Air Quality Measurements

Middle School

3rd Floor

Wilmington, MA

10/09/2020

PREPARED FOR:

Wilmington Public Schools

PREPARED BY:

ENVIROTEST LAB, INC.

639 WASHINGTON STREET

DEDHAM, MA 02026

781-329-1133

Enclosed are the results for the environmental inspection conducted on October 9, 2020. On this day, environmental sampling, analysis and investigations were performed to determine the levels and conditions of the following: Carbon Dioxide, Carbon Monoxide, Microbial Volatile Organic Compounds (MVOCs), Humidity, Airborne Particulate and Temperature.

This report is written in sections where testing is described in detailed with specific reasons and methods explained. Envirotest recommends becoming familiar with the Test Parameters and **then** proceed to the Observation/Conclusion (Section A and B) of this report located below.

Numerical Results are located following each Test Parameter Section.

A. Observation

The entire school was inspected to determine air quality prior to opening.

Air Quality throughout the school was found to be excellent in all areas analyzed.

The weather during the inspection was clear and about 66 degrees Fahrenheit at the beginning of the inspection.

Envirotest performed an environmental and air quality inspection to determine issues which could affect the building structure and the occupant's health.

From the testing performed, Envirotest has determined that at the time of the inspection, visual results and sampling indicate the following:

For the purposes of this report "North" as a direction is the front street facing door and NOT magnetic North

1. The building is functioning optimally at the time of the inspection.
2. At the time of the inspection, there were no identified qualitative or quantitative problematic environmental issues which need to be addressed or remediated.

B. Conclusion

Suggestions for this specific Building:

1. Keep classroom doors closed at all times while classes are in session.
2. Keep teaching materials and furniture away from all negative air vent grates(at entrance door). Ensure that all negative air ventilation ducts are functioning properly in all classrooms while classes are in session by performing routine checks on the airflow (this can be done by placing a piece of paper on the duct and determining if the paper gets sucked into the exhaust draft.)

3. Ensure that there is no chance for accidental or intentional manual override of the unit ventilators by securing the thermostats and removing the unit ventilator switches.
4. Clean exhaust grills on a semi-monthly basis.
5. Do not pile items on top of unit ventilators or within 1 foot of the unit ventilator supply and return grate.
6. Open windows as often as possible to allow for better exchange of fresh air.
7. Do not allow buses to idle outside the school.
8. Close all classroom windows prior to arrival of buses at the school and leave them closed for at least 20 minutes following the last bus leaving site.

The negative air ventilation system for the classrooms is located in the ceilings, by the front door of each classroom or at mid-level walls. This system (when functioning properly) should be changing the air in the classrooms a minimum of 2-4 air changes per hour. The pathway that fresh is introduced into the classroom flows from the unit ventilator fresh air grate (located on an outside wall), across students and then to the negative air grate or “cubby hole” (as indicated in the diagram below) and out the building rooftop unit.

When the negative air vents are blocked by objects such as books, teaching materials, furniture, coats, etc.. airflow does not efficiently vent the stagnant, burdened classroom air. Stagnant air in the classrooms will typically have elevated levels of Carbon Dioxide, ultra-fine/macro airborne particulate, Volatile Organic compounds, etc.. build up which can have deleterious effects to the individuals located in the classrooms.

The recommended air current in the classrooms should always follow a path that flows across the occupants of an area (diagram 1.0). A typical problem that arises is when the classroom door is opened (diagram 2.0), this causes the air current in the classroom to pull air in from the hallway instead of through the unit-ventilator fresh air duct. thereby allowing no change of classroom air.

