Report For
Indoor Air Quality Testing
At The
Souhegan High School
412 Boston Post Road
Amherst, NH

Study Date:
February 1, 2021

Project# 221 045.00

STUDY CONDUCTED BY:

UNIVERSAL ENVIRONMENTAL CONSULTANTS
12 Brewster Road
Framingham, Massachusetts

UEC universal environmental consultants

February 2, 2021

Mr. Roger Preston
Director of Facilities
SAU-39
1 School Street, P.O. Box 849
Amherst, NH 03057

Reference: Indoor Air Quality Testing
Souhegan High School, Amherst, NH

Dear Mr. Preston:

Thank you for the opportunity for Universal Environmental Consultants (UEC) to provide professional services.

Enclosed please find the report for Indoor Air Quality Testing at the Souhegan High School conducted on Monday, February 1, 2021.

Please do not hesitate to call should you have any questions.

Very truly yours,

Universal Environmental Consultants

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Ammar M. Dieb
President

UEC:\221 045.00\IAQReport-HS.DOC

Enclosure

1.0 Scope:

UEC was contracted to perform an Indoor Air Quality Testing at the Souhegan High School, Amherst, NH. Testing was performed at select areas within the school.

Testing was performed on Monday, February 1, 2021.

2.0 Methodology:

Air testing was conducted for the following. The sample length at each test location was 2 minutes.

- Total Volatile Organic Compounds (***TVOCs***).
- Carbon Dioxide (***CO_2***), Carbon monoxide (***CO***), Temperature (***˚F***) and Relative Humidity (***RH %***).
- Airborne particulate matter (***PM***) levels for (***PM_{10}***) and (***$PM_{2.5}$***)***.***

Testing for ***TVOCs*** referenced to isobutylene was performed using a Rae Systems ppbRae3000 Photo-Ionization Detector (PID) model PGM7340 equipped with a 10.6 eV lamp (S/N 594-903008). This is a state of the art instrument capable of detecting total ***TVOCs*** in the parts per billion (ppb) range. The instrument is a direct reading monitor and provided sampling readings at 1 second intervals over the duration of each test. The instrument was calibrated prior to testing and is serviced annually by the manufacturer or an independent vendor.

TVOCs are a broad class of chemicals with diverse applications which are frequently emitted by new carpets, furniture, pressboards, varnishes, adhesives and high gloss finishes. Other common products which may emit ***TVOCs*** include paints, paint strippers, other solvents, wood preservatives, aerosol sprays, cleansers, disinfectants, moth repellents, air fresheners, stored chemicals and fuels, automotive products, hobby supplies, and dry-cleaned clothing. Elevated levels of ***TVOCs*** are a common IAQ problem, especially in newly constructed buildings.

Carbon Dioxide (***CO_2***), Carbon monoxide (***CO***), Temperature (***˚F***) and Relative Humidity (***RH %***) were measured using a TSI Corporation Q-Trak 7575 (S/N 7575X1337003) with a 982 probe (S/N P13350004). The instrument is a direct reading monitor that utilizes infrared technology to measure ***CO_2*** and an electro-chemical cell to measure ***CO*** and provided sampling readings at 1 second intervals over the duration of each test. The instrument was calibrated prior to testing and is serviced annually by the manufacturer or an independent vendor.

CO_2 is a useful measure of ventilation effectiveness in spaces occupied by people (i.e. verification that sufficient fresh air is being introduced into the occupied space being tested). Indoor ***CO*** levels were measured comparatively with outside levels to verify whether sources such as boiler and vehicle exhausts were causing elevated indoor ***CO*** levels. ***CO_2*** and ***CO*** were measured in parts per million (ppm). Temperature and relative humidity readings were taken to verify indoor levels were within ASHRAE[1] comfort ranges.

Airborne particulate matter (***PM***) levels for ***PM_{10}*** and ***$PM_{2.5}$*** were tested using a TSI Corporation DustTrak DRX 8534 handheld aerosol monitor (S/N 8534124302). This is a state-of-the-art instrument capable of simultaneously detecting ***PM_{10}*** and ***$PM_{2.5}$*** in the microgram per cubic meter ($\mu g/m^3$) range. The instrument is a direct reading monitor and provided sampling readings at 1 second intervals over the duration of each test. The instrument was zeroed prior to testing and is serviced annually by the manufacturer or an independent vendor.

Real time ***PM*** Measurement is a useful comparative measure of indoor and outdoor dust levels as well as identifying indoor sources of ***PM***.

Limited moisture testing on interior gypsum walls was performed, and all levels were low.

[1] ASHRAE = American Society of Heating, Refrigeration and Air-conditioning Engineers.

