INDOOR AIR QUALITY ASSESSMENT

Bristol County Superior Court
9 Court Street
Taunton, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Center for Environmental Health
Bureau of Environmental Health Assessment
Emergency Response/Indoor Air Quality Program
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Background/Introduction

In response to a request from Michael Jordan of the Administration Office of the Trial Court, the Massachusetts Department of Public Health (MDPH), Center for Environmental Health's (CEH) Bureau of Environmental Health Assessment (BEHA) conducted an indoor air quality assessment at the Bristol County Superior Court (BCSC), 9 Court Street, Taunton, Massachusetts. Concerns about potential mold contamination (spotting on a wall) in the clerk's office and other water damage prompted the request. On May 26, 2004 a visit was made to this building by Michael Feeney, Director of Emergency Response/Indoor Air Quality (ER/IAQ).

The BCSC is a stone structure constructed in 1896. This building contains courtrooms, judge's chambers, clerk's office, law library, various offices and a records storage area in the basement. Windows are openable throughout the building, with the exception of those that have a window-mounted air conditioner.

Methods

BEHA staff performed a visual inspection of building materials for water damage and/or microbial growth. Air tests for carbon dioxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor, model 8551.

Results

The courthouse has a population of approximately 70 employees with an estimated 300 other individuals who visit the court on a daily basis. The tests were taken under normal operating conditions, however no cases were being tried at the time of the assessment, therefore courtrooms were not in session. Test results appear in Table 1.

Discussion

Ventilation

It can be seen from Table 1 that carbon dioxide levels were below 800 parts per million parts of air (ppm) in all areas sampled. As discussed, the evaluation was conducted with courtrooms not in session. Reduced building occupancy results in decreased carbon dioxide levels, which renders evaluation of the adequacy of the ventilation system difficult.

Fresh air is provided by an air handling unit (AHU) located in a large room on the ground floor. The AHU has a large fan powered by a motor, which operates the large fan belt (Picture 1). Fresh air drawn into the AHU room is controlled by a door/window (Picture 2). Fresh air is mixed in this room prior to being drawn into the heating elements via the air handler. Ductwork connects the AHU to air diffusers throughout the building.

The AHU is reportedly only activated during the heating season. Therefore, no means of mechanical fresh air supply is provided during the remainder of the year. During the summer months, fresh air is provided solely by air infiltration and open exterior doors and windows. In addition, many offices have window-mounted air conditioners, which cool the indoor environment. A number of windows are un-openable because of the installation of such air-conditioning units.

The BCSC has a gravity exhaust system, which consists of airshafts connecting to roof vents (Picture 3). The operation of the exhaust system appears to depend on air pressurization provided when the AHU is operating. Air pressure forces air from the rooms into exhaust vents. Without operation of the fresh air supply system, exhaust ventilation for rooms is minimal.

To maximize air exchange, the BEHA 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 existing ventilation systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994). It is not apparent whether this type of ventilation is designed to be balanced in the manner recommended by SMACNA.

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). 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 at levels measured in this building. 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. For more information concerning carbon dioxide, see Appendix A.

Temperature measurements ranged from 65^{o} F to 69^{o} F, which were below the BEHA recommended guidelines. The BEHA recommends that indoor air temperatures be maintained in a range between 70^{o} F to 78^{o} F in order to provide 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. It is also difficult to control temperature without the mechanical ventilation system functioning properly.

The relative humidity in the building was measured in a range of 45 to 55 percent, which was within the BEHA recommended comfort range. The BEHA recommends a comfort range of 40 to 60 percent for indoor air relative humidity. Relative humidity levels in the building 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

BEHA staff were asked to examine the space above the Clerk of Courts office, which is located at the front portion of the building. The Clerk's office was originally two stories in height and included a balcony in the upper portion of the room. However, a suspended ceiling was installed below the balcony (Picture 4), thereby dividing the two-story space into a conditioned office space and an unconditioned upper space. A cementitious wall in the upper, unconditioned space was observed patterned with discoloration (Picture 5a and 5b). The discoloration did not appear to be microbial growth, but rather a color change related to periodic water exposure. The front of the building has an exterior that is highly detailed and may be subject to rainwater penetration through worn seams between stone (Picture 6). It does not appear likely that this discoloration is mold since it is not in contact with media that supports growth (e.g., carbon-containing materials such as paint, ceiling tiles, gypsum wallboard, paper products).

