INDOOR AIR QUALITY ASSESSMENT

Tewksbury Hospital, Saunders Building
365 East Street
Tewksbury, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health
Indoor Air Quality Program
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Background/Introduction

To assist Tewksbury Hospital with meeting Joint Commission on Accreditation of Healthcare Organizations (JCAHO) requirement for evaluation of adequacy of the operation of the heating, ventilating and air-conditioning (HVAC) system, the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health (BEH) conducted air measurements of carbon dioxide, temperature and relative humidity in the Saunders Building at Tewksbury Hospital (THSB), located at 365 East Street, Tewksbury, Massachusetts. The air sampling was done in cooperation with Mr. Scott Consaul, Director of Environment of Care for Tewksbury Hospital. On March 25, 2011, and April 22, 2011, Ruth Alfasso, Environmental Engineer/ Inspector for BEH's IAQ Program visited to the THSB to conduct the air sampling with Scott Consaul, Director of Environment of Care for Tewksbury Hospital.

The THSB is a U-shaped, five-story building with a flat rubber membrane roof. It was originally built in the 1960s with additional wings added in the early 1970s.

Methods

Air tests for carbon monoxide, carbon dioxide, temperature and relative humidity were conducted with the TSI, Q-Trak, IAQ Monitor, Model 7565.

Results

The THSB has approximately 320 medical and 130 psychiatric services beds, with approximately 1,000 staff over three shifts. Tests were taken during typical operations. Results

from the March 25, 2011 visit appear in Table 1. Results from the April 22, 2011 visit appear in Table 2.

Discussion

Ventilation

It can be seen from Table 1 that carbon dioxide levels were below 800 parts per million (ppm) in all but four (of forty-seven) areas surveyed on March 25, 2011. All forty-eight areas surveyed on April 22, 2011, were below 800 ppm (Table 2). These numbers indicate adequate air exchange throughout the majority of the building at the time it was assessed. As previously mentioned, many locations tested, particularly during the March 25, 2011 visit, were empty or sparsely populated which may result in lower carbon dioxide concentrations than would be experienced during periods of higher occupancy.

The HVAC system consists of air-handling units (AHU) located on the roof of the building and in various places in each wing. Fresh air is ducted into rooms via supply vents (Pictures 1 and 2) and stale air is removed via exhaust vents (Picture 3). Additional heat is provided via radiators which use steam from a central steam plant (Pictures 4 and 5). Some areas, particularly in the patient wings, receive cooling via the ducted AHU systems, while others, mostly the first floor and basement offices, utilize window-based air conditioning units (Picture 5). New chillers were added for the patient care units during 2004 and 2005; fan coil units service these areas.

Most of the windows in the areas of THSB that were surveyed are openable. Ceiling fans are present and operational in many of the common rooms and nurses' station areas (Picture 2).

Some offices in the basement and subbasement are not equipped with supply and/or exhaust ventilation, relying on corridors, and windows where available, to provide fresh air (EB 12/Table 2).

Several locations, including the laboratory, the kitchen and the dishwashing areas have local exhaust ventilation (e.g., hoods) to directly remove moisture and/or contaminants produced or released in these areas. In addition, the laboratory wing (C basement) has its own separate HVAC system, and is kept at negative pressure to prevent release of contaminants to other areas of the building.

The Massachusetts Building Code requires that each room have a minimum ventilation rate of 20 cubic feet per minute (cfm) per occupant of fresh outside air or openable windows (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 MDPH 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. For more information concerning carbon dioxide, please see Appendix A.

During the March 25, 2011 visit, temperatures ranged from 69 ºF to 75 ºF, which were within or very close to the lower end of the MDPH recommended comfort guidelines. During the April 22, 2011 visit, temperatures ranged from 66 ºF to 75 ºF. Four of the locations tested were slightly below the MDPH comfort guidelines; the one location measured at 66 ºF was the guard lobby next to the frequently-opened main entrance door. The MDPH recommends that indoor air temperatures be maintained in a range of 70 ºF to 78 ºF in order to provide for the comfort of building occupants. 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.

During the March 25, 2011 visit, relative humidity measurements ranged from 12 to 22 percent (Table 1). During the April 22, 2011 visit, relative humidity measurements ranged from 14 to 39 percent (Table 2). All of the measurements during both visits were below the MDPH recommended comfort range; the area that measured 39 percent was the dish room, in which a higher relative humidity would be expected. The MDPH recommends a comfort range of 40 to 60 percent for indoor air relative humidity. 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.

