Shaping Tomorrow's Built Environment Today

MINUTES (DRAFT)
Environmental Health Committee (EHC)
June 26, 2023 - Annual 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
Sarah Maston, *Coord. Officer*
Ken Mead
Corey Metzger
Kathleen Owen
Stephanie Taylor
Don Weekes
Junjing Yang
Marwa Zaatari

MEMBERS NOT PRESENT:
Jon Cohen
Farhad Memarzadeh

ASHRAE STAFF:
Steve Hammerling, MOTS
Jacob Karson, AMGAO
Tara Thomas, AA
Alice Yates, DGA

GUESTS:
Charlene Bayer
Seema Bhangar
Hoy Bohanon
Ian Cavahaugh
Dimitris Chardambopoulis, *Incoming Member*
Chein-Fei Chen
Wei-An Chen
John Constantinide
Dru Crawley, *Incoming BOD Ex-O*
Gabrielle Davis
Darryl Deangelis
Jon Douglas
Jonathan Flannery
Carl Grimes
Elliott Horner
Benjamin Jones, *Incoming Member*
Howard Kipen
Josephine Lau
Frederick Marks
Meghan McNulty
Connor Murray, *Incoming Member*
Lisa Ng, *Incoming Member*
LanChi Nguyen-Weekes
Andy Persily
Larry Schoen
Chandra Sekhar
Michael Sherber
Max Sherman, *Incoming Member*
Larry Smith
Wei Sun
Pawel Wargocki
Martin Weiland
Jensen Zhang

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MOTIONS

No.	Motion	STATUS
1	that revisions to the EHC MOP and EHC Reference Manual be approved.	PASSED
2	**t**hat Chris Pyke be replaced by Seema Bhangar as a committee member on the HHWBE PD committee.	PASSED
3	to approve Recent Trends in Environmental Health report and send to Tech Council	PASSED
4	that EHC submit a program on standard 241 impact on ASHRAE ventilation standards for Chicago Meeting.	PASSED
5	that EHC co-sponsor program titled “Occupant Health Must be Considered in Building Design, Operations and Maintenance”	PASSED
6	That EHC support seminar titled “Overview of IEQ at ASHRAE: Committees, Guidelines, and Standards” for Chicago meeting.	PASSED
7	that EHC co-sponsor WS 1928.	PASSED

LIST OF ATTACHMENTS

No.	Attachment
A	EHC MBOs 22-23
B	IEQ/IAQ topics and a list for Development Committee
C	MOP Changes
D	Reference Manual Change
E	PEAC Leadership presentation
F	Indoor Reactive Oxygen and Nitrogen Species EIB
G	Recent Trends in Environmental Health report
H	Occupant Health Must be Considered in Building Design, Operations and Maintenance
I	Handbook topics for revision
J	WS 1928

LIST OF ACRONYMS

ACR	Air Change Rate
AHJ	Authority Having Jurisdiction
AIVC	Air Infiltration and Ventilation Centre
BOD	Board of Directors
CEC	Conferences & Exposition Committee
CMP	Continuous Maintenance Proposal
CNV	Chair Not Voting
CTTC	Chapter Technology Transfer Committee
DL	Distinguished Lecturer
DRSC	Document Review Subcommittee
EHC	Environmental Health Committee
EIB	Emerging Issue Brief
ETF	Epidemic Task Force
ExO	Ex-Officio
GPC	Guideline Project Committee
HHWBE	Human Health & Wellness in the Built Environment
HVAC	Heating, Ventilating, Air Conditioning
HVAC&R	Heating, Ventilating, Air Conditioning & Refrigeration
IAQ	Indoor Air Quality
IAQP	Indoor Air Quality Procedure
IEQ	Indoor Environmental Quality
IEQ-GA	Indoor Environmental Quality Global Alliance
IgCC	International Green Construction Code