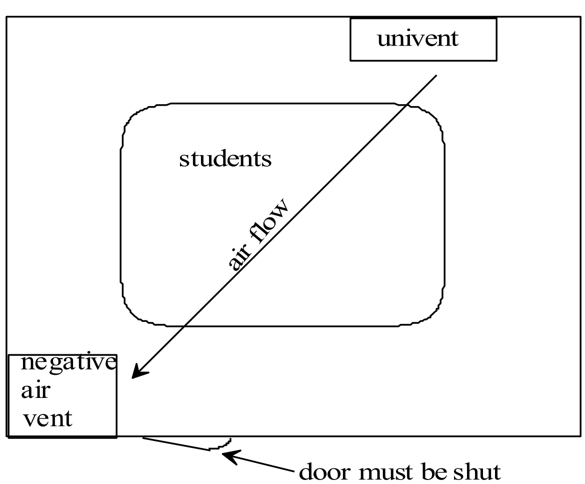

Diagram 1.0

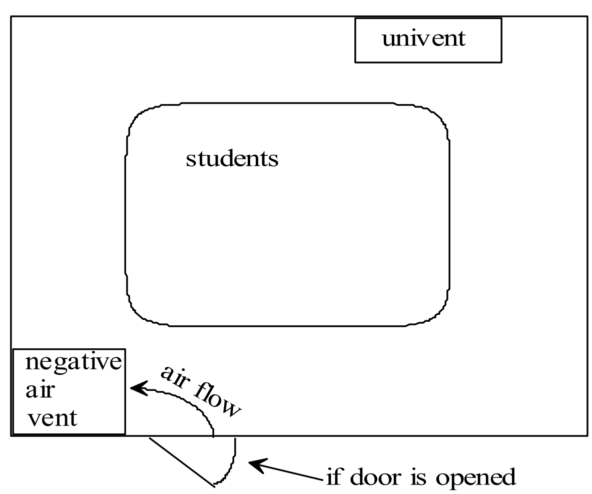

Diagram 2.0

The findings and exposure data reported here are accurate only for the conditions and the parameters tested for and existing at the time of the evaluation. Not all potential health problems or exposures were evaluated fully during this survey which may relate to indoor air quality.

Analysis Performed:

I. Carbon Dioxide (CO_2)

Area	CO_2 CONCENTRATION (PPMv)	Area	CO_2 CONCENTRATION (PPMv)
Room 348	449	Room 307e	485
Room 347	496	Room 307f	476
Room 346	472	Room 307h	460
Room 345	404	Room 306	415
Room 344	428	Room 305	494
Room 343	473	Room 304	462
Room 342	462	Room 303	405
Room 341	468	Room 302	462
Room 340	462	Room 301	461
Room 326	461	Room 309	472
Room 327	484		
Room 329	458		
Room 321	482		
Room 322	461		
Room 323	494		
Room 324	458		
Room 325	407		
Room 308	472		
Room 330	444		
Room 307	463		
Room 307c	473		
Room 307d	476		
		Outside Levels	401

Carbon Dioxide levels were found to be normal in all areas sampled.

II. Carbon Monoxide (CO)

Area	CO CONCENTRATION (PPMv)	Area	CO CONCENTRATION (PPMv)
Room 348	0	Room 307e	0
Room 347	0	Room 307f	0
Room 346	0	Room 307h	0
Room 345	0	Room 306	0
Room 344	0	Room 305	0
Room 343	0	Room 304	0
Room 342	0	Room 303	0
Room 341	0	Room 302	0
Room 340	0	Room 301	0
Room 326	0	Room 309	0
Room 327	0		
Room 329	0		
Room 321	0		
Room 322	0		
Room 323	0		
Room 324	0		
Room 325	0		
Room 308	0		
Room 330	0		
Room 307	0		
Room 307c	0		
Room 307d	0		
		Outside Levels	0

Carbon Monoxide was found to be normal in all areas sampled.

III. Volatile Organic Compounds (VOCs)

Area	VOC CONCENTRATION (ppb)	Area	VOC CONCENTRATION (ppb)
Room 348	0	Room 307e	0
Room 347	0	Room 307f	0
Room 346	0	Room 307h	0
Room 345	0	Room 306	0
Room 344	0	Room 305	0
Room 343	0	Room 304	0
Room 342	0	Room 303	0
Room 341	0	Room 302	0
Room 340	0	Room 301	0
Room 326	0	Room 309	0
Room 327	0		
Room 329	0		
Room 321	0		
Room 322	0		
Room 323	0		
Room 324	0		
Room 325	0		
Room 308	0		
Room 330	0		
Room 307	0		
Room 307c	0		
Room 307d	0		
		Outside Levels	0

VOC levels were found to be normal in all areas sampled.

IV. Humidity (%)

Area	Relative Humidity (%)	Area	Relative Humidity (%)
Room 348	45	Room 307e	45
Room 347	45	Room 307f	45
Room 346	45	Room 307h	45
Room 345	45	Room 306	45
Room 344	45	Room 305	45
Room 343	45	Room 304	45
Room 342	45	Room 303	45
Room 341	45	Room 302	45
Room 340	45	Room 301	45
Room 326	45	Room 309	45
Room 327	45		
Room 329	45		
Room 321	45		
Room 322	45		
Room 323	45		
Room 324	45		
Room 325	45		
Room 308	45		
Room 330	45		
Room 307	45		
Room 307c	45		
Room 307d	45		
		Outside Levels	46

The results indicate humidity levels were normal in all areas sampled.

