



Environmental Analysis Program

Pomona College
Biogeochemistry Laboratory

SOP-F503

Particulate Matter Sampling – Gravimetric Filter Method

Standard Operating Procedure

SOP Number	SOP-F503
Revision	0.2
Author(s)	Marc Los Huertos
Date	2026-06-26
Organization	EA Program, Pomona College

FOR INTERNAL USE ONLY

This document is the property of the Environmental Analysis Program at Pomona College.
Unauthorized distribution is not permitted.

Table of contents

1 Purpose	1
2 Scope	2
3 Responsibilities	2
4 Definitions	2
5 Safety and Hazards	3
5.1 Required PPE	3
6 Equipment and Materials	4
6.1 Sampling Equipment	4
6.2 Filter Supplies	4
7 Procedure	4
7.1 Filter Conditioning and Pre-Weighing	4
7.2 Sampler Setup and Flow Calibration	4
7.3 Deployment	5
7.4 Retrieval	5
7.5 Post-Sampling Conditioning and Weighing	5
7.6 Filter Archiving and Downstream Analysis	6
8 Quality Control	6
9 Waste Disposal	6
10 References	6
11 Related SOPs	7
12 Training Record	7

1. Purpose

This procedure describes the collection of ambient particulate matter (PM) on pre-weighed filters using active (pump-based) samplers for subsequent gravimetric and/or chemical analysis. Gravimetric filter sampling provides a reference-quality mass concentration that can be used to validate or

calibrate low-cost PM sensors (see [SOP-F502](#)) and to collect PM for compositional analysis (metals, ions, elemental/organic carbon) (Chow, 1995; US Environmental Protection Agency, 2017).

Ambient PM is a complex mixture of solid and liquid particles suspended in air, originating from both primary sources (combustion, dust, sea spray) and secondary formation (gas-to-particle conversion of sulfate, nitrate, and organic compounds) (Seinfeld & Pandis, 2016; [poschl2005?](#)). Gravimetric filter sampling remains the reference standard for PM mass measurement because it directly weighs the collected material, avoiding the indirect assumptions inherent in optical or beta-attenuation methods (US Environmental Protection Agency, 2017).

This SOP covers medium- and low-volume filter-based samplers operated by EA Program personnel. It does not cover Federal Reference Method (FRM) high-volume samplers operated by regulatory agencies.

2. Scope

- **Applies to:** Collection of PM_{2.5} and PM₁₀ on filters using portable or semi-permanent medium-volume or personal air samplers (e.g., MiniVol, BGI PQ200, SKC personal samplers) at EA Program field sites
- **Does not apply to:** Low-cost optical sensors without filters (see [SOP-F502](#)); FRM/FEM high-volume samplers operated by AQMD or EPA; indoor air quality sampling; gas-phase pollutant sampling
- **Location:** EA Program field deployment sites in the Pomona College area and surrounding Inland Empire communities

3. Responsibilities

Role	Responsibility
PI / Field Lead	Approve sampling plan, coordinate site access
Trained Personnel	Condition filters, deploy sampler, retrieve and weigh filters
Lab Manager	Maintain balance, desiccator, and sampler calibration
New Students	Complete training before independent deployment

4. Definitions

- **Particulate matter (PM):** A mixture of solid particles and liquid droplets suspended in air, ranging in size from a few nanometers to tens of micrometers (Seinfeld & Pandis, 2016).
- **PM_{2.5}:** Particulate matter with aerodynamic diameter less than 2.5 μm (“fine particles”). Fine particles penetrate deep into the lungs and are associated with cardiovascular and respiratory health effects ([solomon2001?](#)).
- **PM₁₀:** Particulate matter with aerodynamic diameter less than 10 μm . Includes both fine (PM_{2.5}) and coarse (2.5–10 μm) fractions.

