Shaping Tomorrow's Built Environment Today

MINUTES (DRAFT)
Environmental Health Committee (EHC)
February 6, 2023 - Winter Meeting

These minutes have not been approved and are not the official, approved record until approved by this committee

MEMBERS PRESENT:
Nick Clements, Chair
Bill Bahnfleth, Vice-Chair
Brendon Burley
Mark Ereth
Wade Conlan, *BOD Ex-O*
Linda Lee
Claressa Lucas
Ken Mead
Corey Metzger
Stephanie Taylor
Don Weekes
Junjing Yang
Marwa Zaatari

MEMBERS NOT PRESENT:
Sarah Maston, *Coord. Officer*
Jon Cohen
Farhad Memarzadeh

ASHRAE STAFF:
Steve Hammerling, *Manager of Technical Services*
Alice Yates, *Director of Government Affairs*

GUESTS:
Andreas Bezold
Glenn Brinckman
Ginger Chew
Wade Conlan
Darryl Deangelis
Ron George
Paul Grahovac
Carl Grimes
Daniel Hahne
Elliott Horner
Kishor Khankari
Luke Leung
Ed Light
Zhenlei Liu
Frederick Marks
Florian Mayer
Meghan McNulty
LanChi Nguyen-Weekes
Andy Persily
Ashish Rakheja
Larry Schoen
Chandra Sekhar
Lorenzo Servitje
Max Sherman
Pawel Wargocki

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MOTIONS

No.	Motion	STATUS
1	that EHC sponsor a panel titled *Best Practices: Testing, Verifying, and Commissioning for Indoor Air Quality and Pathogen Mitigation*.	PASSED
2	that EHC co-sponsor a SSPC 62.1 program titled *The Effect of Buildings on Occupant Health*	PASSED
3	that EHC recommend to CEC that Jennifer Isenbeck and Iain Walker co-chair ASHRAE IEQ 2025 steering committee.	PASSED
4	that EHC ask ASHRAE to submit letter of interest to host ISIAQ 2025 regional conference.	PASSED

LIST OF ATTACHMENTS

No.	Attachment
A	ASHRAE Leadership Presentation
B	Reformatted Indoor Air Quality PD
C	Reformatted Environmental Tobacco Smoke PD
D	Indoor Reactive Oxygen and Nitrogen Species
E	Panel proposal titled *Best Practices: Testing, Verifying, and Commissioning for Indoor Air Quality and Pathogen Mitigation*.

LIST OF ACRONYMS

ASHRAE	American Society of Heating, Refrigerating and Air-conditioning Engineers
BOD	Board of Directors
CEC	Conferences and Expositions Committee
CTTC	Chapter Technology Transfer Committee
CNV	Chair Not Voting
CO2	Carbon Dioxide
DEI	Diversity, Equity and Inclusion
DRSC	Document Review Subcommittee
EHC	Environmental Health Committee
EIB	Emerging Issue Brief
ENDS	Electronic Nicotine Delivery Systems
ETF	Epidemic Task Force
ExO	Ex-Officio
GAC	Government Affairs Committee
GPC	Guideline Project Committee
H&A	Honors and Awards
HWBE	Health & Wellness in the Built Environment
IAQ	Indoor Air Quality

IAQ	Indoor Air Quality
IAQP	Indoor Air Quality Procedure
IEQ	Indoor Environmental Quality
IEQ-GA	Indoor Environmental Quality Global Alliance
ISIAQ	International Society of Indoor Air Quality and Climate
MBO	Management by Objectives
MOP	Manual of Procedures
MTG	Multi-disciplinary Task Group
PD	Position Document
RAST	Reactive Air and Surface Treatment
ROB	Rules of the Board
RTAR	Research Topic Acceptance Request
SGPC	Standing Guideline Project Committee
SSPC	Standing Standard Project Committee
TC	Technical Committee
TPS	Title Purpose and Scope
UL	Underwriters Laboratory
VRP	Ventilation Rate Procedure

ACTION ITEMS FROM 2023 WINTER MEETING

No.	Responsibility	Action Item	Page	Status
1	EHC	Send Development Committee list of technical topics / areas to focus on related on IAQ so ASHRAE can approach foundations and other institutions with similar interests to solicit funds	2	
2	EHC	Send Development Committee list institutions we should approach	2	
3	Schoen/ Metzger	Updates references, add references as appropriate in Environmental Tobacco Smoke PD	3	
4	Metzger	Draft list of recommended actions for EHC EIBs to consider at future meeting	4	
5	Staff	Explore website options to list or archive expired EIBs	4	
6	Staff	Staff was asked to poll EHC for next meeting	9	

1. CALL TO ORDER & INTRODUCTIONS

Clements called the EHC meeting to order at 8 AM EST. Members and guests introduced themselves. Clements referred to the *Hybrid Meeting Best Practices* and *Simplified Rules of Order – Quick Reference* on the EHC Basecamp.

2. ASHRAE CODE OF ETHICS COMMITMENT

In this and all other ASHRAE meetings, we will act with honesty, fairness, courtesy, competence, integrity and respect for others, and we shall avoid all real or perceived conflicts of interests.

ASHRAE DIVERSITY AND INCLUSION COMMITMENT

ASHRAE is committed to providing a welcoming environment. Our culture is one of inclusiveness, acknowledging the inherent value and dignity of everyone. We proactively pursue and celebrate diverse and inclusive communities understanding that doing so fuels better, more creative, and more thoughtful ideas, solutions and strategies for the Society and the communities our Society serves. We respect and welcome all people regardless of age, gender, ethnicity, physical appearance, thought styles, religion, nationality, socioeconomic status, belief systems, sexual orientation or education.

3. REVIEW OF AGENDA

The following additions were requested:

- 5.D - ASHRAE Development Committee to discuss Research Funding Sources for IEQ/IAQ and Resilience in Buildings (McQuade)
- 10.A – Host committee and hotel for ASHRAE Winter Meeting (McNulty)
- 10.B - ISIAQ call for letters of interest to host 2025 regional conferences (Bahnfleth)

4. MINUTES

Minutes from previous Meetings are already approved.

5. CHAIR'S REPORT (Clements)

A. Past EHC meetings since the 2022 Annual meeting (4 total):
- Jan. 24, 2023
- Sept. 29, 2022
- Aug. 22, 2022
- Jul. 25, 2022

B. Motions from Past Meetings
a. Motion to recommend Tech Council appoint Charlene Bayer as chair of PD committee on Health and Wellness in the Built Environment (1/24/2023) [Tech Council to consider in Atlanta]
b. Motion to recommend to Honors & Awards Committee a recipient of the Donald Bahnfleth Environmental Health Award (1/27/2023) [EHC selected a winner via letter ballot. Sent to H&A for approval]

C. ETF Transition Subcommittee established (1/24/2023)
a. Roster includes Wade Conlan (Chair), Bill Bahnfleth, Corey Metzger, Marwa Zaatari, Max Sherman, Dennis Knight. Group will start their work after ASHRAE Winter Meeting.

b. This subcommittees MBO's will be as follows: Develop a page of key recommendations and reports, distribution of ETF responsibilities/recommendations to other committees, report to Tech Council on "Task Force" approach to organizing during an urgent global event (Policy MBO 1.b assigned to ETF Transition Subcom MBO 4.a)

D. Other
    a. Discussion on Research Funding Sources for IEQ/IAQ and Resilience in Buildings (McQuade, Development Committee)

       McQuade is the current Vice-Chair of the ASHRAE Development Committee. Their main focus, now that we're moving past the pandemic, is on development for strategic plan initiatives, IEQ/IAQ being a key initiative. Development Committee is asking EHC technical topics / areas to focus on related on IAQ so ASHRAE can approach foundations and other institutions with similar interests to solicit funds (**Action Item #1**). Some example topics were air cleaning devices, indoor air quality resilience and commissioning, but they wish to cast a wide net of topics. Funding could result in research, education (k12, post-secondary, etc.) publications, application/building specific, etc. Also, if there are institutions we should approach, this would be appreciated as well (**Action Item #2**). McQuade noted the aim is to get feedback this society the year, so the sooner this can be collected the better. EHC can discuss more at upcoming meeting to finalize priorities. Please post ideas to google sheet.

6. VICE-CHAIR'S REPORT (Bahnfleth)

A. ROB / MOP / Reference Manual changes
   a. Discussion of ROB changes for rules on IEQGA/ASHRAE relationship, process for IEQGA representative
      No changes at this time. There are rules in place, but they've not always been followed

   b. Could add info on IEQ Conference
      No changes at this time. EHC working with CEC to plan next conference.

   c. ROB on IAQ/health in ASHRAE Standards. Implement/Request changes to ROB?
      EHC is reviewing ROB 1.201.004.9 (B,C,D) and may recommend changes to reduce or eliminate the need for granting waivers for standards related to contaminants, such as infectious aerosols (i.e., SSPC241P), that may not meet the requirements described in the ROB.

B. Donald Bahnfleth Environmental Health Award
   The recommended winner has been approved by EHC and sent to Honors and Awards for their consideration. They meet Feb. 6th at noon.

7. BOARD OF DIRECTORS (BOD) & EX-OFFICO (EXO) & COORDINATING OFFICER REPORT

A. BOD EX-Officio
   Conlan presented the ASHRAE Leadership Presentation (**Attachment A**). Highlights of interest to EHC included:
   - Nominations for appointed committees (including EHC) due Feb. 17th
   - DEI resources available at ashrae.org/DiversityEquityInclusion
   - Work of Task Force for Decarbonization continues. Information at www.ashrae.org/decarb
   - 2022 updates of ASHRAE standards 15, 62.1, 90.1

B. Coordinating Officer – Maston
   Maston was not in attendance to support. EHC responded to email request for activities related to decarbonization.

8. SUBCOMMITTEE REPORTS

A. Policy Subcommittee (Metzger)
   1. Position Documents
      a. Filtration and Air Cleaning PD (chair: Wargocki)

i. Status update
Zaatari reported that the PD committee met again yesterday. ASHRAE members and the public were invited to comment. The committee worked on a draft list of positions and recommendations and is working on format changes to streamline next version of PD.

b. Human Health and Wellness in the Built Environment PD
   i. Status update
   Tech Council will consider approving Charlene Bayer as PD chair at their meeting later this week. PD committee members being considered include Lan Chi Weekes, Nick Clements, Carl Grimes, Pawel Wargocki, Nick Agopian, Josephine Lau and Philip Agee. Stephanie Taylor indicated an interest in participating as well.

c. Infectious Aerosols PD
   i. Approved by BOD and published.

d. Indoor Air Quality PD (prior chair: D. Weekes)
   i. Status Update
   Weekes suggested reaffirming reformatted version (**Attachment B)** before it expires in June, 2023. Weekes will discuss with EHC if full revision is appropriate.

e. Unvented Combustion Devices and Indoor Air Quality PD (prior chair: Francisco)
   i. Status Update
   A reformatted PD was sent to Francisco for his comments. EHC will get recommended action from Francisco before it expires in June 2023.

f. Environmental Tobacco Smoke PD (prior chair: Schoen)
   i. Status Update
   Schoen reviewed and commented on a reformatted draft (**Attachment C**) and sent to EHC on Feb. 5th. Schoen volunteered to updates references, add references (but not change positions (**Action Item #3).** He anticipated the title to stay the same, but a new group and a revision would need to formed if the scope is expanded to include positions on other smoke sources such as ENDS, marijuana, incense, candles, smudging, etc.

g. Combustion of Solid Fuels and Indoor Air Quality in Primarily Developing Countries PD (prior chair, Francisco)
   i. Status Update
   This PD does not expire until 2025 but a reformatted version was sent to the chair for input on reaffirmation.

h. Indoor Carbon Dioxide PD (prior chair: Persily)
   i. Status Update
   A reformatted version will be sent to chair for consideration. The past chair noted a revision may be appropriate.

2. Emerging issue briefs
   a. Retire or revise any current *emerging issue briefs (*EIBs)?:
      - Dynamic Thermal Environment (June 2022)
      - Increased Awareness of Health Impacts of Indoor PM2.5 and Need for Particulate Matter Control in Occupied Spaces (April 2022)
      - Increasing Dogs in Office (September 2021)
      - Pandemic COVID-19 and Airborne Transmission

- Electronic Nicotine Delivery Systems (ENDS) in Indoor Environments (July 2018)
- Potential Microbial Contaminants in Biowall Water and Soil Systems (April 2018)
- Indoor Passive Panel Technologies for Air Cleaning in Buildings (July 2016)
- Nano Environmental Health and Safety (nanoEHS) (January 2016)
- Ozone and Indoor Chemistry (January 2011)
- Biological agents and airborne transmission (January 2010)

  Metzger reviewed this list and noted some are likely ready to be retired. He agreed to draft list of recommended actions for EHC consideration at future meetings (**Action Item #4**).

