



OVERVIEW OF ASHRAE STANDARD 241: CONTROL OF INFECTIOUS AEROSOLS

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APRIL 2024

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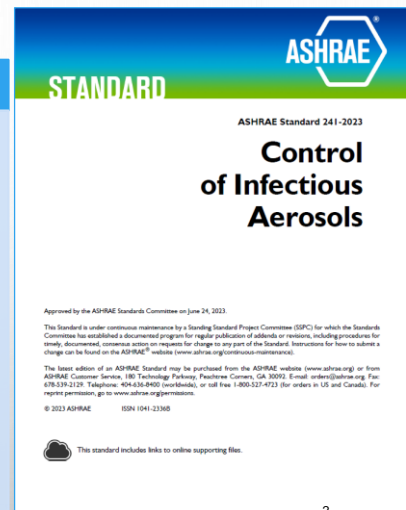
PURPOSE AND SCOPE

Purpose

- Establish minimum requirements for control of infectious aerosols to reduce risk of disease transmission in occupiable space of new and existing buildings and major renovations (non-residential, residential, health care)
- Outdoor air systems, air cleaning systems
 - Design
 - Installation
 - Commissioning
 - Operation
 - Maintenance
- Specify equivalent clean airflow to be provided in infection risk management mode

Scope

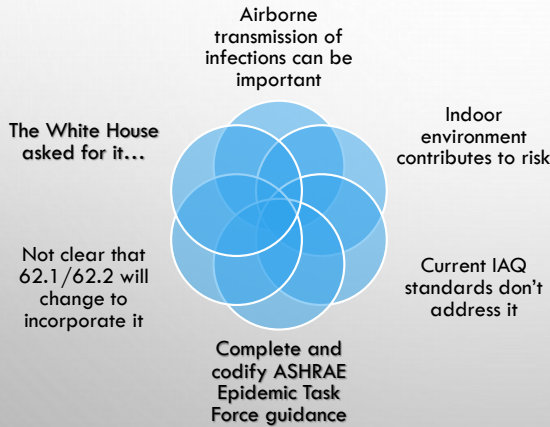
- Does NOT establish overall requirements for acceptable indoor air quality
- Addresses long range transmission, i.e., outside close proximity to an infector



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WHY DEVELOP A STANDARD FOR AIRBORNE INFECTION RISK MITIGATION?



ASHRAE EPIDEMIC TASK FORCE

Core Recommendations for Reducing Airborne Infectious Aerosol Exposure

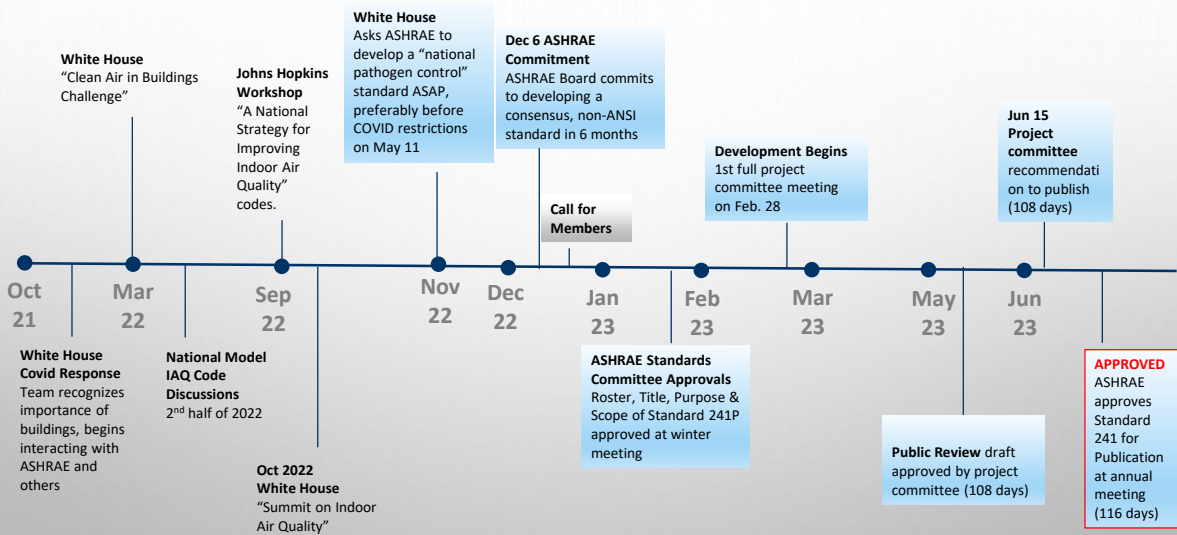
The following recommendations are the basis for the detailed guidance issued by ASHRAE Epidemic Task Force. They are based on the concept that viable limits, ventilation, filtration, and air cleaners can be deployed flexibly to achieve exposure reduction goals subject to constraints that may include comfort, energy use, and costs. This is done by setting targets for equivalent clean air supply rate and expressing the performance of filters, air cleaners, and other removal mechanisms in these terms.