A musty odor was detected in the upper, unconditioned space. The odor was traced to a storage room, adjacent to the upper, unconditioned space and accessible only by the balcony. The storage room is used by the law library to store rarely-used law books (Picture 7). The musty odor appeared to emanate from book volumes, which was confirmed by opening several volumes.

It is likely that high relative humidity during hot and humid weather created the conditions that moistened the book collection and produced mold colonization. In the experience of BEHA staff, excessively humid weather can provide enough airborne water vapor to create adequate conditions for mold growth in buildings. Relative humidity in excess of 70 percent for extended periods of time can provide an environment for mold and fungal growth (ASHRAE, 1989). In general, materials that are prone to mold growth can become colonized when moistened for 24 to 48 hours or more. Since hot, humid weather persisted in Massachusetts for more than 14 days during the month of August 2003 (The Weather Underground, 2003), materials in many public buildings were moistened for an extended period of time. Since moistened materials were not likely dried with mechanical aid within a 24 to 48 hour period (e.g. fans, dehumidifiers, air-conditioning), mold growth occurred.

Three conditions likely contributed to increased relative humidity in this storeroom. First, the installation of the suspended ceiling separated the storeroom from the conditioned space. The suspended ceiling has rendered the storeroom as an unconditioned space, subject to little environmental control by heating from AHUs or cooling via window-mounted air conditioners. Second, it appears that polyethylene plastic was installed over the entranceway to the storeroom, further isolating this area from environmental control. Lastly, the storeroom did not have either a dehumidifier or window-mounted air conditioning system, both of which would have helped to decrease the relative humidity in this area. The most likely source of mold growth appears to be the book collection in the storeroom, rather than the discoloration noted on the exterior wall.

Other conditions related to water damage were also observed at the BCSC. Visible mold growth was noted on a wall in the balcony rotunda, behind a file cabinet (Picture 8). This water damage corresponds to an area on the roof where it appears that a downspout from an upper roof gutter is missing (Picture 9). Without this downspout, water pours on to the lower roof, wetting adjacent exterior stone, resulting in water penetration.

Office room 62, which is located at the rear of the northwest corner of the third floor, has an air conditioner installed in a west-facing window (Picture 10). The flat-topped surface of the air-conditioning cabinet can accumulate water, subsequently wetting the wood frame used to support the air-conditioner. As reported by building occupants, this particular room has experienced water penetration, as evidenced by water damaged to the original plaster walls. In an effort to refinish the walls, a gypsum wallboard (GW) material was installed over the water-damaged materials (Picture 11). It is unclear whether the water leaks damaging the wall plaster were remediated. GW can be susceptible to mold growth if moistened repeatedly and/or not dried within 24 to 48 hours.

A musty odor was noted in an office located at the rear of the northeast corner of the third floor; however, no apparent water damage was observed. A musty odor was also noted on the second floor. The odor was traced to office room 17, which had experienced a radiator leak that flooded the second floor office and soaked the carpet. The radiator leak was repaired, but the water-damaged carpet was left in place. Upon entering the office, a distinct musty odor was detected from the carpet beneath the radiator (Picture 12). It appears that the musty odor from the second floor office was migrating into the third floor office through holes around the radiator pipes. As with other porous materials, the American Conference of Governmental Industrial Hygienists (ACGIH) and the U.S. Environmental Protection Agency (US EPA) recommends that carpeting be dried with fans and heating within 24 to 48 hours of becoming wet (ACGIH, 1989; US EPA, 2001). If carpets are not dried within this time frame, mold growth may occur. Water-damaged carpeting cannot be adequately cleaned to remove mold growth.

Lastly, caulking around windows was crumbling/damaged throughout the building and water stains were seen on windowsills, indicating that water seals for these windows are no longer intact. Under certain conditions, water penetrating through window frames can lead to mold growth. Replacement of caulking and repairs of window leaks are necessary to prevent further/potential water penetration.

Other Concerns

Several additional conditions were noted during the assessment which can affect indoor air quality. Open utility holes were observed in several areas of the building. Utility holes can provide pathways for the movement of drafts, dusts, odors and particulate matter between rooms and floors.

