



**BSR/ASHRAE Addendum c to
ANSI/ASHRAE Standard 52.2-2017**

Public Review Draft

Proposed Addendum c to Standard 52.2-2017, Method of Testing General Ventilation Air Cleaning Devices for Removal Efficiency by Particle Size

**First Public Review (August 2021)
(Draft shows Proposed Changes to Current Standard)**

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FOREWORD

Over the past year of the COVID19 pandemic, the need for efficiency data for all air cleaners when used to remove or inactivate viruses and bacteria from air has never been stronger. ASHRAE has a bioaerosol inactivation test standard for testing ultraviolet light (UVC) devices only. Standard 185.1 is based on using a 52.2 type duct and includes much of the same equipment and QA. The main differences are the use of bioaerosols as the challenge instead of non-biological particles and the use of bioaerosol samplers and subsequent counting to determine the upstream and downstream concentrations. The calculations used in Standard 185 are essentially a simplified version of those used in 52.2.

Since Standard 52.2 is a particle removal test standard, adding an option to test with different particles, in this case bioaerosols, seems logical. This addendum allows users the option of using the basic 52.2 test rig and QA with bioaerosols to determine the efficiency of an HVAC-mounted air cleaner for removal/inactivation of a bioaerosol. Note that the term air cleaner does include filters and other technologies.

[Note to Reviewers: This addendum makes proposed changes to the current standard. These changes are indicated in the text by underlining (for additions) and ~~striketrough~~ (for deletions) except where the reviewer instructions specifically describe some other means of showing the changes. Only these changes to the current standard are open for review and comment at this time. Additional material is provided for context only and is not open for comment except as it relates to the proposed changes.]

Addendum c to Standard 52.2-2017

Add new Informative Appendix c to Standard 52.2-2017

INFORMATIVE APPENDIX C

OPTIONAL METHOD FOR DETERMINING FILTER AND AIR CLEANER EFFICIENCY IN REMOVING OR INACTIVATING AIRBORNE VIRUSES AND BACTERIA

C1. PURPOSE AND SCOPE OF OPTIONAL TEST

This appendix addresses the need, which has been highlighted by the COVID19 pandemic, for efficiency data for air cleaners used to remove or inactivate airborne viruses and bacteria. ASHRAE Standard 185.1¹ only allows testing of UV devices. This appendix uses similar procedures, also based on using a 52.2 type duct and including much of the same equipment and QA as 52.2, to allow testing of other air cleaning devices. The main changes to ASHRAE 52.2 are the use of bioaerosols as the challenge instead of non-biological particles and the use of bioaerosol samplers and subsequent counting to determine the upstream

and downstream concentrations. The calculations are changed from those of 52.2 to those of Standard 185, which are a simplified version of those used in 52.2 to be applicable to bioaerosol data.

This appendix presents a method that allows users to employ the basic 52.2 test rig and QA along with procedures based on Standard 185.1 to determine the efficiency of an HVAC-mounted filter or air cleaner for removal/inactivation of a bioaerosol.

This test may be used in place of the efficiency portion of 52.2 with or without the dust loads of 52.2.

This test is intended for use with most air cleaners. However, for devices using UVC, only those with the UV light completely contained within the device shall be tested. Uncontained UV devices shall be tested with ASHRAE 185.1.

C2. DEFINITIONS AND ACRONYMS

C2.1 Definitions to be used in addition to those listed in Section 3 of the standard are as follows:

air cleaner: device or system for removing contaminants from air in a ventilation system, building, or enclosed space.

Note: air cleaners include, but are not limited to, filters.

bioaerosol: system of viable particles suspended in air.

Note: viable particles include fungi, bacteria, and viruses.

contained UV device: an air cleaner that uses UV but keeps the light completely contained within the device.

uncontained UV device: an air cleaner that shines UV into the duct in which it is installed.

C2.2 Acronyms to be used in addition to those listed in Section 3 of the standard are as follows:

ATCC American Type Culture Collection

CFU Colony-forming unit

PFU Plaque-forming unit

C3. TEST APPARATUS AND PROCEDURES

C3.1 Test Duct. The test duct shall comply with the requirements of Section 4 of the standard except as noted in this section.