1. **Public Health Guidance** – Follow all current regulatory and statutory requirements and recommendations, including vaccination, wearing of masks and other personal protective equipment, social distancing, administrative measures, circulation of occupants, hygiene, and sanitation.
2. **Ventilation, Filtration, Air Cleaning**
 - 2.1 Provide and maintain at least required minimum outdoor airflow rates for ventilation as specified by applicable codes and standards.
 - 2.2 Use combinations of filters and air cleaners that achieve MERV 13 or better levels of performance for air recirculated by HVAC systems.
 - 2.3 Only use air cleaners for which evidence of effectiveness and safety is clear.
 - 2.4 Select control options, including standalone filters and air cleaners, that provide desired exposure reduction while minimizing associated energy penalties.
3. **Air Distribution** – Where directional airflow is not specifically required, or not recommended as the result of a risk assessment, promote mixing of space air without causing strong air currents that increase direct transmission from person-to-person.
4. **HVAC System Operation**
 - 4.1 Maintain temperature and humidity design set points.
 - 4.2 Maintain equivalent clean air supply required for design occupancy whenever anyone is present in the space served by a system.
 - 4.3 When necessary to flush spaces between occupied periods, operate systems for a time required to achieve three air changes of equivalent clean air supply.
 - 4.4 Limit re-entry of contaminated air that may re-enter the building from energy recovery devices, outdoor air, and other sources to acceptable levels.
5. **System Commissioning** – Verify that HVAC systems are functioning as designed.

October 19, 2021

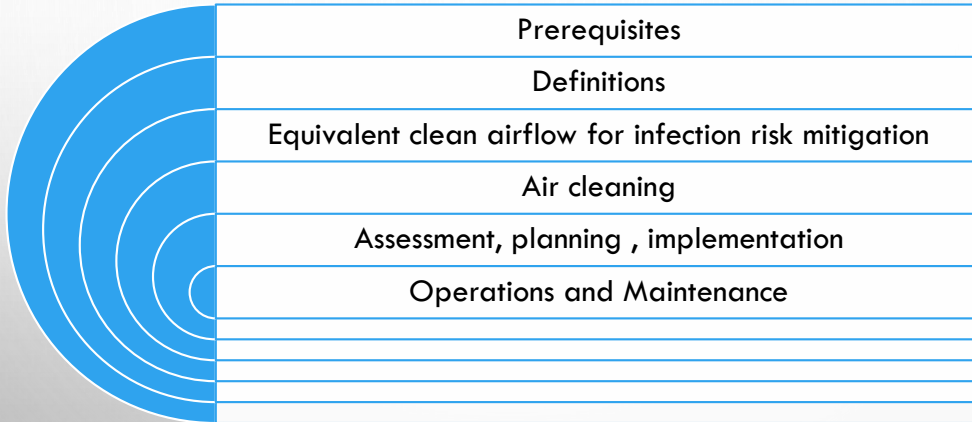
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CHRONOLOGY