V. Temperature (^{0}F)

Area	Temperature (^{0}F)	Area	Temperature (^{0}F)
Room 348	72	Room 307e	72
Room 347	72	Room 307f	72
Room 346	72	Room 307h	72
Room 345	72	Room 306	72
Room 344	72	Room 305	72
Room 343	72	Room 304	72
Room 342	72	Room 303	72
Room 341	72	Room 302	72
Room 340	72	Room 301	72
Room 326	72	Room 309	72
Room 327	72		
Room 329	72		
Room 321	72		
Room 322	72		
Room 323	72		
Room 324	72		
Room 325	72		
Room 308	72		
Room 330	72		
Room 307	72		
Room 307c	72		
Room 307d	72		
		Outside Levels	66

Temperature levels were found to be normal in all areas sampled.

VI. Ultrafine Particulate Levels (Average per Area) (p/cc)

Area	Particulate Levels (p/cc)	Area	Particulate Levels (p/cc)
Room 348	1850	Room 307e	1573
Room 347	1295	Room 307f	1243
Room 346	1946	Room 307h	1834
Room 345	1862	Room 306	1086
Room 344	1279	Room 305	1342
Room 343	1992	Room 304	1225
Room 342	1526	Room 303	1738
Room 341	1267	Room 302	1952
Room 340	1227	Room 301	1264
Room 326	1873	Room 309	1374
Room 327	1527		
Room 329	1735		
Room 321	1236		
Room 322	1628		
Room 323	1115		
Room 324	1254		
Room 325	1237		
Room 308	1378		
Room 330	1854		
Room 307	1378		
Room 307c	1635		
Room 307d	1142		
		Outside Levels	2391

Airborne particulate was found to be normal in all areas sampled.

VII. Average Air Movement Per Area

Area	Volume (~Cubic Feet)	CFM (~Cubic Feet Per Minute)	Air Movement (Exchanges/Per Hour)	Operable Windows
Room 348	40 x 30 x 11 = 13200	924	4.2	Yes
Room 347	40 x 29 x 11 = 12760	957	4.5	Yes
Room 346	30 x 27 x 11 =8910	668	4.5	Yes
Room 345	30 x 26 x 11 = 8580	643	4.5	Yes
Room 344	29 x 29 x 11 = 9251	724	4.7	Yes
Room 343	42 x 30 x 11 = 13860	1039	4.5	Yes
Room 342	29 x 29 x 11 = 9251	693	4.5	Yes
Room 341	30 x 29 x 11 = 9570	749	4.7	Yes
Room 340	37 x 29 x 11 = 11803	885	4.5	Yes
Room 326	19 x 16 x 8 = 2432	178	4.4	No
Room 327	48 x 19 x 9 = 8208	615	4.5	No
Room 329	48 x 19 x 9 = 8208	642	4.7	No
Room 321	29 x 26 x 10 = 7540	590	4.7	Yes
Room 322	30 x 26 x 10 = 7800	572	4.4	Yes
Room 323	42 x 30 x 10 = 12600	924	4.4	Yes
Room 324	30 x 29 x 10 = 8700	638	4.4	Yes
Room 325	29 x 29 x 10 = 8410	616	4.4	Yes
Room 308	37 x 37 x 10 = 13690	1027	4.5	Yes
Room 330	82 x 8 x 8 = 5248	384	4.4	No
Room 307	20 x 19 x 9 = 3420	257	4.5	No
Room 307c	15 x 9 x 9 = 1215	N/A	N/A	No
Room 307d	9 x 9 x 9 = 729	N/A	N/A	No
Room 307e	20 x 9 x 10 = 1800	132	4.4	Yes
Room 307f	20 x 19 x 10 = 3800	285	4.5	Yes

Room 307h	9 x 9 x 9 = 729	N/A	N/A	No
Room 306	29 x 29 x 10 = 8410	630	4.5	No
Room 305	29 x 29 x 10 = 8410	630	4.5	Yes
Room 304	42 x 29 x 10 = 12180	913	4.5	Yes
Room 303	29 x 26 x 10 = 7540	553	4.4	yes
Room 302	29 x 29 x 10 = 8410	631	4.5	No
Room 301	29 x 29 x 10 = 8410	631	4.5	Yes
Room 309	40 x 26 x 10 = 10400	780	4.5	No

Air Movement was found to be acceptable in all areas tested.

