

Australian Standard[®]

Methods for sampling and analysis of indoor air

Method 7: Determination of total suspended particulate matter—Gravimetric method

PREFACE

This Standard was prepared by the Australian members of the Joint Standards Australia/Standards New Zealand Committee EV-007, Methods of Examination of Air. 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 indoor total suspended particulate matter.

FOREWORD

Suspended particles are emitted in indoor air from a number of sources. Combustion sources such as cigarette smoking, food cooking and space heating are common together with the ingress of suspended particles from outdoor sources such as dust, moulds and similar material. It is recognized that concentration, size, morphology and composition are important health influences. Outdoor sources of suspended particulate matter include vehicle emissions, crustal dust, wear particles, and biogenic material.

The majority of suspended particles indoors are less than 10 µm in EAD and are thus in the respirable range. Indoor sources also contain textiles, moulds, wear particles, skin and dander fragments. Elevated concentrations of suspended particles can increase mortality and morbidity and impair breathing, particularly in those suffering from a respiratory disease such as asthma. Larger particles settle and can cause soiling and increased cleaning costs.

METHOD

1 SCOPE

This Standard sets out the method for the sample collection and gravimetric analysis of suspended particles in indoor air over the sampling period employed. The particles collected will have an equivalent aerodynamic diameter (EAD) of less than approximately 50 µm and greater than about 0.5–1 µm depending on filter loading.

This method is applicable to the measurement of total suspended particles in indoor air at concentrations above $5.0 \mu\text{g}/\text{m}^3$. The sampling head does not incorporate size selection.

NOTES:

- 1 Sampling is normally of 8 h duration to average out the effect of the 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.
- 2 It is possible that some particulate matter, depending upon its hygroscopic and/or volatility, may alter in mass from its initial as-sampled state. This is because of the environmental conditions and filter equilibration procedure referred to in Clause 6. The degree of mass change is largely due to the nature of the sampled aerosol and may vary from day to day, site to site and seasonally.
- 3 A proportion of some particles in indoor air environments (including smoke) which are finer than $1 \mu\text{m}$ EAD may be trapped.
- 4 Fibres from indoor air environments arising from textiles, carpets and mineral sources will also be trapped.

This Standard applies to indoor air environments such as homes, enclosed spaces accessible to the general population, educational and child and aged care institutions and offices. This Standard does not apply to spaces covered by occupational atmospheric standards.

2 DEFINITIONS

For the purpose of this Standard the definitions below apply.

2.1 Indoor air

Air in indoor environment such as dwellings, enclosed spaces accessible to the general population, educational, child and aged care institutions and office work places in buildings which are not subject to health and safety inspections in regard to air pollutants and also cabins of vehicles.

2.2 Air exchange rate

The number of times the volume of the airspace (e.g. room) being measured is replaced each hour by inflowing air.

2.3 Equivalent aerodynamic diameter (EAD)

The diameter of a spherical particle of density $1000 \text{ kg}/\text{m}^3$ which exhibits the same aerodynamic behaviour as the particle in question.

2.4 Total suspended particulate matter (TSP)

Particles within an approximate EAD of less than $50 \mu\text{m}$ and greater than $0.8 \mu\text{m}$.

2.5 U95

A measurement uncertainty with a confidence interval of 95% according to ISO GUM.

3 REFERENCED DOCUMENTS

FRENKEL, R.B. Statistical background to the ISO 'Guide to the expression of uncertainty in measurement'. National Measurement Laboratory Monograph 2: NML Technology Transfer Series Publication number TIP-1242. National Measurement Laboratory CSIRO, Sydney, July 2002.

BENTLEY, R.E. Uncertainty in Measurement: The ISO Guide. National measurement laboratory monograph 1: NML Technology Transfer Series Publication number TIP P1337, Fourth Edition. National Measurement Laboratory CSIRO, Sydney, May 2002.

NATA Tech Note 8: The in-situ calibration of barometers.

NATA Tech Note 13: User checks of balance calibration.

NATA Tech Note 19: Liquid-in-glass thermometers—Selection use and calibration.

ISO Guide to the expression of uncertainty in measurement (ISO GUM)

4 PRINCIPLE

Ambient air is drawn at a known flow rate through a prepared filter mounted in the low volume sampler filter holder. After sampling, the filter is weighed (gravimetric method). The sample volume is then calculated from the average flow rate and sample duration. The TSP concentration is then calculated.