3.0 Results:

The ppbRae 3000 monitor was used to measure ***TVOCs*** in µg/$m^{3.}$

TEMPERATURE, RELATIVE HUMIDITY, CARBON MONOXIDE, CARBON DIOXIDE & TOTAL VOLATILE ORGANIC COMPOUNDS by PID

Location	W	D	#	Temperature (°F)	Humidity %RH	CO (ppm)	CO_2 (ppm)	TVOCs (µg/m^3)
Outside	-	-	-	25.6	52.5	0.0	390	0.0
Main Office	C	O	2	62.8	24.8	0.0	603	66
Room 103	C	C	0	65.4	13.5	0.0	533	299
Room 167 Music	C	O	1	65.7	15.0	0.0	836	131
Theatre	-	C	0	64.3	11.6	0.0	504	126
Gymnasium	-	O	0	64.3	15.0	0.0	646	75
Cafeteria	C	O	1	65.9	14.1	0.0	553	89
Room 133	C	O	9	67.4	13.2	0.0	612	174
Room 129	C	C	0	67.7	13.7	0.0	667	163
Room A122	O	C	0	57.9	26.3	0.0	425	36
Room A108	C	C	1	65.0	16.8	0.0	649	211
Room A212	O	O	0	69.0	12.4	0.0	571	138
Room A203	O	O	1	68.1	12.7	0.0	636	418
Room 222	O	C	0	61.5	19.8	0.0	437	69
Room 226	C	O	0	66.8	13.5	0.0	447	103
Room 200 Library	-	C	0	68.9	11.8	0.0	521	131
Room 202	-	C	0	70.1	10.5	0.0	688	172
Room 206	O	C	0	67.9	12.5	0.0	448	103
Reception	-	O	2	61.2	19.9	0.0	506	52
Room 111 Nurse	-	C	1	63.8	17.8	0.0	685	119

***Total PM - PM_{10}*, Respirable, *$PM_{2.5}$* and PM1**

Location	Total PM	PM 10 (mg/m^3)	Respirable (mg/m^3)	PM 2.5 (mg/m^3)	PM1 (mg/m^3)
Main Office	0.027	0.009	0.002	0.002	0.001
Room 103	0.020	0.008	0.003	0.002	0.002
Room 167 Music	0.037	0.008	0.003	0.002	0.002
Theatre	0.012	0.004	0.001	0.001	0.001
Gymnasium	0.010	0.002	0.001	0.001	0.001
Cafeteria	0.005	0.003	0.001	0.001	0.001
Room 133	0.018	0.007	0.002	0.001	0.001
Room 129	0.047	0.014	0.003	0.002	0.002
Room A122	0.030	0.010	0.002	0.002	0.001
Room A108	0.003	0.002	0.001	0.001	0.001
Room A212	0.031	0.013	0.002	0.002	0.001
Room A203	0.017	0.008	0.002	0.001	0.001

Location	Total PM	PM 10 (mg/m^3)	Respirable (mg/m^3)	PM 2.5 (mg/m^3)	PM1 (mg/m^3)
Room 222	0.008	0.003	0.002	0.001	0.001
Room 226	0.002	0.002	0.001	0.001	0.001
Room 200 Library	0.007	0.002	0.000	0.000	0.000
Room 202	0.007	0.002	0.001	0.001	0.001
Room 206	0.002	0.002	0.002	0.001	0.001
Reception	0.026	0.005	0.002	0.001	0.001
Room 111 Nurse	0.005	0.002	0.001	0.001	0.000

Legend:

W: Windows; D; Doors; # Number of Occupants (e.g. 25 Occupants = 25); O = Open; C = Closed;
mg/m^3 - milligrams per cubic meter; $\mu g/m^3$ - micrograms per cubic meter;
ppm - parts per million;
ppb - parts per billion;
CO OSHA PEL is 30 ppm and ACGIH TLV is 25 ppm;
CO_2 - OSHA PEL is 5000 ppm, Mass DOH Guideline is 800 ppm;
TVOC – Seifert "Target Guideline Value" of 300 ug/m^3

4.0 Observations and Interpretation of Results:

Temperature and Relative Humidity (T & RH):
The outside temperature and relative humidity were approximately 25.6ºF and 52.5%. It is recommended that indoor air temperatures be maintained in a range of 70 - 78 ºF and 35 to 55 % for indoor air relative humidity in order to provide for the comfort of building occupants.

The interior temperature and relative humidity were 57.9 – 70.1 ºF and 10.5 – 26.3 % during the test period. Interior temperature tests were lower than the recommended comfort temperature range of 70 - 78 ºF. Interior relative humidity tests were lower than the recommended comfort relative humidity range of 35 to 55 %.