  Khankari noted MTG.ACR is looking at a brief or white paper on air change rates, eventually looking at ASHRAE position document. May request EHC to participate or help develop an EIB in near future.

  EHC discussed a scheduled review (5 year?) to determine if these topics are still emerging or what appropriate action might me. The consensus was to archive these, even if retired, so that the information is not lost. List 'current' EIBs and 'retired' EIBs on website to keep everything accessible. Staff to explore options (**Action Item #5**).

  Taylor suggested this list may be a good list of topics to send to McQuade related to his Development Committee request

b. New EIBs

- Indoor Reactive Oxygen and Nitrogen Species (**Attachment D**)
  Clements thanked all for input but still needs some work before it is considered for publication.

- Possible New EHC EIBs
  - IAQ and upper respiratory (Taylor, Ereth)
  - Liquid nitrogen ice cream application (Examples for 62.1 listing of unusual contaminant sources)
  - Gas Stoves

3. Other

a. IEQ Audit/Commissioning MTG Proposal

- TPS – Standard 211 Energy Audit as basis? Economic basis for IEQ
- IEQ-GA involvement?

  A group in ASHRAE already develpoing information on this topic:

  TITLE:
  Guideline 45P, Measurement of Whole Building Performance for Occupied Buildings except Low-Rise Residential Buildings

  PURPOSE:
  The purpose of this document is to provide guidelines for reliably measuring whole building performance pertaining to occupied buildings, except low-rise residential buildings.

  SCOPE:

This document provides procedures for measuring whole building performance, including energy, water and indoor environmental quality (IEQ), pertaining to all occupied buildings except low-rise residential buildings.

2.1. What Is Included. The procedures include:

a. IEQ (thermal comfort, indoor air quality, lighting, and acoustics);
b. energy, water, and on-site renewables;
c. occupant behaviors;
d. metrics, measurement methods (including data integrity), and benchmarking/evaluation methods;
e. multiple levels of measurements (accuracy/complexity); and
f. all types of occupied buildings except low-rise residential buildings.

2.2 What Is not Included. The procedures do not include:

a. carbon metrics;
b. rating methods; or
c. quantitative measurement cost

It was recommended that EHC liaison with this group and contribute here instead of spearheading a new group.

B. Education Subcommittee (Taylor/Burley)

1. EHC programs for 2023 Annual Meeting

(1) it was moved (Clements) and seconded (Bahnfleth) that EHC sponsor a panel titled *Best Practices: Testing, Verifying, and Commissioning for Indoor Air Quality and Pathogen Mitigation*.

BACKGROUND: The proposal is shown in **Attachment E**. EHC will seek co-sponsorship from TC 9.6 and TC 2.4. Presenters would include Nick Clements, Marwa Zaatari, Elliott Horner and Wade Conlan.

MOTION 1 VOTE: 11-0-0 CNV - PASSES

(2) it was moved (Burley) and seconded (Zaatari) that EHC co-sponsor a SSPC 62.1 program titled *The Effect of Buildings on Occupant Health.*

BACKGROUND:

- Premise: The recent MTG-Health and Wellness in the Built Environment (HWBE) report approved by the EHC explicitly states that the purpose of most buildings is for human occupancy. Further, the MTG report elaborates on the multiple effects that the built environment has on occupant health. One of the charges to the MTG was to survey ways in which ASHRAE can have a positive impact on Health and Wellness in the Built Environment. This session will review the effect of buildings on health, spotlight the ASHRAE documents and activities that have the most potential to Impact occupant health, and recognize the value of better indoor environments relative to their cost. These three presentations will support the message that ASHRAE should strengthen requirements in their standards (62.1, 62.2, and 189.1) to better protect occupants when and where ASHRAE standards are adopted as code.
- Elliott Horner – Chair
- Andy Persily – Historical Perspective on ASHRAE and Health
- Stephanie Taylor – Health Effects
- Others to be named

- Linda Lee offered to participate with a primer on these concepts for ASHRAE audience, a Public Health 101.
- The full Committee approved co-sponsorship of this presentation

MOTION 2 VOTE: 11-0-0 CNV - PASSES

Other Proposals due 2/27/2023 (link)

EHC discussed the following other ideas:

- A seminar or panel on quantifying the relationship on human health (IAQ or DALY).
- TC 9.6, SSPC 170, 62.1, SGPC10 likely interested in co-sponsorship.
- Indoor Air Chemistry
- Elliott Horner to submit seminar on MTG.HWBE for EHC participation

2. EHC sponsored proposals for 2023 Winter Meeting:
   a. Seminar 36, The Interaction of Indoor Environmental Quality Variables in Schools: Health and Performance Impacts (link) was cosponsored by EHC and SGPC 10.

3. ASHRAE Journal IEQ Applications Column
   a. Status (Burley)
   Burley noted we've published columns in each of last six months and thanked authors for their work. An article on an ETF retrospective is due at the end of this month.

   Other ideas were mentioned:
   - PM2.5 (Bohanon)
   - Relationship between Air Pollution and Decarbonization (Zaatari/Taylor)
   - Carbon impact of poor IAQ (carbon/DALY).
   - Strategies to improve IAQ in environmental justice communities (Clements) mid-March
   - Challenges of disease transmission (Lee)
   - Gas stove technologies and impact (Ron George)

   Burley to reach out to volunteers to schedule, give details, etc.

4. Handbook Chapter
   a. Next revision due in 2024 for 2025 publication (09.B.4), topics needing update are identified, authors will be identified during 2023

5. EHC Webinar Planning
   a. Two public webinars to be schedule during 2023
   Metzger would reach out to CTTC as they typically plan 5-6 programs and would be receptive to programs from EHC. Ideas of topics were listed:
   - Assessing air mixing in room (Persily, Tom Smith, Dan Hahne)
   - stratified ventilation in healthcare facilities (Yuguo Li)

C. Coordination and Outreach Subcommittee (Weekes)
   1. IEQ/IAQ 2025
      a. Conference Co-chairs

(3) The Coordination and Outreach Subcommittee moved that EHC recommend to CEC that Jennifer Isenbeck and Iain Walker co-chair ASHRAE IEQ 2025 steering committee.

BACKGROUND: The co-chairs would develop recommend steering committee membership. Volunteers contacted earlier will be asked to be participate on planning committee. The eventual committee will a recommend timing, theme, location to CEC. The expected location would be North America.

MOTION 3 VOTE: 11-0-0 CNV – PASSES

2. Current EHC sponsored or co-sponsored research
RP-1579 - *Testing and Evaluation of Ozone Filters for Improving IAQ* (Bohanon)
RP-1579 final report was approved in January 22 and is now published. 62.1 is reviewing for possible updates to standard.

3. Weekes invited all to attend IEQ-GA Meeting. BOD meeting at 1 PM Tuesday.

9. LIAISON ACTIVITIES

A. GAC
McNulty thanked EHC for their work on PDs as they are a great resource for GAC. McNulty asked input on timing of upcoming PDs:

- Human Health and Well Being (just underway, expect within a year+)
- Filtration and Air Cleaning (this draft is in the works, expect within a 1 year)

B. Standard 62.1 (*Burley)*
Burley noted the SSPC met in Atlanta. A few interpretations were approved by subcommittees. The committee is working on changes related to radon separation distances and expanding the IAQP test procedure section requirements.

C. Standard 188 (*Lucas*)
Lucas reported no change proposals since last update.

D. Standard 55
Guests reported the standard committee is currently working through requirements for documenting standard compliance, as well as specifying non-compliance for specific applications where compliance is unlikely (meat packing plant) or for occupants in spaces that have different activities levels within the space (front desk workers in a gym for example). This standard expects to republish later this year.

E. Standard 62.2
Sherman reported there are three addenda to BOD for approval related to requiring UL2998, MERV 11 filtration and prohibiting unvented gas space heaters.
An advisory public review out now for DALY approach to IAQP to seek input to complete a continuous maintenance proposal.

The committee is looking at possible addenda to help comply with positions in the Environmental Tobacco Smoke PD, and to give credit for particle filtration in ventilation rate procedure (VRP) method of compliance.

Staff noted that members can be made aware of standard actions by signing up for listserv at https://ashrae.realmagnet.land/standards-actions-sign-up.

F. Standard 189.1
Persily reported this committee is developing several addenda and is meeting tomorrow.

G. Guideline 10
Clements noted the latest version out for publication shortly (approved already). Committee seeking new members. The section on moisture is to be expanded and updates on occupant behavior in buildings are being explored.

H. Standard 170
Burley reported SSPC 170 is meeting Monday and Tuesday in Atlanta. They've held two interim meetings since Toronto.

I. Guideline 44P
This group continues to meet but no other updates were reported.

J. Guideline 42P committee
Burley stated this guideline is out for its 3rd public review through Feb 27. The committee passed a request to make a continuous maintenance guideline.

K. MTG.ACR Air Change Rate
Mead noted this group is reviewing a research final report and expect to have a seminar in Tampa.

L. MTG.VIC Ventilation for Infection Control
Bahnfleth is on the MTG and reported they last met in Toronto to discuss an RTAR. He speculated that Standard 241P effort may displace this effort.

M. TG2.RAST
Zaatari noted this group now has a new chair. The committee is meeting in Atlanta later today. Kathleen Owen helped start a185.5 method of test for effectiveness of such filters.

N. TC 2.1
TC 2.1 is meeting later this week in Atlanta. They are working on an RTAR related to measuring CO2 and metabolic rates and aerosols. Encouraged EHC members to attend.

O. GPC 45P (request liaison for next EHC meeting)
Burley agreed to help recruit an EHC member to liaise with this group.

P. Others
Lee reported SSPC 185.3, a method of test standard for indoor air treatment is in a final draft and will be posted for public review shortly.
Lee also reported SSPC 185.4 on ultraviolet treatment for surfaces expects a 1st draft later this year.

10. NEW BUSINESS

A. Host committee and hotel for ASHRAE Winter Meeting (McNulty)
McNulty updated EHC on host committee activities related to the host hotel and IAQ for the ASHRAE Winter Meeting in Atlanta. McNulty was a member of a risk reduction committee for the hotel to implement ETF recommendations for this meeting location. Activities included free N95s, outdoor seating options, an HVAC walk through with facility manager two weeks before conference, and box fan filters in meeting rooms.

McNulty thanked EHC members who helped and noted there is a QR code for a survey about these IAQ related activities. ASHRAE is collecting and generating ideas for using ASHRAE resources and expertise to leave conference venues better than we found. There are studies on the epidemiological impacts of conferences like our (see https://navsa2022.org/the-navsa-study/). McNulty reported the goal is to develop a package to use going forward by ASHRAE host committees, conference venues, etc.

EHC thanked McNulty and host committee for these efforts!

Development Committee may have an interest in helping to fund these sorts of ideas for ASHRAE conferences and EHC was encouraged to communicate such ideas to them. The ASHRAE BOD has subcommittee to elevate ASHRAEs name recognition and these sorts of ideas would be of interest to them as well.

B. ISIAQ call for letters of interest to host 2025 regional conferences
Bahnfleth the ASHRAE IEQ conference could be the ISAIQ 2025 regional conference. He asked EHC if ASHRAE should try to submit a letter before the Feb. 28th deadline.

(4) It was moved (Bahnfleth) and seconded (Clements) that EHC ask ASHRAE to submit letter of interest to host ISIAQ 2025 regional conference.

BACKGROUND: The deadline to send a letter of interest is Feb. 28th. EHC would work with ASHRAE's CEC, staff, and conference co-chairs to develop letter. The idea is to cohost ASHRAE's IEQ 2025 conference and the ISIAQ regional conference event as a single conference.

MOTION 4 VOTE: 11-0-0 CNV - PASSES

C. NEXT MEETING
1. February/March Virtual Meeting
Staff was asked to poll EHC for next meeting (**Action Item #6**). Plan was to poll for week/day of week/time that would work as a standing meeting of EHC until the Annual Meeting. Please respond accordingly.

2. Annual Meeting, Tampa, FL. June 24-28, 2023
EHC planned to meet again Monday morning. Subcommittees were asked to hold their subcommittees virtually ahead of Annual Meeting.

<u>11. ADJOURNMENT</u>

EHC adjourned at 11:15 AM EST. All attendees were thanked for their participation.

