# INDOOR AIR QUALITY ASSESSMENT

**Burlington Town Hall Annex**
**25 Center Street**
**Burlington, Massachusetts**


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

In response to concerns associated with indoor air quality (IAQ) issues, the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health (BEH) conducted an IAQ assessment at the Burlington Town Hall Annex (BTA), located at 25 Center Street, Burlington, Massachusetts. The assessment was done at the request of Ms. Joanne Faust, Human Resources Director for the Town of Burlington. On October 29, 2013, Michael Feeney, Director of BEH's IAQ program visited the building to conduct an IAQ assessment. He was accompanied by Ruth Alfasso, Environmental Engineer/Inspector for BEH's IAQ Program.

The BTA is a two-story building with basement, originally built as a police station and later used as a library. Approximately thirty years ago, a second story was added to the building. The BTA is a wood-framed structure with brick façade and a partially flat, rubber roof with a complex, shingled-sloped portion and a central skylight. Most areas are carpeted. The majority of windows in the building are openable.

## Methods

Air tests for carbon monoxide, carbon dioxide, temperature and relative humidity were conducted with the TSI, Q-Trak, IAQ Monitor, Model 7565. Air tests for airborne particle matter with a diameter less than 2.5 micrometers were taken with the TSI, DUSTTRAK™ Aerosol Monitor Model 8520. BEH/IAQ staff also performed visual inspection of building materials for water damage and/or microbial growth.

## Results

Approximately 30 currently people work in the BTA and provide a range of services to the public. The building is also used for public meetings. Tests were taken during normal operations and results appear in Table 1.

## Discussion

### Ventilation

It can be seen from Table 1 that carbon dioxide levels were below 800 parts per million (ppm) in all but two areas surveyed (i.e., the conference and photocopy room), indicating adequate air exchange for most areas at the time of assessment (Table 1). The heating, ventilation and air conditioning (HVAC) system consists of air-handling units (AHU) located in the basement and attic. Fresh air for basement HVAC units comes from intake vents at ground level (Picture 1). Conditioned air is distributed to variable air volume (VAV) boxes, which further adjusts the temperature of the air and distributes it to ceiling-mounted air diffusers (Picture 2). Exhaust air is drawn through ceiling-mounted return vents and ducted back to AHUs (Picture 3).

The HVAC system is controlled by rotary thermostats. Each thermostat examined had a fan switch with two settings, *on* and *auto*. When the fan is set to *on*, the system provides a continuous source of air circulation and filtration. The *automatic* setting on the thermostat activates the HVAC system at a preset temperature. Once the preset temperature is reached, the HVAC system is deactivated. Therefore, no mechanical ventilation is provided until the thermostat re-activates the system. The MDPH recommends that thermostats be set to the fan *on* setting during occupied hours to provide continuous air circulation.

To maximize air exchange, the MDPH recommends that both supply and exhaust ventilation operate continuously during periods of occupancy. In order to have proper ventilation with a mechanical supply and exhaust system, the systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. It is recommended that HVAC systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994). The date of last balancing was not available at the time of the assessment.

Minimum design ventilation rates are mandated by the Massachusetts State Building Code (MSBC). Until 2011, the minimum ventilation rate in Massachusetts was higher for both occupied office spaces and general classrooms, with similar requirements for other occupied spaces (BOCA, 1993). The current version of the MSBC, promulgated in 2011 by the State Board of Building Regulations and Standards (SBBRS), adopted the 2009 International Mechanical Code (IMC) to set minimum ventilation rates. <u>Please note that the MSBC is a minimum standard that is not health-based</u>. At lower rates of cubic feet per minute (cfm) per occupant of fresh air, carbon dioxide levels would be expected to rise significantly. A ventilation rate of 20 cfm per occupant of fresh air provides optimal air exchange resulting in carbon dioxide levels at or below 800 ppm in the indoor environment in each area measured. MDPH recommends that carbon dioxide levels be maintained at 800 ppm or below. This is because most environmental and occupational health scientists involved with research on IAQ and health effects have documented significant increases in indoor air quality complaints and/or health effects when carbon dioxide levels rise above the MDPH guidelines of 800 ppm for schools, office buildings and other occupied spaces (Sundell et al., 2011). 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.

Temperatures in occupied areas ranged from 68º F to 75º F, which were within or close to the MDPH recommended comfort guidelines. The MDPH recommends that indoor air temperatures be maintained in a range of 70º F to 78º F 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.

The relative humidity ranged from 18 to 34 percent, which was below the MDPH recommended comfort range in all areas surveyed. 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.

