

Examining the Effectiveness of
Ozone in Reducing VOCs in a
New Display House,
Maple Ridge, British Columbia

Table of Contents

1.0	EXECUTIVE SUMMARY	1
2.0	INTRODUCTION.....	1
3.0	SITE DESCRIPTION	3
4.0	SITE VISIT	3
5.0	SAMPLING and ANALYSIS.....	3
5.1	INTRODUCTION.....	3
5.2	SAMPLING METHOD and INFORMATION.....	3
5.3	TEST METHODS	4
5.3	ANALYSIS RESULTS of AIR SAMPLES.....	4
6.0	EVALUATIONS of FINDINGS.....	5
7.0	SUMMARY of FINDINGS and RECOMMENDATIONS.....	6
8.0	QUALIFICATIONS.....	7
8.1	COMPETENCE OF THE INSPECTOR.....	7
9.0	REFERENCES and SUPPORTING DOCUMENTATION	7
9.1	REFERENCE No. 1	8
9.2	REFERENCE No. 2	8
9.3	REFERENCE No. 3	8
10.0	LIMITATIONS and USE of REPORT	8

1.0 EXECUTIVE SUMMARY

Indoor Air Tests were conducted on a newly constructed Display house located at 24129 – 102 Avenue Maple Ridge, British Columbia, Canada to assess and evaluate the effectiveness of using Ozone to reduce the indoor air concentrations of Formaldehyde and Volatile Organic Compounds (VOCs). Occupants of homes having high concentrations of these chemicals can experience health problems and discomfort.

Tests were conducted immediately before the application of Ozone administered by Medallion Healthy Homes of Canada Inc. in accordance with the Standard Medallion Methodology. Follow-up tests were conducted ONE day after treatment and sixteen days later on.

Results show a substantial reduction of the Formaldehyde and VOCs after Ozonation. These results are comparable with a similar study conducted on an identical home located in the same community. Based on the findings of these two reports, it is our opinion that the proper application of Ozone is shown to be effective in significantly reducing the indoor air concentrations of these chemicals. This overall reduction is considered to be a benefit to the health and comfort of occupants of homes with high concentrations of Formaldehyde and VOCs.

2.0 INTRODUCTION

Medallion Healthy Homes of Canada Inc. engaged **LOWEN AND ASSOCIATES** to conduct an investigation into the effectiveness of ozone in reducing the VOC concentrations in a newly constructed Display home. Medallion Healthy Homes of Canada Inc. through the use of proprietary ozone generation equipment provides a service whereby indoor air is purified. Using this equipment, Medallion has developed a methodology in which very high levels of ozone are introduced into a vacated and locked out home, office, boat, etc. Once the Ozonation phase is completed, the residual ozone is extracted and the air tested to ensure that any remaining ozone is at a level acceptable for human occupation.

Air samples were taken from the interior of the Display House prior to the application of Ozone to determine the “*Pre-Ozonation*” concentrations of Formaldehyde and VOCs.

The Display House was subjected to the application of Ozone using the standard “Medallion” Methodology for a period of 12 hours. The Ozone was extracted and air samples were obtained on the following day and 16 days later to determine the “*Post-Ozonation*” concentrations of Formaldehyde and VOCs at those times.

"Volatile organic compound" or VOC is the name given to a substance that contains carbon and that evaporates (becomes a vapor) or "off-gases" at room temperature.

Some examples of VOCs include benzene, formaldehyde, methylene chloride, hexane, toluene, trichloroethane, styrene, heptane, and perchloroethylene.

A number of building and household materials may be sources of VOCs. New carpeting, backing, and adhesives; draperies; wood products that use certain glues, finishes, and waxes in the manufacturing process; and vinyl type flooring and wall coverings may all release VOCs into the air.

The ability of VOCs to cause health effects varies greatly. As with other chemicals, the effects of VOC exposure depends on several factors including the type of VOC, the amount of VOC and the length of time a person is exposed.

Exposure to elevated levels of VOCs may cause irritation to the eyes, nose, and throat. Headaches, nausea, and nerve problems can also occur. Some people do not appear to have any kind of reaction to fairly "low" amounts of VOCs, while other people are fairly sensitive.

Studies of animals have shown that breathing some types of VOCs over a long period of time can increase the risk of getting cancer.

Although VOCs can be found in both outdoor and indoor settings, the levels of VOCs found indoors can be much higher than those found outdoors. This is because a house or building that doesn't have enough ventilation does not allow potential indoor pollutants to escape. In newly constructed houses, the concentrations of VOCs are substantially higher due to the presence of new materials that off-gassing at a higher rate

Depending on several factors, VOCs can be given off for days, weeks, months or even years. The following is a list of factors to be considered.