A number of rooms contain photocopiers. Photocopiers can produce ozone (Schmidt Etkin, 1992), which is a respiratory irritant, particularly if the equipment is older and in frequent use. These areas are not equipped with local exhaust ventilation to help reduce excess heat and odors.

A pipe joint with exposed insulation that consists of a white, powdered material was found in the basement (Picture 13). The material may contain asbestos and, if so, should be remediated in conformance with all applicable Massachusetts asbestos abatement and hazardous materials disposal laws.

Conclusions/Recommendations

The discoloration observed in the Clerk of Courts' office, while unlikely to be mold, is an indication that water is penetrating through the exterior walls of the building. Other areas with water-damaged plaster indicate that the window system leaks during rainstorms, dependent upon wind direction. If not repaired, breaches in the building envelop will continue produce water damage. The creation of an unconditioned space above the suspended ceiling rendered the book storage room without the means to control temperature or relative humidity, creating conditions that subjected the book collection to mold colonization.

A decision should be made concerning the mold contaminated materials stored in this area. These books, boxes, documents and other stored materials will continue to be a source of mold associated particulates, unless the items are removed/remediated. As an initial step, options concerning the preservation of materials stored in this area should be considered. Porous materials that are judged not worthy of preservation, restoration or transfer to another media (e.g., microfiche or computer scanning) should be discarded. Where stored materials are to be preserved, restored or otherwise handled, an evaluation should be conducted by a professional book/records conservator. This process can be rather expensive, and may be considered for conservation of irreplaceable documents that are colonized with mold. Due to cost of book conservation, disposal or replacement of moldy materials may be the most economically feasible option.

In order to address the conditions discussed in the assessment, the following recommendations should be considered. Recommendations to improve indoor air quality are divided into short and long-term corrective measures. The short-term recommendations can be implemented as soon as practicable. Long-term measures are more complex and will require planning and resources to adequately address the overall indoor air quality concerns within the courthouse.

Short Term Recommendations:

1. Remove water-damaged carpeting from offices in a manner consistent with recommendations found in Mold Remediation in Schools and Commercial Buildings published by the US Environmental Protection Agency (US EPA, 2001). Copies of this document can be downloaded from the US EPA website at: http://www.epa.gov/iaq/molds/mold_remediation.html. If moldy, disinfect areas of floor underneath water-damaged carpeting with an appropriate antimicrobial.
2. Remove the GW around the window of room 62 in a manner consistent with the US EPA mold remediation guidelines.
3. Install a window-mounted air conditioner above the suspended ceiling in the book storage area to control temperature and humidity in this area.
4. Move the air conditioner in room 62 from the west-facing window and install in the north facing window in a manner to prevent water penetration.
5. Repair the gutter/downspout system shown in Picture 9.
6. Use window/wall-mounted air conditioning units to provide an additional means of fresh air, if possible.
7. Replace filters as per the manufacturer's instructions for all air-conditioning and air handling equipment, or change more frequently if needed.

8. 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).
9. Replace water-stained ceiling tiles. Examine the area above ceiling tiles for mold growth. Disinfect areas of water leaks with an appropriate antimicrobial. Clean area(s) thoroughly after disinfection.
10. Repair water-damaged ceilings, walls and wall-plaster. Examine exterior brickwork for signs of water intrusion. Consider consulting a building engineer to examine the feasibility of repairing mortar and brickwork to eliminate water penetration through walls.
11. Replace missing or damaged caulking around window frames to prevent further water penetration.
12. Repair utility holes and wall cracks to prevent the egress of odors, fumes and vapors between rooms and floors.
13. Use photocopiers in a well-ventilated area or provide adequate local exhaust ventilation for photocopiers when used.

Long Term Recommendations

The key to addressing on-going indoor air quality problems in this building is to re-establish the integrity of the building envelope. These remedial efforts can include the following activities:

1. Re-point the exterior brickwork where water damage is evident (e.g., the area above the clerk of courts office)
2. Repair roof leaks.
3. Replace and/or restore the window system in the building.
4. Repair of water-damaged plaster once the building envelope is reestablished.