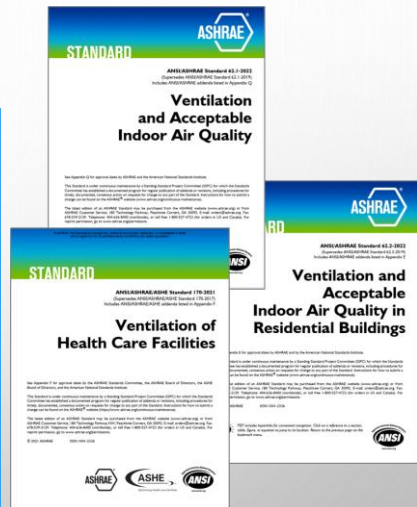
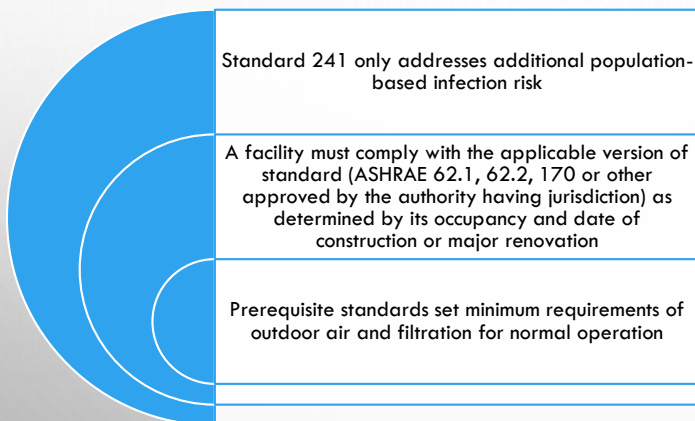


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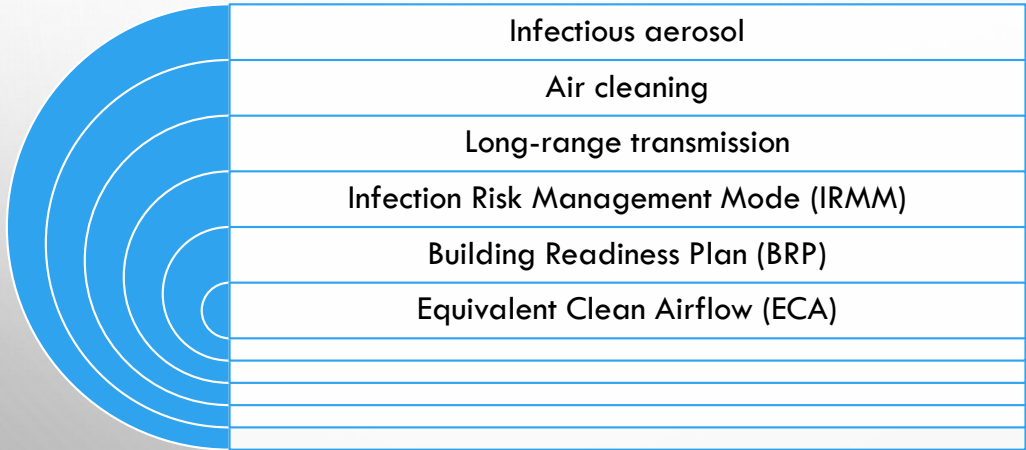
MAIN TOPICS OF STANDARD:



PREREQUISITES



KEY DEFINITIONS SAY IT ALL:

