in the building. Photocopiers can emit heat and odors. Photocopiers can also produce VOCs and ozone, particularly if the equipment is older and in frequent use. Ozone is a respiratory irritant (Schmidt Etkin, D., 1992). Photocopiers should be located in an area with adequate local exhaust ventilation to help reduce odors, pollutants and excess heat.

A cardboard odor was noted in the storeroom (area 21). The source of this odor appears to be from boxes containing DSS records (see Picture 11). The storage boxes were dry, however, new cardboard boxes contain glues that can emit odors. Office personnel should ensure that the mechanical ventilation in this area is operating to both dilute and remove odors that may be present.

Painting was being conducted in the area 19 storeroom. Paint odors were noted in and around this area. Latex paint may contain volatile organic compounds (VOCs) which can be a source of eye and respiratory irritation for sensitive individuals.

Currently installed in AHUs are filters that strain particulates from airflow. The filters provide filtration of respirable dusts. In order to decrease aerosolized particulates, disposable filters with an increased dust spot efficiency can be installed in the AHUs. The dust spot efficiency is the ability of a filter to remove particulates of a certain diameter from air passing through the filter. Filters that have been determined by ASHRAE to meet its standard for a dust spot efficiency of a minimum of 40 percent (Minimum Efficiency Reporting Value equal to 9) would be sufficient to reduce many airborne particulates (Thornburg, D., 2000; MEHRC, 1997; ASHRAE, 1992). Note that increasing filtration can reduce airflow (called pressure drop) which can reduce the efficiency of the univent due to increased resistance. Prior to any increase of filtration, each piece of air handling equipment should be evaluated by a ventilation engineer to ascertain whether it can maintain function with more efficient filters.

Conclusions/Recommendations

In view of the findings at the time of the visit, the following recommendations are made:

1. Inspect rooftop AHUs to ensure fresh air intake louvers are operable. Change filters for AHU equipment as per the manufacturer's instructions or more frequently if needed. Examine AHUs periodically for maintenance and function, repair/replace parts as necessary.
2. Continue to operate HVAC systems during periods of occupancy. Consider having the mechanical fresh air supply and exhaust balanced by an HVAC engineer. Increase in the percentage of fresh air if necessary.
3. Examine the feasibility of installing more efficient filters in HVAC equipment. Prior to any increase of filtration, each AHU should be evaluated by a ventilation engineer to ascertain whether it can maintain function with more efficient filters.
4. Ensure all plants are equipped with drip pans. Examine drip pans periodically for mold growth and disinfect with an appropriate antimicrobial where necessary.
5. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a HEPA filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).

6. Repair cracks on the exterior wall/foundation of the building to prevent water penetration.
7. Remove plant growths against the building.
8. Repair any existing water leaks and replace any remaining water-stained ceiling tiles. Examine the areas above these tiles for mold growth. Disinfect areas of water leaks with an appropriate antimicrobial as needed.
9. Report any roof leaks or other signs of water penetration to building owner/manager for prompt remediation.
10. Ensure photocopiers are located in a well-ventilated area.
11. If possible, conduct painting during unoccupied periods or periods of low occupancy (e.g., Friday evenings, holidays, weekends, etc.). If not possible isolate area and vent paint odors to the outside using local exhaust.

References

ASHRAE. 1992. Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter. American Society of Heating, Refrigeration and Air Conditioning Engineers. ANSI/ASHRAE 52.1-1992.

BOCA. 1993. The BOCA National Mechanical Code-1993. 8th ed. Building Officials & Code Administrators International, Inc., Country Club Hills, IL. M-308.1

MEHRC. 1997. Indoor Air Quality for HVAC Operators & Contractors Workbook. Mid Atlantic Environmental Hygiene Resource Center, Philadelphia, PA.

OSHA. 1997. Limits for Air Contaminants. Occupational Safety and Health Administration. Code of Federal Regulations. 29 C.F.R. 1910.1000 Table Z-1-A.

SBBRS. 1997. Mechanical Ventilation. State Board of Building Regulations and Standards. Code of Massachusetts Regulations. 780 CMR 1209.0

Schmidt Etkin, D. 1992. Office Furnishings/Equipment & IAQ Health Impacts, Prevention & Mitigation. Cutter Information Corporation, Indoor Air Quality Update, Arlington, MA.

Thornburg, D. Filter Selection: a Standard Solution. *Engineering Systems* 17:6 pp. 74-80.