ASHRAE Leadership Presentation
2023 Winter Conference

ASHRAE Policies

Code of Ethics

"We will act with honesty, fairness, courtesy, competence, inclusiveness and respect for others, which exemplify our core values of excellence, commitment, integrity, collaboration, volunteerism and diversity, and we shall avoid all real or perceived conflicts of interest."

Harassment and Discrimination Policy

ASHRAE strictly prohibits and does not tolerate discrimination against members or applicants for membership because of such individual's race, color, religion, age, sex, sexual orientation, national origin, physical or mental disability, pregnancy, genetic information, veteran status, uniformed service member status, or any other category protected under applicable law.

Commercialism

ASHRAE's Commercialism Policy allows for Society activities that fulfill the mission of technological advancement with adherence to business plans that generate income to offset operational expenses such as AHR Exposition, ASHRAE periodicals, website, and Society conference events such as the Welcome Party, luncheons, registration kits, and receptions.

ashrae.org/commercialism

View ASHRAE Governing Documents at ashrae.org/about/governance

Nominations Needed!

Committee Nominations

- Nominations for elected positions (Councils, RAC, TAC, Standards, and Handbook) are due **mid-September**.
- Nominations for appointed committees are due **February 17**.
- Speak with your committee ExO/CO if your current appointment ends in June and you wish to be nominated for another committee.

Technical and Society Level Committees
ashrae.org/committee-nominations

Honors & Awards Nominations

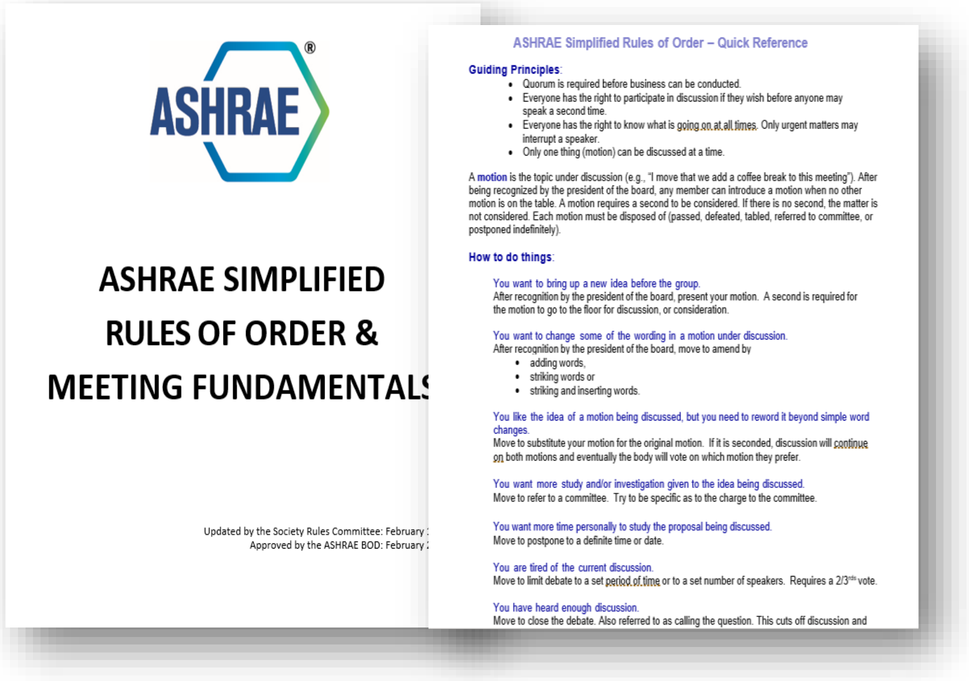
ASHRAE's awards fall into one of six categories:

- Personal Honors
- Personal Awards for General & Specific Society Activities
- Paper Awards
- Society Awards to Groups or Chapters
- Chapter and Regional Awards

Learn More and Nominate Someone Today
ashrae.org/honorsandawards

ASHRAE Technical Committees (TCs) and Volunteer Opportunities at ashrae.org/communities

ASHRAE Simplified Rules of Order & Quick Reference


ASHRAE SIMPLIFIED RULES OF ORDER & MEETING FUNDAMENTALS

Updated by the Society Rules Committee: February
Approved by the ASHRAE BOD: February

ASHRAE Simplified Rules of Order – Quick Reference

Guiding Principles:
- Quorum is required before business can be conducted.
- Everyone has the right to participate in discussion if they wish before anyone may speak a second time.
- Everyone has the right to know what is going on at all times. Only urgent matters may interrupt a speaker.
- Only one thing (motion) can be discussed at a time.

A **motion** is the topic under discussion (e.g., "I move that we add a coffee break to this meeting"). After being recognized by the president of the board, any member can introduce a motion when no other motion is on the table. A motion requires a second to be considered. If there is no second, the matter is not considered. Each motion must be disposed of (passed, defeated, tabled, referred to committee, or postponed indefinitely).

How to do things:

You want to bring up a new idea before the group.
After recognition by the president of the board, present your motion. A second is required for the motion to go to the floor for discussion, or consideration.

You want to change some of the wording in a motion under discussion.
After recognition by the president of the board, move to amend by
- adding words,
- striking words or
- striking and inserting words.

You like the idea of a motion being discussed, but you need to reword it beyond simple word changes.
Move to substitute your motion for the original motion. If it is seconded, discussion will continue on both motions and eventually the body will vote on which motion they prefer.

You want more study and/or investigation given to the idea being discussed.
Move to refer to a committee. Try to be specific as to the charge to the committee.

You want more time personally to study the proposal being discussed.
Move to postpone to a definite time or date.

You are tired of the current discussion.
Move to limit debate to a set period of time or to a set number of speakers. Requires a 2/3rds vote.

You have heard enough discussion.
Move to close the debate. Also referred to as calling the question. This cuts off discussion and

Download the rules and quick reference on the ASHRAE website

REMINDER! Councils and Committees should now be fully operational in the new ASHRAE Simplified Rules of Order meeting guidance.

Questions or comments regarding the new rules of order and quick reference?

Contact boardservices@ashrae.org

ashrae.org/communities/committees/society-rules-committee

2022-23 Board of Directors

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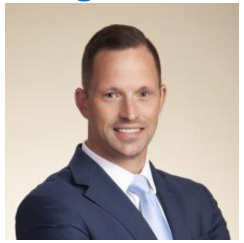
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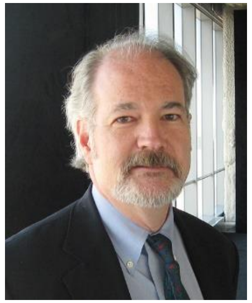

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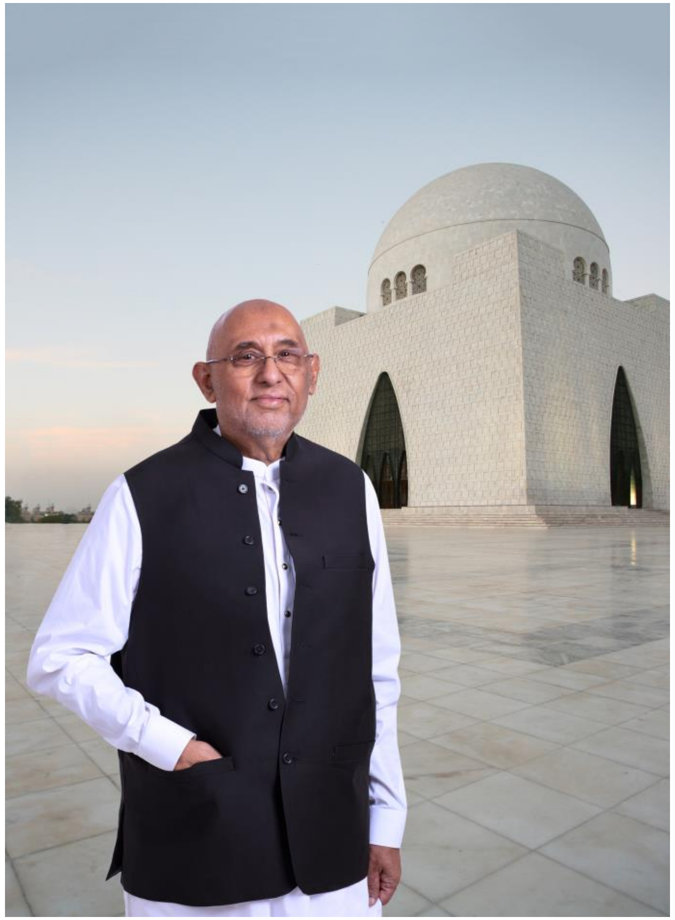
President's Luncheon + Board Meetings



President's Luncheon
(Ticket Required)

Monday, 12:15 pm – 2:00 pm
Omni CNN Center, Grand Ballroom

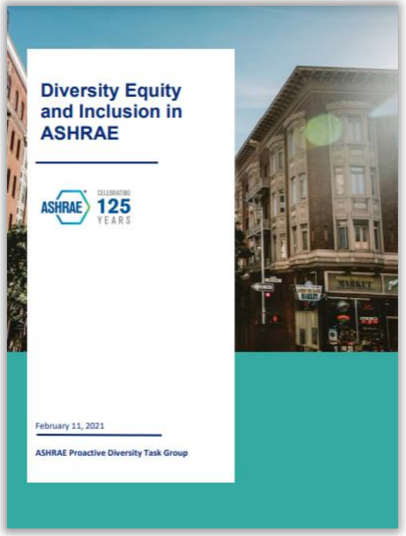
Connect with attendees and hear updates from Farooq Mehboob, Fellow Life Member ASHRAE, 2022-23 ASHRAE President

Board of Directors Meetings
Attend in person in the Omni CNN Center, Grand Ballroom or stream live (link in ASHRAE 365).

Sunday, 1:30 pm – 5:30 pm
Wednesday, 2:00 pm – 6:00 pm

Diversity, Equity, & Inclusion (DEI) in ASHRAE

BOD Subcommittee created by the Board in January 2021



The purpose of the BOD DEI Subcommittee is to advise and engage the Board of Directors on:

- All matters relating to diversity, equity and inclusion - with a view to improving organizational awareness and performance in these areas amongst both staff and the Society membership
- The establishment of annual budgets for DEI program and ongoing initiatives
- The prioritization of inclusivity issues which have relevance to ASHRAE, together with plans for addressing these issues
- DEI training modules for Chapters and Committees are available at the DEI Training website available through the ashrae.org/DiversityEquityInclusion page. An ASHRAE login is required to access videos.

New Resources available at

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Members of the BOD DEI Subcommittee

Adrienne Thomle (Chair); Kishor Khankari (Vice Chair); Devin Abellon; Susanna Hanson; Wei Sun; Ashish Rakheja; Tanisha Meyers-Lisle (Staff Liaison); Billy Austin; Dennis Knight; Farooq Mehboob (Consultant)

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- Establishing relevant training & education

Email questions or input to decarb@ashrae.org

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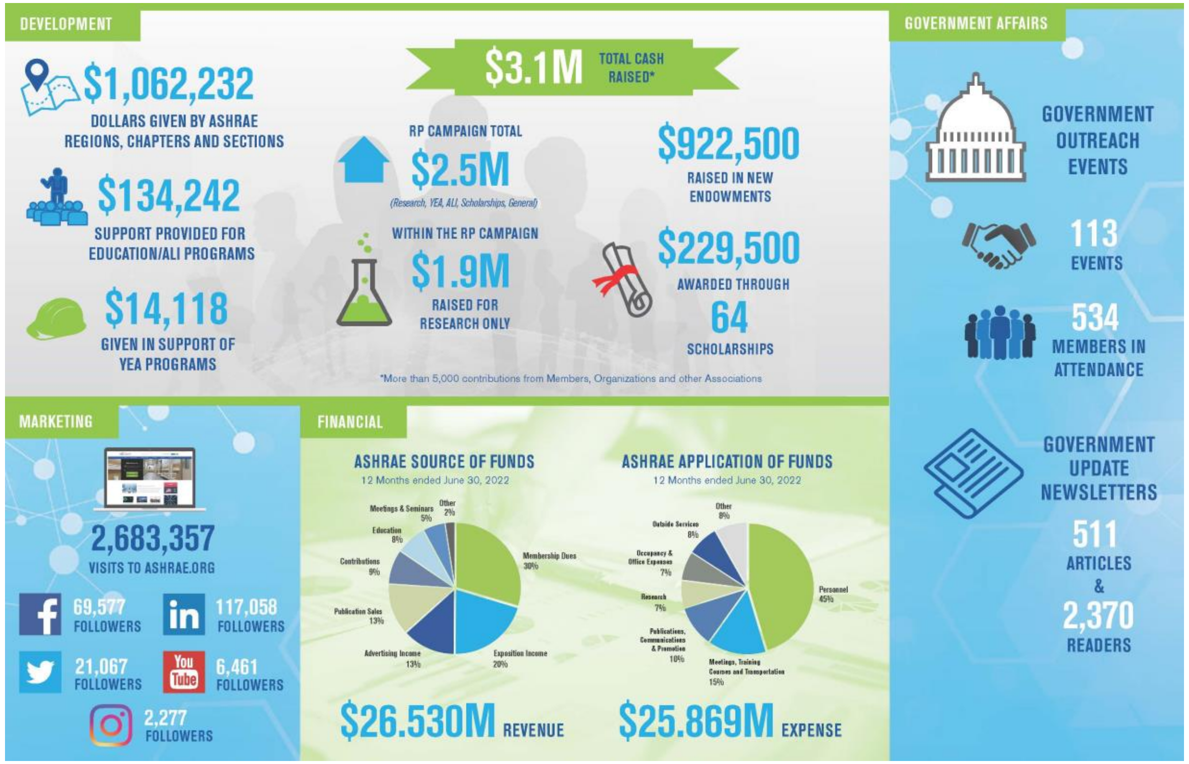