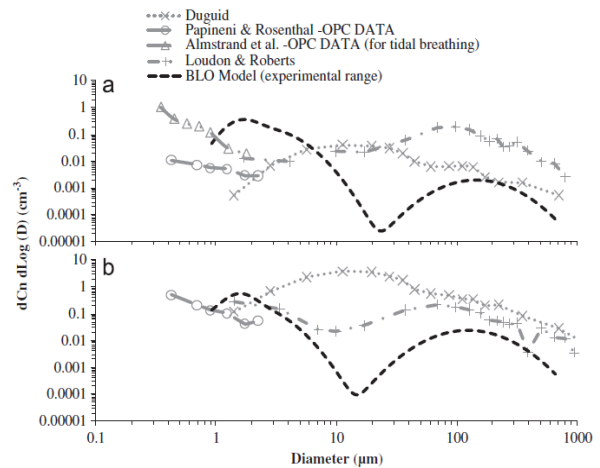


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INFECTIOUS AEROSOL

Airborne particles containing active pathogens capable of causing infection

Size, emission rate determined by respiratory activity, not pathogen size

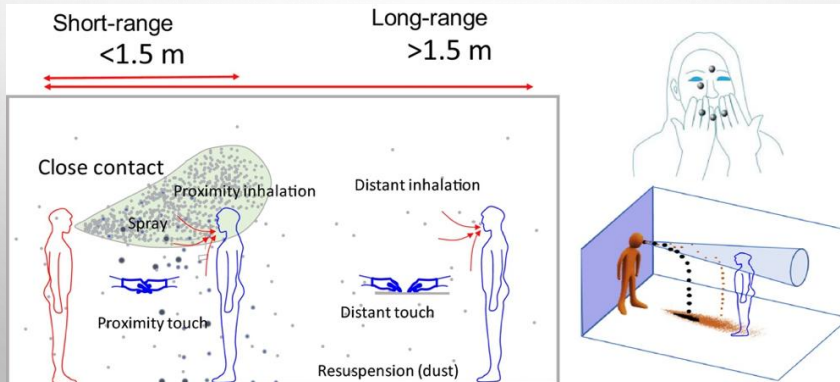


Johnson, et al. 2011. Modality of human expired aerosol size distributions. Journal of Aerosol Science 42:839-851.

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LONG-RANGE TRANSMISSION ONLY

- TRANSMISSION BY EXPOSURE TO **INFECTIOUS AEROSOL** NOT IN CLOSE PROXIMITY TO AN INFECTOR: NOT PPE



Li, Y. 2020. *Indoor Air*. DOI: 10.1111/ina.12786

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AIR CLEANING

- REDUCING INFECTIOUS AEROSOL CONCENTRATION THROUGH CAPTURE AND REMOVAL OR INACTIVATION
- AIR CLEANING TECHNOLOGIES
 - MECHANICAL FILTERS (INCLUDING ELECTRET MEDIA)
 - GERMICIDAL ULTRAVIOLET LIGHT
 - REACTIVE SPECIES – IONIZERS, PHOTOCATALYTIC OXIDATION, OTHER OXIDANTS
- MENTION OF SPECIFIC TECHNOLOGIES IN THE STANDARD IS NOT ENDORSEMENT!



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INFECTION RISK MANAGEMENT MODE

	<p><i>The mode of operation in which measures to reduce infectious aerosol exposure documented in a building readiness plan are active</i></p>	
	<p>Decision on IRMM Enable / Disable</p>	<ul style="list-style-type: none"> •Public health official •Owner •Occupant
	<p>Why not all the time?</p>	<ul style="list-style-type: none"> •Potential Energy use and cost increase •Infection risk and consequences of infection vary over a wide range
	<p>An example of resilience applied to IAQ</p>	

BUILDING READINESS PLAN (BRP)

	<p><i>A plan that documents the engineering and non-engineering controls that facility systems will use for the facility to achieve its goals</i></p>	
	<p>Summarizes results of assessment and planning exercises and documents measures to be implemented in IRMM</p>	
	<p>Direct descendant of ASHRAE Epidemic Task Force guidance</p>	

EQUIVALENT CLEAN AIRFLOW (ECA)

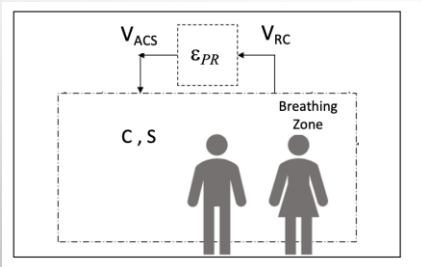
The flow rate of pathogen-free air that, if distributed uniformly within the breathing zone, would have the same effect on infectious aerosol concentration as the sum of actual outdoor airflow, filtered airflow, and inactivation of infectious aerosols