Conclusions/Recommendations

In view of the findings at the time of the visits, the following recommendations are made to improve indoor air quality:

Maintain the HVAC system (e.g., filter replacement) in accordance with manufacturer's instructions and hospital good practice.

For areas in the basement and subbasement where mechanical ventilation is indirect or unavailable, ensure that windows can be opened as needed and that sufficient supply air is introduced. Consider providing additional ventilation for these areas (e.g., EB 12/Table 2).

References

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

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

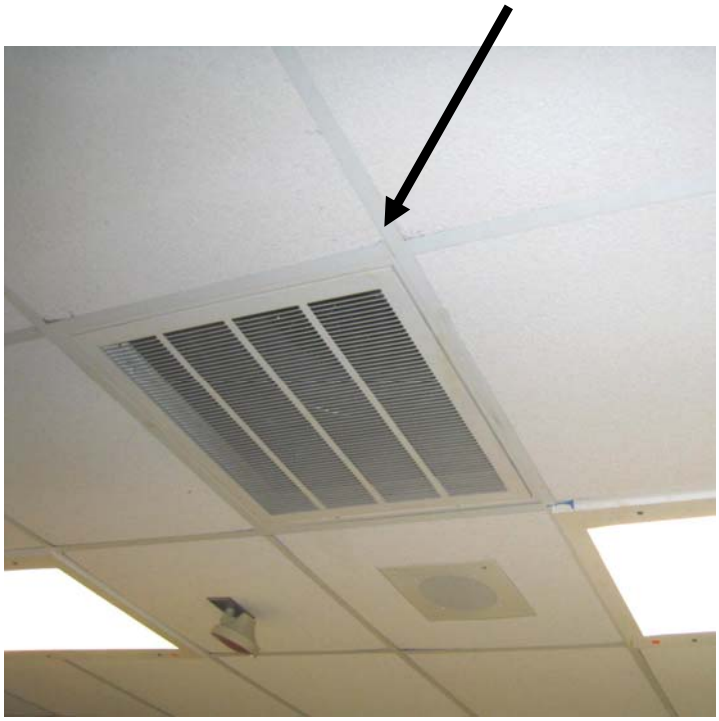
Picture 1

Typical Supply Vent (note dust along air path)

Picture 2

Typical Supply Vent (arrow) with Ceiling Fan

Picture 3



Typical Exhaust Vent (arrow)

Picture 4

Typical Steam Radiator in Corridor

Picture 5

Window Air Conditioner and Steam Radiator

Location: Tewksbury Hospital Saunders Building **Indoor Air Results**

Address: 365 East Street, Tewksbury MA **Table 1** **Date: 3/25/2011**

Location/ Room	Carbon Dioxide (ppm)	Temp (°F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation		Remarks
						Supply	Exhaust	
Background	410	44	20					(Saunders C parking lot)
A1 (conference)	430	74	13	0	Y	Y	Y	Office areas nearly empty in this section
A2 elevator area	590	73	14	0	Y	Y	Y	
A3 elevator area	540	74	16	0	Y	Y	Y	
A3 nurses	624	75	17	6	N	Y	Y	
A4 elevator lobby	530	73	13	0	Y	Y	Y	Radiator on
A4 nurses	385	74	12	1	N	Y	Y	This section is closed for renovation, HVAC is off and isolated from other floors
A4/E4 elevator lobby	517	74	15	1	N	Y	Y	
A5 elevator lobby	558	74	17	0	Y	Y	Y	Office area, no office occupants, today being used for training
A5 end	475	73	15	0	N	Y	Y	

ND = not detected

CF = ceiling fan

ppm = parts per million

AC = air conditioner

HVAC = heating, ventilation and air conditioning

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%

Location: Tewksbury Hospital Saunders Building **Indoor Air Results**

Address: 365 East Street, Tewksbury MA **Date: 3/25/2011**

Table 1 (continued)

