INDOOR AIR QUALITY ASSESSMENT

Augustine Belmonte Middle School
25 Dow Street
Saugus, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
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Background/Introduction

At the request of Deborah Rosati, Health Agent of the Saugus Board of Health, the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA) provided assistance and consultation regarding indoor air quality concerns at the Belmonte Middle School, Saugus, MA. Concerns about recurring odors and general indoor air quality prompted this inspection.

On February 1, 2000, a visit was made to the school by Cory Holmes, Environmental Analyst for BEHA's Emergency Response/Indoor Air Quality (ER/IAQ) program, to conduct an indoor air quality assessment. Mr. Holmes was accompanied by Suzan Donahue, BEHA Research Assistant.

The school is a three-story cement slab building constructed in 1965. The building is currently housing the Veteran's Memorial Elementary School, grades 1-5, as well as middle school grades 6-8. The south wing contains general classrooms, science rooms, library and offices. There are also five modular classrooms which were added to the south wing in the mid 1970s. The north wing contains the gymnasium, cafeteria, auditorium, home economics, technical education, shop areas, music/band rooms and offices.

The building was previously evaluated by a private consultant in the spring of 1999 (Covino, 1999). The report concentrated specifically on the odor concerns of room 107 and made several recommendations, which were acted upon by the school. Also included in this report were observations regarding the steam pipe crawlspace and modular classrooms. The report indicated that carbon dioxide levels were elevated and that fresh air dampers were closed. Accumulations of debris in both supply and exhaust

ventilator units indicated that the units appeared to not have been in use for some time. Pooling water on the roof of portable classrooms was also noted.

It was reported by Veteran's Memorial Elementary School staff (currently housed at Belmonte Middle School) that odors have manifested in other rooms of the school besides classroom 107. No unusual odors were detected by BEHA staff during the assessment.

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. Screening for total volatile organic compounds (TVOCs) was conducted using an HNU Systems, Photo Ionization Detector (PID). Outdoor background TVOC measurements were taken for comparison to indoor levels. Tests for hydrogen sulfide and carbon monoxide (CO) were taken using a BW Defender, Multi-gas Detector. CO measurements were taken throughout the building as well as outside for comparison to indoor levels. Hydrogen sulfide measurements were taken outside for comparison to indoor levels (i.e., classroom 107, the crawlspace and in areas thought to be impacted by potential crawlspace odors).

Results

This school is currently housing a student population of approximately 1,143 and a staff of approximately 140. The tests were taken during normal operations at the school. Test results appear in Tables 1-9.

Discussion

Ventilation

It can be seen from the tables that carbon dioxide levels were elevated above 800 ppm (parts per million) in fifty-three of sixty areas surveyed, indicating an overall ventilation problem in the school. It should also be noted that eight classrooms had carbon dioxide levels in excess of 2,000 ppm (see Tables), which indicates little or no air movement. Classrooms throughout the school have openable windows.

Fresh air in classrooms is supplied by a unit ventilator (univent) system (see Figure 1). Univents were found deactivated in many areas. As an example, the library contained four ceiling mounted univents, none of which were operating during the assessment. Without mechanical ventilation, fresh air cannot be introduced into classrooms on a consistent basis. Obstructions to airflow, such as paper and boxes stored on univent air diffusers and desks in front of univent return vents were also noted in classrooms (see Picture 1). In order for univents to provide fresh air as designed, univent air diffusers and return vents must remain free of obstructions. More importantly, these units must remain activated while classrooms are occupied.

Exhaust ventilation in classrooms is provided by unit exhaust ventilators. Exhaust ventilators were not operating in areas surveyed, with the exception of classroom 107. Blockages to exhaust air intake vents were also noted in several areas. Exhaust ventilation in the library is provided by two wall-mounted exhaust fans located on either side of the room. These fans direct air from the library to the hallways. The library exhaust fans were not operating at the time of the assessment. As with the univents, in

order for exhaust ventilation to function as designed, exhaust fans and unit ventilators must be activated and remain free of obstructions.

It was reported to BEHA staff that the operation of both univents and exhaust ventilators are controlled by thermostats that control room temperature. The thermostat deactivates the ventilators once a set temperature is met in the classroom. BEHA recommends that ventilation systems remain on at all times that rooms are occupied.

Modular classrooms on the south wing had no mechanical ventilation system. Reportedly, mechanical exhaust vents and univents were removed as a result of energy conservation measures. Spaces formerly occupied by air intakes and exhaust vents were sealed with plywood and sheet metal (see Pictures 2 and 3). Carbon dioxide levels were above 800 ppm in all modular classrooms (see Tables).

The cafeteria is divided into two sections by a wall (front and rear). Fresh, heated air is supplied by two ceiling mounted air-handling units (AHUs) connected by ductwork to the rooftop air intakes. These AHUs were not operating at the time of the assessment. The AHU supplying fresh air to the front section was activated by school maintenance staff to verify function. It was reported by school staff that this unit is turned off due to excessive heat produced by the AHU when activated. This heat production may indicate a faulty thermostat or mechanical problem with the fresh air intake. The unit providing fresh air to the rear section was not functioning. A large wall-mounted vent, located on the rear wall of the cafeteria provides exhaust ventilation; this vent was operating during the assessment. Cafeteria doors between the sections, as well as to hallways, were all open. Doors to the divider should remain open to provide exhaust ventilation for all sections of the cafeteria.

