

Australian/New Zealand Standard™

**Methods for sampling and analysis of
ambient air**

**Method 9.17: Demonstration of
equivalence for ambient particulate
matter monitoring methods**



AS/NZS 3580.9.17:2018

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Australian/New Zealand Standard™

Methods for sampling and analysis of ambient air

Method 9.17: Demonstration of equivalence for ambient particulate matter monitoring methods

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PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee EV-007, Methods for Examination of Air.

The objective of this Standard is to provide a methodology for determining whether a particulate matter monitoring instrument is equivalent to a reference method under Australian or New Zealand ambient conditions, where the instrument is not covered under a specific Standard for that technology.

During preparation of this Standard, the Committee took note of the European Commission Working Group on Guidance for the Demonstration of Equivalence publication (January 2010), ‘Guide to the Demonstration of Equivalence of Ambient Air Monitoring Methods’ (the EC Guide). Acknowledgment is made to JRC-IEC (Joint Research Centre—Institute for Environment and Sustainability) and the extracts used from the guide have been modified.

This Standard represents a subset of the methods and procedures outlined in the EC Guide. For this reason, candidate method instruments will have undergone testing in accordance with EN 15267* or have been designated United States Environmental Protection Agency (US EPA) equivalent method status†, for the particulate matter size fraction under consideration.

The terms ‘normative’ and ‘informative’ have been used in this Standard to define the application of the appendix to which they apply. A ‘normative’ appendix is an integral part of a Standard, whereas an ‘informative’ appendix is only for information and guidance.

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* Refer to www.qa11.de

† Refer to <https://www3.epa.gov/ttn/amtic/criteria.html>

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STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

Australian/New Zealand Standard
Methods for sampling and analysis of ambient air

Method 9.17: Demonstration of equivalence for ambient particulate matter monitoring methods

1 SCOPE

This Standard applies to continuous methods for monitoring particulate matter size fractions in ambient air, specifying a procedure for determining whether a candidate method is equivalent to the reference method under the ambient conditions experienced at its intended sampling locations. Only instruments that conform with the requirements of EN 15267, or have obtained US EPA equivalent method status, are acceptable as candidate method instruments for the particulate matter size fraction under consideration.

2 APPLICATION

This Standard is suitable for the evaluation of continuous particulate matter monitoring instruments not covered under a specific Standard for that technology, such as in-situ optical methods.

The procedure in this Standard enables the establishment of relationships with the reference method (RM) that can be applied to correct the candidate method (CM) output in order to demonstrate equivalence.

The test procedure consists of a series of field tests in which the candidate method is tested alongside the filter-based gravimetric reference method, operated in accordance with the applicable Australian or Australian/New Zealand Standard, i.e. AS/NZS 3580.9.6, AS/NZS 3580.9.7, AS 3580.9.9, AS 3580.9.10 or AS/NZS 3580.9.14.

NOTE: The particle size range measured by most continuous methods is unsuited to the measurement of total suspended particulate matter.

3 REFERENCED DOCUMENTS

The following documents are referred to in this Standard:

AS

3580	Methods for sampling and analysis of ambient air
3580.9.9	Method 9.9: Determination of suspended particulate matter—PM ₁₀ low volume sampler—Gravimetric method
3580.9.10	Method 9.10: Determination of suspended particulate matter—PM _{2.5} low volume sampler—Gravimetric method

AS/NZS

3580	Methods for sampling and analysis of ambient air
3580.1.1	Method 1.1: Methods for sampling and analysis of ambient air—Guide to siting air monitoring equipment
3580.9.6	Method 9.6: Determination of suspended particulate matter—PM ₁₀ high volume sampler with size selective inlet—Gravimetric method
3580.9.7	Method 9.7: Determination of suspended particulate matter—Dichotomous sampler (PM ₁₀ , coarse PM and PM _{2.5})—Gravimetric method

AS/NZS

3580.9.14 Method 9.14: Determination of suspended particulate matter—PM_{2.5} high volume sampler with size selective inlet—Gravimetric method

3580.14 Method 14: Meteorological monitoring for ambient air quality monitoring applications

ISO/IEC

Guide 98 Uncertainty of measurement

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

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 50, Appendix L

EC Working Group

Guide to the Demonstration of Equivalence of Ambient Air Monitoring Methods, European Commission Working Group on Guidance for the Demonstration of Equivalence

4 DEFINITIONS

For the purpose of this Standard the definitions below apply:

4.1 Candidate method (CM)

A measurement method proposed as an alternative to the relevant reference method against which equivalence is to be demonstrated.