Renovations/GW Removal

For buildings undergoing renovations, the following recommendations are generally suggested and should be implemented in order to reduce contaminant migration into occupied areas. We suggest that these steps be taken on any renovation project within a public building:

1. Establish communications between all parties involved with remediation efforts, including building occupants, to prevent potential IAQ problems. Develop a forum for occupants to express concerns about remediation efforts as well as a program to resolve IAQ issues.
2. Develop a notification system for building occupants immediately adjacent to (and above) the storage area to ensure reports of remediation/construction/ renovation related odors and/or dusts problems are made to the building administrator. Relay

concerns to the contractor in a manner that allows for a timely remediation of the problem.

3. Schedule projects which produce large amounts of dusts, odors and emissions during unoccupied periods or periods of low occupancy, when possible.
4. Disseminate scheduling itinerary to all affected parties. This can be done in the form of meetings, newsletters or weekly bulletins.
5. Obtain Material Safety Data Sheets (MSDS) for all remediation/ decontamination materials used during renovations and keep them in an area that is accessible to all individuals during periods of building operations as required by the Massachusetts Right-To-Know Act (MGL, 1983).
6. Consult MSDS' for any material applied to the effected area during renovation(s), including any sealant, carpet adhesive, tile mastic, flooring and/or roofing materials. Provide proper ventilation and allow sufficient curing time as per the manufacturer's instructions concerning these materials.
7. Use local exhaust ventilation and isolation techniques to control remediation pollutants. Precautions should be taken to avoid the re-entrainment of these materials into the building's HVAC system. The design of each system must be assessed to determine how it may be impacted by renovation activities. Specific HVAC protection requirements pertain to the return, central filtration and supply components of the ventilation system. This may entail shutting down systems (when possible) during periods of heavy construction and demolition, ensuring systems are isolated from contaminated environments, sealing ventilation openings with plastic and utilizing filters with a higher dust spot efficiency where needed (SMACNA, 1995).

8. Seal utility holes, spaces in roof decking and temporary walls to eliminate pollutant paths of migration. Seal holes created by missing tiles in the ceiling temporarily to prevent renovation pollutant migration.
9. Seal hallway doors with polyethylene plastic and duct tape. Consider creating an air lock of a second door inside the remediation spaces to reduce migration.
10. Relocate susceptible persons and those with pre-existing medical conditions (e.g., hypersensitivity, asthma) away from the general areas of remediation until completion, if possible.
11. Implement prudent housekeeping and work site practices to minimize exposure to spores. This may include constructing barriers, sealing off areas, and temporarily relocating furniture and supplies. To control for dusts, a high efficiency particulate air filter (HEPA) equipped vacuum cleaner is recommended. Non-porous materials (e.g., linoleum, cement) should be disinfected with an appropriate antimicrobial agent. Non-porous surfaces should also be cleaned with soap and water after disinfection.