The band room, auditorium and gymnasium have ceiling mounted or wall-mounted supply and exhaust vents, which are connected by ductwork to rooftop AHUs. Due to the height of these vents, BEHA staff could not determine if the vents were operating, with the exception of the gymnasium exhaust vent. The gymnasium exhaust vent was not operating during the assessment and the grill was damaged.

To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of school 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. The date of the last balancing of these systems was not available at the time of the assessment.

The Massachusetts Building Code requires a minimum ventilation rate of 15 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.

The BEHA recommends that indoor air temperatures be maintained in a range between 70 ^{o} F to 78 ^{o} F in order to provide for the comfort of building occupants. Temperature readings in the school were measured between 66^{o} F to 78^{o} F, with most temperatures within the BEHA recommended range for comfort. 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 should be noted that drafts were noted around windows throughout the school (called air infiltration). Cold air infiltration through window systems can make temperature control in rooms difficult to maintain.

The relative humidity measured in the building was within a range of 7 to 35 percent, which is below the BEHA recommended comfort range. The BEHA recommends a comfort range of 40-60 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

Throughout the school, caulking around the interior and exterior windowpanes was crumbling, missing or damaged (see Picture 4). Several rooms contained loose fitting windowpanes and/or cracked or broken windows. Air infiltration was noted around windows. Many of the metal window frames were corroded and/or water-damaged, which can result in chronic water penetration through improperly sealed windows (see Picture 5). Water penetration through window frames can lead to mold growth under certain conditions. Repairs of window leaks are necessary to prevent further water penetration. Repeated water damage can result in mold colonization of window frames, curtains and items stored on or near windowsills.

A number of classroom walls had cracks due to settling and/or showed signs of efflorescence. Efflorescence is a characteristic sign of water damage to building materials, but it is not mold growth. As moisture penetrates and works its way through building materials, water-soluble compounds dissolve, creating a solution. As this solution moves to the surface, the water evaporates, leaving behind white, powdery mineral deposits. Water-damaged building materials, if wetted repeatedly, can be a medium for mold growth. A number of rooms had water-stained ceiling tiles, which are evidence of historic roof or plumbing leaks. Water-damaged ceiling tiles can provide a source of mold and mildew and should be replaced after a water leak is discovered and repaired.

The crawlspace at the far south side of the building was examined. Several inches of water was found on the floor of this space. Fiberglass pipe insulation was severely water damaged and showed signs of possible mold growth (see Picture 6). Also within the crawlspace were saturated cardboard boxes and other debris that showed signs of possible mold growth. Although no odors from mold growth in the crawlspace were noted at the time of the assessment, the potential for odors exists. Standing water can become stagnant, which can lead to mold, bacterial, or other microbial growth that can be a source of unpleasant odors.

Pooling water was also noted on a number of areas on the roof (see Picture 7). Roof sections over the cafeteria and gymnasium were elevated above the main roof. Draining rainwater from these elevated sections of the roof is directed onto the main roof via downspouts (see Picture 8). The pooling of water and the subsequent freezing and thawing during winter months can lead to roof leaks and water penetration into the interior of the building.

Wood siding of the modular classrooms was damaged and warped from moisture exposure (see Picture 9). Exterior walls of these classrooms should be inspected periodically and repaired and/or replaced to prevent water penetration into interior areas behind wooden planks.

The perimeter also has several problems with drainage. The roof is outfitted with a drainage system that is connected to downspouts. The downspout shown in Picture 10 ends approximately 10 feet above ground, which allows back-splashing rainwater to pool and splash on the ground below and chronically wet the exterior wall. Downspouts should be designed to direct rainwater away from the base of the building to prevent

water pooling and subsequent penetration through exterior walls that can result in damaged building materials and/or mold growth.

Several classrooms contained plants. Plant soil and drip pans can serve as a source of mold growth. Plants should be located away from univents and exhaust ventilation to prevent aerosolization of dirt, pollen or mold.

Other Concerns

As reported by building occupants the odor is intermittent and occurs at random times. Carbon monoxide, hydrogen sulfide and TVOC readings within the building were found to be equal to or below levels measured outdoors in all occupied areas surveyed. These results indicate that no source producing these pollutants in measurable levels exists within the school.

Several other conditions were noted during the assessment, which can affect indoor air quality. Wall cracks, spaces around windows and missing/dislodged ceiling tiles were noted in a number of classrooms. In addition to being a source of water penetration, these areas are breaches of the building envelope and can serve as an egress for vapors, fumes, dusts and odors between rooms and floors.

Science room 309 had flammable materials, including methanol, isopropyl alcohol, and numerous containers of liquid propane fuel, stored in cabinets under the sink and other areas (see Picture 11). The woodshop storage area contained flammables on open shelves. Flammable materials should be stored in flammable storage cabinets that meet the specifications of the National Fire Protection Association (NFPA) (NFPA, 1996). The woodshop storage area also had items that appeared to be of significant age.

