Monitoring Parameter: **Particulate Matter (PM)**	Title: **Standard Operating Procedure for the Non-Continuous Measurement of Particulate Matter in Ambient Air Using a Low Flow Rate Sampler DRAFT**
Revision No: Draft **Revision Date: 09 April, 2018**	**Reference No: SOP-05e** **Parent Document: Part B1 – B.C. Field Sampling Manual**

1. Introduction and Scope

This Standard Operating Procedure (SOP) provides operating guidelines and instructions for discrete non-continuous ambient monitoring of total suspended particulate (TSP), particulate matter of 10 microns (µm) or less in aerodynamic diameter (PM_{10}), and particulate matter of 2.5 µm or less in aerodynamic diameter ($PM_{2.5}$), within the provincial jurisdiction of British Columbia (B.C.).

This SOP describes particulate matter (PM) measurements using a low flow rate sampler, (e.g., Partisol™). Subsequent analysis of the sample filter by an analytical laboratory is required to complete the measurement of PM. The laboratory analysis procedure is not covered in detail within this SOP.

Operating guidelines and instructions for particulate matter measurements using other analytical methods are provided in SOPs 5a through 5d.

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 low flow rate sampler within the provincial jurisdiction of B.C. should be carried out with consideration to Part B of the BCFSM, the equipment manufacturer's manual, and this document.

2. Document Control

This Standard Operating Procedure is a controlled document. Document control provides a measure of assurance that the specifications and guidance it provides 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 Measurement Method

Low Flow Rate Filter Collection and Gravimetric Mass Determination

The Sampler can be fitted with a TSP, PM_{10} or $PM_{2.5}$ inlet head to provide selective sampling of the particulate size fraction of interest. The Sampler draws ambient air through the inlet head and a 47 millimeter (mm) diameter sample filter, which traps the particulate. The sample filter is pre-conditioned, inspected and pre-weighed before sampling. After sampling the filter is reconditioned and reweighed. The difference in filter weights provides the mass of the target size particulate that accumulated on the filter during the sampling period. The Sampler draws air through the filter at a controlled flow rate of 16.67 liters per minute (l min^{-1}). During the sampling period the elapsed sampling time is recorded. The flow rate and elapsed time are used to calculate the total sample volume in cubic meters (m^3). The mass of the accumulated particulate and sample volume are used to calculate the average particulate

concentration in micrograms per cubic meter (µg/m^3) over the sampling period.

The Partisol™ model 2025i is equipped to exchange sample filters automatically at a pre-set time interval, and a capacity of 16 filter cassettes. A dichotomous version of this Sampler provides dual sample trains that sample both PM_{10} and $PM_{2.5}$ simultaneously in the same unit.

4. Interferences

Filter contamination can interfere with measurement results. The filter should be secured and kept clean prior to filter installation. After the sampling event the filter should be removed as soon as practical. To minimize contamination it is recommended that powderless nitrile gloves are worn when handling filter cassettes.

Any damage to the filter during handling will invalidate the measurement.

5. Precision and Accuracy

Since particulate measurement relies on pre-sampling and post-sampling filter weights any contamination of the filter can lead to invalid results.

One blank filter should be submitted to the laboratory with each shipment of sampled filters. The blank filter is a 'trip blank' and as such should remain in the holder/petri dish and be returned to the laboratory with the same batch of filters it was received with. It is recommended that you consult with your laboratory to determine if your particular monitoring objectives should also include a field blank.

6. Recommended Equipment and Apparatus

The following instruments are commercially available and suitable for use within the B.C. ENV's jurisdiction:

- Thermo Scientific Partisol™ Model 2025i and 2025i-D
- Thermo Scientific Partisol™ Model 2000i and 2000i-D
- Thermo Scientific Partisol™ Model Plus 2025 and 2025D
- Thermo Scientific Partisol™ Model 2000-D
- Thermo Scientific Partisol™ Model 2000-FRM
- Rupprecht & Patashnick Partisol™ Model 2000

Generally, a 47 mm Teflon filter is used for $PM_{2.5}$ sampling and a TX40 (Teflon coated glass fibre), quartz fibre or Teflon materials are used for PM_{10} and TSP sampling. However; if further analysis (e.g. metals analysis) on the sample filter is required, a different filter type may be recommended by the analytical laboratory.

This list does not necessarily exclude other commercially available non-continuous PM filter Samplers, and Samplers recognized by United States (US) Environmental Protection Agency's (EPA) Federal Reference and Equivalent Methods. It is recommended however that you consult with the B.C. Ministry of Environment and Climate Change Strategy (ENV) if you intend to deploy a non-continuous PM Sampler 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

By using different sample inlets, low flow rate samplers can be used to collect TSP, PM_{10} and $PM_{2.5}$ samples.

The lower range of particulate concentration resulting from this method of sampling is typically around 2 µg/m^3. Environment Canada reported in 2008 that the upper concentration limit is at least 200 µg/m^3 for $PM_{2.5}$ sampling at a flow rate of 16.7 l min^{-1} and a sampling period of 24 hours.

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 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 the location.

Refer to Section XX of the B.C. Field Sampling Manual for further information on site selection.

9. Installation Requirements

Follow the Air Sampler's 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 meter 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's inlet should be at least twice the height of the obstruction.
- The Sampler should be located in a position that accommodates an unrestricted air flow in 3 of the 4 wind quadrants.
- The appropriate size fraction separator must be installed onto the instrument for the particulate size fraction of interest.
- The tube connecting the size selective inlet to the filter compartment should be vertical with no bends.
- The Sampler should be located away from localized sources of particulate such as unpaved roads that could influence monitoring results unless identified as a source of interest when establishing monitoring objectives.