References

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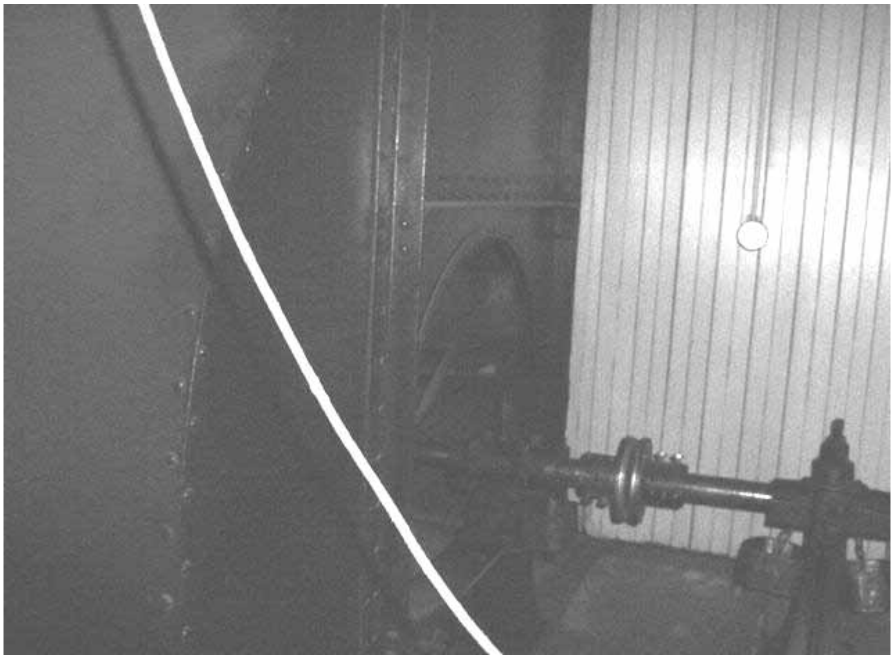
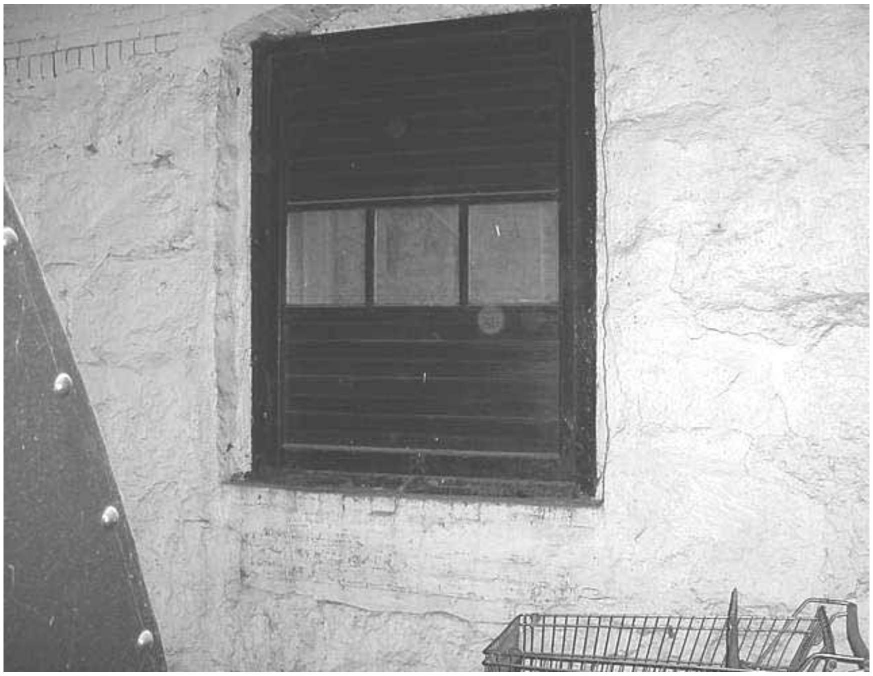
Picture 1