- **Gravimetric analysis:** Determination of PM mass by weighing a filter before and after exposure, under controlled temperature and humidity conditions (US Environmental Protection Agency, 2017).
- **Size-selective inlet:** An impactor or cyclone that removes particles above a defined aerodynamic diameter cutpoint (e.g., 2.5 or 10 μm) before they reach the filter.
- **PTFE filter:** Polytetrafluoroethylene (Teflon) membrane filter. Chemically inert, hydrophobic, and low in artifact mass; the standard substrate for gravimetric PM analysis.
- **Quartz fiber filter:** A filter made of quartz (SiO_2) fibers, used when thermal-optical analysis for elemental and organic carbon is planned. Must be pre-fired at 500 C for 4 hours to remove organic artifacts.
- **Filter conditioning:** Equilibrating filters at controlled temperature (20–25 C) and humidity (30–40% RH) in a desiccator for at least 24 hours before weighing. Conditioning removes adsorbed water that would bias the mass measurement.
- **Field blank:** A conditioned filter transported to the field site, briefly exposed to ambient conditions without running the pump, then resealed and returned for weighing. Field blank mass quantifies contamination introduced during handling and transport.
- **Flow rate:** The volumetric rate at which air is drawn through the sampler, typically expressed in L/min. The flow rate must match the design specification of the size-selective inlet (e.g., 5 L/min for a MiniVol $\text{PM}_{2.5}$ impactor).
- **Chemical speciation:** Analysis of the chemical composition of collected PM (e.g., metals by XRF or ICP-MS, ions by IC, carbon fractions by thermal-optical analysis) (**chow2015?**).

5. Safety and Hazards

Hazards

- **Electrical:** Sampling pumps require AC or battery power. Protect connections from rain and moisture.
- **Traffic:** Many monitoring locations are near roadways. Wear a high-visibility vest and follow [SOP-F001](#) traffic safety procedures.
- **Lifting:** Medium-volume samplers (e.g., MiniVol TAS) and batteries can be heavy (10–15 kg). Use proper lifting technique.
- **Heat:** Enclosures and pumps can overheat in direct sunlight during Inland Empire summers.

5.1. Required PPE

- ☐ Nitrile gloves (when handling filters)
- ☐ Closed-toed shoes
- ☐ High-visibility vest (if near roadways)
- ☐ Sun protection

6. Equipment and Materials

6.1. Sampling Equipment

Item	Notes
Medium-volume sampler (e.g., MiniVol TAS, BGI PQ200) or personal sampler (SKC, Leland Legacy)	With size-selective inlet (PM _{2.5} or PM ₁₀ impactor)
Calibrated flow meter (rotameter or primary standard, e.g., Bios DryCal)	For verifying and adjusting flow rate
Timer or elapsed-time indicator	Built into most samplers
Tripod or mounting pole	For positioning inlet at 1.5–2 m
Battery or AC power source	Sufficient for the planned sampling duration

6.2. Filter Supplies

Item	Notes
Pre-weighed PTFE filters, 47 mm	For gravimetric analysis
Pre-weighed quartz fiber filters, 47 mm	If EC/OC analysis is planned; pre-fire at 500 C for 4 h
Filter cassettes or holders	Matched to the sampler
Petri dishes or filter transport cases	For transporting conditioned filters
Forceps (flat-tipped, non-serrated)	For handling filters
Desiccator with active desiccant	For filter conditioning
Analytical balance (0.01 mg or better)	Per SOP-L200

7. Procedure

7.1. Filter Conditioning and Pre-Weighing

1. Place unused filters in a desiccator at controlled temperature (20–25 C) and humidity (30–40% RH) for at least 24 hours (US Environmental Protection Agency, 2017)
2. Weigh each filter on the microbalance to the nearest 0.01 mg. Record the filter ID and tare weight.
3. Weigh each filter a second time (at least 1 hour later) to confirm stability. The two weights should agree within 0.015 mg.
4. Place the conditioned filter in a labeled Petri dish or cassette. Seal and transport in a cooler if traveling to a remote site.

7.2. Sampler Setup and Flow Calibration

1. Install the appropriate size-selective inlet (PM_{2.5} or PM₁₀ impactor head) on the sampler

2. Load a blank filter cassette and connect the calibrated flow meter downstream of the filter holder
3. Start the pump and adjust the flow rate to the nominal design flow for the inlet (e.g., 5 L/min for a MiniVol PM_{2.5} impactor)
4. Record the calibrated flow rate, temperature, and barometric pressure. If the site is at a different elevation than the calibration location, apply a volumetric correction.
5. Remove the blank cassette and load the pre-weighed sample filter using forceps. Handle the filter only by its edges.