- How long ago the product was made
- How long it was stored or allowed to "off gas" at the warehouse
- How tightly the product was wrapped and how it was delivered
- The amount and type of ingredients in the product
- Where the product is used in the building
- The amount of ventilation in the building
- The amount of moisture and the temperature of the air

3.0 SITE DESCRIPTION

The subject site was a newly constructed house being currently used as a “Display Home” situated at 24129 - 102nd Street, Maple Ridge, British Columbia. It is a 2 story wood frame house with a full sized poured concrete basement. It has a forced air gas fired furnace located in the basement. It contained new furniture and appliances.

4.0 SITE VISIT

The subject site was visited on July 29, 2003 for the purpose of setting up and running air-testing apparatus. The purpose of this visit was to conduct air sampling to ascertain the concentrations of VOCs and Formaldehyde in the house prior to the house being ozonated by Medallion Healthy Homes of Canada Inc.

The subject property was again visited on July 30, 2003 and August 15, 2003 for the purpose of setting up and running air-testing apparatus subsequent to the application of Ozone.

5.0 SAMPLING and ANALYSIS

5.1 INTRODUCTION

After discussions with the client “Medallion Healthy Homes of Canada Inc. and Chad Born, B.Sc., Supervisor, Industrial Hygiene - Cantest Ltd. it was decided to test the air in the house for Formaldehyde and total hydrocarbons (VOCs)

5.2 SAMPLING METHOD and INFORMATION

Sampling for Formaldehyde was conducted using portable battery operated air pumps supplied and calibrated by CANTEST LTD. The air being sampled was drawn through a glass impinger containing approximately 20 ml of a solution of 75mg/ml Sodium Bisulphite In deionized water.

Sampling for Formaldehyde was conducted using portable battery operated air pumps supplied and calibrated by CANTEST LTD. The air being tested was drawn through a standard SKC glass tube containing charcoal.

The sampling times were set for appropriate time intervals to ensure an adequate and representative air sample was obtained as laid out in the NIOSH manual of Analytical Methods (NMAM), Forth Edition, 8/15/94 for Formaldehyde and Aromatic Hydrocarbons.

5.3 TEST METHODS

Total or light hydrocarbons in Air-Analysis was performed by CANTEST LTD. Using procedures based on WCB Method 2901. The procedure involves sampling using charcoal tubes, desorption of analytes from the charcoal using carbon disulphide, and analysis using gas chromatography with flame ionization detection.

Formaldehyde in Air-samples were collected in impingers. Analysis was performed using procedures based on NIOSH Method 3500 using chromotropic acid and sulphuric acid reagents and UV-Visible spectrophotometry.

5.3 ANALYSIS RESULTS of AIR SAMPLES

TABLE ONE

Volatile Organic Compounds (VOCs) in Air :

SAMPLE IDENTIFICATION:	SAMPLE DATE	CANTEST ID	TOTAL HYDROCARBONS
001 Blank	July 29/03	307310284	-
002 VOC (Pre-Ozonation)	July 29/03	307310285	0.6
004 VOC (1 Day Post-Ozonation)	July 30/03	307310295	>0.2
007 VOC (16 Day Post-Ozonation)	August 15/03	308150600	>0.2

DETECTION LIMIT 0.2
 UNITS mg/cu. m
 mg/cu. m = milligrams per cubic meter
 < = less than detection limit

TABLE TWO

Formaldehyde Analysis in Air:

SAMPLE IDENTIFICATION:	SAMPLE DATE	CANTEST ID	FORMALDEHYDE in AIR
003 Formaldehyde (Pre-Ozonation)	July 29/03	307310286	0.749
005 Formaldehyde (1 Day Post-Ozonation)	July 30/03	307310298	0.04
006 Formaldehyde (16 Day Post-Ozonation)	August 15/03	308150597	0.045

DETECTION LIMIT 0.005
 UNITS mL/cu. m
 mL/cu. m = milliliters/cubic meter or ppm (v/v)

6.0 EVALUATIONS of FINDINGS

At the present time, there are no national or provincial standards that are specific for schools, offices, or homes regarding safe concentrations of VOCs. In addition, there are many different opinions in the science and medical communities about the degree of risk posed by various concentrations of VOCs. **Health Canada** produced a **Technical Guide – Indoor Air Quality in Office Buildings (1995)** (see: References and Supporting Documentation)

In it they made the following observations:

5.2.7.1 Standards. The threshold limit values (TLVs) for individual chemical substances that have been adopted by the ACGIH are not appropriate for office environments, for several reasons. For example, ACGIH TLVs apply to industrial workers who may be exposed to a few known contaminants at high concentrations over a 40-hour workweek. Industrial workers are usually provided with adequate protective equipment (e.g., source ventilation, protective clothing or face masks, breathing equipment). In addition, the industrial work force is generally made up of young, healthy, adult males.

