ADDENDA

ANSI/ASHRAE Addendum c to
ANSI/ASHRAE Standard 52.2-2012

Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size

Approved by ASHRAE on July 1, 2015, and by the American National Standards Institute on July 28, 2015.

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FOREWORD

ASHRAE RP-1287 presented several recommendations related to particle counter specifications, and SSPC 52.2 reviewed the findings and incorporated a number of those recommendations into this addendum. In addition, input from several particle counter manufacturers was obtained to help ensure that the proposed recommendations are achievable and practical. These changes are to improve the reproducibility of the test. For that reason, the particle counter is limited to one class of counters, specifically light-scattering optical particle counters, which are currently in wide use. Additionally, stringent requirements on the particle counter's sizing resolution, calibration, sampling rate, and other performance factors are specified. This addendum intends to make the specifications sufficiently (but not excessively) stringent and comprehensive in order to provide significantly improved reproducibility.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum c to Standard 52.2-2012

Add the following new definition to Section 3.1.

3.1 Definitions

aerosol particle counter (OPC): an instrument that samples, counts, and sizes aerosol particles. While several different technologies exist for aerosol particle counters (e.g., optical, aerodynamic, electrostatic mobility), only optical aerosol particle counters based on light scattering are used in this standard. Optical aerosol particle counters are often referred to as "OPCs" and, when the particles are sized into a number of sizing channels, are also sometimes referred to as "aerosol spectrometers."

Modify Section 4.6 as shown.

4.6 Particle Counter(s). The particle counter specifications consist of the following:

~~**4.6.1** Permissible particle counters are optical particle counters (OPCs) with wide angle collection optics or other counters demonstrating good correlation in measuring particle size efficiencies, such as aerodynamic particle counters (APCs).[10] An APC shall first be tested with KCl to establish the relationship between the aerodynamic particle size and the light-scattering particle size determined by an OPC. Calibrate the APC with PSL and use the relationship to express results as equivalent light-scattering size of KCl.~~

a. Measurement technology
b. Size range
c. Counting efficiency
d. Resolution of particle size measurement
e. Number of sizing channels and their boundaries
f. Degree of monotonic response required
g. Calibration methods
h. Sampling flow rate stability
i. Zero-count specification
j. Requirements when dual counters are used
k. Sample flow rate measurement and recording

4.6.1 The aerosol particle counter shall be based on optical particle sizing and counting (i.e., light scattering). These instruments are commonly known as "optical particle counters" and also as "optical aerosol spectrometers."

4.6.2 The particle counter(s) shall ~~be capable of counting~~ count and ~~sizing~~size individual ~~KCl~~aerosol particles in the 0.30 to 10 μm diameter size range.

4.6.3 The counting efficiency shall be at least 50% for 0.3 μm NIST-traceable polystyrene latex (PSL) particles.

4.6.4 The sizing resolution of the particle counter shall be ≤10% (standard deviation/mean) and shall be measured in accordance with ISO 21501-1, ISO 21501-4, IEST-RP-CC014.1, or equivalent. The resolution shall be measured at a particle size in the range of 0.5 to 0.7 μm.

4.6.5 The particle counter(s) shall ~~measure the test aerosol~~ group measured particles ~~and then group them~~ into 12 size ranges. The range boundaries (based on ~~the physical size of the KCl aerosol~~PSL calibration) shall conform to Table 4-1.

4.6.6 The particle counter's correlation of measured response~~[11]~~[10] to physical particle size shall be monotonic for PSL particles from 0.30 to 10 μm, such that only one size range shall be indicated for any measured response (i.e., any lack on monotonic response must be such that the associated ambiguity in particle size is contained within one channel of the particle counter).

4.6.7 Particle counter calibration shall conform to the following:

a. The OPC shall be calibrated in accordance with ISO 21501-4.
b. The calibration shall be performed with monodisperse NIST-traceable PSL.
c. The calibration shall include at least one particle diameter in each of the ranges of 0.3 to 0.4 μm, 9 to 11 μm, and 4 other sizes in between.
d. The size calibration of the particle counter shall be ~~to report the actual physical size of the PSL particles, and it shall be performed~~performed at least annually.

~~10. An OPC determines particle size based on the intensity of the particle's scattered light. An APC determines particle size by measuring the time of flight of the particle.~~

~~11.~~10. Voltage, for example.

4.6.5 At least 90% of all observed counts shall register in size ranges 4 and 5 of Table 4-1 when the particle counter is challenged with monodisperse 1.0 mm diameter PSL particles.

4.6.8 The particle counter shall have less than 10% coincidence loss at a particle counting rate of 300,000 particles per minute[12] and shall have a minimum inlet volume flow rate of 47.2 cm^3/s (0.100 cfm). ThisThe inlet volume flow rate shall not change more than 2% with a 1000 Pa (4.0 in. of water wc) change in the pressure of the sampled air.