It was noted that the building had humidifier units located on walls of several offices and common areas (Pictures 4 and 5). It was reported that these units were installed in the 1990s, but had been deactivated with the water service to each unit shut off. The reasons for installing these units were reportedly to improve the functioning of copy machines, which had been known to experience paper jams during periods of low relative humidity, as well as to improve occupant comfort. The humidifying machines had reportedly been deactivated because of the expenses associated with maintenance and repair; in addition, newer copy machines are more tolerant of dry conditions. MDPH/BEH does not recommend the use of humidifying devices in office spaces.

**Microbial/Moisture Concerns**

In order for building materials to support mold growth, a source of water exposure is necessary. Water-damaged ceiling tiles were seen in a few areas on the upper floors, indicating leaks from the roof or plumbing system. In the basement, there was evidence of water damage from windows which are partially below-grade. Window wells are installed to create a catch basin for water during precipitation events rather than draining water away (Picture 6), which can lead to leaks inside the building. The basement area also is carpeted in many areas. Carpeting is not recommended for below-grade areas due to the potential for moistening through leaks and condensation.

BEH/IAQ staff examined the outside perimeter of the building to identify breaches in the building envelope and/or other conditions that could provide a source of water penetration. Downspouts were observed to drain only a short way from the building (Picture 7). If downspouts are not configured to drain correctly, water from the roof may be directed to the walls/foundation. Plants were also observed to be growing in close proximity to the building where roots can penetrate the foundation and foliage may hold moisture against the building. These conditions can undermine the integrity of the building envelope and provide a means of water entry by capillary action into the building through exterior walls, foundation concrete and masonry (Lstiburek & Brennan, 2001).

During an examination of the attic area, one of the VAV boxes was inspected. VAV boxes at the BTA are equipped with a drip pan that is designed to collect condensate from the HVAC system when in cooling mode. It was reported that VAV box drip pans use sponges to absorb water; this is not an optimal method of moisture control. Drip pans should be designed to collect and *drain* moisture to a properly-designed condensate drainage system. The drip pan examined had accumulated mineral deposits (Picture 8), suggesting that a significant amount of water builds up inside during the cooling season. Collected condensate can be a source of leaks, microbial contamination and odors. It appeared that in an attempt to prevent microbial contamination, treatment tablets containing ammonium chloride are used in the drip pan (Pictures 8 and 9). These tablets can release ammonia, which can be a respiratory irritant and should not be used in this manner; properly draining drip pans prevent the need for any condensate treatment.

Additionally, the VAV box examined had two plastic tubes coming off what appeared to be the coolant line (Picture 10). The ends of these tubes were found to contain water (Picture

11). The tubes are likely designed to relieve excess pressure in coolant lines; however they should also be directed to a proper condensate/coolant drain rather than being allowed to drain onto the floor. If other VAV boxes are similar to the one observed, they may be significant sources of moisture/leaks to the interior of the building.

Plants were noted in some areas (Table 1). Plants can be a source of pollen and mold which can be respiratory irritants to some individuals. Plants should be properly maintained and equipped with drip pans and should be located away from ventilation sources to prevent aerosolization and distribution of dirt, pollen or mold.

Water dispensers and refrigerators were observed to be located in carpeted areas (Picture 12). Spills or leaks from these appliances can moisten carpeting. Water-dispensing and other appliances should be located in an area with non-porous flooring or on a waterproof mat.

The US Environmental Protection Agency (US EPA) and the American Conference of Governmental Industrial Hygienists (ACGIH) recommend that porous materials (e.g., ceiling tiles, carpeting) be dried with fans and heating within 24 to 48 hours of becoming wet (US EPA, 2001; ACGIH, 1989). If not dried within this time frame, mold growth may occur. Once mold has colonized porous materials, they are difficult to clean and should be removed/discarded.

### Other IAQ Evaluations

Indoor air quality can be negatively influenced by the presence of respiratory irritants, such as products of combustion. The process of combustion produces a number of pollutants. Common combustion emissions include carbon monoxide, carbon dioxide, water vapor and smoke (fine airborne particle material). Of these materials, exposure to carbon monoxide can produce immediate, acute health effects upon exposure. To determine whether combustion products were present in the building environment, BEH/IAQ staff obtained measurements for carbon monoxide.

*Carbon Monoxide*

Carbon monoxide is a by-product of incomplete combustion of organic matter (e.g., gasoline, wood and tobacco). Exposure to carbon monoxide can produce immediate and acute health effects. Several air quality standards have been established to address carbon monoxide and prevent symptoms from exposure to these substances. The MDPH established a corrective action level concerning carbon monoxide in ice skating rinks that use fossil-fueled ice resurfacing equipment. If an operator of an indoor ice rink measures a carbon monoxide level over 30 ppm, taken 20 minutes after resurfacing within a rink, that operator must take actions to reduce carbon monoxide levels (MDPH, 1997).