TVOCs:
With the exception of the sample collect at Room A203***, TVOC*** tests on this day were lower than the Seifert "Target Guideline Value" of 300-µg/m^3. The Seifert Target Guideline Value (reference #3 and #8 below) is a widely recognized ***TVOCs*** guideline for pollutant levels based on Seifert's personal judgment, rather than on toxicological data, for long term exposure. Seifert proposed that 1 week after completion of construction or renovation ***TVOC*** concentration of 50 times higher be acceptable (i.e., 15,000 ug/m^3) and after 6 weeks, 10 times higher be acceptable (i.e., 3,000 ug/m^3). ***TVOCs*** test levels were between 0.0 and 418 ug/m^3, mostly lower than the Seifert target guideline of 300 ug/m^3 and much lower than the 1-week and 6-week post-construction/renovation acceptable limits of 15,000 ug/m^3 and 3,000 ug/m^3.

Neither OSHA (Occupational Safety and Health Administration) nor ACGIH (American Conference of Governmental Industrial Hygienists) promulgates exposure standards for ***TVOCs*** that relate to protection of the general population as opposed to industrial occupational standards. Both have limits on individual VOCs but they relate to industrial occupational standard.

The testing conducted was of short duration and did not assess representative full-day occupancy levels. Measurements were made using a real-time, portable ***TVOC*** monitor referenced to isobutylene and not by sample collection for individual VOC analysis by gas chromatography technique and evaluation based on Seifert's chemical classes.

Mølhave of Denmark reported at INDOOR AIR '90 (reference #8 below) on low levels of indoor air VOCs and human health. Bearg summarized Mølhave's findings as follows.

Table 4.5 Tentative Dose-Response Relationship for Discomfort Resulting from Exposure to Solvent-Like VOCs

Total concentration (ug/m^3)	Irritation and discomfort	Exposure
<200	No irritation or discomfort	The comfort range
200 – 3,000	Irritation and discomfort possible if other exposures interact	The multifactorial exposure range
3,000 – 25,000	Exposure effect and probable headache possible if other exposures interact	The discomfort range
>25,000	Additional neurotoxic effects other than headache may occur	The toxic range

TVOCs test levels were between 0.0 and 418 ug/m^3.

Bearg points out that the overlap between Seifert's and Mølhave's recommendations could be interpreted as a consensus on recommendations for guideline values.

Carbon Monoxide:
No ***CO*** levels were detected during testing.

Carbon Dioxide:
CO_2 levels were lower than the acceptable range. For comparative purposes, fresh outdoor air has approximately 400 ppm of ***CO_2***. All areas were well below the OSHA/NIOSH limit of 5000 ppm and lower than the State of New Hampshire recommended guideline of 1,000 ppm for publicly occupied office buildings. We use this value as a reference for schools. Exposure to high levels of ***CO_2*** for prolonged periods could cause building occupants to become lethargic and generally uncomfortable. ***CO_2*** levels will rise over the course of the day especially in those areas which have a high occupancy. ***CO_2*** at these levels are a comfort as opposed to a health issue.

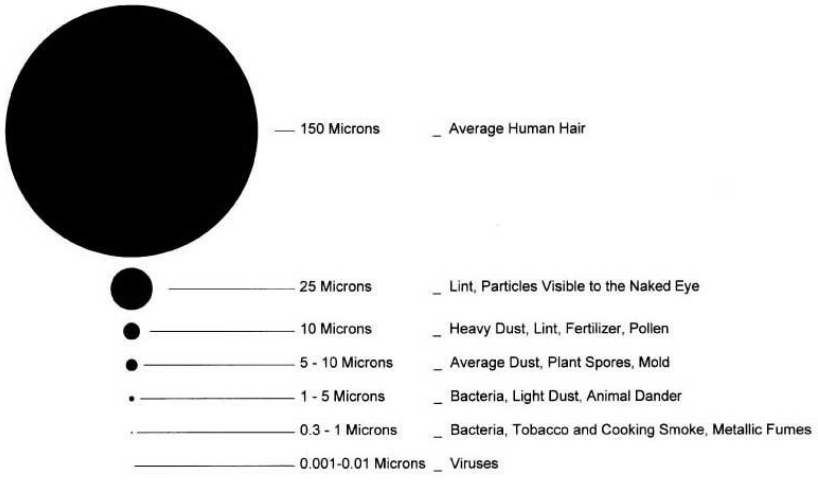
Airborne Particulate Matter (Dust):
Dust monitoring is one aspect of air quality that an industrial hygienist can use to determine the amount of dust particles present in the workplace, cities or communities over a given period.