C3.2 Bioaerosol injection. Bioaerosol will be injected at the same location as the standard aerosol. The bioaerosol injection system shall produce an upstream challenge that meets the qualification criteria of Section C4.3. The injection system design is described in Section C5.2.

C3.3 Installation of Test Device. Installation of the test device shall be as designated by the manufacturer or equipment provider.

C3.4 Installation of Bioaerosol Sampler. One or more bioaerosol samplers shall be installed upstream of the test device and downstream of the device. These samplers shall be collocated with the probes specified in the standard. If multiple samplers are used, they shall be located so that the inlet air streams do not interfere with each other. The inlets of the bioaerosol samplers shall face into the airflow. Isokinetic

sampling (to within 10% of a measured target flow velocity as measured by the instruments indicated) shall be used. Flow rate through the sampling system shall be measured with volumetric devices such as orifice plates or rotameters having an accuracy of $\pm 5\%$.

C4 APPARATUS QUALIFICATION TESTING

C4.1 Apparatus Qualification Tests. Apparatus qualification tests shall verify quantitatively that the test rig and sampling procedures are capable of providing reliable bioaerosol measurements.

C4.2 Air velocity Uniformity in the Test Duct. The velocity uniformity test shall comply with Section 5.2 of the standard.

C4.4 Duct Leakage Test. A duct leakage test shall be conducted as described in Section 5.9 of the standard.

C4.5 No Device Correlation (Penetration) Test. This test shall be performed in the same way as the standard bioaerosol test described in Sections C5 and C6 but with no device in the rig. The No Device test must meet the specifications in Table C1.

C5 BIOAEROSOL PREPARATION

C5.1 Test Organisms. The bioaerosol tests shall be conducted using an organism that is safe to work with when aerosolizing enough for a full-scale test. This will usually mean working with surrogates for human diseases. ASHRAE 185.1 requires two organisms, covering the range of reasonable interest for UV-C device applications. The first organism to be used in Standard 185.1 is *Mycobacterium parafortuitum* (ATCC[®] 19686), and the second organism is *Aspergillus sydowii* (ATCC[®] 96916). *These are possible organisms to use for Appendix C testing.*

This appendix C test does not specify the organisms to be used as the need will vary by the intended use of the device.

C5.2 Bioaerosol Preparation and Generation. Preparation of the test organism suspension for the aerosolization requires that the test organism be grown in the laboratory and the suspension prepared for aerosol generation in the test duct. The microbial challenge suspensions are prepared by inoculating the test organism onto solid or into liquid media, incubating the culture until mature, wiping organisms from the surface of the pure culture (if solid media), and eluting them into sterile fluid to a known concentration to serve as a stock solution. The organism preparation is then diluted into the nebulizing fluid. The nebulizing fluid is quantified on agar plates to enumerate the number of test organisms in the suspension. The number of culturable organisms shall be at least 10^6 CFU per mL.

The generation system may include a six-jet collision nebulizer that is based on air atomizing spray nozzles in which a suspension of microorganisms is nebulized with compressed air and then dried. Other nebulizers are acceptable. The nebulizer used shall be able to generate particles of the appropriate size for the challenge organism.

The six-jet nebulizer generates droplets with an approximate volume mean diameter of 2 μm . The particle diameter after the water evaporates depends on the solids content of the suspension. Particle size is determined by the size of the suspended particles. The concentration in the collision should be such that only singlets are generated. The bioaerosol generator shall be designed to ensure that the microorganisms are dry prior to being introduced into the test duct. After drying, the bioaerosol shall be neutralized using a charge neutralizer.

TABLE C1 System Qualification Measurement Requirements

<u>Parameter</u>	<u>Control Limit</u>
<u>No device correlation (penetration)</u>	<u>Acceptable Penetration</u> <u>0.80 to 1.20</u>

C6 BIOAEROSOL TESTING

C6.1 Test air flow rate. The test shall be conducted using the air flow rate recommended by the filter or air cleaner manufacturer. Air flow rate, temperature, and relative humidity shall be measured as indicated in Section 4.5 of the standard.

C6.2 Test Procedure. Bioaerosol sampling shall not be initiated until a steady-state bioaerosol challenge concentration has been established. Sampling shall be conducted simultaneously upstream and downstream of the test device or by alternating samples. For alternating samples, the first and last samples shall be the same location to compensate for any aerosol concentration drift.

