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Project #6673

TOTAL VOLATILE ORGANIC COMPOUND and FORMALDEHYDE ASSESSMENT CITADEL HIGH SCHOOL HALIFAX, NOVA SCOTIA

November 15, 2007

Halifax Regional School Board
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1.0 INTRODUCTION

ALL-TECH Environmental Services Limited conducted a total volatile organic compound (TVOC) and formaldehyde assessment of Classroom 105 and surrounding area at Citadel High School, Halifax, Nova Scotia. The assessment was conducted over a two day period (September 23, 2007 and October 28, 2007). The scope of work involved measuring TVOCs using a direct reading instrument and conducting air sampling for formaldehyde.

The purpose of the assessment was to identify any general contaminants associated with air quality due to complaints of sensitivity by one of the occupants in Classroom 105. The parameters were then compared with appropriate IAQ guidelines.

1.1 Building History

Citadel High School is a new building. Construction began in summer 2005 and the school opened to students in September, 2007, replacing Queen Elizabeth and St. Patrick's High Schools. It includes a 8,400 square foot gymnasium, 4,800 square foot cafeteria and a 3,000 square foot library and currently accommodates approximately 1400 students.

2.0 TOTAL VOLATILE ORGANIC COMPOUND ASSESSMENT

The purpose of the assessment was to measure Total Volatile Organic Compounds (TVOC) with a direct reading instrument and compare levels with current indoor air quality guidelines.

2.1 Exposure Criteria

The term "organic compounds" covers all chemicals containing carbon and hydrogen. These bonded compounds can easily evaporate at room temperature and enter the atmosphere under normal conditions as a gas. Generally, volatile organic compounds (VOCs) are chemicals that have boiling ranges from 50 - 260 degrees Celsius. Chemicals, paints, paint strippers, air fresheners, inks, stored fuel, solvents, cleaning supplies, new carpets, cosmetics, dry cleaning, vehicle exhaust and numerous other household items can contribute to indoor VOC emissions.

Common health effects can range from dizziness, headaches, blurred vision, nausea, and eye and throat irritation. Health effects are directly related to levels and duration of exposure. For many of the individual materials that would fall under this category, there are established exposure levels set.

Neither Nova Scotia nor the Federal Government has set standards specifically for TVOC levels in non-industrial settings. However, global consensus has resulted in the emergence of preliminary guidelines for TVOC standards for IAQ. Risk assessment and guidelines settings for VOCs is an exceptionally difficult task because of the potential for such a large

number and varied composition of organic compounds to be present in indoor air. One practical approach for providing indoor air quality guidelines for VOCs has been to use the TVOC approach as general indication of the quality of air. This approach is generalized from published toxicological studies performed to determine the health effects elicited by humans exposed to mixtures of VOCs under controlled conditions. A general TVOC guideline provided based on such studies is summarized in Table 1.

Table 1
Summary of Exposure Guidelines for Total Volatile Organic Compounds

Concentration Range	Exposure Range	Health Effects
< 0.2 mg/m^3	comfort range	No irritation or discomfort.
0.2 to 3.0 mg/m^3	Multifactorial Exposure Range	Irritation or discomfort possible if other exposures interact.
3.0 to 25.0 mg/m^3	Discomfort Range	Exposure effects and probable headache if other exposures interact.
> 25.0 mg/m^3	Toxic Range	Additional neurotoxic effects other than headache may occur.

Source: the European Collaborative Action Report 11: "Guidelines for Ventilation Requirements in Buildings" (ECA, 1992).

In addition to the above Table, several other organizations have issued guidelines associated with recommended TVOC concentrations inside buildings. *Indoor Air Quality in Office Buildings: A Technical Guide* provides guidance for individuals conducting IAQ investigations in office buildings and is designed to be used by individuals such as consultants working in the occupational environment field. This guideline states that there is no Canadian standard for TVOCs but indicates that a target level concentration of 1.0 mg/m^3 is being discussed. The Canada Green Building Council recommends a maximum TVOC concentration of 0.5 mg/m^3 in their Green Building Rating System document (LEED® Canada-NC Version 1.0, December 2004).