Location/ Room	Carbon Dioxide (ppm)	Temp (°F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation		Remarks
						Supply	Exhaust	
A5 nurses	510	73	15	~3 (passing through)	N	Y	Y	Sounds like no air being supplied
B1 elevator area	436	71	14	0	Y	Y	Y	
B3	488	70	15	0	N	Y	Y	New tile floor
B5	484	73	14	3	N	Y	Y	DMH offices, carpeted
C1 elevator area	473	70	14	0	Y	Y	Y	“Clinic Area”
C2 nurses	502	73	15	0	N	Y	Y	Not currently used
C2/D2 elevator area	618	75	17	0	N	N	N	
C3 elevator area	494	69	17	1	Y	Y	Y	
C3 nurses’s station	583	70	19	5	N	Y	Y	Contains running office equipment, adjacent food prep area
C3/D3 elevator area	695	72	19	0	N	Y	Y	

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Table 1 (continued)

Location/ Room	Carbon Dioxide (ppm)	Temp (°F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation		Remarks
						Supply	Exhaust	
C4 nurses station	546	72	16	2	N	Y	Y	
C5 elevator area	685	69	22	1	Y	Y	Y	
C5/D5 elevator area	690	71	20	0	N	Y	Y	
D1 “solarium room”	461	73	15	0	Y	N	N	Storage of wheelchairs
D1 end	480	73	16	0	N	Y	Y	Storage of wheelchairs in this area
D1 nurses	881	72	17	3	N	Y	Y	No central AC in this area, window AC available in outer rooms
D2 end	599	74	17	4	N	Y	Y	
D2 nurses station	662	74	17	3	N	Y	Y	CF (off)
D3 end	747	73	19	0	N	Y	Y	
D3 group room	656	74	18	0	Y	Y	Y	Hot from solar gain

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Address: 365 East Street, Tewksbury MA **Date: 3/25/2011**

Table 1 (continued)

Location/ Room	Carbon Dioxide (ppm)	Temp (°F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation		Remarks
						Supply	Exhaust	
D3 nurses station	630	74	17	4	N	Y	Y	CF (off)
D4 end @ stairs	578	72	17	0	N	Y	Y	
D4 nurses station	624	72	17	1	N	Y	Y	
D5 end	631	71	19	0	N	Y	Y	
D5 nurses station	683	72	20	1	N	Y	Y	
Dialysis office	869	72	21	8	Y	Y	Y	This area has a separate ventilation system
E1	446	72	16	0	N	Y	Y	Offices and day use areas in this section
E1 end	443	72	16	0	N	Y	Y	Empty day use area
E1 solarium (meeting room)	573	73	16	0	Y	Y	Y	Contains radiators for heat; sink, ceiling fans
E2 elevator area	455	75	15	0	Y	Y	Y	

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Address: 365 East Street, Tewksbury MA **Date: 3/25/2011**

Table 1 (continued)

Location/ Room	Carbon Dioxide (ppm)	Temp (°F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation		Remarks
						Supply	Exhaust	
E2 end	716	74	19	3	N	Y	Y	CF on in adjacent solarium
E2 nurses	896	75	19	6	N	Y	Y	CF (on)
E3 end	672	72	22	2	N	Y	Y	CF on in each side room
E3 nurses	809	73	19	7	N	Y	Y	
E3/A3 elevator area	705	75	18	0	N	Y	Y	
E4 end	494	73	14	3	N	Y	Y	
E4 nurses	636	74	16	3	N	Y	Y	
Patient/ employee gym area	455	70	15	0	N	Y	Y	2 portable AC (running)

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Location: Tewksbury Hospital Saunders Building **Indoor Air Results**

Address: 365 East Street, Tewksbury MA **Table 2** **Date: 4/22/2011**

Location/ Room	Carbon Dioxide (ppm)	Temp (°F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation		Remarks
						Supply	Exhaust	
Background	404	49*	41*					(Saunders parking lot) *Temperature and relative humidity taken from wunderground.com weather history for Tewksbury, MA
103C	438	75	16	0	Y	N	N	CF (on)
A center outside industrial therapy	434	71	22	0	Y	N	N	
A1 corridor	437	71	18	0	N	N	N	Openable windows at end of corridor
A1 elevator lobby	499	71	18	0	Y	N	N	Baseboard radiator
AB-B elevator lobby	507	71	19	0	N	N	N	End of corridor has openable window
Auditorium	431	73	14	0	N	Y	Y	Dirty supply vents and ceiling