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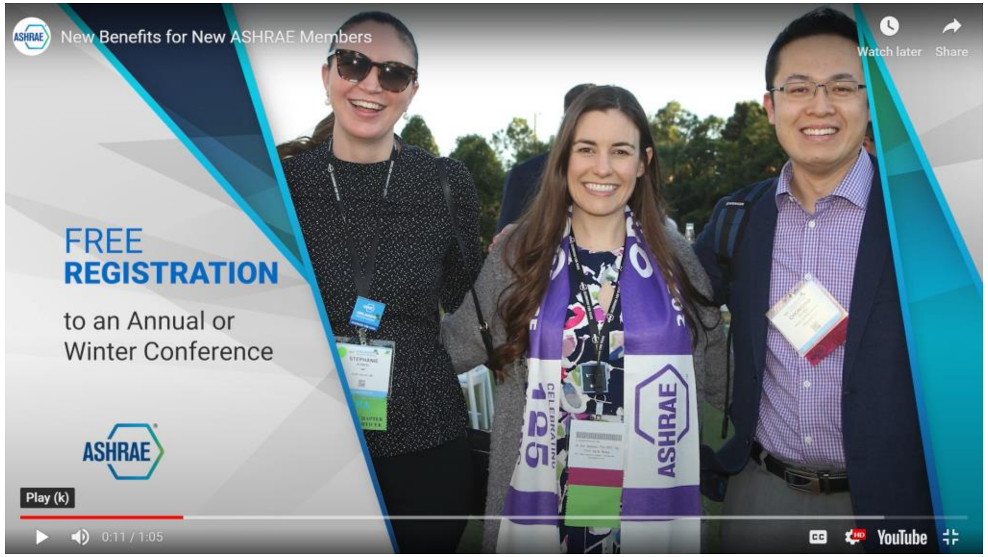

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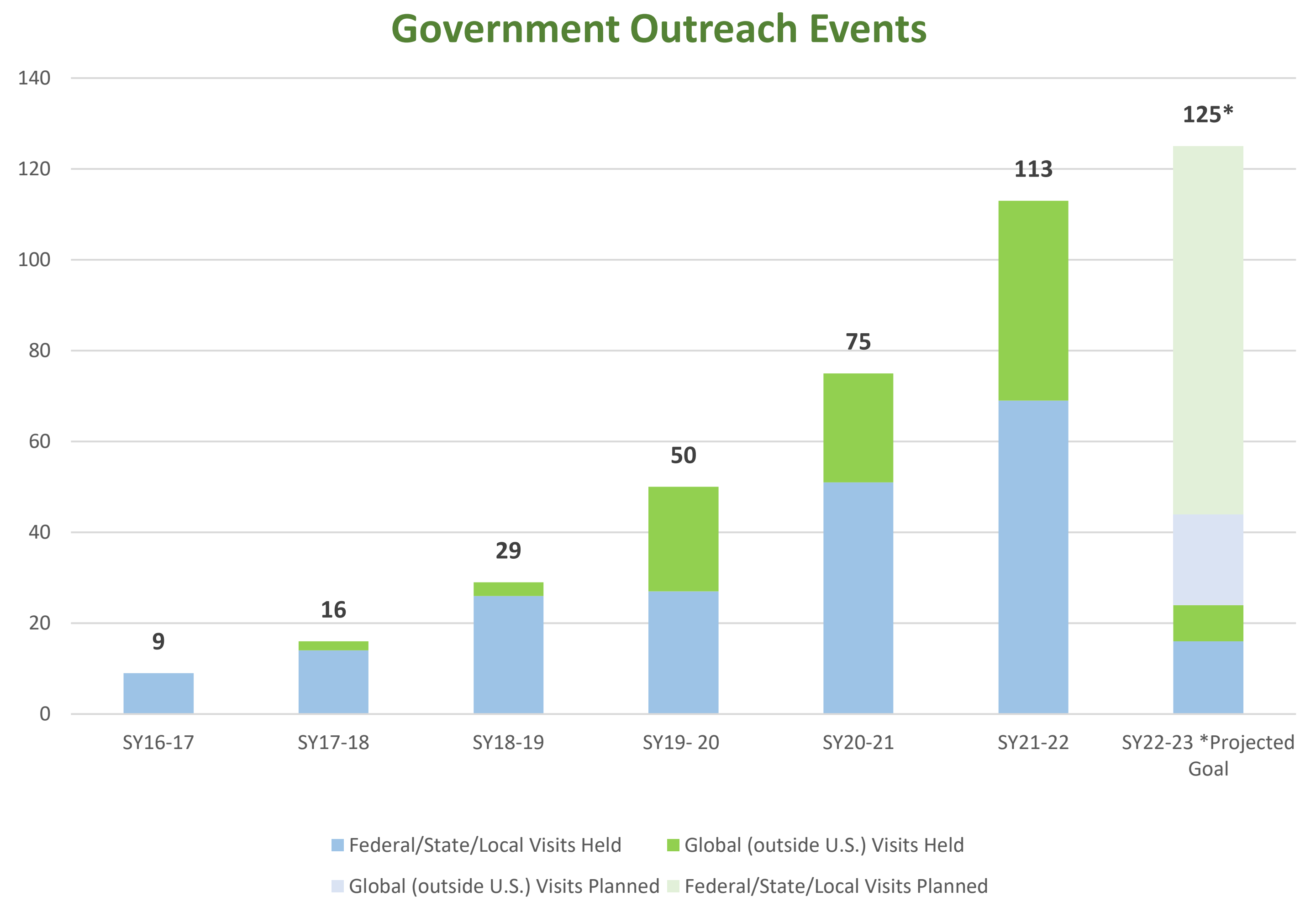

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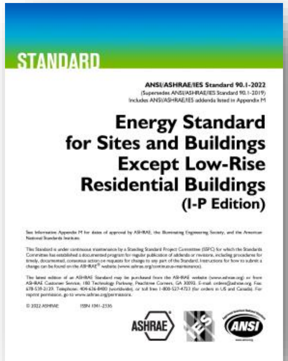
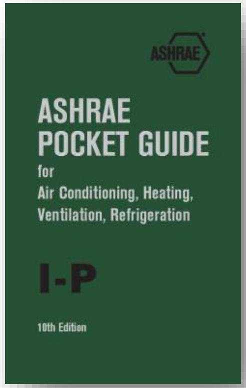
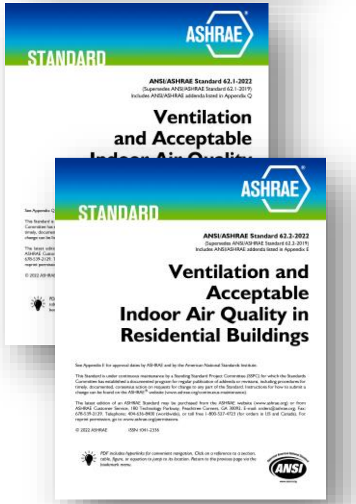


ANSI/ASHRAE Standard 90.1-2022, *Energy Standard for Sites and Buildings Except Low-Rise Residential Buildings*



***ASHRAE Pocket Guide for Air Conditioning, Heating, Ventilation, Refrigeration,* 10th Ed.**

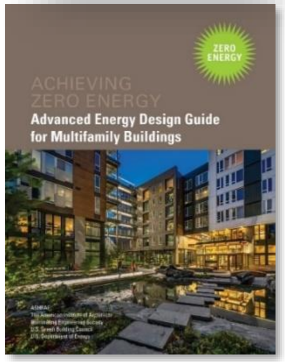
Lucy's Engineering Adventure



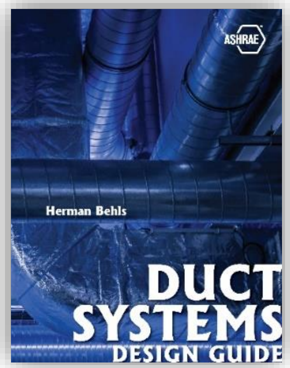
ANSI/ASHRAE Standard 62.1-2022, *Ventilation and Acceptable Indoor Air Quality*

&

ANSI/ASHRAE Standard 62.2-2022, *Ventilation and Acceptable Indoor Air Quality in Residential Buildings*



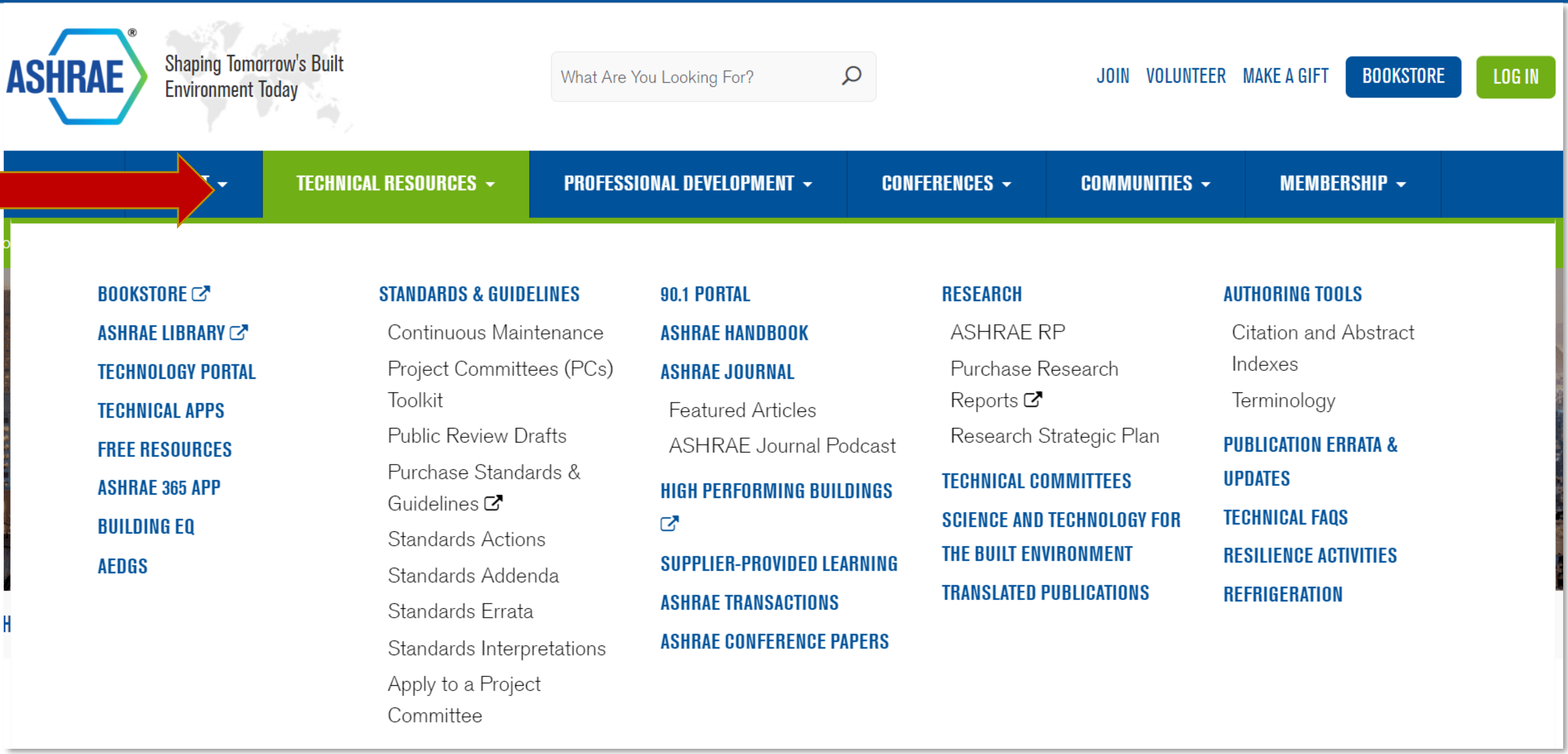
Advanced Energy Design Guide for Multifamily Buildings – Achieving Zero Energy (AEDG)