C6.3 Bioaerosol Sampling Procedure. Sampling devices shall be the same type upstream and downstream. Impingers and impactors are acceptable samplers. Samplers shall be covered to avoid exposure to light or external contamination. At least three replicate samples shall be taken both upstream and downstream. All procedures shall be the same for processing of the upstream and downstream samples. Good lab practices appropriate for the sampler type shall be used and documented in the test report.

C6.4 Test precision. Standard deviations of the upstream and downstream concentrations shall be calculated based on the CFU or PFU counts from the replicate plates.

C7 DETERMINATION OF REMOVAL/INACTIVATION EFFICIENCY

C7.1 Calculation of Uncorrected Removal/Inactivation Efficiency. The primary measure of performance within this test method is the single-pass bioaerosol removal/inactivation efficiency. This efficiency, η , shall be quantified by comparing the average bioaerosol concentration upstream and downstream of the device using the following general equation:

$$\eta (\%) = \left(1 - \frac{C_{Downstream}}{C_{Upstream}}\right) \times 100\% \quad \text{Equation C1}$$

Where $C_{Downstream}$ = the average culturable bioaerosol concentration measured in the test duct downstream of the device;

$C_{Upstream}$ = the average culturable bioaerosol concentration measured in the test duct upstream of the device.

This general equation is corrected for system biases according to Section C7.2.

C7.2 Correction for No Device Correlation (Penetration)

The No Device Correlation (Penetration) ratio is calculated by measuring the numbers of culturable organisms upstream and downstream without the device in the duct (or with the device off if the device does not block much of the cross-section of the test rig). The Device-Off option is allowed to aid in switching between the tests quickly and allow the possibility of using a single nebulizer solution for both tests. The same sampling methods are used as in the Bioaerosol Efficiency test. The equation is:

$$P_{No\ Device} = \frac{C_{Down,No\ Device}}{C_{Up,No\ Device}} \quad \text{Equation C2}$$

Where: $P_{No\ Device}$ = No Device Correlation (Penetration) Ratio
 $C_{Down,No\ Device}$ = Downstream, No Device, culturable bioaerosol concentration
 $C_{Up,No\ Device}$ = Upstream, No Device, culturable bioaerosol concentration

To remove this system bias, the Single-Pass Bioaerosol Inactivation Efficiency from Equation C1 shall be corrected using the No Device Correlation (Penetration) Ratio from Equation C2. Thus, the final corrected value for the Single-Pass Bioaerosol Inactivation Efficiency becomes:

$$\eta_{Corr}(\%) = \left(1 - \frac{C_{Downstream}}{C_{Upstream} \times P_{No\ Device}}\right) \times 100\% \quad \text{Equation C3}$$

C8 REPORTING RESULTS

C8.1 Outline. This test yields a removal/inactivation efficiency for the test organism rather than a MERV. The summary section of the performance report shall include the following information:

- a. Name and location of the test laboratory
- b. Date of the test
- c. Test operators' names
- d. Device manufacturer's name (or name of the marketing organization, if different from the manufacturer)
- e. How the device was obtained
- f. Description of the test device, including the following:
 1. Brand and model number
 2. Physical description of construction
 3. Photos of device as positioned in the test rig
- g. Summary of Test data
 1. Test air temperature and relative humidity
 2. Test Airflow rate
 5. No-device test correlation (penetration) data
 6. Type of organism used for bioaerosol test
 7. Make and model number of bioaerosol sampler used for the test
 8. Name and address of the laboratory analyzing the samples
 9. Table of upstream and downstream CFU or PFU from the efficiency test
- h. Calculated Single-pass bioaerosol removal/inactivation efficiency
 1. Uncorrected removal/inactivation efficiency from Equation 1
 2. Corrected removal/inactivation efficiency from Equation 3

C8.2 Details of Test Data. Inclusion of all test raw data in the report is required. Data shall include details of the bioaerosol samples analysis.

C9 APPENDIX C REFERENCES

C1. ASHRAE. 2020. Standard 185.1 *Method of testing UVC lights for use in air handling units or air ducts to inactivate airborne microorganisms.*