ISIAQ	International Society of Indoor Air Quality and Climate
MBO	Management by Objectives
MOP	Manual of Procedures
MTG	Multi-disciplinary Task Group
OSHA	Occupational Safety and Health Administration
PD	Position Document
PMP	Performance Management Protocols
PTAR	Publication Topic Acceptance Request
RAC	Research Administration Committee
RAST	Reactive Air and Surface Treatment
ROB	Rules of the Board
ROS	Reactive Oxidation Species
RP	Research Project
SGPC	Standing Guideline Project Committee
SPC	Standard Project Committee
SSPC	Standing Standard Project Committee
SY	Society Year
TC	Technical Committee
US EPA	United States Environmental Protection Agency
USGBC	United States Green Building Council
VIC	Ventilation for Infection Control
WG	Work Group
WS	Work Statement

ACTION ITEMS FROM TAMPA MEETING

No.	Responsibility	Action Item	Status
TB1	Staff	Send list of topics and organizations to McQuade and Development Committee	
TB2	Weekes (chair) , Sherman, Burley, Bahnfleth	Develop proposed changes to ROB 1.201.004.9	
TB3	Staff	Send a reminder email with rules and verify eligibility for Environmental Health Award	
TB4	EHC	Review Indoor Reactive Oxygen and Nitrogen Species before next meeting	
TB5	Burley	Consider IEQ column article on EHC trends report	
TB6	Burley	Burley would submit program on Standard 241 impact on ASHRAE ventilation standards by Aug. 2 deadline	
TB7	EHC	Develop DL proposal presentation on Standard 241 by July 15th	
TB8	Staff	Determine if MTG.VIC Ventilation for Infection Control is still an active MTG.	

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 (*01.2*) and Simplified Rules of Order – Quick Reference (*01.3*) 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.

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3. REVIEW OF AGENDA

A. Proposed changes to Agenda
- No changes were requested to latest version of agenda.

4. MINUTES

Minutes from previous Meetings are already approved.

5. CHAIR'S REPORT (Clements)

A. Past EHC meetings since 2023 Winter meeting (4 held prior to winter meeting, 9 total):
- June 1, 2023
- May 4, 2023
- April 6, 2023
- March 2, 2023

B. Motions from Past Meetings
a. Human Health and Wellness in the Built Environment PD committee membership recommended to DRSC to recommend to Technology Council. *[Motion passed DRSC and will be considered by TechC in Tampa]*
b. Recommended to DRSC to recommend to Technology Council that the following PDs are reaffirmed following being converted to current PD format and reference updates: Indoor Air Quality PD, Unvented Combustion Device and Indoor Air Quality PD, and Environmental Tobacco Smoke PD. *[Motion passed DRSC and will be considered by TechC in Tampa]*

C. 2022-2023 MBO's –Status Report
A final report on MBOs (**Attachment A**) will be reported to Operations Subcommittee.

D. Discussion on Research Funding Sources for IEQ/IAQ and Resilience in Buildings (McQuade, Development Committee)
EHC reviewed and made additions (sleep, effects of IEQ on sleep) draft list of IEQ/IAQ topics and a list (**Attachment B**) of foundations and other institutions for use by the ASHRAE Development Committee) to assist them to approach for funding of ASHRAE activities. Staff would send list to McQuade and Development Committee (**Action Item #1**).

E. Opportunities to work with CTTC to recommend talks (Constantinide, CTTC)
EHC would discuss later today, under liaison reports.

6. VICE-CHAIR'S REPORT (Bahnfleth)

A. ROB / MOP / Reference Manual changes

a. ROB discussion:

1.201.004.9 Indoor Air Quality or Ventilation Standards. *Any existing and all future ASHRAE indoor air quality or ventilation code-intended standards must meet the following requirements:*

A. The standard shall specify concentration limits of only those specific contaminants for which a nationally or internationally recognized authority (such as US EPA, OSHA or the World Health Organization) has established a maximum permissible concentration limit and for which standardized test procedures have been established. Nationally or internationally recognized authorities and procedures may be those developed by ANSI consensus procedures for private standards-setting -12- organizations, those established by statute, or those duly adopted regulations issued by governmental agencies.