Fresh Air Supply Fan in Basement

Picture 2

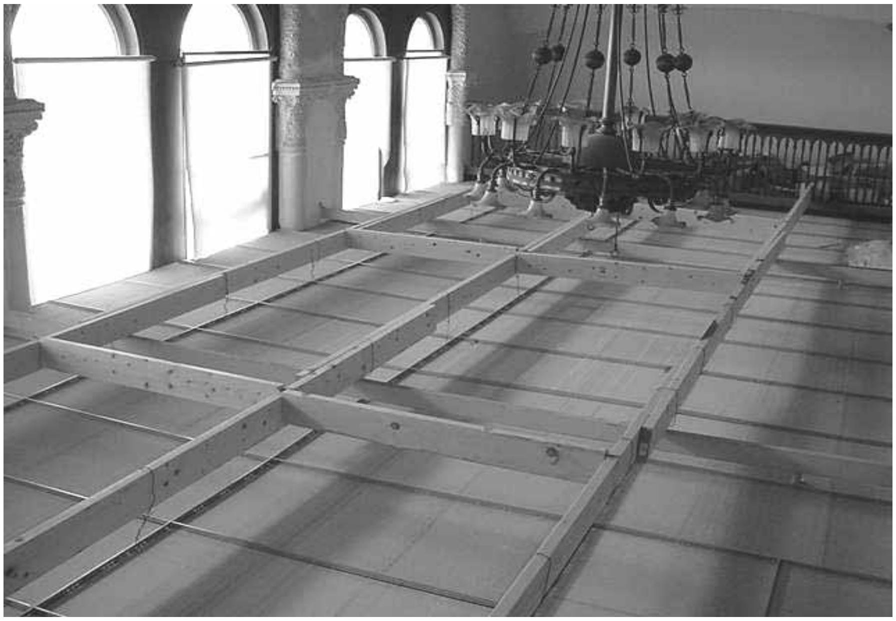


Source of Fresh Air Supply to Basement Fan

Picture 3

Rooftop Exhaust Vent

Picture 4

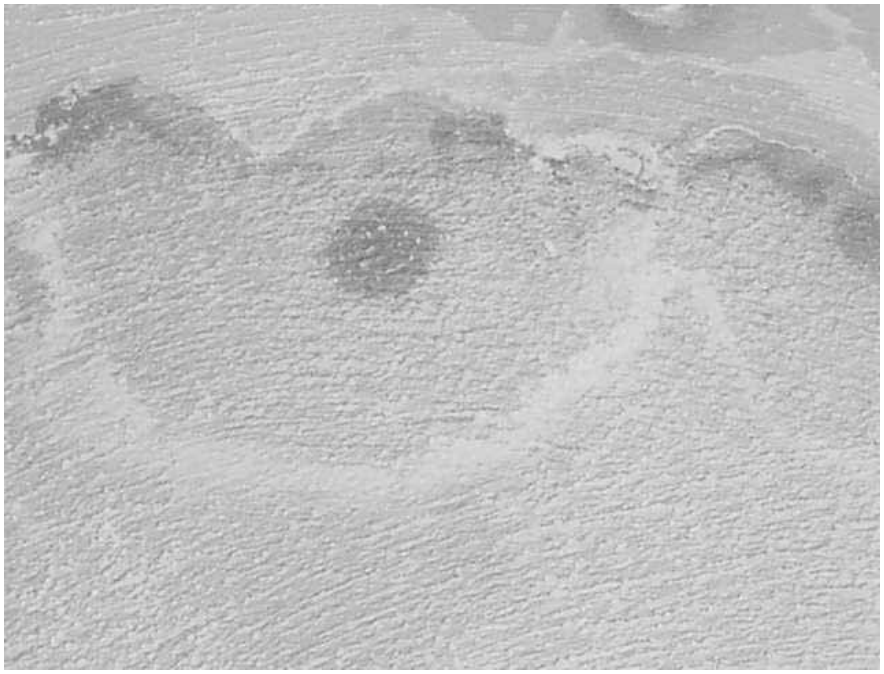


Suspended Ceiling Installed In Clerk of Courts Office Which Separates the Balcony from the Office below the Ceiling

Picture 5a

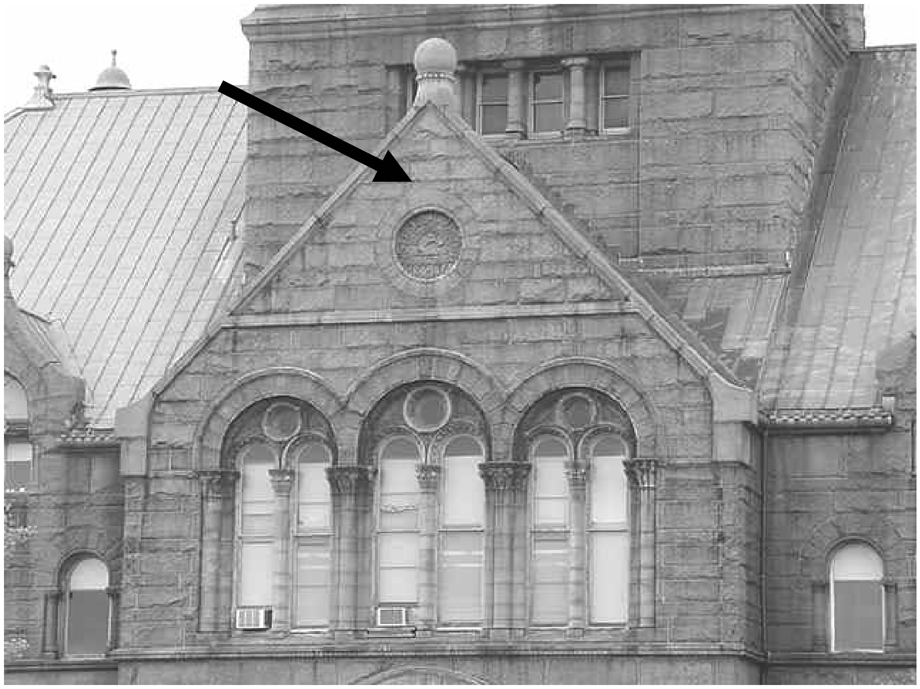
Discoloration of Wall Material above Clerk's Office Suspended Ceiling