The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) has adopted the National Ambient Air Quality Standards (NAAQS) as one set of criteria for assessing indoor air quality and monitoring of fresh air introduced by HVAC systems (ASHRAE, 1989). The NAAQS are standards established by the US EPA to protect the public health from six criteria pollutants, including carbon monoxide and particulate matter (US EPA, 2006). As recommended by ASHRAE, pollutant levels of fresh air introduced to a building should not exceed the NAAQS levels (ASHRAE, 1989). The NAAQS were adopted by reference in the Building Officials & Code Administrators (BOCA) National Mechanical Code of 1993 (BOCA, 1993), which is now an HVAC standard included in the Massachusetts State Building Code (SBBRS, 2011). According to the NAAQS, carbon monoxide levels in outdoor air should not exceed 9 ppm in an eight-hour average (US EPA, 2006).

*Carbon monoxide should not be present in a typical, indoor environment.* If it *is* present, indoor carbon monoxide levels should be less than or equal to outdoor levels. On the day of the assessment, outdoor carbon monoxide concentrations were non-detect (ND) (Table 1). No measureable levels of carbon monoxide were detected inside the building during the assessment (Table 1).

*Particulate Matter*

The US EPA has established NAAQS limits for exposure to particulate matter. Particulate matter includes airborne solids, which can result in eye and respiratory irritation if exposure occurs. The NAAQS originally established exposure limits to particulate matter with a diameter of 10 μm or less (PM10). According to the NAAQS, PM10 levels should not exceed 150 micrograms per cubic meter (μg/m$^3$) in a 24-hour average (US EPA, 2006). These standards were adopted by both ASHRAE and BOCA. Since the issuance of the ASHRAE standard and BOCA Code, US EPA established a more protective standard for fine airborne particles. This more stringent PM2.5 standard requires outdoor air particle levels be maintained below 35 μg/m$^3$ over a 24-hour average (US EPA, 2006). Although both the ASHRAE standard and BOCA Code adopted the PM10 standard for evaluating air quality, MDPH uses the more protective PM2.5 standard for evaluating airborne particulate matter concentrations in the indoor environment.

Outdoor PM2.5 was measured at 10 μg/m$^3$ (Table 1). Indoor PM2.5 levels ranged from 4 to 10 μg/m$^3$ (Table 1). Both indoor and outdoor PM 2.5 levels were below the NAAQS PM2.5 level of 35 μg/m$^3$. Frequently, indoor air levels of particulates (including PM2.5) can be at higher levels than those measured outdoors. A number of mechanical devices and/or activities that occur indoors can generate particulate matter during normal operations. Sources of indoor airborne particulates may include but are not limited to particles generated during the operation of fan belts in the HVAC system, use of stoves and/or microwave ovens in kitchen areas; use of photocopiers, fax machines and computer printing devices; operation of an ordinary vacuum cleaner and heavy foot traffic indoors.

*Volatile Organic Compounds*

Indoor air concentrations can be greatly impacted by the use of products containing volatile organic compounds (VOCs). VOCs are carbon-containing substances that have the ability to evaporate at room temperature. Frequently, exposure to low levels of total VOCs (TVOCs) may produce eye, nose, throat and/or respiratory irritation in some sensitive individuals. For example, chemicals evaporating from a paint can stored at room temperature would most likely contain VOCs. In an effort to identify materials that can potentially increase indoor VOC concentrations, BEH/IAQ staff examined rooms for products containing these respiratory irritants.

Some offices and areas contained dry erase boards and related materials (Table 1). Materials such as dry erase markers and dry erase board cleaners may contain VOCs, such as methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve (Sanford, 1999), which can be irritating to the eyes, nose and throat.

Air fresheners were observed in restrooms and other areas (Table 1). Air fresheners contain chemicals that can be irritating to the eyes, nose and throat of sensitive individuals. Many air fresheners contain 1,4-dichlorobenzene, a VOC which may cause reductions in lung function (NIH, 2006). Furthermore, deodorizing agents do not remove materials causing odors, but rather mask odors that may be present in the area.

Paints were stored in the Engineering area (Table 1, Picture 13). Opened cans of paint may evaporate during storage; partially used cans should be stored away from occupied areas.

**Other Conditions**

Other conditions that can affect IAQ were observed during the assessment. Gasoline-like odors were reported to occur at times on the second floor of the BTA corresponding to filling and maintenance at gasoline pumps/tanks located to the northwest of the building (Picture 14). The roof has a large candy-cane style vent (Picture 14) that serves as a pressurization relief vent for the elevator shaft, which may be drawing in vapors from the tanks when they are in use or being filled, particularly under northwesterly wind conditions. Vapors and odors can then be distributed throughout the building by the piston-like action of the elevator. It is recommended that the elevator vent be rotated 180º to have its opening facing away from the gas pumps to minimize gasoline vapor entrainment.