Office workers, on the other hand, are exposed, without protective equipment, to a broad spectrum of contaminants at low concentrations over periods often longer than 40 hours per week. The synergistic effect of these compounds on occupant comfort is not known. As well, the population composition of the office workforce covers a much broader spectrum than that of the industrial workforce.

It would therefore seem that individual limits much lower than ACGIH TLVs are more appropriate. ASHRAE Standard 62-1989 recommends using one tenth of the ACGIH limits for compounds for which comfort guidelines do not exist. Although there are at present no Canadian or US standards for Total Volatile Organic Compounds (TVOCs), target and action units of 1.0 and 5.0 mg/cu. m respectively are being discussed. The European Community has prepared a target guideline value for TVOC of 0.3 mg/cu. m, where no individual VOC should exceed 10% of the TVOC concentration.

5.2.7.2 Health and Comfort Effects. Research in Europe and North America has demonstrated that VOCs at concentrations much lower than the ACGIH TLVs can cause discomfort. Symptoms of low TVOC exposure include fatigue, headaches, drowsiness, dizziness, weakness, joint pains, peripheral numbness or tingling, euphoria, tightness in the chest, unsteadiness, blurred vision, and skin and eye irritation.

In an exposure range of 0.3 – 3.0 mg/cu. m, odours, irritation, and discomfort may appear in response to the presence of TVOC together with thermal comfort factors and stressors. Above 3.0 mg/cu. m, one may expect complaints; above 25 mg/cu. m, temporary discomfort and respiratory irritation have been demonstrated for a common mix of chemicals in an office building. Typical office levels cover a range from below to above the amounts found to cause discomfort.

Hypersensitive individuals can have severe reactions to a variety of VOCs at very low concentrations. They can react to organic compounds that are released by building materials, carpets, and various consumer

Examining the Effectiveness of Ozone in Reducing VOCs in a New Display House
products including cosmetics, soaps, perfumes, tobacco, plastics, and dyes. These reactions can occur following exposure to a single sensitizing dose or sequence of doses, after which time a much lower dose can provoke symptoms. Chronic exposure to low doses can also cause reactions. Symptoms are usually non-specific and may be insufficient to permit identification of the offending compounds.

Because of the available knowledge of toxicological and sensory effects of VOCs and their mixtures is incomplete, reduction of overall exposure is desirable.

The State of California Air Resources Board recommends that home owners take action if the Formaldehyde concentrations are above 0.10 parts per million (ppm) even if occupants do not have adverse symptoms, and that concentrations be reduced to a “target level” of 0.05 or less. (See: References and Supporting Documentation)

TABLE ONE (VOCs) shows concentrations of Volatile Organic Compounds in the air of **0.6 mg/cu. m** *before* and **<0.2 mg/cu. m** one day *after* Ozonation and remained at **<0.2 mg/cu. m** sixteen days *after* Ozonation. According to these figures, the concentrations of VOCs after Ozonation were less than **33.3%** of the original concentrations. This is a significant reduction.

TABLE TWO (Formaldehyde) shows concentrations of Formaldehyde in the air of **0.749 mL/cu. m** *before* and **0.04 mL/cu. m** one day *after* Ozonation and **0.045 mL/cu. m** sixteen days *after* ozonation. We note that the sixteen day sample is **0.05 mL/cu.m** higher than the one day sample. It is our opinion that this extremely small increase can be put down to the continued out gassing of the formaldehyde from the building materials which is a normal occurrence and because of its low concentration it should not be considered an indication of lack of efficiency in the action of the ozone. According to the resulting figures in this set of samples, the concentrations of Formaldehyde after Ozonation were **5.34%** (after one day) and **6.0%** (after sixteen days) of the original concentrations. This again is a significant reduction.