Duct Systems Design Guide

Standard 241P: White House Ventilation Standard for Pathogen Mitigation (Non-ANSI Standard) **Target to Publish Fall 2023**

Resources



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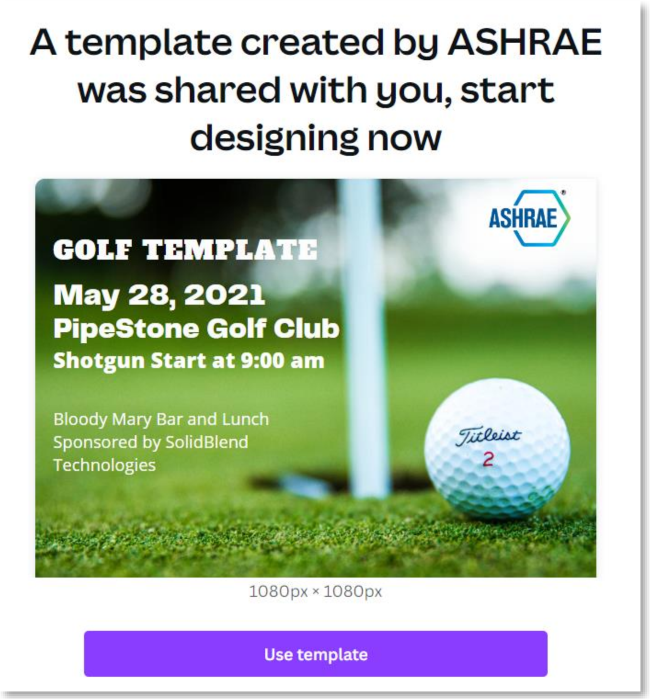

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2023 ASHRAE Annual Conference
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Thank you!
Questions or Comments?

ASHRAE Positions on

Indoor Air Quality

Approved by ASHRAE Board of Directors July 1, 2020

Expires July 1, 2023

Indoor Air Quality is a Public Interest Issue

Indoor air is the dominant pathway for exposure to airborne contaminants given that people spend the majority of their time indoors, and indoor air commonly contains numerous contaminants originating from both indoor and outdoor sources. Many of the contaminants impact health, comfort, well-being, learning outcomes and work performance. It is important that IAQ is considered in the design, construction and operation of buildings and HVAC systems. ASHRAE and its partners have long pursued improved IAQ through a range of activities.

Why ASHRAE Takes Positions on Indoor Air Quality

Indoor air quality (IAQ) has long been a critical issue for ASHRAE and its members because of the connection to ventilation and other HVAC systems in buildings.

ASHRAE's Standards 62.1 (commercial and institutional buildings) and 62.2 (residential buildings) (ASHRAE 2019a, 2019b) intended to support acceptable IAQ have been the benchmarks for ASHRAE's members and others involved with IAQ (e.g., practitioners; contractors; industrial hygienists) since 1973. ASHRAE has been concerned with all aspects of IAQ through its Position Documents, other standards and guidelines, conferences, and other efforts.

ASHRAE Takes the Positions That:

- IAQ impacts people's health, comfort, well-being, learning outcomes and work performance. Improved IAQ brings substantial health and economic benefits from a broad public health perspective, as well as to individual building owners and occupants.
- The provision of acceptable IAQ is an essential building service and central to ASHRAE's purpose.
- Achieving and maintaining good IAQ should be included in all decisions that affect the design and operation of buildings and HVAC systems, including efforts to improve building energy efficiency, sustainability and resiliency.

- The importance of IAQ and the fundamentals of achieving good IAQ through building design and operation should be included in educational programs.
- ASHRAE's IAQ standards should be adopted by building codes and regulations.

The appendix of this document provides evidence to support these positions, including the effects of IAQ on human health, comfort, well-being, learning outcomes and work performance, and the economic benefits of improved IAQ.

ASHRAE Recommends That:

- ASHRAE recommends fundamental and applied IAQ research and standards development in the following areas:

- The relationship of ventilation rates and contaminant concentrations to occupant health, comfort, well-being, learning outcomes and work performance.
- Approaches to improving IAQ beyond dilution ventilation, e.g., air cleaning and source control.
- Development of tools to allow economic valuation of IAQ benefits for individual buildings and groups of buildings.
- Development of monitoring and HVAC equipment to control IAQ by measurement of contaminants.
- Development of diagnostics for commissioning and maintenance of ventilation and related IAQ systems.
- The role of IAQ in building sustainability and resilience.
- Development of IAQ control systems and solutions that contribute to other building goals including reducing energy use and greenhouse gas emissions and supporting grid integration.
- Research on new contaminants of concern and development of technologies and approaches to address them.

- ASHRAE is committed to:
  - Maintaining and updating IAQ standards, guidelines and handbooks.
  - Integrating principles of IAQ within its professional education programs
  - Advancement of IAQ research including tools and applications.
  - Using its leadership position to develop partnerships with international organizations to promote research, education, and best practices in IAQ.

REFERENCES

ASHRAE 2020a. Position Document on Infectious Aerosols
ASHRAE 2020b. Position Document on Environmental Tobacco Smoke ASHRAE 2020c. Position Document on Unvented Combustion Devices and IAQ
ASHRAE, 2019a. ANSI/ASHRAE Standard 62.1-2019: Ventilation for Acceptable Indoor Air Quality.
ASHRAE, 2019b. ANSI/ASHRAE Standard 62.2-2019: Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings.
ASHRAE (Ed.), 2018a. Residential indoor air quality guide: best practices for acquisition, design, construction, maintenance and operation, ASHRAE. ASHRAE, Atlanta, GA.
ASHRAE, 2018b. ASHRAE Position Document on Filtration and Air Cleaning.
ASHRAE 2018c. ASHRAE Position Document on Limiting Indoor Mold and Dampness in Buildings
ASHRAE 2017a. Handbook—Fundamentals. Atlanta: ASHRAE.
ASHRAE, 2017b. ANSI/ASHRAE Standard 170-2017: Ventilation of Health Care Facilities.
ASHRAE, 2017c, ANSI/ASHRAE/ICC/USGBC/IES Standard 189.1, Standard for the Design of High-Performance, Green Buildings Except Low-Rise Residential Buildings
ASHRAE (Ed.), 2009. Indoor air quality guide: best practices for design, construction, and

commissioning. American Society of Heating, Refrigerating, and Air- Conditioning Engineers, Atlanta, GA.

ICC, 2018. 2018 International Green Construction Code (IgCC)

APPENDIX A – BACKGROUND

This document contains a high level discussion of indoor air quality given that ASHRAE has published many informative documents related to indoor air quality such as the Handbook - – Fundamentals (ASHRAE 2017a) (particularly Chapters 9 through 12) and two IAQ guides: "Indoor Air Quality Guide – Best Practices for Design, Construction and Commissioning" and "Residential Indoor Air Quality Guide: Best Practices for acquisition, design, construction, maintenance and operation" (ASHRAE 2009, 2018a).

Additionally, many other important IAQ issues are not covered here, as there are separate Position Documents that cover specific topics including: Infectious Aerosols, Environmental Tobacco Smoke, Unvented Combustion Devices and IAQ, Filtration and Air Cleaning, and Limiting Indoor Mold and Dampness in Buildings (ASHRAE 2020a, 2020b, 2020c, 2018b, 2018c). Instead, this document focuses on recommendations in several broad areas including policy, research, and education related to IAQ.

1.1 Overview

An established and still growing body of literature, summarized in the Appendix of this document, has demonstrated that: (1) IAQ impacts occupant health, comfort, well-being and the ability to work and learn, and therefore, (2) improving IAQ will bring benefits at the societal and individual levels.

Indoor air quality (IAQ) refers to the types and concentrations of airborne contaminants found in buildings. And while there is no universally accepted definition of "good" IAQ, there are three widely accepted approaches to improving IAQ in buildings:

- **Source control**
  - Use building materials, furnishings, appliances, and consumer products with low contaminant emissions.
  - Minimize indoor contaminant sources caused by occupant activities.
  - Remove outdoor contaminants via filtration and air cleaning before they enter a building; and
  - Design, operate, and maintain building enclosures, HVAC systems, and plumbing systems to reduce the likelihood of moisture problems and/or quickly mitigate them when they happen.

- **Ventilation**
  - Ensure that clean air is delivered to occupied spaces in order toeffectively dilute and remove contaminants emitted by indoor sources and that air is exhausted in the vicinity of localized indoor sources.
- **Air cleaning**
  - Use effective air cleaning technologies to remove contaminants from outdoor ventilation air and recirculated indoor air.

Cost-benefit analyses have estimated that the health and economic benefits of improved IAQ are far greater than the costs of implementing these improvements. Also, many strategies exist, and others continue to emerge, that can help achieve good IAQ with lower energy impacts. Ultimately, an integrated design approach that considers both IAQ and energy, in addition to other key aspects of building performance such as site impacts, water use and other environmental impacts, is required to achieve high performing buildings that are energy efficient and achieve good IAQ. For more information on integrated design in context of IAQ see the ASHRAE IAQ Design Guide.

1.2 ASHRAE Activities in Support of IAQ

ASHRAE provides technical resources, coordinates and funds research, organizes conferences, and educates practitioners about IAQ. ASHRAE has also developed and continues to support standards, guidelines, and other resources related to improving IAQ. For example, ASHRAE promulgates the following standards that specifically address IAQ:

- ANSI/ASHRAE Standard 62.1, *Ventilation for Acceptable Indoor Air Quali*ty. This Standard, first published in 1973, establishes minimum ventilation and other IAQ related requirements for buildings other than residential and health care. Its outdoor air ventilation rate requirements have been adopted into the International Mechanical Code and Uniform Mechanical Code, the two most common model building codes in the US. The standard is also referenced by most green building programs including LEED.
- ANSI/ASHRAE Standard 62.2, *Ventilation and Acceptable Indoor Air Quality in Residential Buildings*. This Standard, first published in 2003, covers residential buildings. Minimum ventilation requirements from this standard have been adopted into codes, including California's Title 24, and into LEED for Homes and the U.S. Environmental Protection Agency's (EPA) Indoor airPlus program.
- ANSI/ASHRAE/ASHE Standard 170, *Ventilation of Health Care Facilities* ASHRAE 2017b*)*. Standard 170 brought together several documents used throughout North America into a single standard. It is now widely used in building codes for ventilation requirements in hospitals and other health care facilities.
- ANSI/ASHRAE/ICC/USGBC/IES Standard 189.1, *Standard for the Design of High- Performance, Green Buildings Except Low-Rise Residential Buildings (*ASHRAE 2017c*)*. Developed in conjunction with USBGC, the International Code Council and Illuminating Engineering Society (IES), this standard provides IAQ requirements beyond those in Standard 62.1. The standard was developed to be adopted as part of voluntary green/sustainable rating systems, green building incentive programs, and local building regulations. The most recent version of the

standard (2017) serves as the technical content of the 2018 International Green Construction Code (ICC 2018).

In addition, ASHRAE has published a number of guidelines and design guides help practitioners achieve good IAQ in buildings, including:

- ASHRAE *Indoor Air Quality Guide – Best Practices for Design, Construction, and Commissioning*. This Guide, resulting from a collaborative effort of six leading organizations in the building community, presents best practices for design, construction, and commissioning that have proven successful in other building projects. It provides information and tools that architects and design engineers can use to achieve an IAQ-sensitive building that integrates IAQ into the design and construction process along with other design goals, budget constraints, and functional requirements.
- ASHRAE *Residential Indoor Air Quality Guide: Best Practices for Acquisition, Design, Construction, Maintenance and Operation*" addresses IAQ issues in residential buildings.