Concept on which the entire standard depends

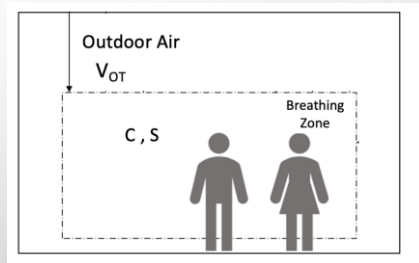
- Determine ECA for infection risk mitigation (ECA_i)
- Determine total flow rate for spaces, systems (V_{ECAi})
- Figure out how to achieve it during IRMM

Equivalent Clean Airflow (ECA) controlling source "S" to achieve concentration "C"

Filtration of recirculated air with efficiency " ϵ_{PR} " at flow rate " V_{RC} "



Outdoor air at flow rate " V_{OT} "



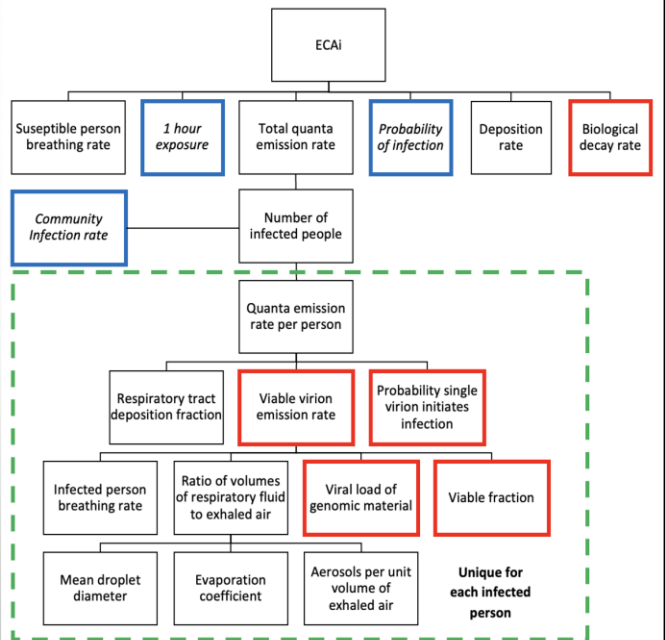
For an equivalent dilution process with uncontaminated air: $V_{ECAi} = V_{OT} = V_{ACS} = \frac{\epsilon_{PR}}{100} \times V_{RC}$

RISK ASSUMPTIONS IN STANDARD 241

Wells-Riley model

- Some variables are deterministic. Other variables are probabilistic using distributed variables.
- Some are based on SARS-COV-2.
- Variables inside the green Box represent variables that are unique for each infected person.

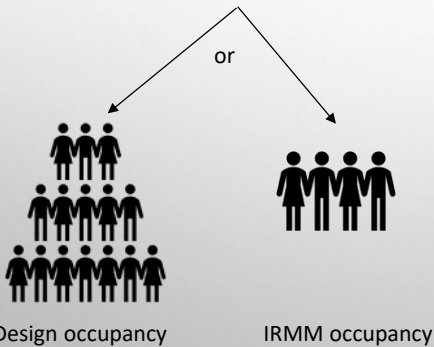
Equal (low) risk per space, per hour regardless of space type