10. Operational Requirements

Follow instrument specific operational requirements discussed in the manufacturer's manual. Exact requirements will vary by Sampler, however in general the following activities should be performed by the operator of a low flow rate Sampler:

Action	Time/Frequency	Description	Record Keeping
Sampling Frequency	At installation	• Sampler to operate every 6th day on the North American standard, unless	Record in logbook

		an alternative schedule has been agreed with by the B.C. ENV.	
Sampling Period	At installation	• Samples should be collected over a 24 hour period (midnight to midnight).	Record in logbook
Filter Cassettes	At installation	• Use filters within 30 days of conditioning by the laboratory. • Record Sampler ID, filter and cassette ID's and date.	• Record in logbook • Complete Chain of Custody (COC) information required by the analytical laboratory.
	After each use	• Clean cassette as per manufacturer's operation manual. • Inspect the rubber seals and replace if necessary.	Record in logbook
Data retrieval	At filter retrieval	• Retrieve filter within 5 days of the sampling event. • Record end and elapsed time, sample volume, filter temperature, ambient temperature (minimum, maximum and average), and ambient pressure.	• Record in logbook • Complete COC information required by the analytical laboratory.
Routine checks	• Weekly	• Check water trap on PM_{10} inlet and empty if required.	Record in logbook
	• Quarterly • Prior to calibration	• Verification (as-is check) as per manufacturer's operation manual for flow, pressure, temperature, date and clock. • If any of the parameters are outside of the pass criteria listed in the table provided in Section 12 of this SOP, a calibration should be performed. • Perform leak check. • Inspect inlets and impactor; clean if required. • Lubricate O-rings. Inspect and replace if required. • Lubricate V seals on the $PM_{2.5}$ inlet. Inspect and replace if required.	
	• Bi-annual	• Inspect Sampler interior, inlet and impactor and clean if required. • Check the in-line filter and replace if required. • Perform calibration (temperature, pressure, flow and clock).	
	• Annual	• Replace the in-line filter. • Rebuild the pump. • Check the clock battery and replace if required. • Temperature, pressure and flow rate verification check standards should be calibrated against a National	

		Institute of Standards and Technology (NIST) traceable standard.	
Internal/External Leak check	• Monthly • Prior to bi-annual inspection (of Sampler interior, inlet and impactor) • Prior to calibration	• Perform Internal and external leak check as per the manufacturer's operation manual.	Record in logbook
Calibration (temperature, pressure, flow, clock)	• At installation • Bi-annually	• As per Section 12 of this SOP • If the temperature or pressure sensor requires calibration (adjustment) then the flow must be verified and recalibrated.	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 the manufacturer's manual. The following instructions and information are specific to low flow rate Sampler calibration.

Several parameters require calibration including flow, temperature, ambient pressure, clock and date. The calibration procedure comprises the following sequential steps:

- Step 1 – As-found verification of flow, temperature and pressure
- Step 2 – Leak check
- Step 3 – Multi-point verification; calibrate if necessary.
- Step 4 – As-left verification

Step 1, verification is used to determine that prior samples were obtained under valid conditions. The verification comprises a check against a known standard. The flow verification should be performed using a flow meter which is calibrated or certified annually against a 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. In Step 2 the leak checks (internal and external) are undertaken to ensure there are no leaks in the sample train before undertaking a calibration. If leaks are detected during this step they should be addressed, and the flow re-verified as in Step 1. The pass criteria for all parameters for Steps 1 and 2 are provided in the following table.

Parameter	**Pass Criteria**
Flow	±4% of 16.7 l min^{-1} (between 16.00 l min^{-1} and 17.34 l min^{-1})
Temperature	±2 °C from true
Ambient pressure	±10 mmHg from true
Relative Humidity	±10%
Clock and date verification check	Clock should be within ±2 minutes of standard time, and the date

	should be correct.
Leak check	As per instrument manual

Parameters that do not meet the pass criteria in the table above should be adjusted in Step 3. After adjustment a final verification (Step 4) is undertaken to confirm parameters are within the required criteria.

13. References

National Air Pollution Surveillance (NAPS) Program. Monitoring and Quality Assurance/Quality Control.

Environment Canada 2008. *Method for the measurement of PM10 Concentration in Ambient Air Using Filter Collection*. Environment Canada Environmental Science and Technology Centre.

Environment Canada 2004. *NAPS Network Quality Assurance and Quality Control Guidelines*. EC Environmental Protection Service Environmental Technology Advancement Directorate Analysis and Air Quality Division. Report No. AAQD 2004-1.

Environment Canada 2012. *National Air Pollution Surveillance (NAPS) Network Reference Method for the Measurement of PM2.5 Concentration in Ambient Air Using Filter Collection and Gravimetric Mass Determination*. Air Quality Research Division.

Alberta Environment (AENV) 2011. *Standard Operating Procedure for Measurement of Particulate Matter in Ambient Air Using the Partisol 2000H.* AENV Air Monitoring and Audit Centre.

California Environmental Protection Agency Air Resources Board (CARB) 2016. *Standard Operating Procedures for Thermo Scientific Partisol Model 2025i Sequential Air Sampler*. AQSB SOP 404, Second Edition.

Thermo Scientific 2015. *Partisol 2025i Sequential Air Sampler/Partisol 2025i-D Dichotomous Sequential Air Sampler Instruction Manual.*

United States Code of Federal Regulations 2013. *Title 40 Part 58 Appendix E, Probe and Monitoring Path Siting Criteria for Ambient Air Quality Monitoring.* Prepared by the US Government Publishing Office.

United States Environmental Protection Agency (US EPA) 2013. *QA handbook for Air Pollution Measurement Systems Volume II Ambient Air Quality Monitoring Program*. US EPA Office of Air Quality Planning and Standards Air Quality Assessment Division.

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Approval