One container was labeled with a question mark (see Picture 12). It is recommended that a thorough inventory of woodshop and science materials be done to assess storage and/or disposal in an appropriate manner consistent with Massachusetts hazardous waste laws.

A number of sinks in current or former science rooms appear to be abandoned or are reportedly rarely used. If not in use, sink traps can dry out, this can allow sewer gas to back up into occupied areas. Sewer gas can create nuisance odors and be irritating to certain individuals. These drains should be properly capped or wet regularly to prevent sewer gas back up.

Woodshop room 179 contained wood cutting/sanding equipment supplied with local exhaust. This exhaust was functional, but appeared to have little or no draw of air. Woodshop room 176 contained a window-mounted exhaust fan. This exhaust vent is located under a second floor univent air intake (see Picture 13). The close proximity of these vents presents the opportunity for wood dusts and odors to be drawn into the univent air intake (called entrainment) and distributed into the second floor classroom when the exhaust fan is activated.

Reading room 233 contained the computer mainframe located near an exhaust vent (see Picture 14). This vent was not operating at the time of the assessment. Faculty lounges in the south wing contained photocopiers. Volatile organic compounds (VOCs) and ozone can be produced by photocopiers, particularly if the equipment is older and in frequent use. Ozone is a respiratory irritant (Schmidt Etkin, D., 1992). Photocopiers and computer equipment also give off excess heat. Without active mechanical exhaust ventilation, pollutants produced by office equipment can build up. School personnel

should ensure that local exhaust ventilation is activated while equipment is in use to help reduce excess heat and odors.

Exhaust vents to the girls' restrooms, located on each floor of the south wing, did not appear to be operating. It is important to provide exhaust ventilation in restrooms to remove moisture and to prevent odors from migrating into adjacent areas.

Office areas contained window-mounted air conditioners. Portable air-conditioning units are normally equipped with filters, which should be cleaned or changed as per the manufacturer's instructions to avoid the build up and re-aerosolization of dirt, dust and particulate matter.

Birds' nests were noted around the building, one of which was located in a fresh-air intake vent (see Pictures 15 & 16). Birds can be a source of disease and bird wastes and feathers can contain mold and mildew, which can be irritating to the respiratory system. If this vent is in use, these materials can be introduced into the building. Accumulated chalk dust was noted in several classrooms. Chalk dust is a fine particulate, which can be easily aerosolized and serve as an eye and respiratory irritant.

Conclusions/Recommendations

The conditions found in the Belmonte Middle School present a number of problems that require a series of remedial steps. For this reason a two-phase approach is required, consisting of immediate (short-term) measures to improve air quality within the school and long-term measures that will require planning and resources to adequately address overall indoor air quality concerns. In view

of the findings at the time of this assessment, the following **short-term** recommendations are made:

1. To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy independent of classroom thermostat control.
2. Examine each univent for function. Survey classrooms for univent function to ascertain if an adequate air supply exists for each room. Consider consulting a heating, ventilation and air conditioning (HVAC) engineer concerning the calibration of univent fresh air control dampers school-wide.
3. Remove all blockages from univents and exhaust ventilators to ensure adequate airflow.
4. Once both the fresh air supply and exhaust ventilation are functioning, the systems should be balanced by a ventilation engineer.
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. Remove cardboard boxes and debris from crawlspace.

7. Repair/replace any water-stained ceiling tiles and wall plaster. Examine the area above and around these areas for mold growth. Disinfect areas of water leaks with an appropriate antimicrobial.
8. Inspect roof for proper drainage; examine periodically for standing water.
9. Move plants away from univents in classrooms. Examine drip pans for mold growth and disinfect areas of water leaks with an appropriate antimicrobial where necessary.
10. Examine the feasibility of extending downspouts to ground level and directing water away from the base of the exterior wall.
11. Replace missing ceiling tiles and fill utility holes and wall cracks to prevent the egress of dirt, dust and particulate matter between rooms and floors. Particular attention should be applied to sealing utility holes on the first floor to prevent potential crawlspace odors from entering occupied areas.
12. Seal drains in abandoned sinks or pour water down them regularly to prevent sewer gas back up.
13. Consider relocating photocopiers in the faculty lounges to underneath the exhaust vents. Ensure that exhaust vents are functioning whenever equipment is in use.
14. Re-activate wall-mounted exhaust vent in reading room 233 to help remove excess heat and odors generated by computer mainframe equipment.
15. Have a complete inventory done in all storage areas and classrooms. Discard hazardous materials or empty containers of hazardous materials in a manner consistent with environmental statutes and regulations. Follow proper procedures for storing and securing hazardous materials. Obtain Material Safety Data Sheets

(MSDS') for chemicals from manufacturers or suppliers. Be sure all materials are labeled clearly.

16. Change filters in window-mounted air conditioners as per the manufacturer's instructions to prevent the re-aerosolization of dirt, dust and particulate matter.
17. Consider obtaining flameproof cabinets that meet NFPA requirements. Store flammable materials in the flameproof cabinets in a manner consistent with state and local fire codes.
18. Remove birds' nests from fresh air intake vents.
19. Examine the feasibility of increasing/improving local exhaust ventilation for wood cutting/sanding machinery in shop areas.