A more complete list of standards, guidelines, and other relevant ASHRAE publications is included in the Appendix of this document.

APPENDIX B – LITERATURE

This appendix summarizes the relevant literature supporting ASHRAE's IAQ Position Document and provides additional context for the positions and recommendations contained in that document.

What is indoor air quality?

For the purposes of this document, indoor air quality (IAQ) refers to the types and concentrations of contaminants in indoor air that are known or suspected to affect people's comfort, well-being, health, learning outcomes and work performance. Primary classes of these contaminants include particulate matter (both biological, including allergens, potential pathogens, and non-biological), organic gases (e.g., volatile and semi-volatile organic compounds), and inorganic gases (e.g., carbon monoxide, ozone, and nitrogen oxides). Other factors contributing to IAQ include water vapor and odors. Indoor concentrations of contaminants are influenced by outdoor concentrations, ventilation and infiltration, indoor emissions, and a number of other contaminant-specific source and sink mechanisms (e.g., deposition, chemical reactions, and air cleaning).

IAQ impacts humans by exposure to pollutants by inhalation, dermal and ingestion pathways. Personal and indoor exposures to many airborne contaminants are commonly higher than outdoor exposures (e.g., Meng et al., 2009; Morawska et al., 2013; Sexton et al., 2004; Wallace, 2000; Wallace et al., 1991, 1985), and the majority of human exposure to outdoor contaminants also typically occurs indoors (e.g., Asikainen et al., 2016; Azimi and Stephens, 2018; Chen et al., 2012, 2012; Logue et al., 2012; Weschler, 2006). These elevated exposures arise because of the large amount of time that people spend indoors (Klepeis et al., 2001) and because concentrations of many contaminants are higher indoors than outdoors (e.g., Abt et al., 2000; Adgate et al., 2004; Meng et al., 2005; Rodes et al., 2010; Wallace et al., 1991; Zhang et al., 1994).

While this appendix does not address hygrothermal conditions, the recommendations in the position document recognize the effects of temperature and moisture levels on IAQ through changes in contaminant emission rates, the growth of microorganisms on building surfaces, the survival of infectious pathogens in air and on surfaces, the survival of house dust mites (a source of allergens), people's perception of the quality of indoor air, and ultimately, the effects of moisture and moisture associated problems (e.g. mold, fungi or house dust mite) on the prevalence of building related symptoms.

How does IAQ impact health, comfort, well-being, learning outcomes and performance?

IAQ impacts occupant health, comfort, well-being, learning outcomes and performance (Jones, 1999; Spengler and Sexton, 1983; Sundell, 2004). There is a small but growing body of epidemiology literature that has specifically linked indoor contaminant exposures or sources to various adverse health outcomes, including but not limited to: combustion appliances (e.g., gas stoves) and respiratory illness in children (e.g., Garrett et al., 1998; Kile et al., 2014; Lanphear et al., 2001; Melia et al., 1977); VOCs and childhood asthma (e.g., Rumchev, 2004); chemical household products and respiratory symptoms in children (e.g., Sherriff, 2005) and asthma in adults (e.g., Zock et al., 2007); phthalates and asthma and allergy symptoms in children (e.g., Bornehag et al., 2004; Jaakkola and Knight, 2008; Kolarik et al., 2008); pet allergens and childhood asthma (e.g., Lanphear et al., 2001); radon exposure and lung cancer (Samet, 1989); airborne-transmitted infectious diseases such as pulmonary tuberculosis (TB) (Burrell, 1991), severe acute respiratory syndrome (SARS) (Li et al., 2007), COVID-19 (ASHRAE, 2020) and the common cold (Myatt et al., 2004); and carbon monoxide (CO) poisoning (Ernst and Zibrak, 1998); among others.

Some attempts have been made to quantify the burden of health effects associated with chronic (i.e., long-term) exposure to contaminants in indoor air. For example, Logue et al. (2011) and Logue et al. (2012) estimated the health impacts of long-term exposure to contaminants commonly found in U.S. homes using Disability Adjusted Life Years (DALYs) to establish a hierarchy of contaminants of concern. Similarly, Asikainen et al. (2016) estimated the annual disease burden caused by exposure to air pollutants in residential buildings in the European Union to be approximately 2.1 million DALYs per year, driven primarily by exposure to fine particulate matter (diameter ≤ 2.5 µm; $PM_{2.5}$) originating from outdoor sources, followed by $PM_{2.5}$ from indoor sources.

Additionally, excessive dampness or moisture in buildings is associated with a range of problems including mold, dust mites and bacteria; and exposure to damp environments is associated with respiratory problems including asthma (e.g., Heseltine et al., 2009; IOM, 2004; Kanchongkittiphon et al., 2014; Mendell et al., 2011). Indoor contaminants can act as respiratory irritants, toxicants, and adjuvants or carriers of allergens (Bernstein et al., 2008) and can adversely affect human productivity (Wargocki et al., 1999) and cause odor problems. Recent evidence has also suggested that pollutants in indoor air may reduce cognitive function (Allen et al., 2016; Satish et al., 2012).

One of the most common health complaints is the occurrence of building-related symptoms including eye, nose, and throat irritation, difficulty in concentrating and thinking clearly, headaches, fatigue and lethargy, upper respiratory symptoms, and skin irritation and rashes, as well as overall poor well-being (e.g., Bluyssen et al., 1996; Mendell, 1993; Mendell and Smith, 1990; World Health Organization, 1983). The term "sick building syndrome" ("SBS") has been used to describe the excess prevalence of these symptoms, without attribution to specific pathogens or illnesses or building characteristics and is viewed as more informative than building-related symptoms (Redlich et al., 1997). The term "building-related illness" refers to diseases including hypersensitivity pneumonitis and Legionnaires' disease, which are associated with specific exposures to pathogens and other contaminants in a building (Bardana et al., 1988).

What are effective ways to improve IAQ?

The foremost approach to improving IAQ is source control both indoors and outdoors (Carrer et al., 2018; Nazaroff, 2013). Reducing or minimizing indoor contaminant sources can be achieved through selection of construction materials, furnishings, and maintenance products with low emission rates, restricting occupant use of fragranced or scented products (Steinemann et al., 2011), and minimizing the emissions from human activities for example by installing "walk-off" mats (Farfel et al., 2001; Layton and Beamer, 2009). Another form of source control is local exhaust ventilation, which removes contaminants before they have the opportunity to mix within occupied spaces, such as for residential cooker/range hoods (Delp and Singer, 2012; Lunden et al., 2015), and wet spaces, e.g., bathrooms and laundry rooms.

One element of source control is to keep buildings dry, for example by minimizing indoor sources of water vapor through source control and the control of moisture using humidifiers and dehumidifiers, as well as by designing and constructing building enclosures and HVAC systems to limit moisture problems (ASHRAE, 2018a, 2009; Heseltine et al., 2009). Episodic water events that invariably happen (e.g., floods, leaks, etc.) must be managed rapidly and effectively to prevent water damage and sustained dampness.

After effective source control, ventilation is used to dilute indoor contaminants with clean outdoor air. Literature reviews show that increasing ventilation rates led to improved health outcomes (e.g., Carrer et al., 2015; Sundell et al., 2011). Using ventilation to improve IAQ should also include minimizing the entry of contaminants from outdoors in polluted ambient environments (e.g., Liu and Nazaroff, 2001; Singer et al., 2016; Stephens et al., 2012; Stephens and Siegel, 2012; Walker and Sherman, 2013), (for example by reducing enclosure leakage or effectively filtering the outdoor air supply).

The third strategy, after source control and ventilation, is to clean indoor air via particle filtration and gaseous air cleaning. The ASHRAE Position Document on Filtration and Air Cleaning (ASHRAE, 2018b) and the U.S. Environmental Protection Agency's Guide to Air Cleaners in the Home (US EPA, 2018) both address many important issues related to filtration and air cleaning, as do recent literature reviews (e.g., Fisk, 2013; Zhang et al., 2011). For example, particle filters have been shown to reduce indoor concentrations of airborne particles and some empirical evidence shows that their use can have positive impacts on health. Some sorbent air cleaners have been shown to effectively reduce concentrations of gaseous contaminants, albeit with minimal empirical data on their impacts on health.

The complex relationship between IAQ and external environmental conditions, coupled with the effects of climate change, necessitates a shift towards designing and operating buildings that are not only comfortable and healthy for the occupants but are also sustainable. It is generally believed that achieving good IAQ can only result with increased energy consumption. However, many strategies exist that can both secure high IAQ and reduce energy use, including increased envelope airtightness, heat recovery ventilation, demand-controlled ventilation, and improved system maintenance (Persily and Emmerich, 2012). Additionally, more dynamic ventilation strategies are being developed that allow time shifting and other variable ventilation strategies such as smart ventilation (e.g., Rackes and Waring, 2014; Sherman et al., 2012; Sherman and Walker, 2011).

What are the economic costs and benefits of improving IAQ?

Socio-economic costs of air pollution can be substantial (Asikainen et al., 2016; Boulanger et al., 2017; Jantunen et al., 2011). Providing improved IAQ is estimated to have substantial economic benefits (e.g., Aldred et al., 2016a, 2016b; Bekö et al., 2008; Brown et al., 2014; Chan et al., 2016; Fisk et al., 2012, 2011; Fisk and Chan, 2017; MacIntosh et al., 2010; Montgomery et al., 2015; Rackes et al., 2018; Zhao et al., 2015). The economic benefits accrue from having higher worker productivity (e.g., Allen et al., 2016; Wargocki and Wyon, 2017), improved learning (e.g., Haverinen-Shaughnessy et al., 2011; Wargocki and Wyon, 2013), lower absentee rates (e.g., Milton et al., 2000), and reduced healthcare costs. In workplaces, measures that result in only small improvements in performance or absence will often be cost effective because, in developed countries, employee costs (e.g., salaries, health benefits) far exceed the costs of maintaining good IAQ (Wargocki et al., 2006; Woods, 1989). Additional economic benefits are possible through reduced maintenance costs and avoidance of IAQ investigations and remediation measures by designing, constructing, and operating buildings in a manner that reduces the likelihood of serious IAQ problems, such as widespread dampness and mold.

Several studies that have estimated the costs and benefits of improved source control, ventilation, and air-cleaning technologies are summarized below:

Source Control: Wargocki and Djukanovic (2005) estimated the costs associated with improving IAQ by reducing the load of pollution sources in a hypothetical building. The additional investments in energy, HVAC first costs and maintenance costs, and building construction costs were highly cost effective, with payback times below two years and an estimated return on investment that was four to seven times higher than the assumed interest rate of 3.2%. However, no specific analysis was conducted to estimate how much of these effects can be attributed to source control and how much to increased ventilation rates. Asikainen et al. (2016) estimated that a 25% reduction in indoor PM2.5 sources, a 50% reduction in indoor VOCs and dampness, and a 90% reduction in radon, carbon monoxide, and second hand smoke in residential buildings in the European Union could reduce the burden of disease associated with residential indoor air exposures by approximately 44%.

Ventilation: Fisk et al. (2011) estimated that the combined potential annual economic benefit of implementing a combination of IEQ improvements in U.S. offices (including increasing ventilation rates, adding outdoor air economizers, eliminating high indoor temperatures during winter, and reducing dampness and mold problems) is approximately $20 billion per year. Similarly, Fisk et al. (2012) estimated that the economic benefits of increasing minimum ventilation rates in U.S. offices far exceed energy costs and that adding economizers would yield health, performance, and reduced absence benefits while saving energy. Dorgan et al. (1998) estimated the costs of improving ventilation in 40% of office buildings in the US considered unhealthy i.e., not meeting standard 62.1; the payback time of such activity was estimated to bebelow 1.4 years because of benefits for health and work performance resulting from it. Rackes et al. (2018) introduced an outcome-based ventilation framework for assessing performance, health, and energy impacts to inform ventilation rate decisions in U.S. office buildings and estimated that the economic benefits of increased ventilation rates in offices are routinely greater than additional energy costs or adverse health costs associated with introducing more outdoor contaminants through increased ventilation.

Filtration and air cleaning: Bekö et al. (2008) estimated that the health and productivity benefits of higher-performance filters would exceed their costs by well over a factor of 10 in an example office building. Montgomery et al. (2015) estimated benefit- to-cost ratios of up to 10 for improved filtration in office buildings in a variety of cities.

