ADDENDA

ASHRAE

ASHRAE Addendum a to
ASHRAE Guideline 28-2016

Air Quality within Commercial Aircraft

Approved by ASHRAE on January 22, 2019.

This addendum was approved by a Standing Guideline Project Committee (SGPC) for which the Standards Committee has established a documented program for regular publication of addenda or revisions, including procedures for timely, documented, consensus action on requests for change to any part of the guideline. Instructions for how to submit a change can be found on the ASHRAE® website (https://www.ashrae.org/continuous-maintenance).

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(This foreword is not part of this guideline. It is merely informative and does not contain requirements necessary for conformance to the guideline.)

FOREWORD

Addendum a clarifies the test criteria for HEPA filters in Section 8.1.2.4, "Respirable Particulate Matter," and adds/updates the relevant references in Section 9.

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 a to Guideline 28-2016

Revise Section 8.1.2.4 as shown.

8.1.2.4 Respirable Particulate Matter (RPM). Respirable particulate matter consists of solid or liquid particles that, with diameters less than 10 μm, are easily suspended in air and inhaled by exposed persons. RPM on aircraft can be generated from a variety of sources. The relative contribution of different sources to RPM on aircraft is currently not known. A major source of RPM is the airplane occupants. Pollutants generated by occupants are distinct from other types of particle sources in that the emissions occur where an individual is located and the occupant is not always stationary, but rather can move around. Occupants can generate RPM that may contain viruses or bacteria that are suspended in mucus generated from coughing or sneezing and that are found in organic and inorganic compounds carried by larger particles such as skin flakes or clothing fiber. Another source of RPM on airplanes is accumulated dust, which is resuspended in the air by occupants as they move around the aircraft cabin. This dust could contain allergenic material such as endotoxins and mycotoxins, as well as other irritating and potentially toxic chemicals such as pesticides. Other sources of RPM include galley operations, episodic introduction of fluids such as fuel and oil via the ventilation system, spraying of pesticides and cleaners, and equipment operation. Fleecy materials (e.g., carpet, seating) can be sources of RPM as a result of occupant movement (SAE 2006a).

Particle diameter, chemical composition, airborne concentrations, duration of exposure to RPM, and individual sensitivity all play a part in the impact particles have on aircraft occupants. A recent study showed that during normal operations, the highest concentrations of particulate matter were present during boarding and deplaning (Dumyahn et al. 2000). At the same time, a number of studies, including ASHRAE Research Projects 957 (RP-957) (Pierce et al. 1999) and 959 (RP-959) (Nagda et al. 2001) have shown that mass concentrations of particles during cruise are very low during normal conditions, often in the range of 10 μg/m^3. In a typical aircraft ventilation system, air that is recirculated is usually passed through high-efficiency particulate air ~~arresting~~ (HEPA) filters~~.~~ ~~removing particles with great efficiency.~~ HEPA filters that meet or exceed the requirements for Filter Type "A," as defined by ~~of~~ Institute of Environmental Science and Technology IEST-RP-CC001.6 (IEST 2016), ~~7.21 is,~~ Class H13 ~~be tested~~ according to EN1822-1 (CEN 2009), or Class ISO35H according to ISO 29463 (ISO 2011). ~~efficiency rating is provide a minimum of 99.977% collection efficiency for 0.3 μm particles as defined by Institute of Environmental Science and Technology (IEST, 2016). Alternatively, the filters shall meet or exceed the requirements for filter class H13 to EN1822 (CEN, 2009) and shall provide a minimum of 99.95% overall collection efficiency at the most penetrating particle size. Outside air typically passes through the system without filtration but is no of concern as a source of particles since there are very few particles at altitude.~~ The U.S. Environmental Protection Agency (EPA) has developed National Ambient Air Quality Standards (NAAQS) for PM2.5 (particulate matter with aerodynamic diameter <2.5 μm). PM2.5 is not regulated by the federal aviation regulations (FARs). They are included in this guideline because PM2.5 has been documented to cause adverse chronic health effects upon exposure and because particles in this size range have the ability to penetrate into the deepest areas of the human lung upon inhalation. The NAAQS maximums for PM2.5 are 15 μg/m^3 annual arithmetic mean (three-year average) and 65 μg/m^3 over 24 hours (three-year average of the 98th percentile of 24-hour concentrations). Canadian Expo- sure Guidelines place a limit of <100 μg/m^3 for a one-hour interval for particles having <2.5 μm mass median aerodynamic diameter.