The following **long-term** measures should be considered:

1. Examine methods to eliminate water penetration into the building. Continue to examine options to ventilate the steam-pipe crawl space. Consult a ventilation engineer to provide increased ventilation. Be sure to provide ventilation that will not draw further moisture from the ground into the crawl space. Continue to explore options for providing a barrier between the dirt floor and crawl space. Consider consulting a building engineer, hydrogeologist and/or an environmental engineering firm about possible options to eliminate water accumulation in the crawlspace. Once water is removed, replace water damaged insulation. Consider replacing with a waterproof insulating material.
2. Repair/replace broken and/or loose windows and replace missing or damaged window caulking to prevent water penetration through window frames.

3. Consider consulting a ventilation engineer concerning the installation of mechanical ventilation for modular classrooms.

References

BOCA. , 1993. The BOCA National Mechanical Code/1993. 8th ed. Building Officials and Code Administrators International, Inc., Country Club Hill, IL. Section M-308.1.1.

Covino. 1999. Indoor Air Quality Survey Report to Saugus Board of Health, Dated April 2, 1999. Covino Environmental Associates Inc., Woburn, MA.

NFPA. 1996. Flammable and Combustible Liquids Code. 1996 ed. National Fire Prevention Association, Quincy, MA. NFPA 30.

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.

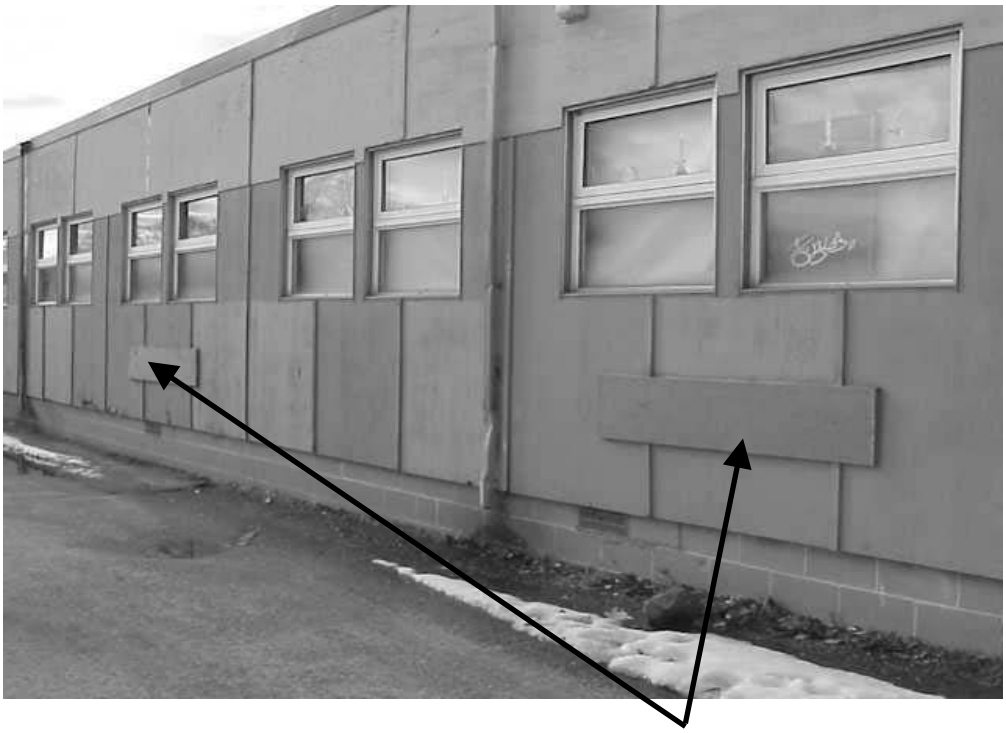
Schmidt Etkin, D. 1992. Office Furnishings/Equipment & IAQ Health Impacts, Prevention & Mitigation. Cutter Information Corporation, Indoor Air Quality Update, Arlington, MA.