The building appears to have two furnaces. One furnace is located in the basement along with a gas-fired water heater (Picture 15). The exhaust vents for these units are located along the foundation in the southwest corner of the building (Pictures 1 and 16). These vents are directly adjacent to the fresh air intake for the building (Picture 1) and directly below a vent/wall penetration of unknown function (Picture 16). Because of the location of these vents and the fact that windows in this building are not completely airtight, exhaust from the furnaces may be able to penetrate into the second floor of building during the heating season.

The second furnace, located in the attic area, was examined (Pictures 17 and 18). During the course of the assessment, BEH/IAQ staff detected natural gas and combustion odors in the attic space, which did not appear to impact office space. However, the conditions noted in the attic pose a number of potential issues:

- The roof of the attic is wooden-framed. Sprinklers are installed in the attic, however the space above or near the furnace does not have any sprinkler heads. The existence of this equipment along with the lack of sprinklers poses a fire risk.
- None of the Burlington town officials in the building or on-site at the time of the assessment were aware of the existence of this equipment. This suggests that the furnace may not be regularly serviced/properly maintained.
- The notation "belts 10/24/05" was hand-written on the cabinet suggesting that 2005 was the most recent time the belts were changed (Picture 19). This suggests that regular maintenance on this equipment is not occurring.
- The furnace was found to be equipped with air filters, but the configuration requires that the filters to be bent/folded to be inserted into the unit. Air filters in HVAC equipment should be changed at a minimum twice a year; these filters appeared to not have been changed in some time.
- Because of the inaccessibility of the air filters, gaps were observed around where the filters should be installed (Picture 20). This will allow air from the attic to be drawn into the unit, unfiltered, which may include dust and debris, which is then distributed to portions of the building served by this HVAC equipment.

The attic furnace/HVAC equipment needs to be thoroughly evaluated as to function, connection, and service history. If this unit is needed, modifications are required to ensure that it can function safely and effectively, including installation of effective sprinklers overhead. In addition, rearrangement of items in the attic should be conducted such that the filters, belts and other areas are accessible for regular maintenance.

The filters for the ducted HVAC system appear designed to be installed on return vents inside the grill. Although a few of them were observed with filters installed (Picture 21), most of these grilles did not have filters (Picture 3). Without the designed filtration, dusts and debris from inside the BTA are collected and redistributed throughout the building.

In a number of areas, items were observed on the floor, windowsills, tabletops, counters, bookcases and desks. The large number of items stored provides a source for dusts to accumulate. These items (e.g., papers, folders, boxes) make it difficult for custodial staff to clean. Items should be relocated and/or be cleaned periodically to avoid excessive dust build up. In addition, these materials can accumulate on flat surfaces (e.g., desktops, windowsills and carpets) in occupied areas and subsequently be re-aerosolized causing further irritation.

Many areas of the building contain wall to wall carpeting. It was unclear if a regular carpet cleaning program was in place. The Institute of Inspection, Cleaning and Restoration Certification (IICRC), recommends that carpeting be cleaned annually (or semi-annually in soiled high traffic areas) (IICRC, 2005).

## Conclusions/Recommendations

Based on observations made during the assessment, a number of issues related to the heating system and products of combustion exist in the building, in addition to general IAQ conditions noted. Therefore the following recommendations are made to improve indoor environmental conditions:

1. Ensure that the exhaust vent for the attic furnace is free of holes to vent products of combustion completely outdoors.
2. Render the windows above the basement furnace vents airtight.

3. Extend the basement furnace exhaust vents to a sufficient height above the roof-line and HVAC/elevator intakes. Determine the use of the vent shown in Picture 16 and seal if not needed.

4. Consult with an elevator/ventilation engineer relative to reducing the size of the elevator make-up air vent ("candy-cane style" vent) and changing the direction of the open end to reduce the chance for entraining odors/vapors from the fueling area located outside. This may additionally make more space for accessing the HVAC system in the attic.

5. Accessibility to the attic furnace needs to be improved. Reducing the diameter of the elevator shaft air vent will allow more space around the HVAC unit for accessibility.

6. Determine if the furnace in the attic is required. If it is, have the unit thoroughly serviced and regularly maintained, including changing of filters at least twice a year.

7. Add/replace sprinkler heads over the attic furnace and ensure they are functional.

8. Given the inherent danger of a gas-fired furnace beneath a wood roof, conversion of this unit from gas to electric power is advisable.

