

Australian Standard®

AS 3580.9.9:2017

Methods for sampling and analysis of ambient air

Method 9.9: Determination of suspended particulate matter—PM₁₀ low volume sampler—Gravimetric method

PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee EV-007, Methods for Examination of Air, to supersede AS/NZS 3580.9.9:2006.

After consultation with stakeholders in both countries, Standards Australia and Standards New Zealand decided to develop this Standard as an Australian Standard rather than an Australian/New Zealand Standard.

The objective of this Standard is to provide regulatory and testing bodies with a standard method for determining suspended particulate matter with an equivalent aerodynamic diameter of less than 10 µm utilizing a low volume sampler and size selective inlet.

This Standard deals with the determination of suspended particulate matter with an equivalent aerodynamic diameter (EAD) of less than approximately 10µm (PM₁₀). This is one in a series of Standards for the determination of particulate matter in ambient air.

The procedure described in this Standard involves batch sampling and the gravimetric determination of PM₁₀, and is based on the United States Code of Federal Regulations, Title 40, Chapter 1, Part 50 Appendix J, *Reference method for the determination of particulate matter as PM₁₀ in the atmosphere*.

The term ‘normative’ has been used in this Standard to define the application of the appendix to which it applies. A ‘normative’ appendix is an integral part of a Standard.

FOREWORD

Suspended particulate matter measured by this method includes particles with an equivalent aerodynamic diameter (EAD) of less than 10 µm, as passed by a size selective inlet (PM₁₀). Particles with EAD of 10 µm and less are classified as respirable and hence may affect health. Particles larger than 10 µm generally have nuisance and aesthetic impacts only. PM₁₀ emission sources include industrial processes, fuel combustion, burning of vegetation, incineration and natural causes such as wind blown dust and salt laden air.

METHOD

1 SCOPE

This Standard sets out a gravimetric method for determination of PM₁₀ in ambient air utilizing low volume sequential and non-sequential samplers equipped with size selective inlets. The method provides a measure of mean concentration of PM₁₀ in units of micrograms per cubic metre (µg/m³), normally sampled over a 24 h period.

This method may be used to collect particle samples for subsequent physical or chemical analysis.

2 REFERENCED DOCUMENTS

The following documents are referred to in this Standard:

AS ISO/IEC

17025 General requirements for the competence of testing and calibration laboratories

AS/NZS

3580 Methods for sampling and analysis of ambient air

3580.1.1 Part 1.1: Guide to siting air monitoring equipment

3760 In-service safety inspection and testing of electrical equipment

ISO/IEC

Guide 98 Uncertainty of measurement

Guide 98-3 Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)

EN

12341 Ambient air—Standard gravimetric measurement method for the determination of the PM₁₀ or PM_{2.5} mass concentration of suspended particulate matter.

ASTM

E563 Standard practice for preparation and use of an ice point bath as a reference temperature

US EPA

US Code of Federal Regulations—Environment Protection Agency 40 CFR, Chapter I, Part 50, Appendix J

US Code of Federal Regulations—Environment Protection Agency 40 CFR, Chapter I, Part 53

3 DEFINITIONS

For the purposes of this Standard the definitions below apply.

3.1 Equivalent aerodynamic diameter (EAD)

The diameter of a spherical particle of unit density (1 g/cm³) which exhibits the same aerodynamic behaviour as the particle in question.

3.2 Field blank filter

A filter not used for sampling, which has been taken into the field. The filter is handled as a sample filter, including placing it in the sampler filter holder, and removing it, except the sampler is not in operation during this time. A field blank filter is used to assess the effect of field conditions, transport conditions and field operator technique on the weighing procedure.

3.3 Laboratory blank filter

A filter not used for sampling, which remains in the laboratory. A laboratory blank filter is used to assess the effect of laboratory conditions and balance operator technique on the weighing procedure.