ND = not detected ppm = parts per million CF = ceiling fan

NA = not applicable AC = air conditioner PF = personal fan

WD = water damaged CT = ceiling tile DO = door open

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Address: 365 East Street, Tewksbury MA **Date: 4/22/2011**

Table 2 (continued)

Location/ Room	Carbon Dioxide (ppm)	Temp (°F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation		Remarks
						Supply	Exhaust	
Auditorium foyer	463	72	16	0	N	Y	N	
B wing hallway first floor	459	71	17	0	N	Y	Y	
B1 center	440	71	16	0	N	N	N	
B1 end	465	72	15	0	Y	N	N	
B17	473	74	17	2	Y	N	N	DO
C basement end	433	70	17	0	N	N	N	
C wing @B1 middle hallway	540	69	18	0	N	N	N	
C132 Chapel	472	72	17	0	N	Y	Y	Dirty exhaust

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Table 2 (continued)

Location/ Room	Carbon Dioxide (ppm)	Temp (°F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation		Remarks
						Supply	Exhaust	
C151D, Code compliance office	505	69	22	0	N	Y	Y	WD CT
C155, near B1 center	540	71	17	1	N	Y	N	
C157B	496	72	18	1	N	Y	Y	dirty exhaust
C173 middle	470	71	18	1	Y	N	N	Window AC
CG14 vestibule	444	71	19	0	N	Y	N	DO
D basement elevator	450	73	17	0	N	N	N	
D basement end	464	72	19	0	N	N	N	
D1 corridor	601	71	20	0	N	Y	N	
D1 end	514	74	18	0	Y	N	N	Storage of electric wheelchairs

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Table 2 (continued)

Location/ Room	Carbon Dioxide (ppm)	Temp (°F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation		Remarks
						Supply	Exhaust	
D1 middle	632	72	19	2	N	Y	Y	CF (off)
Dish wash station	463	72	39	4+	N	Y	Y	Contains dish washing line equipment with direct (hood) exhaust ventilation
DMH admin office	466	74	17	1	Y	N	N	Half old chapel room AC ducted through window, DO
E basement "nurses station" area	492	70	21	0	N	Y	Y	
E basement elevator lobby	449	71	19	0	N	N	N	Next to loading dock
E basement wing end	461	70	18	0	Y	N	N	Doors open to outside from here and were open
EB 16	477	73	19	1	Y	N	N	DO, window AC, PF
EB 17	527	74	17	1	Y	N	N	DO, window AC

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Table 2 (continued)

Location/ Room	Carbon Dioxide (ppm)	Temp (°F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation		Remarks
						Supply	Exhaust	
EB12 back right office	510	72	20	0	Y	N	N	Window AC EB12 office occupants concerned about lack of ventilation, all doors open to corridor
EB12 center back office	557	73	19	0	Y	N	N	Window AC
EB12 center left office	562	72	19	0	Y	N	N	Steam radiator
EB12 central area	580	72	20	2-3	N	N	N	Steam heat radiator
Electrical shop SG9A	498	74	20	2	N	Y	Y	DO
Front lobby guard station	527	66	24	2	Y	Y	Y	Adjacent to frequently opened door to outside
HR office	609	74	17	2	N	Y	Y	PF, photocopier
Industrial therapy room	469	71	21	2	Y	Y	Y	Window AC

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Location/ Room	Carbon Dioxide (ppm)	Temp (°F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation		Remarks
						Supply	Exhaust	
Lab center	453	70	21	1	N	Y	Y	Dedicated supply and exhaust ventilation for lab wing to keep negative pressure, lab DO to corridor
Lab services room	526	72	22	0	N	Y	Y	Storage of CO_2 in this room, DO
Old lobby	458	73	15	0	Y	Y	N	Radiator against outside wall, hand sanitizer
Plumbing shop	735	70	29	3	N	N	N	CO_2 stored in adjacent closet/storeroom, DO
SG10A	485	75	19	0	N	Y	Y	
SG12	499	72	25	1	N	Y	Y	Ventilation system non-standard add-on by occupants
Subbasement Elevator 3 lobby	407	69	23	0	N	N	N	
Sub-basement hallway	431	70	20	0	N	Y	N	

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Table 2 (continued)

Location/ Room	Carbon Dioxide (ppm)	Temp (°F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation		Remarks
						Supply	Exhaust	
Subbasement near elevator 10	471	69	22	0	N	N	N	

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