9. Examine VAV boxes throughout the building for proper drainage from condensate drain pans and overflow tubing. Repair/reconfigure as necessary to provide drainage. Do not use water treatment chemicals in condensate drain pans, but have the pans cleaned periodically to prevent build-up of minerals and other materials.

10. Operate the HVAC system continuously in the fan "on" mode during periods of occupancy to maximize air circulation and filtration.

11. 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 high efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Avoid the use of feather dusters. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).

12. Ensure that all water service to the disused humidifier units is cut and capped to prevent leaks. Consider having these units properly removed.

13. Repair/reconfigure basement window wells so that water drains away from windows rather than accumulating.

14. Remove/replace water-damaged ceiling tiles. Examine the area above and around these areas for mold growth. Disinfect areas of water leaks with an appropriate antimicrobial.

15. Consider use of non-porous flooring in basement areas.

16. Ensure downspouts drain at least five feet away from the outside of the building.

17. Trim/remove shrubbery and other plants from the perimeter of the building.

18. Prevent water damage by using drip pans for plants and cleaning them regularly.

19. Consider outfitting water dispensers and refrigerators with a rubber/plastic mat to prevent water damage to carpeting.

20. Store opened cans of paint and other VOC sources away from occupied areas.

21. Avoid the use of air fresheners and scented products.

22. Replace all filters on exhaust/return vents. Ensure they are changed at least twice a year or as per the manufacture’s instructions.

23. Relocate or consider reducing the amount of stored materials to allow for more thorough cleaning. Clean items regularly with a wet cloth or sponge to prevent excessive dust build-up.

24. Consider consolidating areas where food is stored and heated, and locate them near an exhaust vent to draw particulates and odors away from occupants.

25. Clean carpeting annually or semi-annually in soiled high traffic areas as per the recommendations of the Institute of Inspection, Cleaning and Restoration Certification (IICRC). Copies of the IICRC fact sheet can be downloaded at: http://1.cleancareseminars.net/?page_id=185 (IICRC, 2005).

26. Refer to resource manuals and other related indoor air quality documents for further building-wide evaluations and advice on maintaining public buildings. Copies of these materials are located on the MDPH's website: http://mass.gov/dph/iaq.

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**Picture 1**

**Fresh air vent for basement HVAC units (arrow). Note HVAC exhaust vents (white pipes) to the left**

**Picture 2**

**Fresh air diffuser**

**Picture 3**

**Exhaust vent, note open channel to exhaust ducting**

**Picture 4**


**Humidifying unit**

**Picture 5**

**Inside view of humidifying unit**

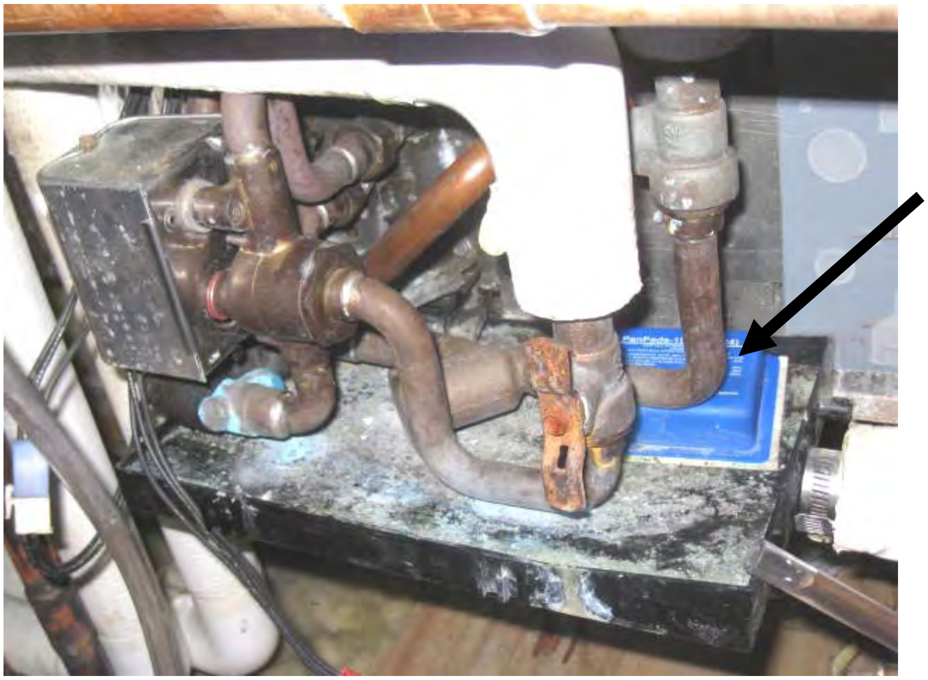
**Picture 6**

**Window well from inside the basement, note corrugated metal basin that is reported to fill with water, and water-damaged sill**