The U.S. EPA has also developed NAAQS for PM10 (particulate matter with aerodynamic diameter <10 μm). PM10 is not regulated by the FARs. They are included in this guideline because of their irritancy potential, although they are large enough that they will not penetrate to the deepest areas of the human lung when inhaled. The NAAQS for PM10 are 50 μg/m^3 annual arithmetic mean and 150 μg/m^3 over 24 hours.

To meet the NAAQS for PM2.5 and PM10, particulate matter is collected on filter media using certified air-sampling instrumentation and gravimetrically analyzed. The EPA recommends gravimetric determination of mass concentrations by collecting particulate matter on filters using certified air-sampling instrumentation since NAAQS are based on health effects studies that predominantly used gravimetric methods to characterize particular matter. In addition to mass concentrations, particle diameter and number concentrations are also very important parameters for describing airborne particulate matter. Particle deposition in the lungs upon inhalation is a strong function of particle size. Optical-laser particle counters (OPCs) are commonly used instruments that count the number of particles in sampled air as a function of particle diameter and time. However, very few of the health standards are based on characterization of particulate matter using optical particle counters. Typically, OPCs measure particles in the size range 0.1 to >10 μm, depending on the instrument and how it is calibrated. Particles smaller than 0.1 μm diameter are typically referred to as ultrafine particulate matter. Ultrafine particles are currently measured using condensation particles counters (CPC), which increase the diameter of the particle by using it as condensation nuclei until it is large enough to be detected optically by a laser. CPCs only provide total number of particles as a function of time and do not provide any sizing information. To size particles smaller than 0.1 μm, a CPC is usually coupled to an electrostatic classifier, which uses electrostatic forces to separate the particles according to size (Baron and Willeke 2001). Aerodynamic sizing instruments are also in common use. These instruments allow real-time measurement of aerodynamic diameter based on acceleration and time-of-flight principles (Baron and Willeke 2001). Typically, these instruments can measure particle diameters from about 0.5 to 100 μm.

Add the following references to Section 9. The rest of Section 9 remains unchanged.

9. REFERENCES

CEN. 2009. EN1822, *High Efficiency Air Filters (EPA, HEPA and ULPA)—Part 1: Classification, Performance Testing Markings*. Brussels, Belgium: European Committee for Standardization.

IEST. 2016. IEST-RP-CC001.6, *HEPA and ULPA Filters*, 6th Edition. Mt. Prospect, IL: Institute of Environmental Science and Technology.

ISO. 2011. ISO 29463-1: 2011(E), *High-efficiency filters and filter media for removing particles in air—Part 1: Classification, performance testing and marking* (First Edition). Geneva, Switzerland: International Organization for Standardization.

POLICY STATEMENT DEFINING ASHRAE'S CONCERN FOR THE ENVIRONMENTAL IMPACT OF ITS ACTIVITIES

ASHRAE is concerned with the impact of its members' activities on both the indoor and outdoor environment. ASHRAE's members will strive to minimize any possible deleterious effect on the indoor and outdoor environment of the systems and components in their responsibility while maximizing the beneficial effects these systems provide, consistent with accepted Standards and the practical state of the art.

ASHRAE's short-range goal is to ensure that the systems and components within its scope do not impact the indoor and outdoor environment to a greater extent than specified by the Standards and Guidelines as established by itself and other responsible bodies.

As an ongoing goal, ASHRAE will, through its Standards Committee and extensive Technical Committee structure, continue to generate up-to-date Standards and Guidelines where appropriate and adopt, recommend, and promote those new and revised Standards developed by other responsible organizations.

Through its *Handbook*, appropriate chapters will contain up-to-date Standards and design considerations as the material is systematically revised.

ASHRAE will take the lead with respect to dissemination of environmental information of its primary interest and will seek out and disseminate information from other responsible organizations that is pertinent, as guides to updating Standards and Guidelines.

The effects of the design and selection of equipment and systems will be considered within the scope of the system's intended use and expected misuse. The disposal of hazardous materials, if any, will also be considered.

ASHRAE's primary concern for environmental impact will be at the site where equipment within ASHRAE's scope operates. However, energy source selection and the possible environmental impact due to the energy source and energy transportation will be considered where possible. Recommendations concerning energy source selection should be made by its members.

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