The following is an explanation of each parameter analyzed. All numbers correspond to analysis taken above.

I. **Carbon Dioxide (CO_2)**

Carbon Dioxide levels were analyzed using a TSI Q-Track Plus 8554 Air Quality Monitor with a data logger. CO_2 measurements were recorded by the data logger at marked intervals over the course of the monitoring period.. The TSI Q-Track Plus 8554 Air Quality Monitor uses an infrared sensor to analyze for CO_2. The CO_2 System was calibrated to NIST certified CO_2 standards before and after the monitoring period.

As a point of reference, ASHRAE[1] recommends levels of 1000 PPMv of CO_2 as the acceptable indoor limit[1]. This value (1000 ppm) corresponds to approximately 15 cubic feet per minute of outside air per person supplied to occupied spaces.

Carbon dioxide is a non-toxic gas. It has beneficial uses and is the "fizz" in carbonated beverages. When frozen, it is "dry ice". At concentrations from of 1,100 ppm to 5,000 ppm carbon dioxide can cause headaches. At extremely high levels of 100,000 ppm (10 percent) people lose consciousness in ten minutes, and at 200,000 ppm (20 percent) CO2 causes partial or complete closure of the glottis.

Levels of 2,500 to 5,000 ppm do not normally occur in structures. Use of any type of non-vented fuel-burning space heater, such as a kerosene, natural gas, or propane heater will result in elevated levels. High levels also can occur when several people are in a poorly ventilated room. Carbon dioxide is commonly used as an indicator of the adequacy of ventilation systems. When the windows and doors are closed, all buildings need ventilation both summer and winter.
In buildings, the normally occurring leaks and cracks around windows and doors typically provide this ventilation. New, energy-efficient houses are now so tight that most leaks have been eliminated and some type of ventilation system may be needed.

In commercial buildings the required ventilation is typically provided by a fresh air intake to the heating and cooling system. Unfortunately, many firms have closed the fresh air intake to save energy. Many other systems were installed without fresh air intakes. In older buildings many fresh air exchangers and intakes may either be not working or in need of repair.

The American Society of Heating Refrigerating and Air-Conditioning Engineers, Inc. publishes "ASHRAE Standard 62-1989, Ventilation for Acceptable Indoor Air Quality." This standard specifies that the minimum ventilation rate per person is 15 cubic feet per minute (cfm) of outdoor air. Higher rates are in place for specified applications, i.e., 20 cfm for a school training shop, and 30 cfm for a hospital operating room. Residential dwellings are covered by a special specification, which is 0.35 air changes per hour, but not less than 15 cfm/person. (Note, additional special requirements are listed in the ASHRAE Standard and the complete standard should be consulted for specific recommendations.)

Since carbon dioxide is produced by human respiration, the amount of carbon dioxide can be easily used as an indicator of the adequacy of fresh air ventilation in occupied buildings. Outdoor levels are approximately 400 ppm. The ASHRAE standard requires that sufficient fresh air be provided to keep the level below 1,000 ppm. The CO2 levels in buildings with sufficient ventilation will range between these two readings.

Buildings with insufficient ventilation will range from 1,000 ppm up. Often the levels will be low in the morning and increase while the building is occupied. In buildings occupied during the day the reading should be taken in mid-afternoon, because this is when the CO2 reaches its highest level.

High levels of carbon dioxide often indicate inadequate ventilation. Persons in buildings with high CO2 levels may complain of burning eyes, tiredness, and headaches. These symptoms can be caused by a combination of carbon dioxide and the many other pollutants that occur in a poorly ventilated space.

When too little outdoor air enters a building, pollutants can accumulate to levels that can pose health and comfort problems. Unless special mechanical means of ventilation are designed and constructed into a building to minimize the amount of outdoor air that can "leak" into and out of the building, these buildings may have higher pollutant levels. .

Outdoor air enters and leaves buildings by: infiltration, natural ventilation, and mechanical ventilation. In a process known as infiltration, outdoor air flows into the house through openings, joints, and cracks in walls, floors, and ceilings, and around windows and doors. In natural ventilation, air moves through opened windows and doors. Air movement associated with infiltration and natural ventilation is caused by air temperature differences between indoors and outdoors and by wind.

There are a number of mechanical ventilation devices, from outdoor-vented fans that intermittently remove air from a single room (bathroom vents) to air handling systems that use fans and duct work to continuously remove indoor air and distribute filtered and conditioned outdoor air to strategic points throughout the house. The rate at which outdoor air replaces indoor air is described as the air exchange rate. When there is little infiltration, natural ventilation, or mechanical ventilation, the air exchange rate is low and pollutant levels can increase.