5 APPARATUS

All flow, temperature, humidity and mass measurement apparatus shall be calibrated in accordance with NATA requirements, as detailed in NATA Tech Notes 8, 13 and 19.

5.1 Sampling train

The train shall meet the following requirements (typically illustrated in Figure 1):

- (a) A filter holder capable of housing a standard 47 mm diameter filter.
- (b) A stand or device to support the filter holder.
- (c) Flexible hose of internal diameter sufficient to permit the airflow through the sampling train at the specified rate without collapsing under the vacuum in the hose.
- (d) A pump capable of maintaining a constant flow rate at the sampling head. The pump may be external to the room under the conditions of test.
- (e) A calibrated dry gas meter of appropriate capacity with an uncertainty to within $\pm 2\%$ U95.
- (f) A calibrated flow meter capable of measuring the flow rate to within $\pm 2\%$ U95.

The pump and gas meter should be contained in a well-ventilated housing.

5.2 Light-table

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

5.3 Filters

Typically 47 mm diameter, of PTFE, cellulose membrane or polycarbonate construction with an effective pore size of $0.8\ \mu\text{m}$. The type selected is dependent on possible subsequent analysis and particle loading in the air. Generally cellulose membrane and PTFE are more suitable for chemical analysis and polycarbonate suitable for biological or fibre analysis.

NOTE: Glass fibre filters can be used. Other materials may be used for specific purposes. Electrostatic charge accumulation should be diffused with an ionization source before and during weighing.

5.4 Static eliminator

An alpha particle source (Americium 241 of 4×10^5 Bq activity, or Polonium 210 of 2×10^7 Bq activity), or 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 (typically 1 to 2 years).

NOTE: A licence from your state radiation regulator may be required to operate and dispose of an alpha particle source.

Alternatively, a high voltage static eliminator may be used.

5.5 Reference thermometer

A thermometer with an accuracy of $\pm 1^\circ\text{C}$ U95.

5.6 Analytical balance

An analytical balance with a resolution of 1.0 µg or less and capable of accommodating the filter without creasing.

5.7 Relative humidity and temperature measuring devices

Devices for measuring the relative humidity to within ±5% U95.

6 SAMPLING PERIOD

6.1 Sampling period

Sampling is normally over a period of 8 hours, but may range from a few hours to several days. The sampling period needs to take account of activities and personal exposure and assessment to air quality goals. This method does not estimate the inspirable or respirable dust fraction except in that it establishes an upper limit for them.

For an 8 hour sample at 20 L/min an indoor concentration of 10 µg/m³ suspended particles can be measured with a relative uncertainty of ±10%. The sampling rate should not exceed 10% of the total volume of the measured space subject to the air exchange rate. Air-conditioned spaces are considered to be the total volume of the air-conditioned space in the building. Consideration should be given to distributed air handling units.

NOTES:

- 1 Sampling is normally of 8 hour duration to average out temporal variations. Provided that the mass of the filter is determined under carefully controlled laboratory conditions, mean concentrations of 5 µg/m³ and greater may be determined using an 8 hour sampling period.
- 2 It is possible that some particulate matter, depending upon its hygroscopic and/or volatility, may alter in mass from its initial sampled state because of the environmental conditions and filter equilibration procedure referred to in Clause 6. The degree of mass change is largely due to the nature of the sampled aerosol and may vary from day to day, seasonally and from site to site.

6.2 Sampling position

The inlet to the sampling system should be placed in a position in the room which is representative of the air the occupants are likely to breathe. The sample inlet shall be orientated such that the filter is horizontal with the exposed side facing downwards. The sampling inlet should not be placed in a position in a corner, immediately against a wall in stagnant air or in a restricted space. If personal exposure assessments are required, location of the sampler should reflect the breathing space of the individual.

7 PROCEDURES

7.1 Balance and filter conditioning environment

A laboratory environment with a controlled atmosphere is required for conditioning and weighing filters for the entire conditioning period. The temperature shall be controlled between 15°C and 30°C with less than ±3°C measurement variation and relative humidity shall be controlled between 20% and 50% with less than ±5% measurement variation. Record the temperature and humidity of the controlled environment for each filter weighing session at minimum intervals of 15 minutes.

7.2 Filter preparation

The procedure shall be as follows:

- (a) Visually examine the filters on a light-table to ensure they are free from pinholes and other defects.
- (b) Allow the filters to come to equilibrium within the controlled atmosphere for at least 24 hours. Record the start time of the equilibration period.