Monitoring Parameter: **Formaldehyde**	Title: **Standard Operating Procedure for the Non-Continuous Measurement of Ambient Formaldehyde DRAFT**
Revision No: Draft **Revision Date: 09 April, 2018**	**Reference No: SOP-09** **Parent Document: Part B1 – B.C. Field Sampling Manual**

1. Introduction and Scope

This Standard Operating Procedure (SOP) provides operating guidelines and instructions for the non-continuous active ambient sampling of ambient formaldehyde using cartridge samplers, within the provincial jurisdiction of British Columbia (B.C.).

Subsequent analysis of the sample by an analytical laboratory is required to complete the measurement of ambient formaldehyde. The laboratory analysis procedure is not covered in detail within this SOP. For further information regarding the laboratory analysis of formaldehyde see section 8 of the B.C. Environmental Laboratory Manual (B.C. ENV, 2015).

This SOP forms part of the B.C. Field Sampling Manual (BCFSM). Part B - Air and Air Emissions Testing, of the BCFSM provides additional information on Air Quality Monitoring that must be used in conjunction with the information provided in this SOP. Installation and maintenance of a cartridge formaldehyde sampler within the provincial jurisdiction of B.C. should be carried out with consideration to Part B of the B.C. Field Sampling Manual, the sampler manufacturer's manual/instructions, and this document.

The sampling method described in this SOP can be used to measure ambient concentrations of formaldehyde over long durations. This method is suitable for durations of 1 to 24 hours when formaldehyde concentrations are low (~1 ppb to 20 ppb), or short durations of 5 to 60 minutes, when concentrations are in the parts per million (ppm) range. For longer monitoring durations (up to 7 days), passive monitoring or continuous methods should be considered. This method is not compatible with personal sampling pumps due to the high pressure drop across the cartridge.

2. Document Control

This Standard Operating procedure is a controlled document. Document control provides a measure of assurance that the specifications and guidance are based on current information that has been scrutinized by a qualified reviewer/s. Controlled documents are reviewed within a five year life cycle. Please ensure that the revision date listed in the header of this document does not exceed five years.

This SOP and the B.C. Field Sampling Manual are available at: www2.gov.bc.ca.

3. Principle of the Sampling Method

Cartridge Sampler

Air is drawn through a sampling cartridge containing silica gel that is coated with 2,4-Dinitrophenylhydrazine (DNPH) reagent. The sampler system draws air through the cartridge at a controlled flow rate that is generally between 0.5 l min^{-1} and 2 l min^{-1}. Aldehydes and ketones, if present in the sample stream readily form stable derivatives which are captured within the cartridge. During the sampling period the elapsed sampling time is recorded. When sampling is complete the cartridge is sent for laboratory analysis by high performance liquid chromatography (HPLC) to determine the

formaldehyde content. The flow rate and elapsed time are used to calculate the total sample volume in cubic meters (m^3). The mass of formaldehyde and the sample volume are used to calculate the average formaldehyde concentration in micrograms per cubic meter ($\mu g/m^3$) over the sampling period.

4. Interferences

Potential common interferences include the presence of ozone in the sample, reagent contamination, sunlight, ambient temperature, relative humidity and system leaks.

Ozone

The presence of ambient ozone in concentrations of 50 ppb and greater is known to interfere with the cartridge sampling method. Ozone reacts with both the DNPH coating and the derivatives captured on the cartridge. To minimize this interference an ozone denuder or scrubber (typically a copper tube coated with potassium iodide) can be placed upstream of the sampling cartridge.

Reagent contamination

The DNPH reagent may be contaminated with formaldehyde. This potential interference can be minimized by instructing the laboratory to determine impurity levels prior to use, and confirming that they are less than the certification blank levels of 0.15 µg/cartridge.

Sunlight

Exposure of the cartridges to sunlight may cause artifacts. Sunlight exposure should be avoided during storage, and during sampling by using a sampler shield.

Ambient temperature

High temperatures can cause loss of formaldehyde-DNPH derivatives. Cartridges should be stored and transported at temperatures less than 4 degrees Celsius (°C) prior to, and following sampling. Ambient air temperatures during sampling may also affect sample collection efficiency and a heated inlet probe is recommended for ambient temperatures less than 15 °C.

Relative humidity

Very low (<10%) or high (>90%) humidity is reported to impact collection efficiency. Very low or high relative humidity conditions also affect the performance of ozone denuders or scrubbers used in the sampling system. In high humidity environments the scrubbers can become saturated. To avoid this potential interference a heated inlet probe can be used.

System Leaks

Air leaks in the sampling system can result in reduced formaldehyde measurement. The formaldehyde sampler must pass a leak check to produce valid results. Consult the manufacturer's operation manual for leak check instructions specific to the sampler.

5. Precision and Accuracy

Cartridge sampling measurements are affected by factors such as measurement height, meteorological conditions and the laboratory's analysis method.

The precision of a measurement is generally considered to be the 'repeatability of the measurement'. The accuracy of the measurement is generally considered to be a measure of the 'deviation from true'. Determination of precision and bias should be completed by the analytical laboratory as per their quality

assurance/quality control (QA/QC) procedures. During sampling at least one field blank should be used, or the number of blanks should be 10% of field samples whichever is greater. The use of trip blanks and laboratory blanks is also recommended.

6. Recommended Equipment and Apparatus

The following instruments are commercially available and suitable for use within the provincial jurisdiction of B.C.:

- Xonteck Model 924 Toxic Air Sampler
- ATEC Model 2200 Toxic Air Sampler

Depending on ambient sampling conditions, a heated inlet probe or dryer may be required. An ozone denuder or scrubber should be used.