[1] **ASHRAE Standard 62-1989(1989), "Ventilation for Acceptable Indoor Air Quality"**
American Society of Heating, Refrigeration, and Air Conditioning Engineers, Inc., Atlanta, Georgia.

II. Carbon Monoxide (CO)

The TSI Q-Track Plus 8554 Air Quality Monitor equipped with a datalogger for CO was used to monitor for CO. The TSI Q-Track Plus 8554 uses an electrochemical sensor to analyze for CO. This instrument was calibrated prior to all uses with outside air and daily by utilizing a 100 ppm CO span gas prior to use. Calibration is performed against a known standard to ensure precision and accuracy. Measurements were taken at marked intervals for the duration of the survey.

Carbon Monoxide is odorless, colorless, and highly toxic. It kills by reducing the oxygen supply in the body and is a deadly poison. It adversely affects human health at only a few parts per million and causes death at 250 parts per million (250 ppm). CO produces it's toxic effect by competing with oxygen for hemoglobin molecules in the blood. Since it has a greater affinity for hemoglobin than does oxygen, CO is more readily accepted into the blood stream. Low amounts of CO can cause headaches, while higher levels can be fatal.

Properly installed and maintained heating appliances cause little threat from carbon monoxide. Poorly installed and maintained systems can be deadly. All fossil fuels contain carbon. During the combustion process the carbon in the fuel combines with oxygen in the air. With sufficient oxygen, sufficient turbulence, and at high ignition temperatures, nearly all of the carbon combines with two atoms of oxygen, producing the relatively innocuous carbon dioxide.

Heating appliances are designed to provide excess oxygen, and a clean, properly installed and maintained system will produce primarily carbon dioxide (CO_2), a large amount of water vapor, small amounts of carbon monoxide (CO), and a number of other pollutants. These products of combustion from a properly maintained heating system will be vented outdoors through the chimney, and do not pose an undue risk to the building occupants.

When insufficient oxygen is available for complete combustion, one atom of carbon combines with one atom of oxygen and carbon monoxide is produced. If the heating appliance or the venting system is defective, some or all of the carbon monoxide might be circulated into the building, posing an extremely hazardous health risk. A warning sign of heating trouble might be sudden excessive levels of moisture in the building, since water vapor is also produced by combustion of fossil fuels. CO is also a by-product of tobacco smoke and motor vehicle exhaust.

III. Volatile Organic Compounds (VOCs)

Volatile Organic Compounds (VOCs) were tested with the use of the PpbRae. The PpbRae is the most sensitive hand held VOC monitor available. This machine measures with true parts per billion detection of extremely low level, low vapor pressure and highly toxic VOCs, like paint fumes, rug off-gassing, pesticide residues and isocyanates (polyurethane foam, insulation materials, surface coatings, car seats, furniture, foam mattresses, under-carpet padding, packaging materials, shoes, laminated fabrics, polyurethane rubber, and adhesives, and during the thermal degradation of polyurethane products.) This instrument senses measurements of off-gassing from carpets and fabrics, spot checks for ethylene oxide and formaldehyde.

At room temperature, volatile organic compounds (VOCs) are emitted as gases from certain solids or liquids. These include pesticides, solvents, fuels, plastics, perfumes, cleaning agents, hair sprays, rugs, oven cleaners, dry-cleaning fluids, building furnishings, office materials like copiers, certain printers, correction fluids, graphics and craft materials etc. VOCs are consistently found at higher levels indoors than outdoors. Products used in building, office, school, arts/crafts and hobby activities emit a wide array of VOCs. Pesticides sold for household use are technically classified as semi-volatile organic compounds. Very low airborne levels of these products have been found to cause symptoms like conjunctival irritation, nose and throat irritation, headache, allergic skin reaction, and nausea to sensitive individuals.

The sensor in this instrument is also very helpful in determining the origination of mold in buildings by sensing the microbial volatile organic compounds (mVOCs) in the air.