Fisk and Chan (2017) similarly estimated benefit-to-cost ratios ranging from three to 133 for the use of filters and/or portable air cleaners in both residences and commercial buildings. In all of the above studies, the avoided health care costs were the largest benefit of air cleaning. These and other studies on the costs and benefits of filtration and air cleaning were reviewed in Alavy and Siegel (2019).

Limited interview-based studies of decision-makers in the building industry in the U.S. have shown that they tend to underestimate the positive impacts of ventilation and filtration upgrades while overestimating costs (Hamilton et al., 2016). These findings suggest the need for educational activities to inform the industry on the costs and benefits of achieving good IAQ.

A.5 Summary

It is clear from the work cited in this appendix that IAQ in buildings is an essential building service that is vitally important to building occupants, owners, and designers, and therefore to ASHRAE. The health and economic impacts of IAQ are significant, and it is therefore essential to consider IAQ in all phases of building planning, design, and operation. Current design approaches and technologies include meeting minimum requirements (e.g., for ventilation as provided by ASHRAE Standards 62.1 and 62.2) and following guidelines for beyond-minimum performance (e.g., the ASHRAE IAQ design guides).

APPENDIX B REFERENCES

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DOCUMENT REVISION COMMITTEE ROSTER

The ASHRAE Position Document on Indoor Air Quality was developed by ASHRAE's Indoor Air Quality Position Document Committee formed on January 26, 2018, with Donald Weekes Jr. as its chair.

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Publication and Revision History

(example) ASHRAE's Technology Council and the cognizant committee recommend revision, reaffirmation, or withdrawal every 30 months. The history of this position document is described below:

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ASHRAE Position Document on

Environmental Tobacco Smoke

Approved by the ASHRAE Board of Directors July 1, 2020

Expires July 1, 2023

ASHRAE is a global professional society of over 55,000 members, committed to serve humanity by advancing the arts and sciences of heating, ventilation, air conditioning, refrigeration and their allied fields (HVAC&R). ASHRAE position documents are approved by the Board of Directors and express the views of the Society on specific issues. These documents provide objective, authoritative background information to persons interested in issues within ASHRAE's expertise, particularly in areas where such information will be helpful in drafting sound public policy. The documents also clarify ASHRAE's position for its members and building professionals.

Environmental Tobacco Smoke is a Public Interest Issue

While indoor smoking has become less common in recent years in many countries (WHO 2019), exposure to Environmental Tobacco Smoke (ETS) continues to have significant health and cost impacts (USDHSS 2014).

Researchers have investigated the health and irritant effects among non- smokers exposed to tobacco smoke in indoor environments. Such exposure is also known as passive smoking and as involuntary exposure to secondhand smoke. A number of national and global health research groups and agencies (Cal EPA 2005, EPA 1992, IARC 2004, IOM 2010, NRC 1986, SCTH 1998, USDHHS 2014, USDHHS 2006, WHO 2019) have concluded, based on the preponderance of evidence, that exposure of nonsmokers to tobacco smoke causes specific diseases and other adverse effects to human health most significantly, cardiovascular disease and lung cancer. No cognizant authorities have identified an acceptable level of ETS exposure to non-smokers, nor is there any expectation that further research will identify such a level.

Despite extensive evidence of such harm, the well-documented benefits of bans, including exposure reduction and benefits to public health (CPSTF 2013) and widening adoption of smoking bans, many locations worldwide still lack laws and policies that provide sufficient protection. In many locations, laws and policies are only partially protective, permitting smoking in certain building types including casino, entertainment and multifamily housing. Even where permitted by law, many developers, building owners, and operators, including those of restaurants and other hospitality venues, do not allow smoking indoors.

There are currently trends that increase use of electronic nicotine delivery systems (ENDS), smoking of cannabis, use of hookahs and other related activities that are beyond the scope of this document, but which likely present risks from involuntary exposure in the indoor environment that are not as well understood.

Why ASHRAE Takes Positions on (Topic)

While ASHRAE does not conduct research on the health effects of indoor contaminants, ASHRAE has been involved in this topic for many years. Through its committees, standards, handbooks, guides, and conferences, ASHRAE has long been providing information to support healthful and comfortable indoor environments, including efforts to reduce indoor Environmental Tobacco Smoke (ETS) exposure.

Consequently, ASHRAE's positions, standards and design guidance can help avoid health risks associated with Environmental Tobacco Smoke (ETS).

ASHRAE Takes The Positions That:

1. ~~ASHRAE's position is that~~ all smoking activity inside and near buildings should be eliminated, which is supported by the conclusions of health authorities that any level of ETS exposure leads to adverse health effects.

2. ~~ASHRAE holds the position that~~ the only means of avoiding health effects and eliminating indoor ETS exposure is to ban all smoking activity inside and near buildings. This position is supported by the conclusions of health authorities that any level of ETS exposure leads to adverse health effects and therefore,

    - The building and its systems can reduce only odor and discomfort but cannot eliminate exposure when smoking is allowed inside or near a building.
    - Even when all practical means of separation and isolation of smoking areas are employed, adverse health effects from exposure in non-smoking spaces in the same building cannot be eliminated.
    - Neither dilution ventilation, air distribution (e.g., "air curtains") nor air cleaning should be relied upon to control ETS exposure.

ASHRAE Recommends That:

- ASHRAE's current policy (ROB 1.201.008) that Standards and Guidelines shall not prescribe ventilation rates or claim to provide acceptable indoor air quality in smoking spaces, should be extended to other ASHRAE documents.
- ~~ASHRAE recommends that~~ building design practitioners educate and inform their clients, where smoking is still permitted, of the limits of engineering controls of ETS exposure, that multifamily buildings have smoking bans inside and near them, and that further research be conducted on the health effects of involuntary exposure in the indoor environment from smoking cannabis, using hookahs and electronic nicotine delivery devices (ENDS), and engaging in other activities commonly referred to as e-cigarettes or vaping.

- ~~ASHRAE recommends~~ that building design practitioners work with their clients to define their intent, where smoking is still permitted, for addressing ETS exposure in their building and educate and inform their clients of the limits of engineering controls in regard to ETS.
- ~~ASHRAE recommends~~ that multifamily buildings have complete smoking bans inside and near them in order to protect nonsmoking adults and children.
- ~~ASHRAE recommends~~, given current and developing trends, ~~that~~ further research be conducted by cognizant health authorities on the health effects of involuntary exposure in the indoor environment from smoking cannabis, using hookahs, using ENDS, and engaging in other activities commonly referred to as vaping or using e-cigarettes. ASHRAE is committed to encouraging lawmakers, policymakers and others who exercise control over buildings to eliminate smoking inside and near buildings.

~~Figures and Tables~~

~~When presenting data, charts, tables, figures would be of assistance. These could be added at the end of the text, or inserted in the text upon their being cited.~~

APPENDIX A: BACKGROUND INFORMATION

ASHRAE, through its Environmental Health Committee, TC 4.3 Ventilation Requirements and Infiltration, SSPCs 62.1 Ventilation for Acceptable Indoor Air Quality, 62.2 Ventilation and Acceptable Indoor Air Quality in Residential Buildings, 189.1 Standard for the Design of High-Performance Green Buildings, Handbook-Applications Chapter 46 (ASHRAE 2019) and Handbook-Fundamentals Chapters 10 and 11 (ASHRAE 2017), Indoor Air Quality Design Guides (ASHRAE 2018, 2009), and IAQ conferences, has long been active in providing engineering technology, standards and design guidance in support of providing healthful and comfortable indoor environments.

Previous versions of this position document have been instrumental in informing the public, building scientists and practitioners, policymakers and lawmakers about the inability of HVAC technologies to eliminate health risks to nonsmokers from exposure to tobacco smoke in indoor environments.

The evidence on the health consequences of exposure to ETS is extensive (hundreds of scientific papers) and has been reviewed by numerous independent expert groups in the United States and internationally, all reaching similar conclusions regarding the adverse health effects caused among nonsmokers exposed to tobacco smoke indoors. These include but are not limited to:

U.S. Surgeon General (USDHHS 2014, 2006)
U.S. Environmental Protection Agency (EPA 1992) National
Research Council (NRC 1986)
California Environmental Protection Agency Cal EPA 2005) World Health
Organization (WHO 2019)
International Agency for Research on Cancer (IARC 2004) United
Kingdom Department of Health (SCTH 1998)

The first major studies on passive smoking reported that passive smoking was a cause of lung cancer in non-smokers. Subsequent evidence has identified other health effects in adults and children. Notably, the number of coronary heart disease deaths caused by ETS greatly exceeds the number of ETS-caused lung cancer deaths. Additionally, the scientific evidence recognizes substantial subpopulations, such as children (USDHHS 2014) and adults with asthma or heart disease, whose disease may be exacerbated by ETS exposure.

There is no threshold for ETS exposure below which adverse health effects are not expected, as indicated in the referenced health authority reports. In general, risks tend to increase with the level of exposure and conversely to decrease with a reduction in exposure.

Only an indoor smoking ban, leading to near zero exposure, provides effective control, and only such bans have been recognized as effective by health authorities. Experience with such bans documents that they can be effective (CPSTF 2013, USDHHS 2014, 2006). While there are no engineering design issues related to this approach, the existence of outdoor smoking areas near the building and their potential impacts on entryway exposure and outdoor air intake need to be considered.

Nevertheless, smoking is permitted in some indoor spaces in some buildings. There are now several decades of international experience with the use of strategies, including separation of smokers and nonsmokers, ventilation, air cleaning and filtration, to limit contamination spread from smoking permitted areas to other areas inside the building.

There are three general cases of space-use and smoking activity in sequence from most to least effective in controlling ETS exposure:
1) allowing smoking only in isolated rooms;
2) allowing smoking in separate but not isolated spaces; and
3) totally mixing occupancy of smokers and nonsmokers.

These approaches do not necessarily account for all circumstances. Each leads to different engineering approaches as follows.

1. Smoking Only in Isolated Rooms: Allowing smoking only in separate and isolated rooms, typically dedicated to smoking, can reduce ETS exposure in non-smoking spaces in the same building. Effective isolation requires
   a) sealing of cross contamination pathways and airtightness of the physical barriers between the smoking and nonsmoking areas,
   b) the use of separate ventilation systems serving the smoking and non-smoking spaces,
   c) exhausting air containing ETS so it does not enter the non-smoking area through the outdoor air intakes, windows, and other airflow paths,
   d) airflow and pressure control including location of supply outlets and return and exhaust air inlets to preserve airflow into the smoking space at doorways and other openings, which is powerful enough so that movement of people between non-smoking and smoking areas and so that thermal and other effects do not disrupt intended air distribution patterns.

Even when all available strategies have been employed in multifamily housing, there is a lack of credible evidence that anything short of a smoking ban will provide full protection to occupants of non-smoking residential dwelling units. The risk of adverse health effects for the occupants of the smoking room itself also cannot be controlled by ventilation.

2. Smoking in Separate but Not Isolated Spaces: This approach includes spaces where smokers and non-smokers are separated but still occupy a single space or a collection of smoking and non-smoking spaces not employing all the isolation techniques described in 2. A) through f) above. Examples can be found in restaurants and bars with smoking and non-smoking areas, or buildings where smoking is restricted to specific rooms, but a common, recirculating air handler serves both the smoking and non-smoking rooms.

Engineering techniques to reduce odor and irritation include, directional airflow patterns achieved through selective location of supply and exhaust vents, and air cleaning and filtration. Limited evidence is available, and none supports the significant reduction of health effects on those exposed.

3. Mixed Occupancy of Smokers and Nonsmokers: If smoking is allowed throughout a space or a collection of spaces served by a single air handler, with no effort to isolate or separate the smokers and nonsmokers, there is no currently available or reasonably anticipated ventilation or air cleaning system that can adequately control or significantly reduce the health risks of ETS to an acceptable level.

This situation includes unrestricted smoking in homes, dormitories, casinos, bingo parlors, small workplaces, and open plan office spaces. Air cleaning, dilution ventilation and displacement ventilation can provide some reduction in exposure, but they cannot adequately control adverse health effects, nor odor and sensory irritation for nonsmokers in general.

Ongoing trends, studies and research:

- Electronic nicotine delivery systems (ENDS) are increasing in use and the health effects of primary and secondary exposure continue to be revealed. ENDS and other related exposures in the indoor environment, including those arising from cannabis combustion and use of hookahs, are outside the scope of this position document. ENDS are addressed in an ASHRAE Emerging Issue Brief.
- Third-hand smoke, which results from the release of contaminants from the clothing of smokers and other surfaces, is a relatively new concept. There is evidence of potential hazards (Sleiman 2010) and researchers are still studying it (Mayo Clinic 2017).

