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Control of Infectious Aerosols

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Online Supporting Files: www.ashrae.org/XXXXX

NOTE

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Preview

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(This foreword is not part of this standard. It is merely informative and does not contain requirements necessary for conformance to the standard. It has not been processed according to the ASHRAE requirements for a standard and may contain material that has not been subject to public review or a consensus process. Unresolved objectors on informative material are not offered the right to appeal at ASHRAE.)

FOREWORD

Airborne transmission of communicable diseases occurs when a susceptible person inhales a sufficient number of active pathogens to cause an infection, i.e., an infectious dose. Engineering controls—dilution ventilation, filtration, and air disinfection—can reduce the concentration of active pathogens in the air, which tends to reduce risk of infection. Engineering controls are only one element of a well-designed risk management plan. They cannot eliminate risk and may not be as effective as other risk mitigation measures. However, inadequate control of indoor exposures has been demonstrated to contribute to elevated risk, so it is important to strike a balance between levels of control that create high risk and those that are beyond the point of diminishing returns.

Explicit requirements for airborne infection risk management have been absent for a century from indoor air quality (IAQ) standards with the exception of those written for health care facilities and laboratories. ASHRAE's predecessor society, the American Society of Heating and Ventilating Engineers (ASHVE), published ventilation recommendations in 1895 intended to reduce disease transmission, which were incorporated in a proposed 1914 model law and included in 22 U.S. state codes by 1922. In the 1930s, IAQ standards began adopting definitions of acceptable IAQ that focused on perceived air quality and control of typical chemical and particulate contaminants and that reset minimum ventilation rates to values generally much lower than the original ASHVE values. Since then, there has been growing awareness that indoor environments play a significant role in disease transmission. ASHRAE's early contributions on this topic include the 2009 "ASHRAE Position Document on Airborne Infectious Diseases," revised in 2022 as "ASHRAE Positions on Infectious Aerosols. Unfortunately, that awareness has not, until now, resulted in significant changes to standards and codes, despite concern that a large-scale, historical infectious event on the scale of the 1918 influenza pandemic was highly likely. Many smaller epidemics over the past several decades involving influenza and coronaviruses generated momentary concern and then faded from memory.

The COVID-19 pandemic caused enormous personal, societal, and economic damage, much of which resulted from the closure of public buildings due to widespread perception (supported by considerable evidence) that they were high-risk environments for infection transmission. This experience intensified discussion about the adequacy of existing IAQ standards, including code-basis standards such as ANSI/ASHRAE Standard 62.1, and added renewed urgency to calls for improved guidance. Recognizing that indoor environments were not well-prepared to mitigate the risk of COVID-19 transmission, ASHRAE formed its Epidemic Task Force (ETF) early in 2020. In a matter of months, the ETF produced a large body of guidance that has been well received and widely used. It addressed ventilation, filtration and air cleaning, air distribution, HVAC system operation, and commissioning for multiple building types, and presented a framework for planning effective upgrades. This guidance was not intended to set new enforceable minimum requirements, but it laid the groundwork for their development, which was envisioned as a logical next step.

The catalyst for the development of Standard 241 was discussion between ASHRAE and the White House COVID-19 Response Team about the need for new and better IAQ standards. ASHRAE was encouraged to take the lead in developing a new standard for control of airborne pathogens. On December 6, 2022, the ASHRAE Board of Directors authorized development of a standard with the goal of publishing in six months, and authorized the use of special procedures to make that possible. The project scope approved by the Board also stated the intention to "work to incorporate similar provisions into existing ASHRAE IAQ standards," specifically ANSI/ASHRAE Standards 62.1 and 62.2, perhaps as optional requirements. The Project Committee roster and the title, purpose, and scope of the standard were approved at the ASHRAE 2023 winter meeting, and the committee began its work in February. A draft was approved for advisory public review on May 11, 2023, that received over 1000 comments. The revised draft was approved for publication by the Project Committee on June 15, 2023, and the ASHRAE Standards Committee gave final approval on June 24, 2023. As was the case with the Epidemic Task Force, the work of SPC 241 was accomplished almost exclusively through frequent virtual meetings. The full Project Committee and Executive Committee held bi-weekly meetings, and the six working groups met no less than weekly throughout the development period. The two-day Executive Committee meeting on June 9–10, 2023, at ASHRAE headquarters to assemble the publication review draft was the sole in-person meeting during development of the standard.