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

Picture 1

Univent Return Vent Obstructed by Desk

Picture 2

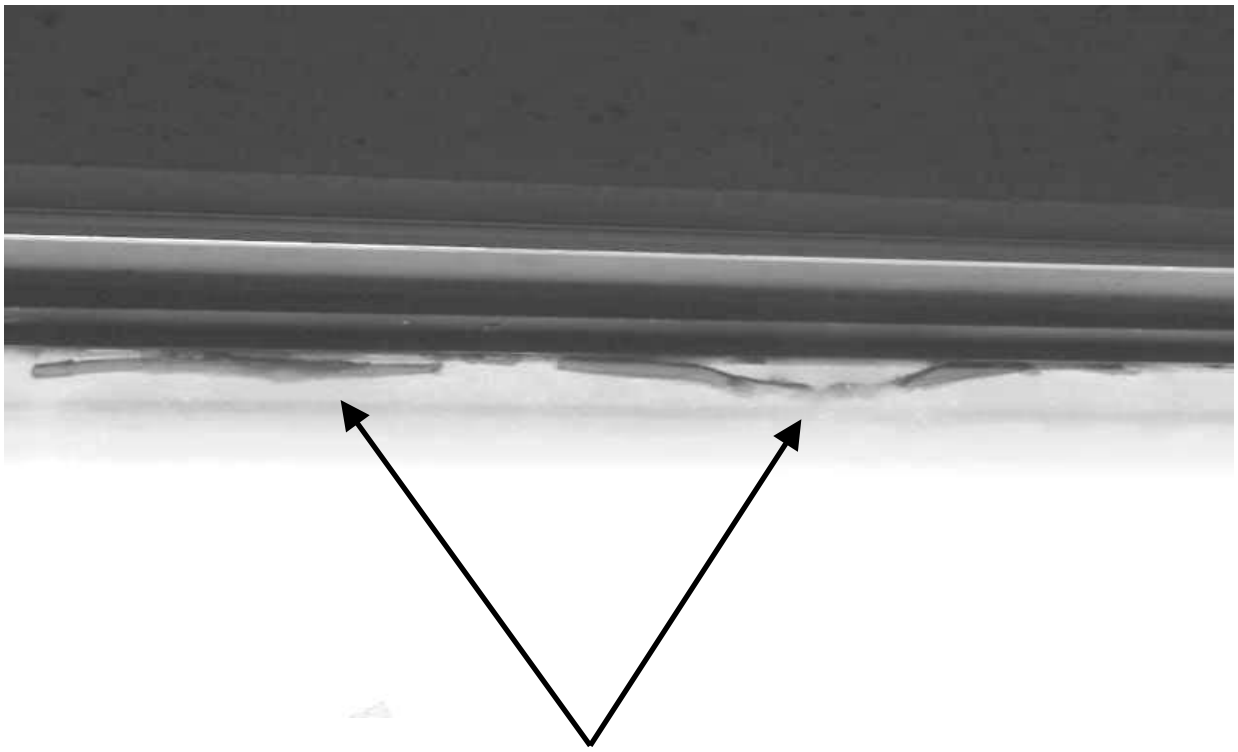


Modular Classrooms –Note Sealed Air Intake Vents and Downspout Ends Approximately 1-1 1/2 Feet above Ground