This list does not necessarily exclude other commercially available formaldehyde sampler systems recognized by the United States (US) Environmental Protection Agency's (EPA) Federal Reference and Equivalent Methods. It is highly recommended however that you consult with the B.C. Ministry of Environment and Climate Change Strategy (ENV) if you intend to deploy a sample system that is not listed above. Regardless of the instrument deployed all samplers should meet the specifications described within this document.

7. Measurement Range and Sensitivity

Analysis range and sensitivity depend on the method employed by the laboratory and the volume of sample. The typical measurement range for formaldehyde using this method is 10 ppb to 1 ppm.

8. Site Requirements

Sampling site specifications should be developed to ensure that the data obtained from the site satisfies the requirements of intended or established sampling objectives. It is recommended that sampling site requirements be established in consultation with the B.C. ENV to ensure that siting requirements are commensurate with sampling objectives.

As a preliminary guideline site selection should consider and address: sampling objectives, representativeness of the region, interference from the surrounding area, zone type (residential, commercial, industrial) of sampling location.

Refer to Section XX of the BCFSM for further information on site selection method.

9. Installation Requirements

Follow sampler specific installation requirements discussed in the manufacturer's manual.
The installation should also conform to the following:

- The sampler inlet should be located at a height of 2 m to 7 m above ground level.
- If the sampler is located on a roof or other structure the inlet should be at least 1 m from walls or parapets and positioned away from building vents or flues.
- The sampler should be located away from structures such as trees and buildings. The distance between any obstacle and the sampler should be at minimum, twice the height of the obstruction above the inlet.
- Air-flow should be unrestricted in 3 of the 4 wind quadrants.

10. Operational Requirements

Follow instrument specific operational requirements discussed in the manufacturer's manual. In general the following activities should be performed by the operator of a sampler:

Action	Time/Frequency	Description	Record Keeping
Sample Start	At the start of each sampling period	• Record start time, flow rate, sample volume, ambient temperature, ambient pressure and relative humidity. • Record the date, time, location, measurement height, and cartridge identification and batch number. • Cartridges should be used within 30 days of preparation by the laboratory.	• Record in logbook • Record available information on the Chain of Custody (COC) form provided by the analytical laboratory.
Sample Retrieval	At end of sampling period	• Record end and elapsed time, flow rate, sample volume, ambient temperature, ambient pressure and relative humidity. • Record the date, time, location, measurement height, and cartridge identification and batch number. • Note any instrument errors. • Remove cartridge using polyethylene gloves, seal at ends using Teflon tape and follow the packing requirements of the cartridge supplier. Packing requirements could include the use of DNPH soaked filter paper within the packaging. • Ship in a box not a cooler (since the cooler could contain formaldehyde). • Refrigerate at 4 °C until analysis. • Refrigeration period prior to analysis should not exceed 2 weeks.	• Record in logbook • Complete the COC as required by the analytical laboratory.
Leak Check	Each sampling event (or at frequency stated by manufacturer)	• As per manufacturers operation manual. • Leak rate should be within the tolerances stated by the manufacturer (e.g. less than 2% of full scale).	• Record in logbook
Calibration	Quarterly or at	• As per Section 12 of this SOP.	• Record in logbook

	replacement frequency stated in manufacturer's manual		
Check that time is within ± 5 min from true • Check pressure on vacuum manifold • Inspect sample inlet, tubing and power cord, replace if required	Monthly	• As per manufacturers operation manual	• Record in logbook
Clean control box filter	Quarterly	• As per manufacturers operation manual	• Record in logbook
Clean inside and outside of control and pump boxes	Quarterly	• As per manufacturers operation manual	• Record in logbook
Check and replace ozone scrubber	Bi-annually or at the replacement frequency stated in manufacturer's manual	• As per manufacturers operation manual	• Record in logbook
Replace pump vanes	Annual	• As per manufacturers operation manual	• Record in logbook

11. Zero and Span Checks

This section is not applicable to this measurement method.

12. Calibration

Calibration should be performed in accordance with Section XX of the BCFSM and following the manufacturer's manual. Certain specifics to a formaldehyde sampling system are as follows:

- Several parameters require calibration including flow, ambient temperature and ambient pressure.
- Calibration of the sampling system flow controller should be undertaken using a flow meter which is calibrated or certified annually against a National Institute of Standards and Technology (NIST) traceable standard.
- Similarly, temperature and pressure verification should be performed using a temperature and pressure standard which is calibrated or certified annually against a NIST traceable standard.

13. References

B.C. ENV 2016. *British Columbia Environmental Laboratory Manual 2015 Edition*. Section 8. Environmental Monitoring, Reporting & Economics Knowledge Management Branch.

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American Standard Test Method (ASTM) 2016. *Standard Test Method for Determination of Formaldehyde and Other Carbonyl Compounds in Air (Active Sampler Methodology).* Designation D5197-16.

ATEC 2014. *Model 2200 Toxic Air Sampler Operations and Maintenance Manual*. Version 2.00.

Bay Area Air Quality Management District (BAAQMD) 2012. *Standard Operating Procedure Data Mgt SOP 607 Toxics 924*. Revision 607.2.00.

California Environmental Protection Agency Air Resources Board 2004. *Standard Operating Procedures for Xontech 924 Toxics Air Sampler*. AQSB SOP 801. First Edition.

US EPA 1999. *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air. Compendium Method TO-11A. Determination of Formaldehyde in Ambient Air Using Adsorbent Cartridge Followed by High Performance Liquid Chromatography (HPLC) [Active Sampling methodology]*. Center for Environmental Research Information Office of Research and Development.

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Approval