**Picture 7**

**Gutter downspout emptying close to the building**

**Picture 8**



**Interior of VAV box showing drain pan with mineral deposits and treatment tablet (arrow)**

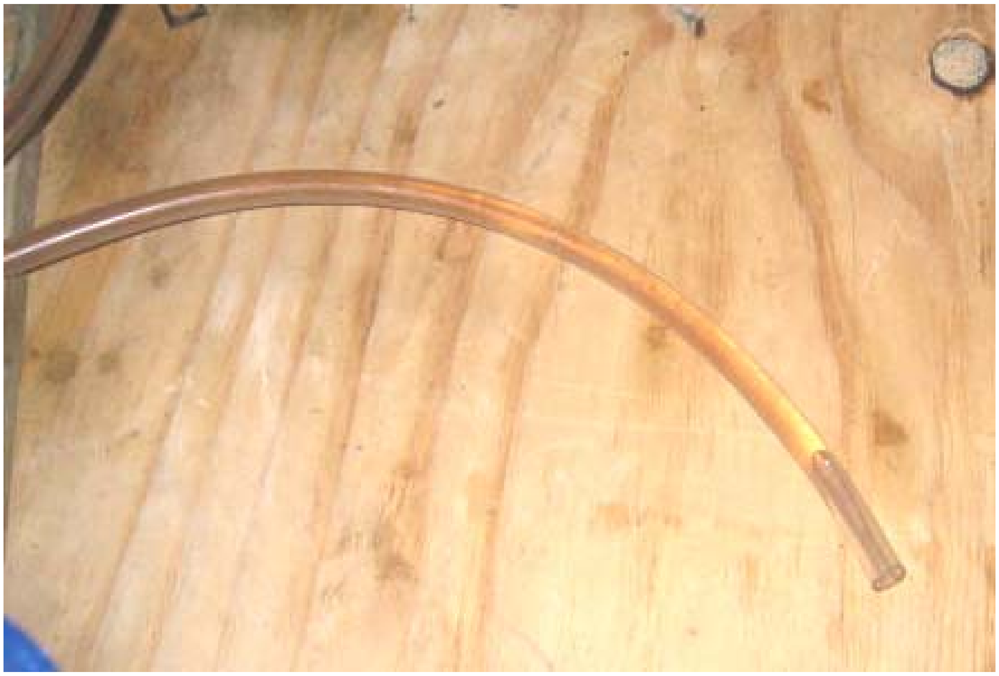
**Picture 9**


**Close-up of drain pan treatment tablet showing list of ingredients**

**Picture 10**

**Plastic blow-off hoses from coolant system in VAV box**

**Picture 11**



**Liquid in end of blow-off hose**

**Picture 12**

**Refrigerator on carpet**

**Picture 13**

**Paint storage**

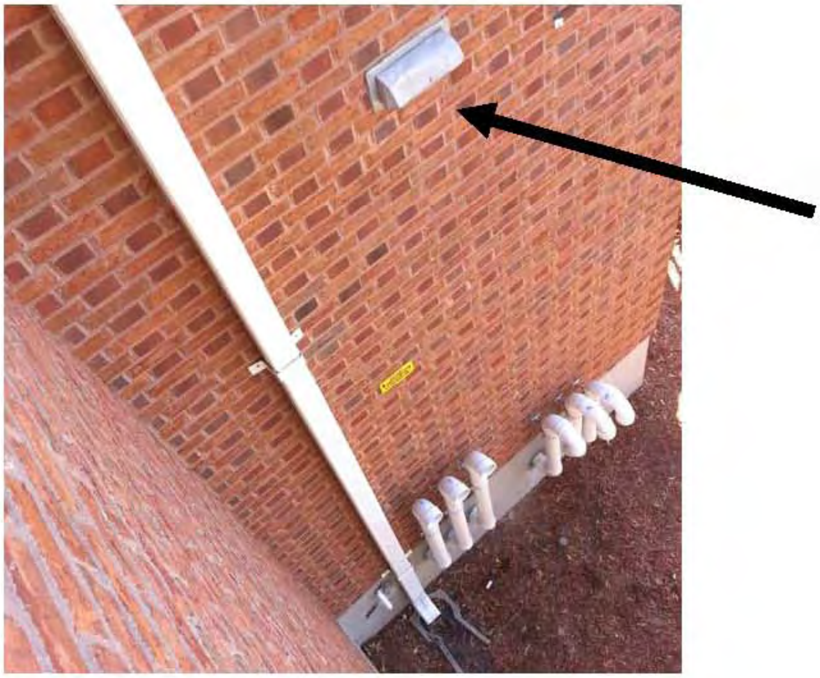
**Picture 14**

**Gasoline pumps (arrow) and large "candy cane" vent (foreground, left)**

**Picture 15**

**Heating units in basement (note exhaust piping)**

**Picture 16**



**Exhaust from heating units in basement directly up against wall, note unknown vent partway up wall (arrow)**

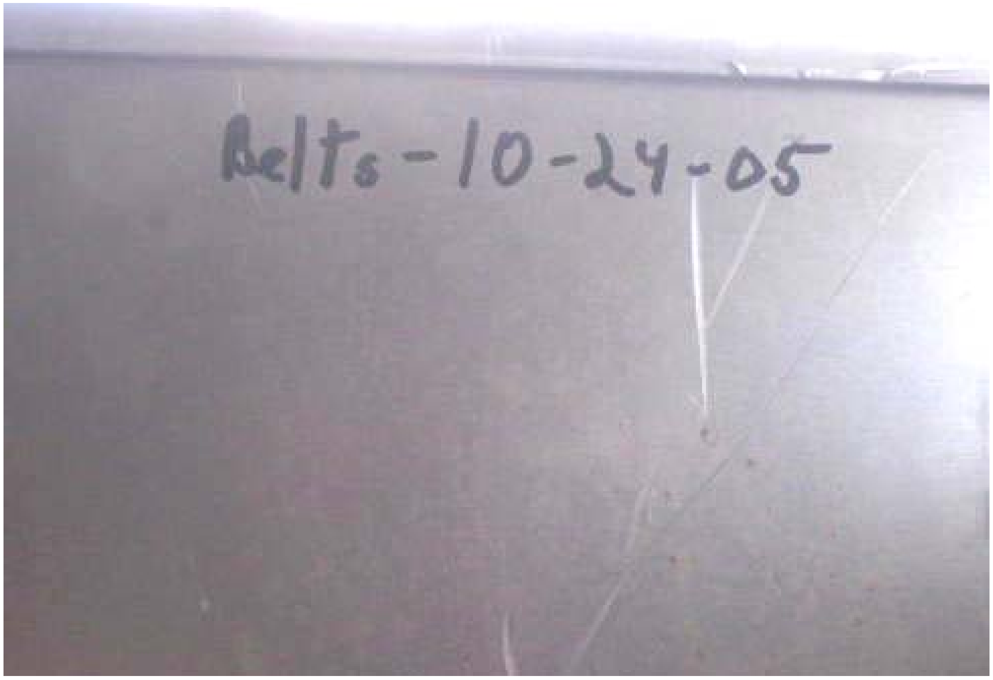
**Picture 17**

**Side view of HVAC equipment in attic; note elevator shaft vent on left side of picture (arrow)**

**Picture 18**


**Gas connection notice on HVAC equipment found in attic**

**Picture 19**




**Notice on HVAC duct in attic which may indicate last time belts were changed/other service performed (10/24/05)**

**Picture 20**

**Filters improperly installed in attic HVAC unit**

**Picture 21**

**Exhaust grill with filter installed (compare with Picture 3, a similar grill