4.2 Equivalent aerodynamic diameter (EAD)

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

4.3 Equivalent method

A measurement method other than the reference method for the measurement of the particulate matter size fraction for which equivalence has been demonstrated.

4.4 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.

4.5 PM_{2.5}

Atmospheric suspended particulate matter having an EAD of less than approximately 2.5 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 L, or equivalent.

NOTE: One of the performance characteristics is a 50% collection efficiency of particles of 2.5 ± 0.2 µm EAD.

4.6 Reference method (RM)

Australian/New Zealand Standard filter-based gravimetric method for the measurement of the particulate matter size fraction under consideration.

4.7 U₉₅

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

5 INSTRUMENT PERFORMANCE

Only instruments that have demonstrated conformance with the requirements of EN 15267, or have obtained US EPA equivalent method status, for the particulate matter size fraction under consideration, shall be acceptable CM. The CM shall be operated in a manner consistent with the configuration and settings used during the demonstration of conformance.

NOTE: The instrument may be used over any range within the limits of the Standards for which it has been tested.

The CM shall be tested under ambient and operational conditions that are representative of its intended use, including conformance with the maintenance, check and calibration intervals recommended by the manufacturer.

6 TEST PROCEDURE

6.1 General

A minimum of two comparisons shall be conducted at a minimum of one in five operating sites under a range of meteorological conditions in accordance with Clause 6.3. Two candidate instruments should be used at each site to assess the between instrument measurement uncertainty.

Laboratories performing the tests outlined in this Standard, including sampling, weighing of filters and analysis of data, shall meet the requirements of AS ISO/IEC 17025.

NOTES:

- 1 A laboratory may demonstrate conformance with the requirements of AS ISO/IEC 17025 through accreditation by a signatory member of the International Laboratory Accreditation Cooperation (ILAC), Mutual Recognition Arrangement (MRA) with a relevant scope of accreditation to cover the tests being performed.
- 2 For example, in Australia ILAC (MRA) accredited bodies include National Association of Testing Authorities (NATA).
- 3 For example, in New Zealand ILAC (MRA) accredited bodies include International Accreditation New Zealand (IANZ).

6.2 Reference method

To ensure the correct operation of the RM, two RM instruments should be used. The mean squared difference of the results of both RM instruments can then be used to estimate the magnitude of the measurement method random error.

6.3 Test sites

Test sites shall be in accordance with the requirements of AS/NZS 3580.1.1.

Test sites shall be representative of typical conditions for which equivalence is to be claimed, including possible episodes of high particulate matter concentrations. Sites shall be chosen with particular emphasis on the following variables:

- (a) Composition of the particulate matter size fraction, notably high and low proportions of semi-volatile material, to enable the impact of semi-volatile material loss to be evaluated, based on the prevalent sources.

- (b) High and low humidity and temperature to enable evaluation of losses during the sampling process.
- (c) High and low wind speeds to evaluate the performance of the instrument inlet.

Due to the highly variable nature of site conditions in Australia and New Zealand, this method only defines equivalence for the specific climate zone for which equivalence has been demonstrated. Equivalence shall not be claimed for other climate zones without first demonstrating equivalence in accordance with the procedures described in this Standard.

Climate zones based on rainfall and temperature applicable to this Standard in Australia and New Zealand are shown in Figures 6.3(A) and 6.3(B) respectively. The climate zones for New Zealand shall be determined by the type category (types A to G and M) in Figure 6.3(B) rather than the rainfall sub-category.