3.4 Measurement uncertainty

A variable associated with the result of a measurement that characterizes the dispersion of the values that could be reasonably attributed to the measurand.

3.5 PM₁₀

Atmospheric suspended particulate matter having an EAD of less than approximately 10 µm, which is passed by a size selective inlet having performance characteristics as defined in United States Code of Federal Regulations: Title 40, Chapter I, Part 50, Appendix J, or equivalent.

NOTE: One of the performance characteristics is a 50% collection efficiency of particles of 10 ±0.5 µm EAD.

3.6 U₉₅

A measurement of uncertainty at a confidence interval of 95% according to ISO/IEC Guide 98-3.

4 PRINCIPLE

Ambient air is drawn at a constant flow rate through a prepared filter via a PM₁₀ size-selective inlet. Size selective inlets designed for low volume air samplers require a specific volumetric flow rate usually between 3.0 and 16.7 L/min to achieve the correct aerodynamic particle size cut-point.

Each sample filter is weighed before and after sampling to determine the mass of the collected particles.

Sampling is normally of 24 h duration to average out the effect of diurnal variations in particle levels and to enable collection of sufficient mass of particulate matter. Provided that the mass of the filter is determined under carefully controlled laboratory conditions, mean concentrations of 5 µg/m³ (3 L/min sample flow rate) or 1 µg/m³ (16.7 L/min sample flow rate) and greater may be determined, based on a 24 h sampling period. It is possible that some particulate matter, depending upon its hygroscopicity or volatility may alter in mass from its initial as-sampled state because of the environmental conditions and filter equilibration procedure referred to in Clauses 7.1 and 7.4. The degree of mass change is largely due to the nature of sampled aerosol and may vary from day to day, site to site and seasonally.

The PM₁₀ concentration is determined by dividing the mass of collected particulate matter by the sample volume, which is calculated from the sample duration and either the average or totalized flow rate.

5 APPARATUS

5.1 PM₁₀ sampler

The PM₁₀ sampler shall consist of a PM₁₀ size-selective inlet fitted to a low volume sampler. The PM₁₀ sampler shall demonstrate a performance equivalent to a U.S. EPA reference PM₁₀ sampler, sited and tested under the conditions described in Appendix A. The manufacturer's published performance specifications shall be deemed as acceptable evidence of conformance provided they have been carried out in accordance with Appendix A or U.S. EPA equivalency testing procedures described in the US Code of Federal Regulations 40 CFR, Part 53.

The PM₁₀ sampler shall consist of the following:

- (a) Sample inlet (incorporating rain cap and insect screen).
- (b) Sample tube.
- (c) Size selective inlet (impaction plate(s) or sharp cut cyclone).

The PM₁₀ size-selective inlet shall be a device designed to separate particles and permit only the PM₁₀ fraction to pass through to the filter. The PM₁₀ size-selective inlet shall be designed to collect particles of EAD 10 ± 0.5 mm at a 50% efficiency, on a mass basis, at the designated low volume sampler volumetric flow rate.

- (d) Filter holder.
- (e) Low volume sampler (incorporating pump, flow rate control, flow rate measurement, timer and enclosure).

NOTE: The sampler should be designed such that the filter temperature does not exceed 5°C above ambient during pre-sampling, sampling and post-sampling periods.

5.2 Filters

No commercially available filter medium is ideal in all respects for all samplers. Certain types of filters may not be suitable for use with some samplers, particularly under heavy loading conditions (high mass concentration), because of high or rapid increase in the filter flow resistance that would exceed the capability of the sampler's flow control device. The filter selected shall have a specified collection efficiency of at least 99.95% for particles of 0.3 µm EAD.

The filters shall be free from pinholes and other defects (see Clause 5.6).

NOTE: Where the collected sample is to be used for other determinant(s), the filter should be selected to ensure minimum interference to such determinant(s). Preferred filters are 37 mm or 47 mm diameter PTFE coated glass fibre, PTFE (with a support ring) or polycarbonate filters. Membrane filters shall have a maximum pore size of 2 µm.