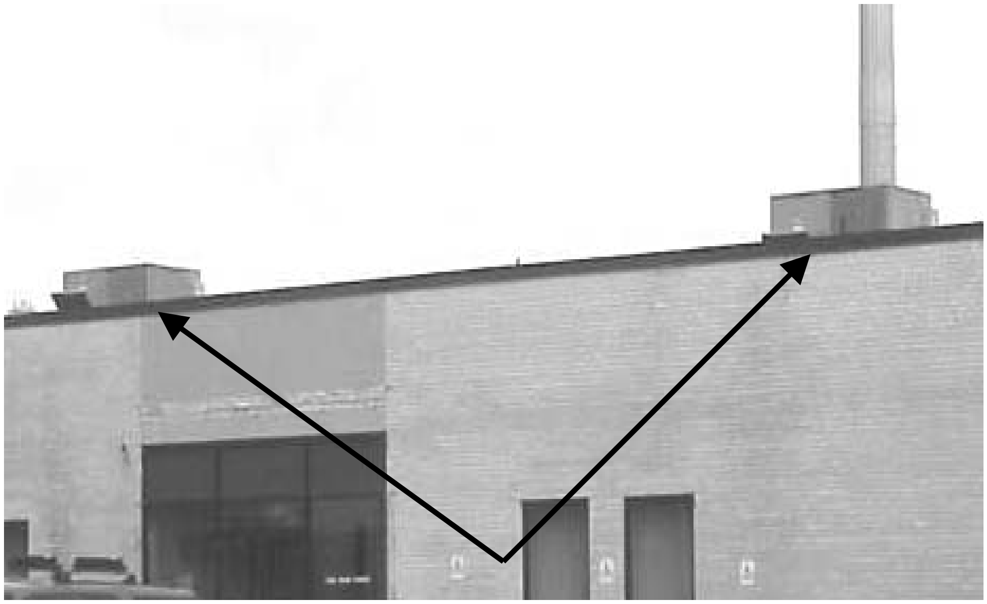
Picture 1

Ceiling-Mounted Multi-directional Air Diffuser

Picture 2

Ceiling-Mounted Exhaust/Return Grille

Picture 3



Rooftop Air-Handling Units

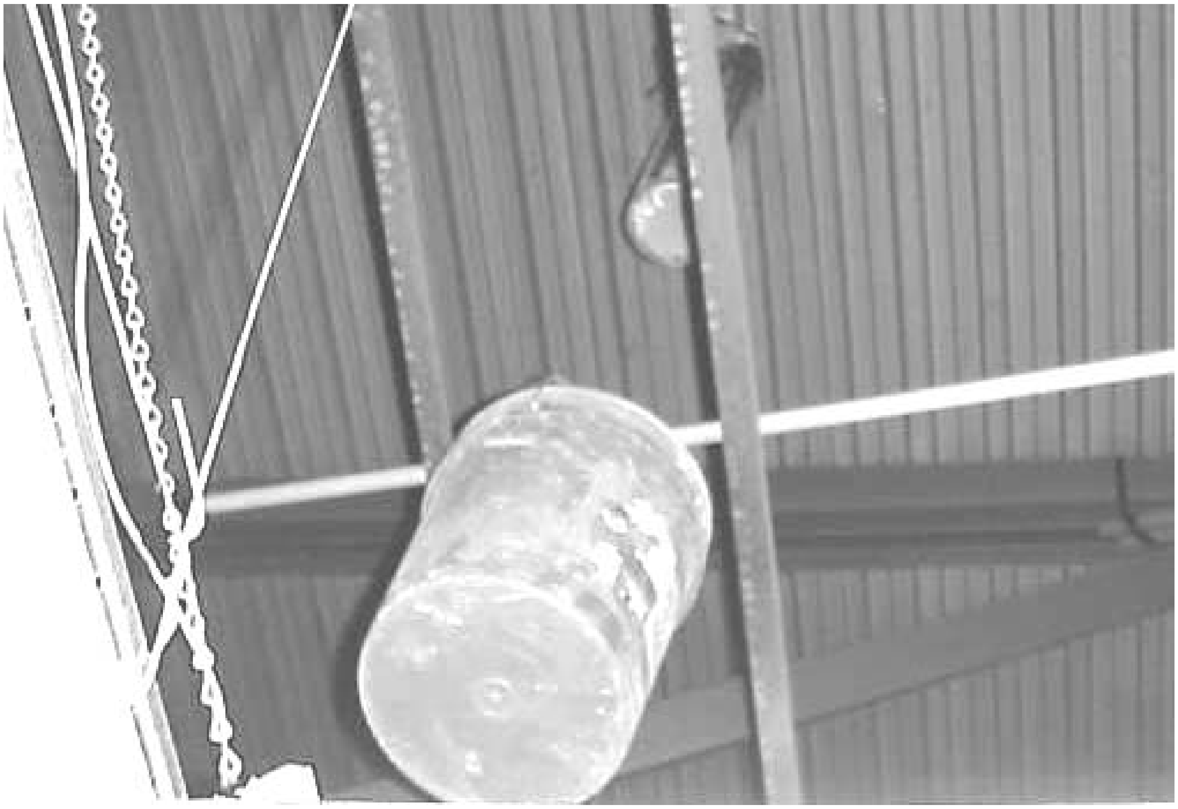
Picture 4

Digital Wall-Mounted Thermostat

Picture 5

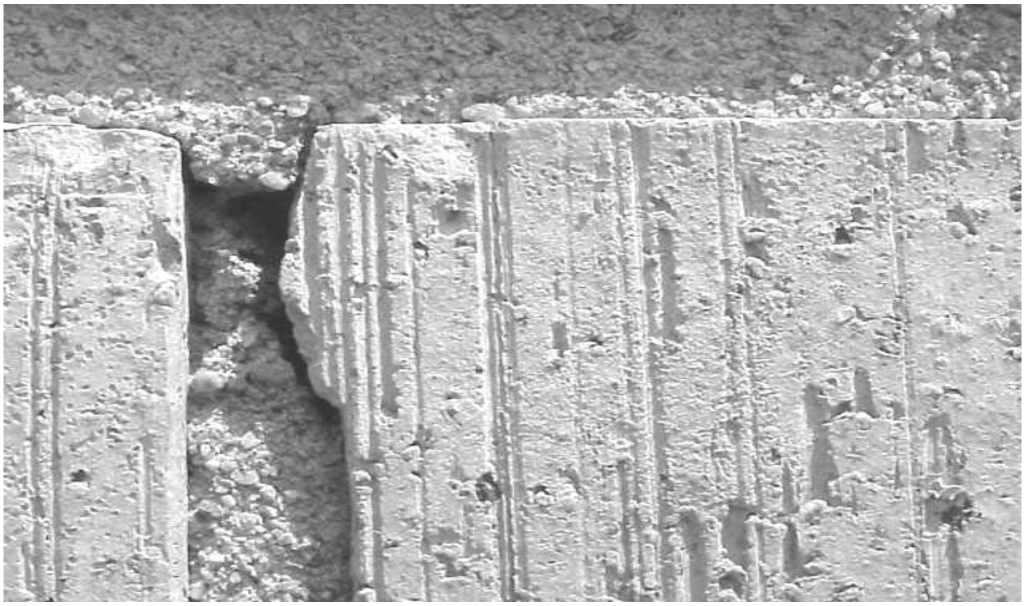
Water-Damaged Ceiling Tile

Picture 6



Plastic Bucket Stationed above Tiles in Ceiling Plenum

Picture 7



Hole/Missing Mortar around Brickwork along Southwest (front) Side of Building

Picture 8

Spaces Noted between the Interior and Exterior Brick of Building

Picture 9

Plants Growing between the Tarmac and Exterior Brick/Foundation of Building

Picture 10

Downspout Missing Elbow Extension

Picture 11

Boxes in Storeroom Containing DSS Records

TABLE 1

Indoor Air Test Results –Department of Social Services, Hyde Park, MA – May 31, 2000

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Outside (Background)	452	60	36					weather conditions: clear, sunny
Family Based Services-Meeting Room	849	77	31	6	no	yes	yes	door open
19-Store Room	710	77	31	0	no	yes	yes	paint odors
20-Data Room	711	73	37	0	no	no	no	main frame, wall mounted air conditioner (a/c)
8	787	73	35	0	no	yes	yes	
Reception Desk	729	74	35	1	no	yes	yes	
59	843	76	38	1	no	yes	yes	
60	805	76	34	1	no	yes	yes	door open
61	776	75	35	0	no	yes	yes	door open
52	737	75	34	2	no	yes	yes	4 plants-with drip pans

*** ppm = parts per million parts of air**
CT = water-damaged ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 2

Indoor Air Test Results –Department of Social Services, Hyde Park, MA – May 31, 2000