The requirements of the standard apply to a wide range of building and space types. Key features include the following:

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- *A requirement that systems comply with the requirements of the applicable ventilation and indoor air quality standards (e.g., ANSI/ASHRAE Standards 62.1 and 62.2 or ANSI/ASHE/ASHRAE Standard 170), including minimum ventilation rates. Standard 241 provides additional requirements for an infection risk management mode of operation (IRMM) that applies during periods when higher levels of infection risk mitigation are desired or are required by authorities based on public health data.*
- *Requirements for infection risk management given in terms of equivalent clean airflow rate in units of flow per occupant in a space (ECAi). The equivalent clean airflow requirement for a space or system can be met not only by outdoor air but also by filtered recirculated air and air disinfected by various other technologies. This allows flexibility for compliance using combinations of controls that optimize factors such as cost and energy use. ECAi requirements are based on extensive risk modeling, using inputs supported by peer-reviewed literature wherever possible. This analysis found flow rate per person to be the most useful and scalable way to represent requirements. To assist users in calculation of equivalent clean airflow, an updated version of the ETF equivalent outdoor air calculator spreadsheet is provided.*
- *Requirements for air distribution in mechanically ventilated, naturally ventilated, and mixed-mode buildings, and requirements for application of in-room air cleaners.*
- *Requirements for filtration and air cleaning that include laboratory testing requirements for performance and safety and calculation procedures for determining the contribution of filters and air cleaners to equivalent clean airflow requirements.*
- *Requirements for assessment, planning, and implementation of airborne infection risk reduction measures in existing buildings, documented in a building readiness plan that is modeled after the document of the same name developed by the ETF. These requirements address commissioning of installed systems to verify compliance.*
- *Requirements for operation and maintenance. Operational requirements also owe much to guidance developed by the ETF, while maintenance requirements are adapted from ANSI/ASHRAE Standard 62.1.*
- *Special requirements for residential and health care facilities which may house infected persons, including requirements for separation areas to be used by infected residents and additional ventilation when there are vulnerable occupants.*

Standard 241 is groundbreaking in a number of ways:

- *By creating a special operating mode for use when conditions warrant (IRMM), it introduces the concept of resilience into indoor air quality standards. A similar approach could be taken to developing requirements for systems to mitigate wildfire smoke.*
- *Expressing control requirements in terms of a quantity (ECAi) that integrates the impact of multiple controls. This concept could also be adapted and applied to other indoor air quality standards.*
- *The requirements for filter and air cleaner testing incorporated in this standard go well beyond what is found in current standards. They are a major step in the direction of creating uniform and effective technology-agnostic criteria for characterizing filter and air-cleaner performance and safety. Ultimately, this should enable more widespread and confident application of these technologies when method-of-test standards currently under development are published and available for reference.*

While the initial publication of Standard 241 provides a complete framework for planning, design, operation, and maintenance of systems that reduce risk of airborne infection transmission, there are ways in which it can be improved in the future with the benefit of needed research. Areas of need include the following:

- *A risk calculator implementing the methodology used to develop prescriptive equivalent clean airflow requirements that will support development of custom targets*
- *Refined air distribution guidance that accounts for contaminant removal effectiveness*
- *Guidance on use of computational fluid dynamics in complying with air distribution requirements*

The Project Committee will take up these and other issues in the next publication cycle.

The publication of Standard 241 is a notable achievement in terms of both its content and the speed with which it was produced. Both are due to the expertise of volunteers and staff, and their commitment to meet an ambitious schedule, along with the strong support of the ASHRAE Standards Committee and ASHRAE Board of Directors. It is their hope that the standard will be widely used to save many lives and help minimize the disruption to society of airborne diseases in the future.

1. PURPOSE

1.1 The purpose of this standard is to establish minimum requirements for control of infectious aerosols to reduce risk of disease transmission in the occupiable space in new buildings, existing buildings, and major