2.2 Methodology

The TVOC assessment of Classroom 105 and the Cafeteria of Citadel High School was conducted over 2 days (September 23, 2007 at 1:30 pm and October 28, 2007 at 2:00 pm). A photo-ionization monitor (PID) which was used for this assessment provided instantaneous readings of TVOC's. The monitor detects airborne chemicals by breaking them into electrically charged fragments by means of an ultraviolet (UV) lamp where it then detects the ions on a metal screen. The number of VOCs that can be detected increases as the lamps UV energy increases. Although the PID cannot differentiate between gases, the gas in which you want the monitor to measure can be selected and the instrument will calculate the equivalent level for that selected gas. This makes the PID a very useful screening device for identifying source location and pollution routes.

The PID used during this assessment was an Ion Science PhoCheck 5000 Ex, measuring TVOC levels in either ppm (parts per million), ppb (parts per billion) or mg/m^3 (milligrams per cubic meter).

2.3 TVOC Results

On both September 23, 2007 and October 28, 2007, TVOC spot measurements were taken at several locations in and around Classroom 105 of Citadel High School. Results are listed in Table 2.0.

Table 2.0
TVOC Air Measurements
Citadel High, Halifax, NS
September 23, 2007 & October 28, 2007

Location	TVOC Results in mg/m^3	TVOC Results in mg/m^3
	September 23, 2007	October 28, 2007
Corridor Outside Rm 105	0.238 to 0.315	0.150 to 0.210
Cafeteria	0.151 to 0.170	0.285 to 0.910*
Stairwell Adjacent Rm 105	0.318 to 0.342	0.085 to 0.167
Room 105	0.089 to 0.400	0.075 to 0.112
Exterior (Ground Level)	0.100 to 0.180	0.065 to 0.135

* Elevated TVOC levels were observed in the cafeteria on October 28, 2007. The floors were polished and waxed that morning using Swish Deep Scrub and a floor finish. MSDS of the products were reviewed and the chemical components of the product can contribute to the elevated TVOC levels measured in the Cafeteria on October 28, 2007.

2.4 Discussion of Results

Classroom 105 and adjacent areas of Citadel High School were within acceptable TVOC guidelines established by Health Canada's target of < 1.0 mg/m^3 on both September 23, 2007 and October 28, 2007 sampling periods.

3.0 *FORMALDEHYDE ASSESSMENT*

The purpose of the assessment was to measure Formaldehyde concentrations in Classroom 105 (complaint area) and Cafeteria (background comparison) and compare levels with current indoor air quality guidelines.

3.1 Exposure Criteria

Formaldehyde is a colourless gas. A pungent odour often indicates its presence at a concentration greater than 0.2 ppm. Formaldehyde is present when vapours off-gas from building materials (e.g., carpets, particle-board, fabrics), cleaning fluids, and adhesives or from combustion sources.

Indoor concentrations are dependent on th age of the building materials, ventilation rate, indoor and outdoor temperatures, and humidity. Formaldehyde concentrations can also vary by as much as 50% from day to day and from season to season. The measured results can be compared with the various guidelines available; typical office levels should be under 0.1 ppm.

Formaldehyde is a known irritant and sensitizer. Symptoms to exposures to elevated levels of formaldehyde include dry or sore throat, nosebleeds, headaches, fatigue, memory/concentration problems, nausea, dizziness, breathlessness, and eye irritation. Irritant effects have been associated with concentrations in the median range of 0.5 ppm, and concentrations as low as 0.01 ppm have been reported to affect sensitive individuals.[1]

The results of the formaldehyde sampling were compared with Health Canada's 2005 Residential Indoor Air Quality Formaldehyde Guideline.

Table 3.0
Health Canada 2005 Residential Indoor Air Quality Guideline for Formaldehyde

Exposure	Concentration	
	mg/m^3	ppm
1 hour	0.123	0.1
8 hour	0.05	0.04

Health Canada's "Proposed residential indoor air quality guidelines for formaldehyde, August 2005", Section 6.4 states that: It is recommended that a guideline be established for short-term (1-hour averaged) exposures to formaldehyde at 0.123 mg/m^3 (0.1 ppm)(i.e. one tenth of the lowest concentration at which eye irritation was reported in the 1993 Kulle et al. controlled exposure study).

It is recommended that the guideline for long-term (8-hour averaged) exposure to formaldehyde be based on the NOAL derived from the Rumchev (2002) case-control study of childhood asthma. Based on this study, the guideline would be 0.05 mg/m^3 (0.04 ppm).