B. The standard may specify means and methods for limiting concentration of pollutants, provided they are related to contaminants normally considered in the design of HVAC systems serving the relevant space type.

C. The standard shall not require the measurement of contaminant or other airborne concentrations except those that can be measured using standardized test equipment and procedures in accordance with ASHRAE Standard 111, Measurement, Testing, Adjusting, And Balancing Of Building HVAC Systems (or its successor) or other consensus Methods of Test. Standardized test equipment is defined as equipment normally available in the HVAC&R industry to test-and-balance technicians or that is common in building ventilation assessment.

D. The standard shall not make any claims or guarantees that compliance will provide health, comfort or occupant acceptability, but shall strive for those objectives, consistent with ASHRAE policy.

E. The standard may contain factors for use in design of calculations such as mixing efficiencies and air change effectiveness, as long as it is the consensus of the standards-writing body that these factors are important to providing acceptable indoor air quality.

EHC discussed the history of this section of the ROB and the impact, implementation and current conflicts with ASHRAE Standards. An exception was granted to develop and publish ASHRAE Standard 241. EHC formed a subcommittee to reviewing ROB 1.201.004.9 and expects to recommend changes to the ROB to reduce or eliminate the need for granting waivers for ASHRAE work that may not meet the requirements described in the ROB. The subcommittee (Weekes (chair) , Sherman, Burley, Bahnfleth) would develop a recommendation for changes (**Action Item #2**).

b. Updated references to IAQ conferences to IEQ conferences in MOP and Reference Manual, and adding Purpose of the External Panel section to EHC Reference Manual

(1) It was moved (Bahnfleth) and seconded (Weekes) that revisions to the EHC MOP and EHC Reference Manual be approved.

BACKGROUND: Changes to the MOP are shown in **Attachment C** and changes to Reference Manual are shown in **Attachment D**. Changes include change to IEQ Conference from IAQ Conference and listing the purpose of the External Expert Panel.

MOTION 1 PASSES – 12-0-0 CNV

B. Donald Bahnfleth Environmental Health Award
   a. Max Sherman received Award in Tampa
      Attendees congratulated Sherman for winning this award.

   b. Nominations for next year due Nov. 1.
      Bahnfleth encouraged nominations. Staff would send a reminder email with rules and verify eligibility (**Action Item #3**).

C. Other
   Bahnfleth reported that planning for next SY would come soon with MBOs, subcommittee assingments, etc., so stay tuned.

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

A. BOD EX-Officio
   Conlan presented the ASHRAE Leadership Presentation (**Attachment E**). Highlights of interest to EHC included:
   - Thank you letters for your employers can be requested by Aug. 12. Forms were emailed. Contact boardservices@ashrae.org with questions.
   - Nominations for elected positions due September 2023. Nominations for appointed committees due February 2024.
   - DEI resources available at www.ashrae.org/dei.
   - Task Force for Building Decarbonization will continue for another year. Information on their activities at www.ashrae.org/decarb.
   - New full dues paying members get 1 free Annual Meeting registration and 12 months subscription to online Handbook
   - ASHRAE Standard 241, Control of Infectious Aerosols, anticipated approval June 24.

B. Coordinating Officer – Maston
   Maston was not in attendance but participated in recent ExCom.

8. SUBCOMMITTEE REPORTS

A. Policy Subcommittee (Metzger)
   1. Position Documents
      a. Filtration and Air Cleaning PD (chair: Wargocki)
         i. Zaatari reported PD committee continues to meet. They are aiming now for draft by Sept. 23 meeting.

      b. Human Health and Wellness in the Built Environment (HHWBE) PD (chair: Bayer)
         This PD committee is meeting later today for their kickoff meeting. EHC passed a motion to recommend PD committee roster. This is on Tech Council agenda for Tampa. However, PD wishes to replace a member.