5.3 Micro balance

An analytical balance with a minimum resolution of 1 µg, calibrated in accordance with Appendix B.

5.4 Static eliminator

An alpha particle source, e.g. Americium 241 of 4×10^5 Bq activity, or Polonium 210 of 2×10^7 Bq activity, or a high voltage static elimination unit, is required to neutralize any static charge on the filters prior to weighing. The alpha particle source shall be renewed when found to be ineffective (e.g. 1 to 2 years).

NOTE: A licence from the relevant radiation licensing authority may be required to operate and dispose of an alpha particle source.

5.5 Flow meter

A traceable transfer standard flow measuring device (e.g. electronic piston meter, electronic bubble meter or flow meter), with a U₉₅ of $\pm 2\%$ at the sampler's operating flow rate, may be used for field applications. The transfer standard device shall be calibrated against a reference standard device on a two yearly basis.

5.6 Light-table

A light-table to check filters for pinholes or other defects.

5.7 Temperature sensor

A traceable temperature sensor with a U₉₅ of $\pm 0.5^\circ\text{C}$ and a resolution of 0.1°C , calibrated in accordance with Appendix C.

5.8 Timing device

A stopwatch or other timing device capable of measuring elapsed time (typically greater than or equal to a period of 15 seconds), with a U_{95} of $\pm 1\%$ and a resolution of 0.1 second. The timing device shall be checked against the recorded time signal, over a minimum period of one hour initially, and then at an interval not exceeding six months.

5.9 Barometer

A traceable barometer with a U_{95} of ± 0.5 kPa, calibrated in accordance with Appendix D.

5.10 Relative humidity and temperature measuring device

A device for measuring and recording the relative humidity (U_{95} of $\pm 5\%$) and temperature (U_{95} of $\pm 1^\circ\text{C}$) of the filter conditioning environment, at intervals not exceeding 15 minutes.

The relative humidity and temperature measuring device shall be checked initially, and then at an interval not exceeding six months, at one relative humidity point and one temperature point.

6 CALIBRATION

6.1 General requirements

Verification checks of the sampler's temperature and pressure measuring devices (if equipped) shall be conducted on an annual basis against transfer standard instruments (see Clauses 5.7 and 5.9). A full calibration of the temperature measuring device(s) shall be conducted if the verification check indicates a difference equal to or greater than 2°C . A full calibration of the pressure measuring device(s) shall be conducted if the verification check indicates a difference equal to or greater than 1.3 kPa.

Calibration of the sampler's flow control and measurement device is required (see Clause 5.5).

NOTE: Low volume air samplers use various types of flow control and flow measurement devices. The specific procedure used for flow rate calibration or verification and the frequency of calibration will vary depending on the type of flow controller and flow indicator used. Calibration in terms of actual volumetric flow rate is generally recommended, but other measures of flow rate (e.g. mass flow controller) may be used providing they conform with the requirements of Clause 5.5. Consult the manufacturer's operational manual for specific guidance on calibration.

6.2 Flow rate calibration

The procedure shall be as follows:

- (a) Ensure that a clean filter has been installed.
- (b) Perform a leak check.
NOTE: A leakage rate less than 1% of the sampler design flow rate, at the maximum operating pressure drop, is acceptable.
- (c) Select the design flow rate for the inlet according to the manufacturer's specifications.
- (d) Connect the flow meter to the sample tube (an adaptor may be required).
- (e) Accurately measure the sampler's flow rate through the filter.
NOTE: For a bubble meter, time the period for the bubble to sweep the calibrated volume, and calculate the flow rate. The volume of a manually timed bubble meter should be such that the measured time period is a minimum of 15 seconds.
- (f) Record the ambient temperature and atmospheric pressure using the temperature sensor (see Clause 5.7) and barometer (see Clause 5.9).

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