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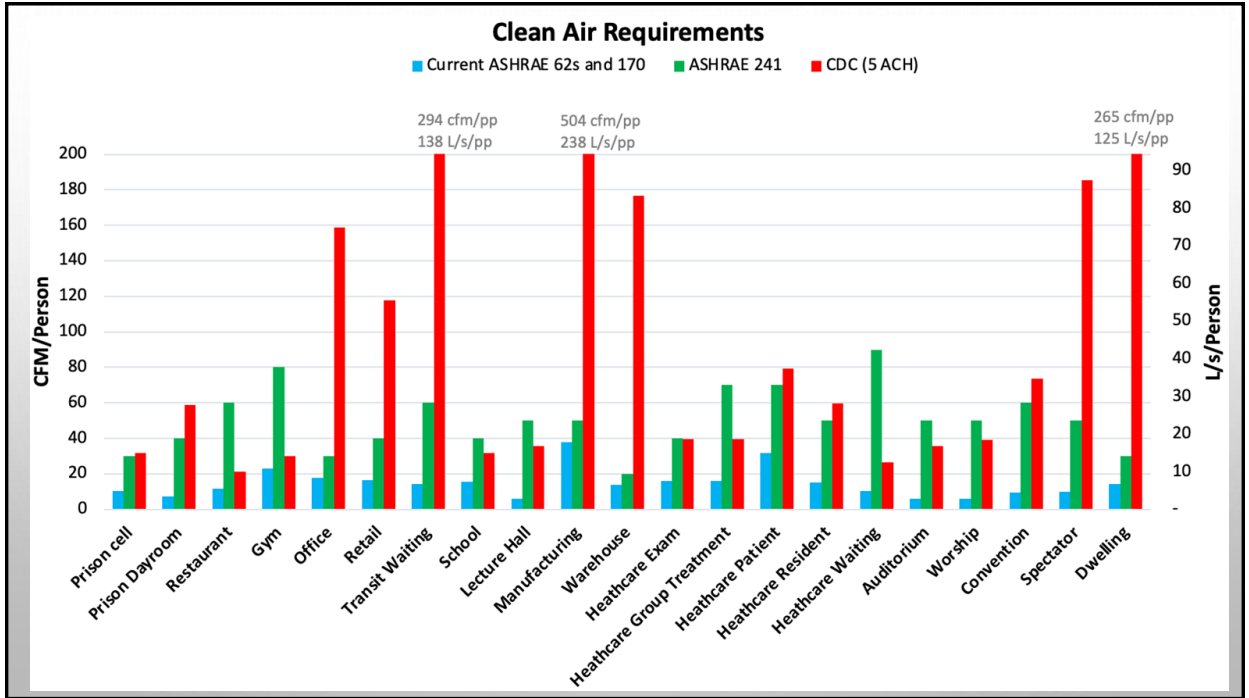
THE REQUIRED ECA DEPENDS ON SPACE TYPE, NUMBER OF PEOPLE AND ACTIVITY.

$$V_{ECAi} = ECAi \times P_{Z,IRMM}$$



Occupancy Category	ECAi	
	cfm/person	L/s/person
Correctional Facilities		
Cell	30	15
Dayroom	40	20
Commercial/Retail		
Food and beverage facilities	60	30
Gym	80	40
Office	30	15
Retail	40	20
Transportation waiting	60	30
Educational Facilities		
Classroom	40	20
Lecture hall	50	25
Industrial		
Manufacturing	50	25
Sorting, packing, light assembly	20	10
Warehouse	20	10
Health Care		
Exam room	40	20
Group treatment area	70	35
Patient room	70	35
Resident room	50	25
Waiting room	90	45
Public Assembly/Sports and Entertainment		
Auditorium	50	25
Place of religious worship	50	25
Museum	60	30
Convention	60	30
Spectator area	50	25
Lobbies	50	25
Residential		
Common space	50	25
Dwelling unit	30	15

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SUMMARY

241 Mitigates long-range transmission of infectious aerosols

Assessment, planning and readiness are key

“Authorities” trigger *infection risk management mode (IRMM)*

Rates are per person and intended to make risk equal everywhere

ASHRAE Standard 241 supplements other activities

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The background of the slide is a light gray gradient with several realistic water droplets of various sizes scattered across it. The droplets have highlights and shadows, giving them a three-dimensional appearance. The text is centered on the slide.

QUESTIONS

THANK YOU