Monitoring Parameter: **Dustfall and Metals**	Title: **Standard Operating Procedure for the Sample Collection of Dustfall (Settleable Particulate Matter) and Metals -DRAFT**
Revision No: Draft **Revision Date: 08 March, 2018**	**Reference No: SOP-05c** **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 measurement of dustfall (settleable particulate matter), within the provincial jurisdiction of British Columbia (B.C.).

This SOP describes dustfall sample collection using a dustfall container. Subsequent analysis of the sample by an analytical laboratory is required to complete the measurement of dustfall. The laboratory analysis procedure is not covered in detail within this SOP.

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. Dustfall sampling within the provincial jurisdiction of B.C. must be carried out with consideration to Part B of the BCFSM, and this document.

Dustfall sampling is considered to be a relatively coarse method of measurement and is used primarily for monitoring nuisance dust. This method provides a measure of airborne substances that settle onto a surface over a period of time, rather than providing the concentration of dustfall in ambient air at a given point in time. Where monitoring objectives include the protection of human heath, monitoring of particulate matter in ambient air (PM_{10} and/or $PM_{2.5}$) would be more appropriate than monitoring dustfall.

2. Principle of the Sampling Method

Dustfall Containment

A weather resistant open top container of known dimensions is prepared by a laboratory. The containers are cleaned and sealed by the laboratory with a measured quantity of reagent water, which acts to prevent resuspension of any material that settles into the container. At the sampling location, the container is set up on a stand and opened so that particulate matter can settle into the container. The container is left for a period of 30 days. At the end of the sampling period the container is sealed and returned to the laboratory for analysis. The laboratory analysis determines the total dustfall as the mass of the water soluble and insoluble material collected within the container. Dustfall results are reported in units of mass per area per time. Common units are milligrams per square decimeter per day ($mg/dm^2/day$).

Additional analysis can be undertaken to determine the fixed (non-organic) and volatile (organic/combustible) portions of the dustfall, and metals content.

3. Interferences

Potential interferences include precipitation (rain and snow), freezing temperatures, hot temperatures, algae growth, wildlife, and contamination by material which did not settle into the container, other

debris (e.g., leaves, etc.).

Freezing

If the liquid within the container freezes, settled particulates are no longer captured by the liquid collection medium and can potentially be re-suspended, invalidating the dustfall measurement. To mitigate the potential of this type of interference the laboratory should be consulted to add an anti-freeze reagent (typically isopropyl alcohol) to the container during the preparation stage.

Precipitation

Rain and snow can collect in the container during the sampling period. The dustfall sample is invalidated if the precipitation during the sample period causes the container to overflow. To prevent this potential interference the liquid level within the sample container should be routinely checked during periods of high precipitation. If the level of the liquid rises to within 2.5 centimetres (cm) of the top of the container a new container should be deployed. In this circumstance both containers are used to determine the dustfall during the 30 day sampling period. Selecting a larger sized sampling container can also help prevent liquid overflow.

High precipitation levels can also cause dilution of the antifreeze mixture used in the container, which in turn can cause the liquid within the container to freeze and possibly damage the container. To prevent this from occurring, the laboratory can increase the ratio of antifreeze to reagent water during the container preparation.

Hot Temperatures

Consistently hot temperatures and or strong winds occurring over the sampling period may cause partial or full evaporation of the reagent water. Complete evaporation of the liquid (reagent water) renders the dustfall sample invalid. During periods when high temperatures are forecast, the reagent water within the sample container should be checked mid-way through the sampling period. If the level of the liquid falls to within 5 centimetres of the container's bottom, the container should be topped up with deionized water to reduce the risk of desiccation. Alternately, selecting a larger sized sampling container with a larger initial charge of reagent water will help prevent desiccation. It is important to note that deionized water is the only acceptable top-up liquid as other liquids may contain dissolved or suspended solids that would invalidate the sampling.

Algae growth

The dustfall measurement relies on the weight of the container's contents, therefore algae growth within the container can be an interferent. To avoid this, the laboratory can add an algaecide in the reagent water for sample events occurring during periods where temperatures are unlikely to drop below freezing. Copper sulphate may sometimes be used as an anti-algae reagent however due to the copper content in the algaecide; this reagent should not be used if the dustfall sample will undergo metals content analysis.

Wildlife

Wildlife interactions with the sampling equipment can cause interference with the dustfall measurement in a number of ways. Birds flying overhead or landing on the sample container can interfere with the collection of dustfall and inadvertently deposit materials into the sample container. Larger animals can damage the equipment, tilt the stand or knock the stand over.

Contamination

The dustfall measurement relies on the weight of the container's contents; therefore, any material that gets into the container that did not settle into the container can be an interferent. This can include material such as leaves and insects.

4. Precision and Accuracy

The precision of a measurement is generally considered to be the 'repeatability of the measurement'.