[1] Health Canada, Indoor Air Quality in Office Buildings: A Technical Guide, 1995, Pp 33-34

Although formaldehyde is a suspected human carcinogen to humans (ACGIH 2007, TLV booklet, Pg 74), the cancer risk associated with a lifelong exposure to that concentration of formaldehyde is estimated to be negligible.[2]

3.2 Methodology

The formaldehyde assessment of Classroom 105 of Citadel High School was conducted over 2 days (September 23, 2007 at 1:30 pm and October 28, 2007 at 2:00 pm). Two samples were collected on each day of assessment; one inside Classroom 105 (complaint area) and one inside the Cafeteria (background comparison) for a total of four (4) samples. The samples were collected following the NIOSH 2016 standard for formaldehyde testing and were sent to Galson Laboratories in East Syracuse, New York for analysis. Galson Laboratories is an accredited lab through the American Industrial Hygiene Association.

3.3 Formaldehyde Results

On both September 23, 2007 and October 28, 2007, TVOC samples were taken inside Classroom 105 (complaint area) and inside the cafeteria (background comparison). Results are listed in Table 4.0.

Table 4.0
Formaldehyde Testing Results
Citadel High, Halifax, NS
September 23, 2007 & October 28, 2007

Sample Location	Formaldehyde Results September 23, 2007, Sample Duration: 70 min		Formaldehyde Results October 28, 2007 Sample Duration: 80 min	
	mg/m3	ppm	mg/m3	ppm
001 -Inside Classroom 105	0.012	0.0098	0.0026	0.0021
002 - Inside Cafeteria	0.0098	0.008	0.0048	0.0039

3.4 Discussion of Results

Classroom 105 and the cafeteria area of Citadel High were within Health Canada Residential Indoor Air Quality Guideline for Formaldehyde of < 0.1 ppm (1 hour exposure) and < 0.04 ppm (8 hour exposure).

[2] Health Canada, Residential Indoor Air Quality Guideline for Formaldehyde, 2005, Pg 2.

4.0 CONCLUSIONS

TVOC Concentrations

On October 28, 2007, the cafeteria floor was waxed approximately 2 hours before the start of the assessment. Odours from the wax were detectable by the hand held PID when approaching the area. However, the TVOC concentrations in the cafeteria measure on October 28, 2007 were within acceptable Health Canada target guidelines for TVOCs.

Decreases of TVOC concentrations in other areas of the school were observed on October 28, 2007 assessment period when compared to TVOC concentrations measured on September 23, 2007. In typical indoor environments there will be slight variation of TVOC concentrations from day to day. Overall, the TVOC concentrations measured in Classroom 105 and the Cafeteria were at concentrations typically observed in indoor environments.

Formaldehyde

Formaldehyde concentrations were within acceptable Health Canada Residential Indoor Air Quality Guidelines on both assessment periods. In fact the formaldehyde concentrations measured on both days were within typical concentration ranges found in Canadian homes. Results from studies carried out in Canada since the early 1990s consistently indicate that formaldehyde concentrations in Canadian homes range between 0.002 ppm and 0.07 ppm with an average between 0.02 ppm and 0.03 ppm (Health Canada, 2005).

Overall, it is difficult to pinpoint air quality complaints and symptoms to a particular air contaminant. The air monitoring sampling completed during the assessment did not indicate ‘unhealthy’ levels of TVOCs and formaldehyde in the Classroom 105 and the Cafeteria. Concentrations of TVOC and formaldehyde were similar in both areas during the assessment periods.

5.0 LIMITATIONS

The findings contained in this report are based upon conditions as they were observed at the time of the survey. The client recognizes that ALL-TECH is committed to providing environmental monitoring services; however, failure to detect certain conditions is an inherent limitation of this specific type of work. The heterogeneous nature of mixtures, manufacture variances, and laboratory detection limitations that ALL-TECH interprets to exist may differ from those that actually exist. ALL-TECH has made our recommendations recognizing these limitations. No assurances are made regarding changes in conditions subsequent to the time of the survey.

If you have any questions regarding this report, please do not hesitate to call me at (902) 835-3727.

Thank you,

Robert Gardner

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APPENDIX 1
Laboratory Reports

APPENDIX 2
Galson Laboratory AIHA Accreditation

APPENDIX 3

Health Canada Residential Indoor Air Quality Guideline
for Formaldehyde

APPENDIX 4
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