Picture 3

Former Exhaust Ventilation Ducts Sealed with Sheet-Metal

Picture 4

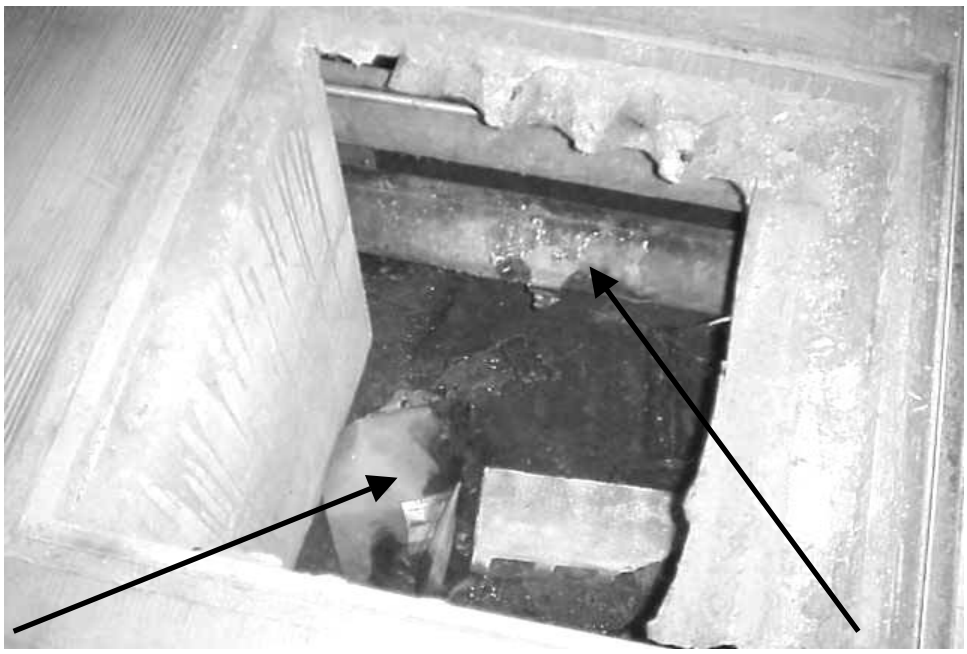


Damaged/Missing Window Caulking

Picture 5

Water Damaged Window Frame

Picture 6



Cardboard Pipe Insulation

Crawlspace Containing Standing Water –Note Water-Damaged Pipe Insulation/ Debris

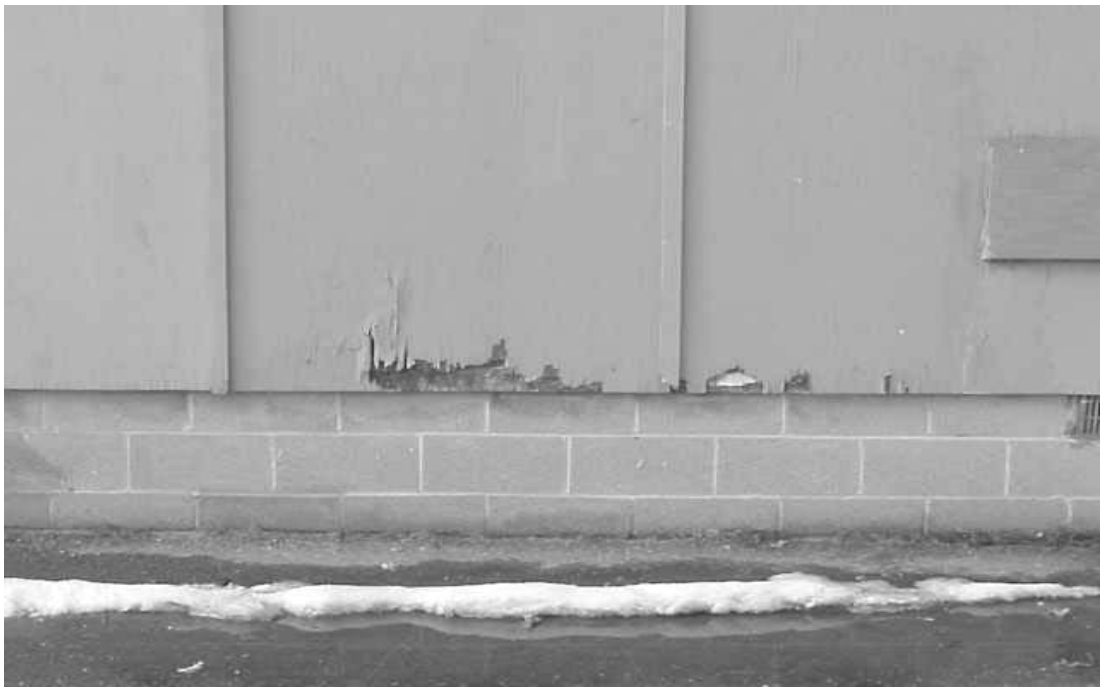
Picture 7

Water Pooling on Roof

Picture 8

Water Accumulation on Roof

Picture 9



Water Damaged Siding on Modular Classrooms

Picture 10

Drain-spout Ending Several Feet above Ground Level

Picture 11

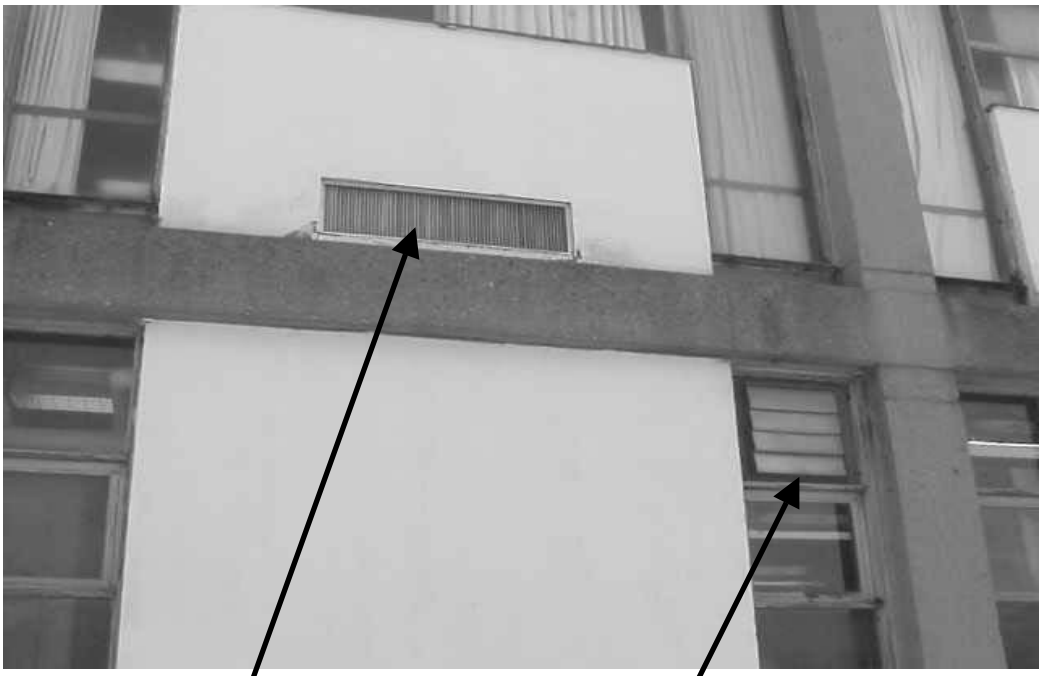
Flammable Materials under Sink in Room 309