7.3. Deployment

1. Position the sampler with the inlet at 1.5–2 m above ground level, unobstructed by walls or overhangs (at least 2 m from any vertical surface)
2. Record the start date, start time, site ID, filter ID, GPS coordinates, and weather conditions
3. Start the sampler and verify that the pump is running
4. For 24-hour integrated samples, allow the sampler to run for 23–25 hours

7.4. Retrieval

1. Record the stop time and elapsed run time
2. Verify the flow rate with the calibrated flow meter before stopping the pump (post-sampling flow check). Record the value.
3. Stop the pump
4. Remove the filter cassette using gloves. Transfer the exposed filter to its labeled Petri dish using forceps. Do not touch the deposit surface.
5. Seal the Petri dish and place in a cooler for transport
6. Calculate the average flow rate: $Q_{\text{avg}} = (Q_{\text{pre}} + Q_{\text{post}})/2$. If pre- and post-flow rates differ by more than 10%, flag the sample.

7.5. Post-Sampling Conditioning and Weighing

1. Condition the exposed filter in the same desiccator and at the same temperature/humidity as the pre-weighing step for at least 24 hours
2. Weigh the filter to the nearest 0.01 mg. Record the gross weight.
3. Repeat the weighing at least 1 hour later to confirm stability.
4. Calculate the net PM mass:

$$m_{\text{PM}} = W_{\text{post}} - W_{\text{pre}}$$

5. Calculate the PM concentration:

$$C_{\text{PM}}(\mu\text{g}/\text{m}^3) = \frac{m_{\text{PM}}(\mu\text{g})}{Q_{\text{avg}}(\text{L}/\text{min}) \times t(\text{min})} \times 10^3$$

7.6. Filter Archiving and Downstream Analysis

1. After gravimetric analysis, archive filters in sealed Petri dishes at room temperature (or at -20 C if chemical analysis is planned)
2. For elemental/organic carbon analysis, submit quartz filters to the analytical laboratory per their instructions
3. For metals analysis by XRF or ICP-MS, submit PTFE filters per [SOP-L205](#) or [SOP-L410](#)
4. Chemical speciation of collected PM provides source apportionment data that complements the mass concentration measurement (**chow2015?**)

8. Quality Control

- Collect at least one field blank per sampling event: load a conditioned filter into a cassette, transport it to the site, open the cassette briefly (without running the pump), seal, and return to the lab for conditioning and weighing
- Collect duplicate samples (co-located samplers) for at least 10% of sampling events. Duplicate PM concentrations should agree within 15%.
- Verify the balance with NIST-traceable check weights at the start of each weighing session
- Document pre- and post-sampling flow rates; flag samples where the difference exceeds 10%
- Re-condition and re-weigh at least 10% of filters as laboratory duplicates; agreement should be within 0.015 mg
- Negative net masses (post-weight less than pre-weight) can occur due to filter handling artifacts or volatile loss; flag and investigate these, but do not discard without documentation

9. Waste Disposal

Waste Type	Disposal Method
Exposed PTFE or quartz filters (after analysis)	Standard trash (non-hazardous)
Impactor grease and oiled impaction substrates	Chemical waste; EH&S pickup
Used desiccant	Standard trash or regenerate per manufacturer

10. References

- Chow, J. C. (1995). Measurement methods to determine compliance with ambient air quality standards for suspended particles. *Journal of the Air and Waste Management Association*, 45(5), 320–382. <https://doi.org/10.1080/10473289.1995.10467369>
- Seinfeld, J. H., & Pandis, S. N. (2016). *Atmospheric chemistry and physics: From air pollution to climate change* (3rd ed.). John Wiley & Sons.
- US Environmental Protection Agency. (2017). *Ambient air monitoring reference and equivalent methods* (40 CFR Part 50, Appendix L). US EPA.

11. Related SOPs

SOP	Title	Relationship
F001	Field Safety	Required prerequisite
F502	Portable PM Sensors	Low-cost sensor companion
F504	Picarro GHG Analyzer	Companion field instrument
F505	Passive Air Samplers	Companion gas-phase sampling
L200	Analytical Balance	Filter weighing
L205	XRF Analysis	Filter metals analysis

12. Training Record

Before deploying PM samplers independently, personnel must:

1. Read this SOP and [SOP-F001](#) in full
2. Demonstrate proper filter handling (forceps, desiccator, conditioning, weighing) under supervision
3. Perform a flow calibration and sampler setup under supervision
4. Deploy and retrieve a sampler for one complete sampling period with acceptable QC results (field blank mass within 0.015 mg of pre-weight; pre/post flow agreement within 10%)
5. Be signed off by the PI or field lead