IV. Percent Relative Humidity (RH)

The TSI Q-Track Plus 8554 Air Quality Monitor and the TSI VELOCICALC air quality meter indicates % Relative Humidity.

a. Relative Humidity

Everyone is familiar with the word "humidity," especially as it applies to one's comfort indoors or outdoors. We can feel the humidity on the hot, sticky days of summer, and we know it is low when static electricity shocks us during cold, dry winters. But few people understand the science behind humidity or what is meant by the more precise term "relative humidity."
The National Oceanic and Atmospheric Administration (NOAA) defines relative humidity as: "A dimensionless ratio, expressed in percent (% RH), of the amount of atmospheric moisture present relative to the amount that would be present if the air were saturated. Since the latter amount is dependent on temperature, relative humidity is a function of both moisture content and temperature. As such, relative humidity by itself does not directly indicate the actual amount of atmospheric moisture present."

For example, if the air contains half as much water vapor as is possible, then the relative humidity reading would be 50% RH. Bear in mind that the warmer the air temperature, the more moisture it can hold, and vise versa. This is an important factor to remember when looking at a particular RH. Using the same example, there is less water vapor at 50% RH (65°) than 50% RH (85°). Almost every meteorologist and hygrometer expresses humidity in this fashion.

b. Humidity and Comfort

Our comfort, whether we feel warm or cold, is determined, among other factors, by the rate at which moisture is evaporated from our bodies. It is this fact which makes the humid summer day so uncomfortable. When there is already so much moisture in the air that the moisture from our skin evaporates very slowly. Therefore, as we perspire, we feel sticky and are generally uncomfortable. Conversely, if the air is dry, evaporation is much more rapid; the more rapid the evaporation, the cooler we feel.

c. Humidity and Health

Air has a tremendous need for moisture. So when we heat our buildings in the winter (drawing in cold, dry air), this air is going to take moisture from wherever it can. This dry air in our buildings and offices not only dries our skin, but also robs the delicate membranes of the nose and throat of their normal moisture. Low humidity may make us more uncomfortable or even subject to various respiratory problems.

However, there may be more effects of both high and low humidity than just discomfort. Studies show that humidity may affect three groups of factors with respect to health:

1. Biological contaminants including bacteria, viruses, fungi, and mites.
2. Pathogens causing respiratory problems including allergic rhinitis and asthma.
3. Chemical interactions including ozone production.

Some of these factors may thrive at low levels of RH while others may prefer high levels of RH.
For example, certain bacteria thrive and grow at very low levels of humidity (0-20% RH) while other bacteria grow and thrive at very high levels of humidity (55%-100% RH).
Most Fungi remain dormant and do not start growing and thriving until %RH levels rise above 50% RH.

The optimal comfort zone for %RH is roughly between 35-45% RH in the summer months and 25-40% RH in the winter months. By following these guidelines the levels of bacteria, fungi, viruses, respiratory infections, allergic rhinitis and asthma will be kept in check.

d. Humidity and Energy Costs

In winter, heated, non-humidified air may dry out and/or shrink wood framing around doors and window frames. Gaps may occur allowing cold, dry outside air to enter the building. This heat loss causes heating systems to output more dry air. To maintain a certain humidity level, many people compensate with the use of a humidifier. However, since it takes four times as much energy to heat water than to heat dry air, it costs more to maintain a specific humidity level in your building for health and comfort reasons. Monitoring the humidity and careful attention to areas of heat loss will help offset costs.

The benefit of humidified air is its effect on how we feel in certain temperatures. In the winter, the air is dry and the increased evaporation of moisture from our skin makes us feel cold. While 70°F is recommended for indoor air temperature, some find that the temperature (when dry) must be near 80°F or even higher for us to feel warm enough to be comfortable. The proper humidity will make 70°F feel comfortable and may help offset the increased energy it takes to heat humidified air. However, Envirotest does not recommend humidification of any sort during the winter months due to the inherent problems associated with humidifiers. Typically most humidifiers require excessive amounts of cleaning and can increase the humidity to levels where fungi and bacterial growth will occur. Envirotest recommends re-hydrating by consuming more liquids when humidity drops in the winter.

e. Interior Building Humidity

Low humidity in winter may cause drying and/or shrinking of furniture, wood floors and interior trim. Doors and drawers may warp or crack and glue joints in fine furniture and veneers may open or split. Low humidity may rob plants of their moisture, and it may contribute to wall and ceiling cracks. All of these problems may be the result of dry air absorbing moisture from whatever source it can find inside your building.

Buildup of moisture may also cause rotting of wood, mildew and mold. In areas of your building where humidity may be very high, such as Sub-Grade area, laundry rooms, Attics, or Crawl Spaces, it is important to prevent damage to your building from excessive moisture. Additional ventilation may be helpful in the case of excessive Attic humidity (Please see appendix C.)