Picture 12

Note question mark on unlabelled container

Materials in Woodshop Storage Area-Bottom Shelf

Picture 13



Air Intake in Close Proximity to Exhaust Vent

Picture 14

Computer Main Frame Located beneath Inactive Exhaust Vent in Reading Room 233

Picture 15

Bird Nest in Air Intake Vent

Picture 16

Bird Nest (taken from inside building) On Front Ledge of Second Floor

TABLE 1

Indoor Air Test Results –Belmonte Middle School, Saugus, MA – February 1, 2000

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Outside (Background)	470	38	33					weather conditions: clear, sunny, light breeze, CO (0), H2S (0), TVOCs (0.3)
107	973	73	23	16	yes	yes	yes	corrosion around windows, missing/damaged window caulking, spaces around pipes, cleaning products under sink, chalk dust, CO (0), H2S (0) TVOCs (0.2)
Crawlspace North & South								CO (0), H2S (0), Water damaged Fiberglass insulation, Water damaged cardboard-possible mold growth TVOCs (0.2)
310A	1386	72	15	1	yes	no	yes	exhaust-off, water-stained curtains, drafts around windows TVOCs (0.2)
310	1815	75	20	19	yes	yes	yes	univent and exhaust-off, (activated by BEHA staff), chalk dust, efflorescence on concrete wall, wall cracks, door open, abandoned sink-drain not capped TVOCs (0.2)
309	2000+	78	15	20	yes	yes	yes	univent and exhaust-off, efflorescence on wall, missing/damaged window caulking, flammables under sink (isopropyl alcohol, sodium hydroxide,

*** 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 –Belmonte Middle School, Saugus, MA – February 1, 2000

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
								methanol), (18+) flammable containers of liquid petroleum, door open
310	1580	75	13	20	yes	yes	yes	univent and exhaust-off, items blocking univent return
312	2000+	78	15	20	yes	yes	yes	univent and exhaust-off, exhaust ventilator would not activate, boxes on univent air diffuser, door open
314	1835	74	17	24	yes	yes	yes	univent and exhaust-off, crate on univent air diffuser
315	2000+	74	20	21	yes	yes	yes	univent and exhaust-off, missing/damaged window caulking, loose plexiglass-draft
205	2000+	73	20	21	yes	yes	yes	univent and exhaust-off, white putty type material in heating fins, door open
2nd Floor Men's Room							yes	CO (0), H2S (0)
111	1343	74	14	12	yes	yes	yes	univent and exhaust-off, damaged fiberglass insulation, dry erase board, door open, CO (0), H2S (0)
112	1451	72	13	22	yes	yes	yes	univent and exhaust-off, water damaged pipe insulation-exposed fiberglass CO (0), H2S (0) TVOCs

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

Comfort Guidelines

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	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 3

Indoor Air Test Results –Belmonte Middle School, Saugus, MA – February 1, 2000

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
								(0.2)
113	814	73	7	19	yes	yes	yes	exhaust-off, window open CO (0), H2S (0) TVOCs (0.2)
114	1065	76	8	17	yes	yes	yes	loose plexiglass-draft CO (0), H2S (0) TVOCs (0.2)
115	863	78	7	4	yes	yes	yes	exhaust-off, chalk dust, damaged fiberglass insulation, door open CO (0), H2S (0) TVOCs (0.2)
116	622	77	7	1	yes	yes	yes	exhaust-off-backdrafting cold air, door open CO (0), H2S (0) TVOCs (0.2)
307	1833	77	27	27	yes	yes	yes	univent and exhaust-off, exhaust ventilator blocked, missing/damaged caulking around plexiglass window, cleaning product on desk
308	1918	77	23	26	yes	yes	yes	univent and exhaust-off, water damaged plaster-ceiling over window, personal fan-off
306	1854	75	24	18	yes	yes	yes	univent-off, water-stained ceiling, efflorescence, chalk dust
305	2000+	73	28	28	yes	yes	yes	exhaust ventilator-off, window open, efflorescence, dry erase board

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

Comfort Guidelines

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	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 4

Indoor Air Test Results –Belmonte Middle School, Saugus, MA – February 1, 2000

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
3rd Floor Faculty Room	1848	74	22	2	no	no	yes	water damaged ceiling, refrigerator, microwave, 2 photocopiers
304	2000+	74	26	15	yes	yes	yes	univent and exhaust-off, water stained ceiling, chalk dust
3rd Floor Girl's Restroom					no	no	yes (2)	no draw from exhaust vents, 2 of 5 toilets stuffed with paper
303	2000+	76	28	23	yes	yes	yes	univent blocked, exhaust ventilator off, chalk dust
320	1735	75	24	1	no	no	no	supply and exhaust vents in hallway outside door
302	1948	76	35	28	yes	yes	yes	exhaust ventilator-off, efflorescence, chalk dust, door open
301	2000+	76	25	19	yes	yes	yes	univent return blocked, exhaust-off, cracked window, cracks in plaster, cleaning products on sink, chalk dust
Library	1349	76	24	0	no	yes	yes	4 ceiling-mounted univents-off, 2 exhaust fans in walls to hallway- 1 on/1off, 3 of 6 wall mounted heaters on, 18 computers
216	1551	74	26	19	yes	yes	yes	exhaust ventilator off

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

Comfort Guidelines

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Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 5