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~~ADDITIONAL ASHRAE RESOURCES~~

~~All resources should be cited in the text, properly elaborated so that they clearly support any relevant statements. ASHRAE's preferred method of citation, widely used in scientific texts, is the author-date method. Follow ASHRAE Authors' Manual.~~

~~OTHER RESOURCES~~

~~All resources should be cited in the text, properly elaborated so that they clearly support any relevant statements. ASHRAE's preferred method of citation, widely used in scientific texts, is the author-date method. Follow ASHRAE Authors' Manual.~~

DOCUMENT REVISION COMMITTEE ROSTER

The ASHRAE Position Document on Environmental Tobacco Smoke was developed by ASHRAE's Environmental Tobacco Smoke Position Document Committee formed on May 16, 2018, with Larry Schoen. As its chair.

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Note: ASHRAE's Technology Council and the cognizant committee recommend revision, reaffirmation, or withdrawal every 30 months.

Environmental Health Committee (EHC) Emerging Issue Brief

~~December 14~~January ~~1~~31, 2023~~2~~

Indoor Reactive Oxygen and Nitrogen ~~Oxygen~~ Species ~~(ROS) and Reactive Nitrogen Species (RNS)~~

What is the issue?

Reactive oxygen species (ROS) and reactive nitrogen species (RNS) are unstable oxygen- and/or nitrogen-containing radicals and non-radical species including superoxide ($O_2^{\bullet -}$), hydroxyl ($HO^{\bullet}$), hydroperoxyl ($HOO^{\bullet}$), alkylperoxides ($ROO^{\bullet}$), hydrogen peroxide (H_2O_2), organic peroxides (ROOR), hypochlorite (OCl^-), ~~and~~ peroxynitrite ($ONOO^-$),[1–3]~~,~~ nitrogen oxides (NO_2, NO; collectively NO_x), nitrous acid (HONO)[4], ~~and nitrous acid (HONO)~~and chlorine nitrite ($ClNO_2$).[5] Here we focus on indoor extracellular ~~ROS~~reactive species (generated exogenously) present in the gas- and particle-phase, rather than intracellular ~~ROS~~reactive species (generated endogenously). Exposure to extracellular ROS and RNS, as well as ~~and~~ endogenous ~~ROS~~ reactive species production, can result in oxidative stress in humans, which can exacerbate or lead to multiple adverse health impacts, including asthma, diabetes, chronic obstructive pulmonary disease (COPD), and cancer.[6–8]

Measurement of total ROS often employs fluorescent probes calibrated with H_2O_2, with results reported as equivalent nmol/m^3 of H_2O_2.[9] While studies of indoor ROS are few, Khurshid et al. (2014) measured concentrations of ROS on $PM_{2.5}$ averaging (±standard deviation) 1.37±1.2 nmol/m^3 across twelve residences, with a range of 0.18-4.01 nmol/m^3. Similar averages and ranges of ROS on $PM_{2.5}$ have been measured in six institutional buildings (1.16±~~1~~0.38~~3~~ nmol/m^3, range of 0.63-1.68 nmol/m^3), five retail buildings (1.09±0.93 nmol/m^3, range of 0.02-3.36 nmol/m^3)[2], a university building (3 nmol/m^3)[10], and six residences (0.90±0.16 nmol/m^3, range of 0.40-1.50 nmol/m^3)[3]. Compared to traditional approaches, advances in real-time ROS detection ha~~s~~ve improved measurement accuracy and enabled understanding the dynamics of ROS transport, production, and removal indoors.[1] Using real-time instrumentation, ROS on $PM_{2.5}$ averaged 2.44±0.40 nmol/m^3 and gas-phase ROS averaged 1.80±0.99 nmol/m^3 in an unoccupied St. Louis, MO, USA test home.[1]

Simultaneous measurements of indoor and outdoor ROS on $PM_{2.5}$ by Khurshid et al. (2014) were not statistically significantly different in residential, institutional, or retail buildings, despite indoor $PM_{2.5}$ mass concentrations being 60% lower than outdoor concentrations.[2,6] Average indoor/outdoor (I/O) ratios of ROS on $PM_{2.5}$ were 0.8±0.75 (retail), 1.02±0.55 (institutional), and 1.22±0.85 (residential). ~~In a follow-up study, t~~Total suspended particulate (TSP) samples collected in eight homes indicated elevated outdoor ROS on TSP concentrations (2.35±0.57 nmol/m^3) compared to indoors (1.59±0.33 nmol/m^3), a result that may be impacted by differential removal of coarse particles containing ROS during particle penetration into buildings.[3] In the same study, indoor ozone and terpene concentrations were varied in a test home when outdoor ozone concentrations were either high (>40 ppb) and or low (<40 ppb). When outdoor ozone concentrations were low, it was estimated that 34% of ROS on TSP was from outdoors for the low indoor ozone and terpene condition, and outdoor ROS on TSP reduced to contributing 16% of indoor ROS on TSP for the high indoor ozone and terpene condition, suggesting significant indoor sources of particulateparticle-bound ROS concentrations. Outdoor ROS on TSP was estimated to contribute 41-51% of the measured indoor ROS on TSP under high outdoor ozone conditions, and the transport of ROS precursors into buildings was suggested to heavily influence indoor generation of particle-bound ROS.[3] Chamber studies demonstrate significant ROS production resulting from limonene ozonolysis, a common indoor reaction.[11]. Using real-time instrumentation, ROS on $PM_{2.5}$ was measured to be similar indoors and outdoors at a residence, regardless of whether windows were open or closed,[1] also suggesting there are indoor sources of particle-bound ROS. Notably, there is the possibility of semi-volatile ROS species accumulating on surfaces and partitioning to particles. A modeling study focused on semi-volatile organic peroxides suggests a substantial amount of ROS on particles can partition from surface films.[6] A recent modeling study estimated that 91-96% of ozone and H_2O_2 deposited onto surfaces in a typical residence.[12]

Due in part to being a US EPA criteria pollutant, indoor NO_2 is better understood than other RNS and ROS. Ambient NO_x infiltrates into buildings, with penetration factors of about 1 for NO and 0.72 for NO_2.[13] In a literature review, median NO_2 concentrations in schools and offices were 26.1 µg/m^3 and 22.7 µg/m^3 with indoor/outdoor ratios of 0.7 and 0.8, respectively.[14] Combustion is the primary indoor source of NO_x, including unvented combustion appliances (e.g., gas stoves), smoking, and kerosene heaters.[15] Ventilating combustion appliances and using a stove hood when cooking with natural gas are methods of reducing indoor NO_x emissions.

Gaseous ROS and RNS play important roles in indoor oxidant chemistry. Gas-phase OH measurements have been conducted in a classroom (reaching up to 1.8x10^6 molecules/cm^3),[16,17] during cleaning with limonene (4x10^6 molecules/cm^3),[18] with an electronic air cleaning running (1.8x10^7 molecules/cm^3),[18] and cooking (2-6x10^6 molecules/cm^3).[4] In comparison, outdoor OH concentrations range from 2-10x10^6 molecules/cm^3 at midday.[4] The House Observations of Microbial and Environmental Chemistry (HOMEChem) campaign conducted extensive measurements of the relationships between OH, NO_x, HONO, and O_3, highlighting the importance of OH production by photolysis of HONO.[4] NO_2 is a precursor species to indoor HONO formation.[16,19–21] When cleaning with chlorine-based solutions, reactive chlorine species can be produced through reactions with OH.[5] See the cited literature above and related research above for additional details.

Besides outdoor ROS and RNS penetrating building envelopes and possible partitioning of semi-volatile ROS from indoor surfaces onto particles, other sources of indoor ROS reactive species include combustion (e.g., incense, cigarettes),[10,22,23] cooking,[4,24] oxidation of gas-phase terpenes (e.g., from surface cleaning),[18,25] nitrous acid (HONO) photolysis,[16,18,19,26] electronic/additive air cleaners,[9,18,27–30] disinfectant spraying/fogging,[30,31] laser printers,[32] and potentially through germicidal UV photolysis of ozone and volatile organic compounds.[33,34] Due to the limited number of studies directly measuring gas- and particle-phase ROS reactive species emissions from human activities and air management technologies, additional sources and the relative importance of the above sources may be identified in the future.

Methods to reduce indoor concentrations of particle-bound ROS and RNS include filtration and reducing organic surface film formation and/or oxidation. Compared to operating a test house without a filter installed, ROS on $PM_{2.5}$ was reduced by 82% when a MERV16 filter was installed.[2] Reducing the concentration of semi-volatile ROS on surfaces formed through oxidation should result in reduced partitioning of such compounds to the particle-phase. Reduction or elimination of emissions from human activities, such as cooking, smoking, incense burning, surface cleaning, and laser printer use, should also reduce indoor ROS reactive species concentrations. It is also important to carefully select air management technologies to ensure ROS reactive species production is not significant. Additional indoor ROS control methods for reactive species may be identified in the future.

What does this mean for ASHRAE?

ROS and RNS are contaminants of concern due to their impact on health and can react with more benign compounds to produce contaminants of concern. Engineering systems can reduce the contribution of outdoor reactive species within buildings. Since significant concentrations of indoor reactive species may be generated indoors, there may be engineering controls that can either reduce production of or remove generated ROS and RNS. ASHRAE should understand the risks associated with reactive species and effective engineering interventions. In the long term ASHRAE may need to change its existing standards or adopt new standards to provide industry guidance on addressing ROS and RNS exposure indoors. [Should not introduce sources of ROS into buildings, or require scrubbing afterwards?]. [Consider impact of ROS on SOA formation and resulting occupant health impacts]. [Control emissions of VOC's that readily react with ROS?]. [Surfaces?].

From Max: This is important to ASHRAE because many ROS are both directly a contaminant of concern as well as are able to interact with more benign compounds to make new CoCs. Some HVAC equipment might generate ROS and that should be reduced. Some HVAC equipment may be able to remove ROS and that should be encourage when needed.

What Actions Should ASHRAE Considered?

- Technical committees should engage with indoor chemists to better understand sources and control approaches for reducing particle- and gas-phase ROS indoors.
- ROS generation should be included in testing and validation of additive air cleaner technologies.
- ROS generation should be assessed for germicidal UV applications.[33]
- Identify knowledge gaps and support research, including but not limited to:
  - The health implications and toxicological responses to ROS exposure.
  - The measurement of semi-volatile ROS in indoor surface films and the extent to which semi-volatile ROS partition to the particle-phase.
  - Physicochemical modeling of ROS production and reaction with indoor gases.
  - Assess the effectiveness of gas- and particle-phase ROS removal approaches, including filtration and adsorption.

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References:

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Best Practices: Testing, Verifying, and Commissioning for Indoor Air Quality and Pathogen Mitigation

Track:
HVAC&R Systems and Equipment

Session Abstract:
In December 2022, ASHRAE announced development of a consensus-based, code-enforceable indoor air quality pathogen mitigation standard that will address:

- Design and operation
- Alternative pathways to achieve equivalent clean air
- Testing, verification, commissioning and periodic recommissioning

This panel discussion will provide an overview of existing and emerging performance-based methodologies for testing, verification, and commissioning for IAQ pathogen mitigation including:

- Describing gas, solid particle, and aerosol tracer approaches to measuring building performance and estimating risk
- Assessing strengths and weaknesses of different measurement approaches
- Discussing real world application of different approaches including field execution, data interpretation, and HVAC system performance optimization

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9.6 Healthcare Facilities

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2.4 Particulate Air Contaminants and Particulate Contaminant Removal Equipment

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75

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No

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Panel

Length:
90

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Presentations

Contact Presenter	Presentation	Speakers	Presentation Review Status
XXXXXXXXXX	33774 - Use of Synthetic DNA Aerosol Tracers for Estimating Infectious Aerosol Risk in Buildings	**Nicholas Clements, PhD, Member**, University of Colorado Boulder, Boulder, CO	Unavailable
XXXXXXXXXXXXX	33777 - Tracer Measurements for Building Operations	**Elliott Horner, PhD, Member**, UL Environment	Unavailable
XXXXXXXXX	33778 - Equipment Considerations for Building Operations	**Marwa Zaatari, PhD, Associate**, D Zine Partners, Austin, TX	Unavailable
XXXXXXXXXXXXX	33779 - Practical Considerations for Building Operation	**Wade Conlan, P.E., Member ASHRAE, BCxP, CxA, LEED®AP BD+C, BCxP, Member**, Hanson Professional Services, Maitland, FL	Unavailable