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
48	714	77	33	1	no	yes	yes	2 plants, fruity odor-candle, door open
47	692	75	34	0	no	yes	yes	1 plant-with drip pan
46	693	75	35	2	no	yes	yes	1 CT, 2 plants
44	723	75	34	1	no	yes	yes	
45	727	74	35	1	no	yes	yes	2 plants, candle`
42	728	74	35	1	no	yes	yes	
43	725	74	35	0	no	yes	yes	thermostat (small office)
40	721	74	36	1	no	yes	yes	
49	713	74	37	0	no	yes	yes	
50	709	74	36	0	no	yes	yes	
53	728	76	35	2	no	yes	yes	

*** ppm = parts per million parts of air**
CT = water-damaged ceiling tiles

Comfort Guidelines

Carbon Dioxide - < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems
Temperature - 70 - 78 °F
Relative Humidity - 40 - 60%

TABLE 3

Indoor Air Test Results –Department of Social Services, Hyde Park, MA – May 31, 2000

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
55	739	77	36	1	no	yes	yes	reported headaches
57	740	76	33	1	no	yes	yes	
63	745	76	35	1	no	yes	yes	photocopier
Lobby (1)	695	74	34	1	no	yes	yes	
Lobby (2)	700	74	35	0	no	yes	yes	
35	660	75	40	2	no	yes	yes	door open
37	656	75	41	0	no	yes	yes	door open
38	656	75	40	0	no	yes	yes	door open
23	654	74	39	0	no	yes	yes	door open
24	634	75	39	1	no	yes	yes	door open
25	629	75	41	1	no	yes	yes	door open

*** ppm = parts per million parts of air**
CT = water-damaged ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 4

Indoor Air Test Results –Department of Social Services, Hyde Park, MA – May 31, 2000

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
57	644	75	41	3	no	yes	yes	door open
55	645	75	41	1	no	yes	yes	door open
Kitchen-64	841	76	41	3	no	yes	yes	door open
9	662	74	39	0	no	yes	yes	door open
11	651	74	40	0	no	yes	yes	door open
16	703	74	40	1	no	yes	yes	supply and exhaust off, door open
17	666	74	40	0	no	yes	yes	exhaust off
18-Store Room	646	73	40	0	no	yes	yes	water bottle, door open
21	591	71	40	0	no	yes	yes	cardboard box odor, door open
26	594	71	41	0	no	yes	yes	door open
27	607	72	40	0	no	yes	yes	perfume odor, door open

*** ppm = parts per million parts of air**
CT = water-damaged ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 5

Indoor Air Test Results –Department of Social Services, Hyde Park, MA – May 31, 2000

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
28	594	72	39	0	no	yes	yes	door open
29-File Cabinet	590	72	39	0	no	yes	yes	door open
30	598	72	41	0	no	yes	yes	water damage-bucket above ceiling, door open
31	632	74	43	0	no	yes	yes	water damage-bucket above ceiling, door open
33	657	74	42	0	no	yes	yes	door open
13	658	73	40	0	no	yes	yes	

*** ppm = parts per million parts of air**
CT = water-damaged ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 6

Indoor Air Test Results –Department of Social Services, Hyde Park, MA – September 29, 2000

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Outside (Background)	440	60	27					
Area 45	928	71	36	2	No	Yes	Yes	Cold complaints
Area 52	944	72	36	1	No	Yes	Yes	
Area 60	1003	72	37	3	No	Yes	Yes	
Area 56	1004	73	37	2	No	Yes	Yes	
Area 103	1009	73	37	1	No	Yes	Yes	
Area 13	900	71	35	1	No	Yes	Yes	
Area 30	1077	71	38	1	No	Yes	Yes	Door open
Area 32	1060	72	38	4	No	Yes	Yes	
Area 34	1125	72	38	5	No	Yes	Yes	
Area 36	1064	72	37	4	No	Yes	Yes	

*** ppm = parts per million parts of air**
CT = water-damaged ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 7

Indoor Air Test Results –Department of Social Services, Hyde Park, MA – September 29, 2000

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Area 38	1009	73	37	1	No	Yes	Yes	Door open
Area 42	984	73	35	1	No	Yes	Yes	
Area 40	950	73	34	2	No	Yes	Yes	
Area 44	950	73	34	1	No	Yes	Yes	
Area 60	994	73	36	1	No	Yes	Yes	Door open
Area 8	1197	73	38	1	No	Yes	Yes	

*** ppm = parts per million parts of air**
CT = water-damaged ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%