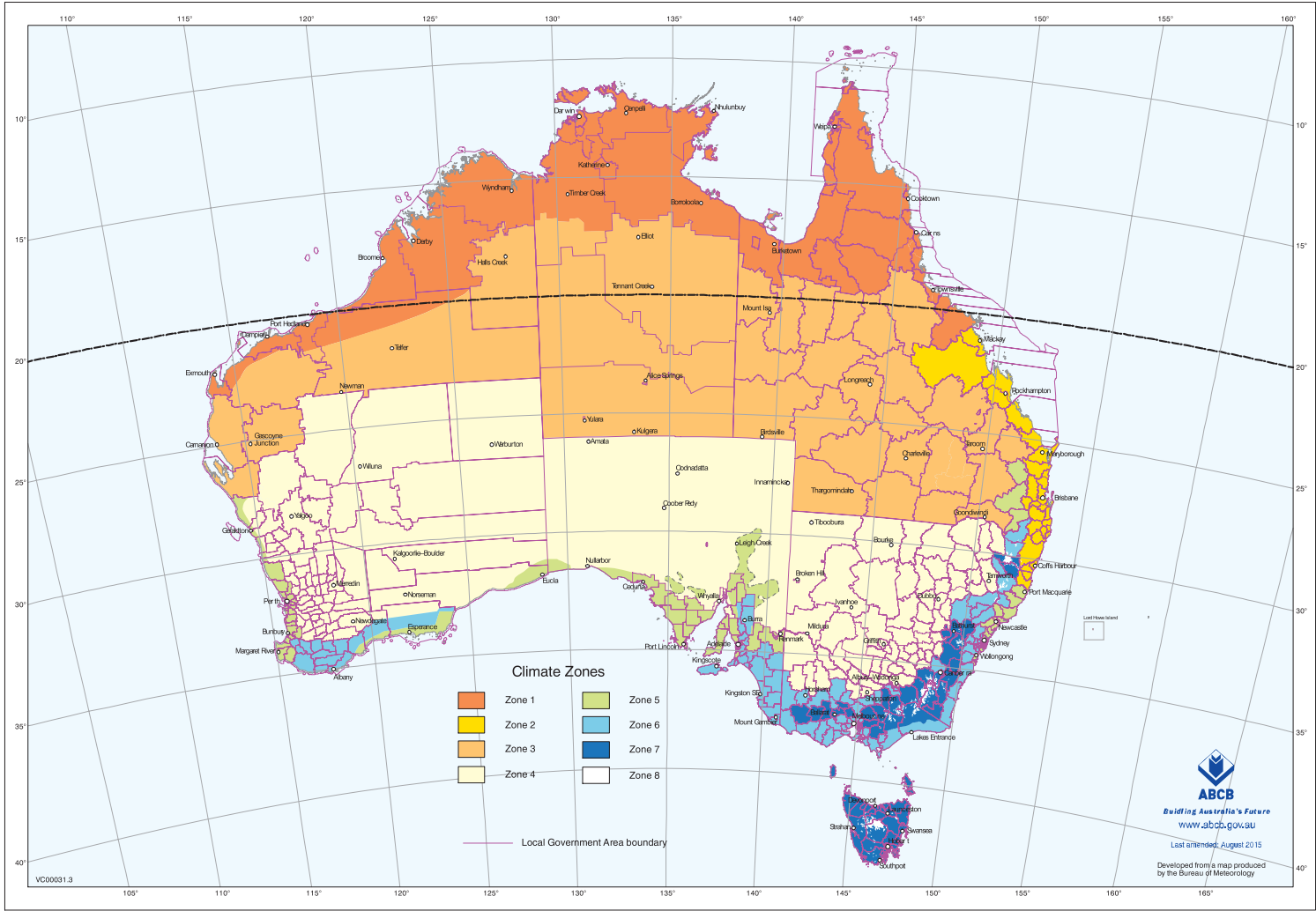


FIGURE 6.3(A) AUSTRALIAN CLIMATE ZONES

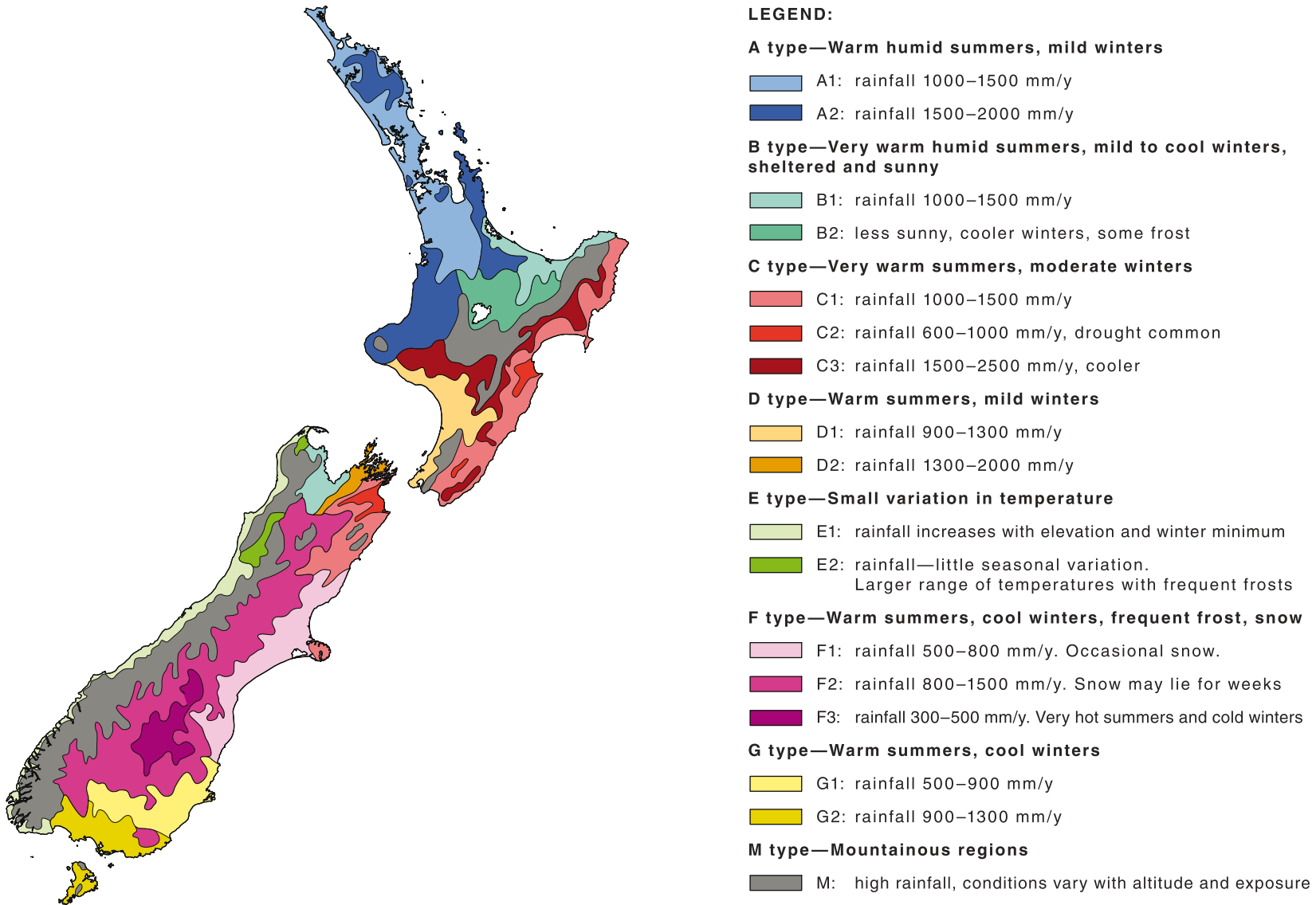


FIGURE 6.3(B) NEW ZEALAND CLIMATE ZONES

NOTES:

- 1 Figure 6.3(A) reproduced (without any modifications) from Figure A1.1, National Construction Code 2016 Volume One Amendment 1 with permission from Australian Building Codes Board (ABCB). Figure A1.1, National Construction Code 2016 Volume One Amendment 1, licenced under a Creative Commons Attribution 4.0 International licence © 2016 Commonwealth of Australia and States and Territories of Australia.
- 2 Figure 6.3(B) 'New Zealand Climate Zones' reproduced with modification with permission of National Institute of Water and Atmospheric Research Limited.

6.4 Test sampling procedure

Comparisons shall be performed under different seasonal conditions that encompass the range of expected climatic conditions (e.g. summer and winter or wet and dry). Comparisons shall be performed such that—

- (a) measurements are performed at regular, uninterrupted intervals;
- (b) sufficient valid results are obtained during each seasonal period evaluated; and
- (c) results are not removed from data sets except in accordance with Clause 8.2.

Reference and candidate instruments shall be positioned in such a way that the effect of spatial inhomogeneity of the particulate matter concentration in the sampled air (e.g. sample inlet heights) is negligible in comparison with other measurement uncertainty contributions.