V. Temperature

The TSI Q-Track Plus 8554 Air Quality Monitor and the TSI VELOCICALC air quality meter indicates Temperature.

Recommended temperature levels for optimal office comfort should be between 68 and 74 ^{0}F for interior comfort conditions. Temperature is an easy and basic indicator of whether the HVAC system is working correctly by indicating if the thermostats are calibrated correctly. In many instances, temperature is taken to determine if an Attic venting system is functioning properly and whether heat is accumulating in the Attic space.

VI. Ultrafine Particulate (p/cc)

Envirotest performed particulate testing to determine the amount of suspended particulate in the environment. Suspended particulate testing is performed utilizing the P-Trak Ultrafine particle counter. The P-Trak detects and counts particles smaller than 0.02 micrometers in diameter. These particles are the ones that often accompany or signal the presence of a pollutant that is the cause of complaints about indoor air quality. Because the P-Trak provides far greater sensitivity to very small particles than traditional instruments, it can actually be used to locate the source and migration of toxic exhaust gases, malfunctioning office equipment, pinhole leaks in heating system gaskets and a wide variety of other problems including airborne mold spores.

Typical Pollutant Sizes	
Bacteria	.01 to 1.0 Microns
Dust	1.0 to 10 Microns
Mold	1.0 to 10 Microns
Hair	10 to 100 Microns
Pollen	10 to 100 Microns
Diesel Particulate	0.1 – 100 Microns

The Following are common sources of airborne articulate. This list in by no means exhaustive, but it gives you an idea of the types of things to be aware of when you are looking for the source of contamination.

Mold	Bacteria
Hair	Combustion Exhaust
Skin Flakes	Dirty Clothing
Cosmetics	Chemicals
Perfumes	Caulks and Paints
Coughing / Sneezing	Aerosols
Excessive Movement	Ions (Rust)
Wood Fibers	Smoke
Paper Fibers	Thinners /Solvents
Tobacco Products	Food
Candles	Incense

Use of scented candles and incense contribute significant quantities of pollutants to the indoor environment, especially soot, benzene and lead. Due to the variability in candles and incense and their respective emission rates, great uncertainty would exist in a generalized risk assessment. The absence of consumer warnings concerning candle emissions and their potential health effects may contribute to exposure of susceptible individuals to respiratory inflammatory agents, carcinogens and teratogens.

Diesel particulate matter as found as a results of burning diesel fuel for heat, is part of a complex mixture that makes up diesel exhaust. Diesel exhaust is commonly found throughout the environment and is estimated by EPA's National Scale Assessment to contribute to the human health risk. Diesel exhaust is composed of two phases, either gas or particle and both phases contribute to the risk. The gas phase is composed of many of the urban hazardous air pollutants, such as acetaldehyde, acrolein, benzene, 1,3-butadiene, formaldehyde and polycyclic aromatic hydrocarbons. The particle phase also has many different types of particles that can be classified by size or composition. The size of diesel particulate that are of greatest health concern are those that are in the categories of fine, and ultra fine particles. The composition of these fine and ultra fine particles may be composed of elemental carbon with adsorbed compounds such as organic compounds, sulfate, nitrate, metals and other trace elements. Diesel exhaust is emitted from a broad range of diesel engines; building heating systems, on road diesel engines of trucks, buses and cars and the off road diesel engines that include locomotives, marine vessels and heavy duty equipment. The most common exposure pathway is breathing the air that contains the diesel particulate matter. The fine and ultra fine particles are respirable which means that they can avoid many of the human respiratory system defense mechanisms and enter deeply into the lung. In the National Scale.

VII. Air Exchanges Per Hour

The TSI Q-Track Plus 8554 Air Quality Monitor and the TSI VELOCICALC air quality meter reads air flow and air exchange.

The minimum ventilation (outdoor air) rates and minimum exhaust rates mandated by code. Most of the modern model codes (Uniform Mechanical Code, International Mechanical Code) refer to ANSI/ASHRAE Standard 62.0-2010 Ventilation for Acceptable Indoor Air Quality as the reference for ventilation rates according to occupancy and type of facility. It is important to note that ventilation is defined as outdoor air.

Air changes per hr (ACH / ACPH) simply describes how many times the quantity of air in a room (or structure) is completely replaced per hour.

If you have a 10'x10'x10′ room, the room contains 1000 cubic feet of air If the supply and return to the room is supplying a balanced 100 cfm (cubic feet per minute) of air to the room you would have 100 cfm x 60 minutes = 6,000 cfh (cubic feet per hour) which would equal 6 air changes per hour (6,000/1000 = 6).