without filter)**

**Location: Burlington Town Hall Annex** **Indoor Air Results**

**Address: 25 Center Street, Burlington, MA** **Date: 10/29/2013**

# Table 1

| Location/ Room | Carbon Dioxide (ppm) | Carbon Monoxide (ppm) | Temp (°F) | Relative Humidity % | PM2.5 (μg/m³) | Occupants In Room | Windows Openable | Ventilation | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Supply | Exhaust | |
| Background | 441 | ND | 55 | 23 | 10 | | | | | Sunny, brisk |
| **Second floor** | | | | | | | | | | |
| Conference room | 1294 | ND | 68 | 34 | 4 | 4 | Y | Y | Y | DEM |
| Photocopy area | 924 | ND | 72 | 24 | 6 | 2 | N | Y | Y | Large printer |
| Director's Office | 659 | ND | 73 | 21 | 4 | 1 | Y | Y | Y | DO |
| Engineering section, front | 742 | ND | 73 | 20 | 5 | 0 | Y | Y | Y | Items/paper |
| Engineering section, middle | 622 | ND | 73 | 20 | 5 | 0 | Y | Y | Y | Items, water-stained carpet |
| Engineering section, rear | 599 | ND | 73 | 21 | 6 | 1 | Y | Y | Y | DEM |
| Engineering main | 656 | ND | 73 | 20 | 5 | 1 | N | Y | Y | |
| DPW administration | 612 | ND | 73 | 19 | 5 | 0 | Y | Y | Y | Heater, plants, food |

ppm = parts per million
μg/m³ = micrograms per cubic meter
AF = air freshener
CP = cleaning products
CT = ceiling tile
DEM = dry erase materials
DO = door open
MT = missing tile
ND = non detect
PC = photocopier
PF = personal fan
WD = water-damaged