7.0 SUMMARY of FINDINGS and RECOMMENDATIONS

Based the results noted in this report, air samples taken after Ozonation by Medallion Healthy Homes of Canada Inc. show a substantial reduction in the concentrations of Formaldehyde and VOCs in the indoor air of the Display House. These results are comparable with a similar study conducted May 1st and 2nd, 2001 on an identical home located in the same community. While no relative quantitative standards appear to exist, it is generally agreed in the Indoor Air Quality

Field that the reduction of overall exposure to VOCs is desirable for the good health and comfort of building occupants.

At this time we can recommend that homes having high concentrations of Formaldehyde and VOCs with occupants experiencing symptoms or discomfort, could benefit in a large measure from the application of Ozone when administered by Medallion Healthy Homes of Canada Inc. in accordance with the Standard Medallion Methodology.

8.0 QUALIFICATIONS

8.1 COMPETENCE OF THE INSPECTOR

Lowen & Associates (L&A) and its Senior Consultant, Marshall L. Lowen, possess knowledge through an appropriate combination of formal education, skills, experience and training to provide a technically sound and rational inspection and air sampling of buildings regarding bioaerosols, Volatile Organic Compounds and other Indoor Air Quality problems. L&A has completed many projects involving Indoor Air Quality problems, contaminated sites and the identification and handling of toxic and hazardous materials. L&A's projects for contaminated sites have typically included historical reviews, field surveys selection, costing and specification of cost-effective treatment options, field supervision, audits, as well as other consulting services. L&A through its associates provides full environmental, occupational safety & health and chemical analysis services to clients for initial assessments of Indoor Air Quality, contamination, design of remediation programs, field supervision and monitoring for remediation sites.

ASSOCIATIONS:

Air and Waste Management Association (AWMA)
Environmental Assessment Association (EAA)
National Environmental Health Association (NEHA)

Mr. Lowen has training, education and knowledge in a number of technical areas relevant to the subject site including:

- (a) Building Sciences, Construction Practices and Standards
- (b) Indoor Air Quality (IAQ)
- (c) Representative Sampling Techniques
- (d) Remediation and Preventive Maintenance of Fungal Contaminated Buildings
- (e) Biology of Fungi
- (f) Environmental Control of Contamination caused by microbial overgrowth
- (g) CMHC Indoor Air Quality Investigation
- (h) Other areas of environmental microbiology

9.0 REFERENCES and SUPPORTING

DOCUMENTATION

9.1 REFERENCE No. 1

Health Canada (1995)

Indoor Air Quality In Office Buildings: A Technical Guide.

(Tedd Nathanson)

9.2 REFERENCE No. 2

Air Quality Sciences Inc.

Health Problems Caused by Volatile Organic Compounds

9.3 REFERENCE No. 3

State of California Air Resources Board

Research Division

Indoor Air Quality Guideline (September, 1991)

Formaldehyde in the Home

10.0 LIMITATIONS and USE of REPORT

This report was prepared by *Lowen & Associates* (L&A) for the exclusive use of Medallion Healthy Homes of Canada Inc. (*The Client*) and is intended to provide *The Client* with an assessment of the Indoor Air Quality of the subject site targeting Formaldehyde and Volatile Organic Compounds. The material in this report reflects L&A's best judgment considering the information available to L&A at the time of preparation. Any use that a third party makes of this report, or any reliance on or decisions to be made on it, are the responsibility of such third parties. L&A accepts no responsibility for damages, if any, suffered by a third party as a result of decisions made or actions based on this report.

The scope of work for this project was limited to a Site inspection, along with sampling and analysis, is to examine and assess the effectiveness of Ozonation in reducing the airborne concentrations of Formaldehyde and Volatile Organic Compounds in a new display home. No other testing or analysis other than that contained in this report was conducted at the site.

This report is based on data and information collected during the investigation conducted by L&A and is based solely on the site conditions of the property at the time of the site inspection, supplemented by data obtained by L&A, as described in this report. Due to possible variations in building practices and site

activities that may have existed at this site, there may be localized zones of contamination that were not

Examining the Effectiveness of Ozone in Reducing VOCs in a New Display House
detected or observed during this inspection.

In evaluating the property, L&A has relied in good faith on information provided by the individuals and Companies noted in the report. We accept no responsibility for any deficiency, misstatements, or inaccuracy contained in this report as a result of omissions, misrepresentation, or fraudulent acts of others involved.

If new information is discovered in future work, including excavations, renovations, remediation, or other studies, L&A should be requested to re-evaluate the conclusions of this report, and provide amendments, as required.

Sincerely,

Marshall L. Lowen

Senior Environmental Consultant

LOWEN & ASSOCIATES
ENVIRONMENTAL CONSULTANTS