Indoor Air Test Results –Belmonte Middle School, Saugus, MA – February 1, 2000

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
215	1669	74	26	24	yes	yes	yes	exhaust off, dry erase board
2nd Floor Girl's Restroom					no	no	yes	2 exhaust vents-off
2nd Floor Faculty Room	1357	75	25	12	no	no	yes	refrigerator, photocopier, microwave
108	1443	75	25	18	yes	yes	yes	univent blocked by books/papers, exhaust ventilator off, plant, dry erase board, chalk dust CO (0), H2S (0) TVOCs (0.2)
106	1060	75	17	15	yes	yes	yes	univent diffuser blocked by books/items, exhaust ventilator-off, door open CO (0), H2S (0) TVOCs (0.2)
105	1172	75	22	14	yes	yes	yes	univent-return blocked by bookcase/diffuser blocked by books, exhaust ventilator off, 2 plants, chalk dust, door open CO (0), H2S (0) TVOCs (0.2)
104	1290	76	20	16	yes	yes	yes	univent return blocked, exhaust off, 3 plants, chalk dust CO (0), H2S (0) TVOCs (0.2)

*** 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 –Belmonte Middle School, Saugus, MA – February 1, 2000

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
103	1064	78	18	25	yes	yes	yes	exhaust ventilator completely blocked, room divided into sections using file cabinets/chalk boards/bookcases/etc., 17 computers, 6 plants, door open CO (0), H2S (0) TVOCs (0.2)
102	1119	75	21	20	yes	yes	yes	univent and exhaust ventilator-off, drafts around windows, chalk dust CO (0), H2S (0) TVOCs (0.2)
101	1025	75	20	18	yes	yes	yes	univent completely blocked by stuffed animal/cart, exhaust ventilator blocked by posters (both-off), chalk dust, drafts around windows, door open CO (0), H2S (0) TVOCs (0.3)
Cafeteria	1133	71	30	~250	yes	yes (2)	yes	air suppliers-off, reported only 1 of 2 ceiling mounted air supplies functional (it was activated during assessment) CO (0), H2S (0) TVOCs (0.3)
Band Room	544	70	22	1	no	yes	yes	supply and exhaust-off, 3 missing ceiling tiles CO (0), H2S (0) TVOCs (0.2)
Gymnasium A-B-C	694	72	17	~50	no	yes	yes	plastic curtain type dividing walls-open, supply/exhaust vent for each

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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 –Belmonte Middle School, Saugus, MA – February 1, 2000

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
								section-off CO (0), H2S (0) TVOCs (0.2)
Gymnasium D	671	71	17	22	no	yes	yes	supply and exhaust-off, missing/damaged grilles
Boy's Locker Room					yes	yes	yes	broken window, soot-like damage on ceiling CO (0), H2S (0) TVOCs (0.2)
Auditorium	614	66	21	12	no	yes	yes	functioning of supply/exhaust could not be determined, carpet, upholstered seats CO (0), H2S (0) TVOCs (0.2)
Front Nurse's Office	765	68	20	2	no	no	no	plant, door open, Restroom-exhaust on
Back Nurse's Office	801	69	18	0	yes	no	no	Restroom-exhaust on
176 – Tech Ed/ Woodshop	1246	66	26	7	yes	yes	yes	flammables on wooden shelf, water stained pipe insulation, chalk/wood dust
178 - Music Room	951	69	20	13	yes	yes	yes	~16 plants
179 – Woodshop	915	71	20	12	yes	yes	yes	local exhaust ventilation-no draw
214	1627	74	23	26	yes	yes	yes	supply and exhaust-off, chalk dust

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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 8

Indoor Air Test Results –Belmonte Middle School, Saugus, MA – February 1, 2000

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
213	1647	75	24	17	yes	yes	yes	supply and exhaust-off, plant, cleaning product on desk
212	1556	75	18	29	yes	yes	yes	2 open windows
233-Reading Room				0	no	yes	yes	supply and exhaust-off, computer main frame
235	1360	74	12	5	no	yes	yes	exhaust-off
249-Home Ec.	1005	74	9	11	yes	yes	yes	wall mounted exhaust-off, door open
247	1346	72	14	10	yes	yes	yes	wall mounted exhaust-off, efflorescence-wall, dry erase board
246	1188	73	11	11	yes	yes	yes	wall mounted exhaust-off,
244	1202	71	13	12	yes	yes	yes	exhaust-off, 13 plants, 19 computers, heat complaints
107 (afternoon)	732	67	8	15	yes	yes	yes	window open CO (0), H2S (0) TVOCs (0.2)
A-04	1052	76	11	13	yes	no	no	10+ CT, chalk dust
A-05	1505	75	15	17	yes	no	no	9+ CT, 1 missing ceiling tile

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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 9

Indoor Air Test Results –Belmonte Middle School, Saugus, MA – February 1, 2000

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
A-02	1450	78	28	8	yes	no	no	plant, reported leaks around windows
Hurvitz Room	1439	76	31	16	yes	no	no	chalk dust
211	1704	77	22	19	yes	yes	yes	univent and exhaust-off CO (0), H2S (0) TVOCs (0.2)

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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%