Dustfall measurements are affected by factors during the sample collection period (such as measurement height and meteorological conditions) as well as the laboratory's analysis method.

American Standard Test Method (ASTM), 2017 report that the use of a wind shield and setting the sample container at a collection height of 2 meters (m) (or higher) provides better precision.

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. In the field duplicate sample containers should be used for every ten sample containers. For programs with less than 10 samples, at least one duplicate sample should be used.

5. Recommended Apparatus

For dustfall sampling, a container and stand are required. The following container sizes are commonly used in B.C.:

	Small Size	**Large Size**
Capacity (litres)	2	4
Height (cm)	24.2	~25
Diameter (cm)	12.0	~15
Opening (cm)	9.0	10

The sample container should be constructed of stainless steel or weatherproof plastic with a tight fitting lid. It is important to use containers that were recently shipped from the laboratory as opposed to containers that have been stored for a few months prior to deployment. This quality control step is important for the following reasons:

- The laboratory keeps a blank sample of the contents of the container,
- The type and composition of reagents in the containers vary seasonally. Reagent compositions are based on weather conditions, and;
- Reagents may change based on monitoring objectives (e.g. metals analysis).

The stand can be fabricated from wood or metal. It should hold the container firm and level at a height of at least 2 metres (to container top) above ground level (ASTM, 2017). Use of a wind shield around the container opening is recommended as a best practice. A cross section and plan view of a wind shield for dustfall sampling are provided within reference ASTM, 2017.

6. Measurement Range and Sensitivity

Analysis range and sensitivity depend on the method employed by the laboratory. The lower range of total dustfall measurement reported by a commercial laboratory is typically 0.1 mg/dm^2/day.

7. Site Requirements

Monitoring site specifications should be developed to ensure that the data obtained from the site meets the intended or established monitoring objectives. It is recommended that monitoring site requirements be established in consultation with the B.C. ENV to ensure that siting requirements are commensurate with monitoring objectives. As a preliminary guideline site selection should consider and address: monitoring objectives, representativeness of the region, interference from the surrounding area, and zone type (residential, commercial, industrial) of the location. Refer to Section XX of the BCFSM for further information on site selection.

8. Installation Requirements

The dustfall station installation should conform to the following:

- The monitoring location should be an open area, with no structures higher than 1 m within a 20 m radius of the dustfall container.
- The container should be placed at 2 m above the ground (2 m from ground to container opening).
- Locate the container more than 10 stack heights from an operating stack (unless the monitoring objectives are to specifically monitor stack impacts).
- Higher objects such as trees and buildings should not exceed 30 degrees from the horizontal as viewed from the monitoring location. This is shown in the following figure.

Figure reference: B.R. Irwin, ENV

9. Sampling Requirements

The following activities should be performed by the operator of a dustfall sampling program:

Action	Time/Frequency	Description	Record Keeping
Container Preparation	Prior to installation	Use an algaecide addition in warm months. Use an antifreeze addition when near freezing or freezing conditions are expected during the sampling period.	Record in logbook
Container Deployment	At installation	Record the date, time, location, measurement height, container opening diameter, sample identification and batch number.	• Record in logbook • Complete Chain of Custody (COC) information required by the analytical laboratory.
Maintenance	As required	Check liquid levels within container:	• Record in logbook

During Sampling Period	during the sampling period	To avoid overflows, change container if the liquid level rises to within 2.5 cm of the container's top. Note on the COC if it is suspected that the container may have overflowed. If the level of the liquid falls to within 5 centimetres of the container's bottom, the container should be topped up with deionized water to reduce the risk of desiccation.	• Complete COC information required by the analytical laboratory.
Container Retrieval	At the end of the sampling period (30 days ±2 days after deployment)	Check for signs of animal interference, and vandalism/tampering. Check the integrity of the sample container. Report any findings. Seal the sample: record the date, time, sample identification and batch number. Send the sealed sample container to the laboratory for analysis. Minimize the storage period and refrigerate the sample container if submission to the laboratory is delayed.	• Record in logbook • Complete COC information required by the analytical laboratory.

10. Zero and Span Checks

This section is not applicable to this measurement method.

11. Calibration

This section is not applicable to this measurement method.

12. References

Alberta Government. 2016. *Air Monitoring Directive Chapter 4: Monitoring Requirements and Equipment Technical Specifications* Version Dec 16, 2016.

American Standard Test Method (ASTM) 2017. *Standard Test method for Collection and measurement of Dustfall (Settleable Particulate Matter).* Designation: D1739 – 98 (Reapproved 2017).

Leung, T.B., Manna, B.B. 1984. *Site Selection Guidelines and Criteria for Ambient Air Monitors*. Air Quality Engineering Unit, Waste Management Branch.

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Approval