The Particulate Matter (PM) monitoring focused on measuring a range of particulate sizes in the air that are equal to or less than 10 micrometers (PM10) and equal to or less than 2.5 micrometers (PM2.5) in diameter (course dust and fine dust respectively), i.e. PM capable of penetrating the outer defenses of the respiratory tract, such as the mouth and nose, and can pass into the lungs based on PM size. PM air pollutants include but are not limited to soot, smoke, salts, metals, acids and soil and road dust. These pollutants are typically monitored along work site fence lines, industrial complexes, during wildfires, and high traffic areas (vehicle exhaust).

EPA's health-based National Ambient Air Quality Standard (NAAQS) for PM10 is 150-µg/m^3 and for PM2.5 is 35-µg/m^3 (measured as a 24-hours period concentration) for outdoor (ambient) air. The OSHA Permissible Exposure Limit (PEL) for occupational exposure for respirable dust is 5-mg/m^3 (5,000-µg/m^3) for a time-weighted average (8 hour) exposure. While the EPA NAAQS is an outdoor, ambient air standard, it is a useful reference guide for acceptable air quality in general with limits far below OSHA worker compliance requirement levels.

The TSI DustTrak DRX 8534 real-time PM monitor used in this survey can measure PM simultaneously as PM10, PMresp, PM2.5 and PM1, i.e. particles in the size range categories of 10, Respirable (4), 2.5 and 1 micrometer diameter.

Figure 1.1-Visual Particle Size Comparison Chart.



Levels of PM10 recorded in areas tested during the survey ranged from **2 to 14-µg/m^3 or 0.002 to 0.014-mg/m^3**. EPA's health-based National Ambient Air Quality Standard (NAAQS) recommended level for PM10 is **150-µg/m^3** or **0.150-mg/m^3**. All areas tested during the survey were below the EPA recommended level.

Levels of PMresp (respirable dust) recorded in areas tested during the survey ranged from **0 to 3-µg/m^3 or 0.000 to 0.003-mg/m^3**. OSHA PEL limit for PMresp is **5,000-µg/m^3** or **5-mg/m^3**. All areas tested during the survey were below the OSHA PEL limit.

Levels of PM2.5 recorded in areas tested during the survey ranged from **0 to 2-µg/m³ or 0.000 to 0.002-mg/m³**. EPA's health-based National Ambient Air Quality Standard (NAAQS) recommended level for PM2.5 is **35-µg/m³** or **0.035-mg/m³**. All areas tested during the survey were below the EPA recommended level.

Direct reading PM monitors are not a reference method for OSHA compliance Respirable Dust testing. However, the direct reading instrument is useful in providing accurate order of magnitude evaluation of Respirable Dust levels.

Samples were collected for approximately 10 minutes at each test location and results/levels are not based on TWA (8-hour time weighted average).

Conclusions and Recommendations:
Interior temperature tests were lower than the recommended comfort temperature range of 70 - 78 ºF. Interior relative humidity tests were lower than the recommended comfort relative humidity range of 35 to 55 %.

All other IAQ parameters tested were within the acceptable ranges.

5.0 Limitations and Conditions:

This report has been completed based on visual and physical observations made and information available at the time of the site visits. This report is intended to be used as a summary of available information on existing conditions with conclusions based on a reasonable and knowledgeable review of evidence found in accordance with normally accepted industry standards, state and federal protocols, and within the scope and budget established by the client. Any additional data obtained by further review must be reviewed by UEC and the conclusions presented herein may be modified accordingly.

This report and attachments, prepared for the exclusive use of Owner for use in an environmental evaluation of the subject site, are an integral part of the inspections and opinions should not be formulated without reading the report in its entirety. No part of this report may be altered, used, copied or relied upon without prior written permission from UEC, except that this report may be conveyed in its entirety to parties associated with Owner for this subject study.

REFERENCES:

1. ACGIH, Threshold Limit values and Biological Exposure Indices, 2007.
2. AIHA, 2700 Prospect Ave., Fairfax, VA. IAQ Paper #130 June 23, 1999.
3. Seifert, B. Regulation Indoor Air. In: Indoor Air '90, Proceedings of the 5th International Conference on Indoor Air Quality and Climate, Volume V, p. 35. Toronto1990.
4. American Society of Heating, Refrigeration and Air-conditioning Engineers' ANSI/ASHRAE 55-1992 **"Thermal Environmental Conditions for Human Occupancy.**"
5. BOCA, 1993. The BOCA National Mechanical Code 1993 8th edition Building Officials and Code Administrators International., Inc., Country Club Hills, Ill
6. SBBRS, 1997. Mechanical Ventilation, State Board of Building Regulations and Standards Code of Massachusetts Regulations 780 CMR 1209.0
7. Field Guide for the Determination of Biological Contaminants in Environmental Samples. (2005)
8. Bearg, David W. Indoor Air Quality and HVAC Systems. (1993). Pages 76, 77 and others.