4.6.9 The total measured particle concentrationcount rate shall be no moreless than 20010 particles/m^3 (5.66 particles/ft^3) per minute when the particle counter is sampling air with a HEPA or ULPAhigh-efficiency filter on its intake.

4.6.10 Dual particle counters, if used, shall be identical models such that they are closely matched in design and sampling flow rate.

4.6.11 The viewed sample flow rate of the particle counter shall be recorded for each data sample.

Informative Note: Some particle counters incorporate measurement of the viewed sample flow rate within the instrument and provide that measurement as part of the data stream associated with each sample. If the particle counter does not provide this output, provisions need to be made to capture this information for each sample (such as adding a mass flowmeter on the outlet stream from the particle counter's sensor). For some particle counters, viewed sample flow rate can be significantly affected by duct pressure, which can change with flow rate; the resistance of the test filter (clean and with dust loading); and test duct setup (such as the diameter of the ASME flow nozzle and pressure drop of the outlet HEPA filter bank). Changes in flow rate through the particle counter sensor will directly change the particle count rate and lead to errors when computing the particle filtration efficiency values. Changes in flow rate may also influence the particle counter calibration.

In some cases, the influence of duct pressure can be significantly reduced by routing the exhaust of the particle counter back to the duct to equalize (or reduce) the differential pressure across the particle counter, by using a mass flow controller downstream of the particle counter's sensor, or by adding a controlled restriction in the exhaust line of the particle counter.

The viewed sample flow rate is that part of the sample stream that passes through the particle counter's sensor. In many particle counters, 100% of the sample flow flows through the sensor; in some counters and/or sampling systems, the viewed sample flow is a fraction of the total sampled flow (to allow isokinetic sampling, reduced residence time in sample line, etc.).

Add new qualifications to Section 5.1 as shown.

5. APPARATUS QUALIFICATION TESTING

12. The particle counting rate is the product of the particle concentration and the viewed volume flow. Example: 100 particles/mL·3000 mL/min = 300,000 particles/min.

5.1 Apparatus qualification tests shall verify quantitatively that the test rig and sampling procedures are capable of providing reliable particle size efficiency measurements. The tests shall be performed in accordance with Table 5-1.

Qualification tests shall be performed for:

a. Air velocity uniformity in the test duct
b. Aerosol uniformity in the test duct
c. Downstream mixing of aerosol
d. Overload tests of the particle counter
e. 100% efficiency test
f. Correlation ratio test
g. Aerosol generator response time
h. Duct leakage test
i. Particle counter zero
j. Particle counter sizing accuracy
k. Radioactivity of the aerosol neutralizer
l. Dust feeder airflow rate
m. Final filter efficiency
n. OPC documentation
o. OPC flow-rate stability test

Insert the following sections between current Sections 5.14 and 5.15.

5.15 OPC Documentation. Secure documentation from the particle counter manufacturer (or other source) that verifies that each specific particle counter requirement of Section 4.6 is being met.

5.16 OPC Flow Rate Stability Check

5.16.1 Install a flow restriction (such as an air filter or flow nozzle) in the test section of the test duct that will provide at least a 1000 Pa (4 in. wc) duct pressure difference between the upstream OPC sampling location and the downstream OPC sampling location when the duct is operated at a flow rate between 500 and 2000 cfm.

5.16.2 Operate the test duct at a flow rate that yields a 1000 Pa ± 10% (4.0 in. wc ± 10%) pressure differential between the upstream and downstream OPC sample locations.

5.16.3 Measure the sampled flow rate of the OPC when sampling upstream and when sampling downstream. If dual counters are used, measure the flow rate of each OPC.

5.16.4 The particle counter's viewed sample flow rate must be the instrument's specified flow rate ±5%.

5.16.5 The difference between the upstream and downstream viewed sample flow rates must not exceed 2%.

Informative Note to Sections 5.16.4 and 5.16.5: Corrective action, if needed, may be to route the exhaust of the particle counter back to the duct to equalize the differential pressure across the particle counter; use of a mass flow controller downstream of the particle counter's sensor; or adding a controlled restriction in the exhaust line of the particle counter.

Modify Section 10.6.2 by adding the following.

10.6.2.5 Viewed Sample Volume. The particle counter's viewed sample flow rate must be the instrument's specified flow rate ±5%.

Modify Section 10.6.4 as follows.

10.6.4.1 Viewed Sample Flowrate Consistency. The difference between the upstream and downstream viewed sample flow rates must not exceed 2%.

10.6.4.~~1~~2

10.6.4.~~2~~3

10.6.4.~~3~~4

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