Picture 5b



Close-Up of Discoloration of Wall Material above Clerk's Office Suspended Ceiling

Picture 6



Exterior Façade of BSC Opposite Wall Stains above Clerk's Office Suspended Ceiling

Picture 7

Book Storeroom off the Balcony above Clerk's Office Suspended Ceiling

Picture 8

Mold Colonization of Wall behind File Cabinets in Rotunda Balcony

Picture 9

Missing Downspout

Stain Indicating Chronic Water Exposure

Missing Downspout of Roof Drainage System opposite Interior Wall Damage Depicted In Picture 8, Note Black Staining Of Stone below Missing Drainpipe

Picture 10

Exterior View of Air-Conditioner Installed In West Facing Wall of Room 62, Note Weathering Of Wood Used To Install the Air Conditioners

Picture 11

Gypsum Wallboard (GW) Material Was Installed Over the Water Damaged Materials

Picture 12

Room 17 Water Damaged Carpet, Likely From Heating System Steam Leak

Picture 13

A Pipe Joint with Insulation That Consists Of a White, Powdered Material Was Found In the Basement

TABLE 1

Indoor Air Test Results
Bristol County Superior Court, Taunton, MA
May 26, 2004

Location	Carbon Dioxide (*ppm)	Temp. (°F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation		Remarks
						Supply	Exhaust	
Outside (Background)	348	55	72	-	-	-	-	Overcast, drizzle
62	584	65	55	0	Y	N	N	Window-mounted air-conditioner
63	670	65	52	0	Y	N	N	Window-mounted air-conditioner Musty odor Water damaged carpet Gypsum wallboard installed over original plaster walls
45	487	66	48	1	Y	Y	Y	Window-mounted air-conditioner Water damaged plaster
53	416	66	48	0	Y	Y	Y	Window-mounted air-conditioner
48	490	67	48	1	Y	Y	Y	Window-mounted air-conditioner Photocopier
56	527	67	48	0	Y	Y	Y	Water damaged plaster
57	533	68	48	5	Y	Y	Y	Hallway door open Photocopier

*** ppm = parts per million parts of air**

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%

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38	512	66	49	0	Y	Y	Y	Photocopier
42 session courtroom	510	66	49	3	Y	Y	Y	Water damaged plaster Plastic installed over windows to prevent drafts
46 Library	482	67	46	3	Y	Y	Y	Water damaged plaster Plastic installed over windows to prevent drafts
44	656	68	46	0	Y	N	N	
43	525	68	46	1	Y	Y	N	Peeling paint
13	607	68	45	6	Y	Y	Y	Window-mounted air-conditioner Photocopier
13 records area	586	68	45	0	Y	Y	Y	Window-mounted air-conditioner Hallway door open Water cooler on carpet
13 Clerk of Courts Main Office	631	69	45	0	Y	Y	Y	Window-mounted air-conditioner Peeling paint Hallway door open

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17	572	68	46	2	Y	Y	Y	Plants Photocopier Water cooler on carpet
17 private office	712	68	48	0	Y	Y	Y	Water damaged carpet Water damaged plaster Holes in walls
24	537	68	47	4	Y	Y	Y	Window mounted air conditioner
26	675	69	47	1	Y	Y	Y	Window-mounted air-conditioner Photocopier
27	591	69	48	0	Y	Y	Y	Water damaged plaster
Rotunda-Main Lobby	567	69	46	5	N	N	N	Mold growth behind file cabinets on balcony
Juvenile Court	720	67	47	0	Y	Y	Y	Water damaged plaster Holes in walls
Juvenile Court Office	654	67	47	0	Y	Y	Y	
64	659	67	46	0	Y	N	N	

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