Different spaces have different ventilation requirements based on occupancy level (how many people are in the room) and use type (see Table Below)

Suggested Air Changes For Proper Ventilation
Change Per Hour = Cubic feet per hour exhausted/Room Volume

Area	Minimum Recommended Air Change Per Hour
Classroom	4 - 6
Music Areas	3 – 10
Nurse's Office	3 – 8
Kitchen	1 – 5
Laboratory	2 – 5
Office	2 – 8
Restroom	4 – 7
Cafeteria	4 - 7

APPENDIX 1
AIR STANDARDS

Constituent	Standard	Source
Carbon Monoxide	35 ppm	OSHA
	25 ppm	ACGIH-TLV*
	9 ppm	NAAQS
Carbon Dioxide	5,000 ppm	OSHA-PEL*
		ACGIH-TLV*
	1,000 ppm	ASHRAE
	800 ppm	MDPH (recommended)
Temperature	68-72 Fahrenheit	
Humidity	25-35%	
Hydrogen Sulfide	20 ppm	OSHA Ceiling[1]
	10 ppm/10 minutes	NIOSH Ceiling
	Over 65 ppm	Evacuation
Volatile Organic Compounds (VOCs)	35 ppb	Envirotest Comfort
Nitrogen Dioxide	5 ppm	OSHA-PEL*
	3 ppm	ACGIH-TLV*
Ultrafine Particulate (Average building)	<1,000 - <6,000 p/cc	Envirotest Comfort
Ultrafine Particulate (Average Construction Area)	5,000-30,000 p/cc	Not to exceed results Typically compiled by Envirotest
Nuisance Dust	5 mg/m^3	OSHA
	3 mg/m^3	ACGIH
	0.3 mg/m^3	ASHRAE

Appendix A
Report Limitations and Disclosure

This report has been produced for Envirotest's client only and is not intended for dissemination outside the Envirotest-Client sphere without written consent from Envirotest personnel. This report is intended only as a general guide to help only Envirotest's client make his/her own evaluation of the overall condition of the inspected areas. The report expresses the personal opinions of the inspector, based upon his visual impressions of the conditions that existed at the time of the inspection only. The inspection and report are not intended to be technically exhaustive, or to imply that every component was inspected, or that every possible defect was discovered. No disassembly of equipment, moving of furniture, appliances or stored items, or excavation was performed. All components and conditions which by the nature of their location are concealed, camouflaged or difficult to inspect are excluded from the report.

Systems and conditions which are not within the scope of this inspection include, but are not limited to: formaldehyde, lead paint, asbestos, environmental hazards; pest infestation, Outdoor sheds, efficiency measurement of insulation or heating and cooling equipment, internal or underground drainage or plumbing, any systems which are shut down or otherwise secured; water wells (water quality and quantity) zoning ordinances; intercoms; security systems; heat sensors; cosmetics or building code conformity. Any general comments about these systems and conditions are informational only and do not represent an inspection.

The inspection report should not be construed as a compliance inspection of any governmental or non-governmental codes or regulations. The report is not intended to be a warranty or guarantee of the present or future adequacy or performance of the structure, its systems, or their component parts. This report does not constitute any express or implied warranty of merchantability or fitness for use regarding the condition of the property and it should not be relied upon as such. Any opinions expressed regarding adequacy, capacity, or expected life of components are general estimates based on information about similar components and occasional wide variations are to be expected between such estimates and actual experience.

To the best of our knowledge and belief, all statements and information in this report are true and correct.

Payment for this report shall constitute a binding contract that should any disagreement or dispute arise as a result of this inspection or report, it shall be decided by arbitration and shall be submitted for binding, non-appealable arbitration to the American Arbitration Association in accordance with its Construction Industry Arbitration Rules then obtaining, unless the parties mutually agree otherwise. In the event of a claim, Envirotest's Client will allow Envirotest and any other pertinent parties to inspect the claim prior to any repairs or waive the right to make the claim. Envirotest's Client agrees not to disturb or repair or have repaired anything which may constitute evidence relating to the complaint, except in the case of an emergency.

All appearances by Envirotest staff concerning this report, the property in question or for any other purpose shall be billed at the rate of $200.00/hour.

If any part of this statement or report is not not agreeable to you, please contact Envirotest at any time and we will endeavor to rectify issues with this report free of charge.