During the tests, the following information shall be collected and recorded:

- (i) Calibration procedures, equipment and intervals.
- (ii) Quality control checks and calibrations (see Clause 7).
- (iii) Temperature and humidity at the sampling location.
- (iv) Barometric pressure, wind speed, wind direction and rainfall representative of the sampling location (refer to AS/NZS 3580.14).
- (v) Particular events/situations that may influence measurement results.

All results obtained shall be averaged over a period of 24 hours, with a minimum data capture of 95%.

In each comparison a minimum of 40 valid daily data pairs (a data pair representing valid results from both the RM and the CM for the same 24 hour period) shall be obtained (see Clause 8.2 for data set requirements).

7 QUALITY CONTROL REQUIREMENTS

7.1 General

Quality checks and calibrations of RM and CM instruments shall be undertaken prior to, during, and at the conclusion of the test procedure. Minimum quality control requirements for the CM are given in this Standard. Quality control requirements for the RM shall be in accordance with the applicable Standard.

Minimum quality control requirements for CM instruments are listed in Table 7.3. The requirements are based on the major factors contributing to measurement uncertainty applicable to particulate matter monitoring instrumentation. For a specific method other contributions may exist which shall be taken into account when applying this method.

7.2 Apparatus

The following apparatus shall be used during the test procedure.

7.2.1 Flow meter

A traceable transfer standard flow measuring device (e.g. electronic piston meter, electronic bubble meter or flow meter), with a U_{95} of $\pm 2\%$ at the operating flow rate, shall be used for checking and calibrating the flow control and measurement system. The transfer standard device shall be calibrated against a reference standard device on a two year basis.

7.2.2 Barometer

A traceable barometer with a U_{95} of ± 0.5 kPa, calibrated in accordance with Appendix A, shall be used to calibrate any pressure transducers that form part of the flow control and measurement system.

7.2.3 Humidity device

A traceable device for measuring relative humidity, with a U_{95} of $\pm 5\%$, shall be used to calibrate any relative humidity sensors that form part of the sampling or measurement system. The device shall be calibrated annually at three representative relative humidities.

7.2.4 Temperature sensor

A temperature sensor with a U_{95} of $\pm 0.5^{\circ}\text{C}$ and a resolution of 0.1°C , calibrated in accordance with Appendix B, shall be used to calibrate any temperature sensors that form part of the flow control and measurement system.

7.2.5 Zero particle filter

A filter fitted to the instrument sample inlet during zero checks. The filter media shall have a minimum collection efficiency of 99.95% for particle diameters above $0.3\text{ }\mu\text{m}$ EAD and have negligible pressure drop at the operating flow rate.

7.3 Frequency of checks and calibrations

Checks and calibrations required to be conducted on the CM instrument, together with their frequency and acceptance criteria, are summarized in Table 7.3. The instrument shall be calibrated when it is—

- (a) initially installed;
- (b) relocated to a new site (both before and after any relocation); and
- (c) subject to maintenance/repair that is likely to affect its performance.

TABLE 7.3
FREQUENCY OF CHECKS AND CALIBRATIONS

Calibration, check or maintenance component	Acceptance criterion	Frequency
Status values of operational parameters†		For each data pair
Volumetric flow rate check	$\pm 6\%$	≤ 3 months
Pressure transducer check	$\pm 1\text{ kPa}$	≤ 3 months
Temperature sensor check	$\pm 2^{\circ}\text{C}$	≤ 3 months
Humidity sensor check	$\pm 7\%$	≤ 3 months
Volumetric flow rate calibration*	$\pm 3\%$	≤ 12 months
Pressure transducer calibration	$\pm 0.5\text{ kPa}$	≤ 12 months
Temperature sensor calibration	$\pm 1^{\circ}\text{C}$	≤ 12 months
Humidity sensor calibration	$\pm 3\%$	≤ 12 months
Zero check (24 hour average)	$\pm 2\text{ }\mu\text{g}/\text{m}^3$	≤ 12 months
Particle measuring system check‡		≤ 12 months

† See Clause 7.4.

* Calibrate volumetric flow rate after any flow control pressure and temperature sensors are calibrated.

‡ As recommended by the manufacturer and after repair, but at least every 12 months.

7.4 Operational parameter checks

The following CM instrument parameters shall be checked for anomalies, deviations outside normal operating range and plausibility during operation. In addition, the instrument status shall be checked for warning and alarm messages. All operational checks shall be performed for the duration covering each reference sample (or data pair). Checks shall include: