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ASHRAE Control of Infectious Aerosols Standard
&
The Future of IAQ Standards after COVID

Good Day, and welcome to IAQ Radio+ Blog. This week we welcomed back Dr. William Bahnfleth to discuss ASHRAE Standard 241-2023 Control of Infectious Aerosols and the future of IAQ standards after COVID.

William Bahnfleth is a professor of architectural engineering at the Pennsylvania State University. He holds a PhD in mechanical engineering from the University of Illinois and is a Registered Professional Engineer. He is the author or co-author of nearly 200 peer-reviewed publications and 14 books/chapters. He is a past president of the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) and was chair of the ASHRAE Epidemic Task Force and currently chairs the project committee for ASHRAE Standard 241 Control of Infectious Aerosols.

Nuggets mined from today's episode:

Why was the ASHRAE Standard 241 Control of Infectious Aerosols standard started? Existing codes and standards, except for healthcare facilities, don't address infection control. The White House COVID-19 Response Team strongly encouraged ASHRAE to develop an airborne pathogen control standard.

Why was the ASHRAE Standard 241 Control of Infectious Aerosols needed? SARS COVID was a good example of the societal disruption caused by an airborne transmitted infection. Most airborne disease transmission occurs indoors and risk is affected by HVAC system operation.

Why is the ASHRAE Standard 241 Control of Infectious Aerosols important? ASHRAE Standard 241 establishes minimum requirements to reduce the risk of airborne disease transmission, such as the SARS-COV-2 virus (COVID-19), flu virus, measles and other pathogens in buildings like homes, offices, schools, and healthcare facilities. Praised by former White House COVID Response Coordinator Dr. Ashish Jha as *"…o*ne of the most important public health interventions seen in years,"

What information is in Standard 241? ASHRAE Standard 241 provides comprehensive guidance on designing, installing, commissioning, and maintaining HVAC systems to control the spread of infectious aerosols. The standard also includes requirements for equivalent clean air delivery rates, testing requirements for filtration and air cleaning technologies. Users of the standard develop a building readiness plan that documents procedures for assessing existing or new HVAC systems to determine if they are working properly.

Z-Man's Notes from Slides – Link to Slides

- Purpose- establish a standard for controlling infectious aerosols indoors to reduce the risk of diseases.
- ASHRAE 241 is NOT a comprehensive IAQ standard. It only addresses infection risk.
- Risk assessments focused and based upon long transmission (beyond 2 meters) in ambient conditions in spaces where someone is infected with: measles, TB, flu, etc. Pathogen gets into mucus and is distributed as respiratory droplets (submicron-100 microns). 3 Operational Modes: Normal, IRMM (infection risk management mode), & Shutdown.
- Definitions
- Prerequisites- set minimum requirements for outdoor and filtration. ASHRAE standards 62.1, 62.2, and 170 apply when a building is in normal operation mode.
- Equivalent Clean Airflow- "the flow rate of pathogen free air distributed uniformly within the breathing zone, would have the same effect on infectious aerosols concentration as the sum of the actual outdoor airflows filtered airflow, and inactivation of infectious aerosols." Example for an in-room air filter:

$$Vacs = \frac{Epr}{100} \times Vrc$$

ECA requirements are based upon a complex risk assessment, but are easy to apply. ECA requirements are given as equivalent clean airflow rate per person.
Many decisions risk reduction, probabilistic approach, random simulations, Wells-Riley model, risk of infection with confidence levels.
Currently 25 different types of spaces
Protective levels- clean air change rates vary with space type (schools might be 10 ACH, busy restaurant might be 30-40 ACH and consider reducing occupancy)

- Air Distribution
- Air Cleaners- any technology to remove or deactivate microbes.
- Assessment- including building readiness plan documents the plan.
- Additional requirements- resilience in IAQ
- Appendices

Note: Standard 241 does not address wildfire smoke (ASHRAE Guideline 44, *Protecting Building Occupants from Smoke During Wildfire and Prescribed Burn Events* will provide guidance when published). Air cleaners installed to comply with Standard 241 can also help mitigate wildfire smoke.

Air Cleaners- How do they work (e.g. single pass or by distributing a disinfecting agent in the room, like upper room UVGI)? How well do they perform? How safe are they (direct exposure, byproduct production)?

There are standards for UV and filtration. There is an absence of useful test standards data for ionizers, photocatalytic oxidation, hydroxyl generators, etc. Some air cleaners are very effective (e.g. particulate filtration). Others such as UV, photocatalytic, ionizers, etc. are permitted but NOT endorsed. They can be used if they pass specified performance and safety tests. Shoe box size test chambers are not the equivalent of large chamber testing (800 ft^3).

There are safety concerns about some types of air cleaners regarding byproducts and secondary contaminants (e.g. formaldehyde, photolytic particle generation, etc.), so it is required that they be tested. Dose response data is needed for ion generators, hydroxyls, photocatalytic, and some others. There is good microbial dose response data for 254 nm germicidal UV.

Manufacturers concern's over testing include: how testing is done – is it fair and representative and scalability of testing - how does a test done in a chamber of one size predict performance in a room.

Is Standard 241 only applicable to new buildings? No, Standard 241 is also applicable to retrofits. IAQ is all about existing buildings!

Regarding airflow patterns and air distribution? ASHRAE 62 says that stratified indoor air patterns (e.g., displacement ventilation) are beneficial for IAQ; however, experiment and modeling show that for exhaled infectious aerosols, mixing may result in lower exposure. Equivalent clean airflow requirements in 241-2023 are based on perfect mixing. Accounting for air distribution effectiveness is a workplan item.

How is Standard 241 being implemented or adopted as a guide for serious disease outbreaks? Standard 241 is the first consensus-based, code enforceable standard of its kind, having the potential for adoption at the federal level for all buildings. It will take an organization willing to lead. So far, adoption of 241 is being considered by government agencies, well building organizations, and at least one state. Dr Bahnfleth would like to see the federal government recommend the standard. The GSA is one large landlord that has expressed interest.

Future of IAQ Dr. Bahnfleth's final comments:

- *What other standards are needed?* Design standards and the building code tell what is expected at occupancy. Operation and maintenance standards are needed. Need standards for scaling lab results.
- Recommendations for Equivalent Clean Air developed for SARS COVID are useful for assessing certain risks during seasonal flu outbreaks, etc. or as a future software tool in which users can input their parameters and get custom answers.
- Would like to see baseline IAQ standards that provide requirements for infection transmission.
- Regulations are needed. Municipalities and states adopt earlier than federal government. (Illinois, New Mexico, Massachusetts and NYC. (Johns Hopkins model). Regulation will require the collection and disclosure of data.

- Standard 241 is a good start. 241 is less complicated than people think. Game changing ideas for IAQ. Think of 241 as one aspect to address the need to improve IAQ.

Z-Man signing off

Trivia:
Name the author of this quotation: “Great works are performed not by strength but by perseverance.”

Answer: Samuel Johnson

NO CORRECT ANSWER