**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%
Particle matter 2.5 < 35 ug/m³

**Location: Burlington Town Hall Annex** **Indoor Air Results**

**Address: 25 Center Street, Burlington, MA** **Table 1** **Date: 10/29/2013**

| Location/ Room | Carbon Dioxide (ppm) | Carbon Monoxide (ppm) | Temp (°F) | Relative Humidity % | PM2.5 ($\mu g/m^3$) | Occupants In Room | Windows Openable | Ventilation Supply | Ventilation Exhaust | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| DPW director | 615 | ND | 73 | 20 | 5 | 2 | Y | Y | Y | Plants, DO |
| DPW cubes | 602 | ND | 73 | 20 | 5 | 2 | Y | Y | Y | Items, plants, food, PC |
| DPW central area | 570 | ND | 73 | 19 | 6 | 1 | N | Y | Y | PF |
| Storage/breakroom | 475 | ND | 72 | 18 | 5 | 0 | Y | Y | Y | Coffeemaker, microwave, food, water dispenser on carpet |
| Ladies room | | | | | | | | | | Switch-operated exhaust (operational), AF, CP |
| Plan room | 537 | ND | 71 | 18 | 5 | 0 | Y | Y | Y | PC, WD-CT, access to attic area, files/papers |
| Engineering | 573 | ND | 71 | 19 | 5 | 0 | Y | Y | Y | Paint storage, door to outside (weather-stripping ok) |
| Lisck office | 542 | ND | 72 | 20 | 5 | 0 | N | Y | Y | Hand sanitizer |
| **First Floor** | | | | | | | | | | |
| Conservation department front | 612 | ND | 73 | 20 | 6 | 1 | N | Y | Y | |

ppm = parts per million
$\mu g/m^3$ = micrograms per cubic meter
AF = air freshener
CP = cleaning products
CT = ceiling tile
DEM = dry erase materials
DO = door open
MT = missing tile
ND = non detect
PC = photocopier
PF = personal fan
WD = water-damaged

**Comfort Guidelines**

| | | | |
|---|---|---|---|
| Carbon Dioxide: | < 600 ppm = preferred | Temperature: | 70 - 78 °F |
| | 600 - 800 ppm = acceptable | Relative Humidity: | 40 - 60% |
| | > 800 ppm = indicative of ventilation problems | Particle matter 2.5 | < 35 $ug/m^3$ |

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|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Supply | Exhaust | |
| Conservation storage | | | | | | | | | | MT |
| Conservation (Judi) | 722 | ND | 74 | 20 | 6 | 1 | Y | Y | Y | Plants |
| Conservation Director's Office | 622 | ND | 75 | 20 | 5 | 1 | Y | Y | Y | Plants, coffee pot |
| Building Inspector | 709 | ND | 74 | 21 | 6 | 1 | Y | Y | Y | Items, DO |
| Wiring Inspector Office | 700 | ND | 75 | 21 | 6 | 0 | Y | Y | Y | Paper |
| Inspectional services cubes | 722 | ND | 75 | 20 | 6 | 2 | N | Y | Y | Plants |
| Building inspection offices | 724 | ND | 75 | 20 | 6 | 1 | Y | Y | Y | Diorama, DEM |
| Storage/break | 697 | ND | 75 | 20 | 5 | 0 | N | Y | N | DO, food, microwave, toaster |
| Planning area | 699 | ND | 75 | 19 | 5 | 0 | N | Y | N | Food, fridge on carpet, microwave |
| Planning reception | 760 | ND | 75 | 19 | 5 | 1 | N | Y | Y | Water dispenser on carpet |

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|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Supply | Exhaust | |
| Planning Department | 796 | ND | 75 | 20 | 5 | 2 | Y | Y | Y | |
| First floor ladies | | | | | | | | | | Switch-activated exhaust |
| **Basement** | | | | | | | | | | |
| Jim Round's office | 553 | ND | 73 | 20 | 5 | 1 | N | Y | Y | Water issues reported in this room in winter from the windows, WD ceiling tiles, walls |
| IT office | 488 | ND | 73 | 20 | 5 | 1 | N | Y | Y | DO, DEM, disconnected downspout reported |
| Meeting room | 479 | ND | 73 | 20 | 10 | 0 | N | Y | Y | Drinking fountain on carpet outside this room. |

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