         (2) It was moved (Metzger) and seconded (Zaatari) that Chris Pyke be replaced by Seema Bhangar as a committee member on the HHWBE PD committee.

         BACKGROUND: Chris is leaving USGBC, and Seema is USGBC's Principal for Building

and Community Health. Committee would still be balanced.

MOTION 2 PASSES: 12-0-0 CNV

c. Combustion of Solid Fuels and Indoor Air Quality in Primarily Developing Countries PD (prior chair, Francisco)
   i. Expiring June 2025
   A reformatted version was sent to chair earlier in June. EHC will await feedback before making a formal recommendation. Aim to consider reaffirmation in Fall 2023.

d. Indoor Carbon Dioxide PD (prior chair: Persily)
   i. Published, expiring February 2025
   A reformatted version was sent to chair earlier in June. EHC will await feedback before making a formal recommendation. Aim to consider reaffirmation in Fall 2023.

2. Emerging issue briefs
   - Retire or revise any current *emerging issue briefs (*EIBs)?:
     - Policy subcommittee is reviewing EIBs to determine which are no longer current and can be archived, what can be updated, or left as is. Seeking reviews from other members to get consensus on how to move forward. It was suggested that any EIBs that are archived include a one-line summary of why it was retired.

   - New EIBs
     - Indoor Reactive Oxygen and Nitrogen Species
     Clements noted some changes to the latest draft of the EIB (**Attachment F**). EHC was asked to review before next meeting (**Action Item #4**).

3. Recent Trends in Environmental Health Report (Weekes, Metzger)
   EHC developed a list of trends to report to Tech Council and the BOD as part of their charge to keep BOD informed on environmental health issues. The intent is to develop an annual report going forward.

   (3) it was moved (Metzger) and seconded (Bahnfleth) to approve Recent Trends in Environmental Health report and send to Tech Council

   BACKGROUND: This annual report (**Attachment G**) is prepared to inform ASHRAE leadership of current trends and future issues that would be of interest or impact to ASHRAE membership. It lists recent trends and research needs related to environmental health that impact the HVAC&R industry.

   MOTION 3 PASSES: 12-0-0 CNV

   It was suggested that this trends report be featured in a IEQ column **(Action Item #5).**

B. Education Subcommittee (Taylor/Burley)
   1. EHC programs for 2024 Winter Meeting. Proposals are due Aug. 2. The following tracks may be a good fit:
      - Track 6: Ventilation, IAQ, and Air Distribution Systems
      - Track 7: Comfort, IEQ, and Energy Efficiency

   A program on standard 241 impact on ASHRAE ventilation standards (62.1, 62.2, 170, etc.) should be developed. The program type (seminar/panel/forum) can be determined later.

(4) It was moved (Taylor) and seconded (Lee) that EHC submit a program on standard 241 impact on ASHRAE ventilation standards for Chicago Meeting.

BACKGROUND: Standards 62.1, 62.2, 170 can be considered. Possible speakers are Flannery, Lee, Emmerich, McNulty or Zaatari.

MOTION 4 PASSES: 11-0-1* CNV

*Burley abstained

Burley would submit program by Aug. 2 deadline (**Action Item #6**).

(5) It was moved (Taylor) and seconded (Lee) that EHC co-sponsor program titled "Occupant Health Must be Considered in Building Design, Operations and Maintenance"

BACKGROUND: This program (**Attachment H**) was rejected for Tampa meeting, but can be resubmitted for Winter meeting

MOTION 5 PASSES: 12-0-0 CNV

(6) It was moved (Taylor) and seconded (Lee) to support seminar titled "Overview of IEQ at ASHRAE: Committees, Guidelines, and Standards" for Chicago meeting.

BACKGROUND: Possible Speakers: (may have to limit to 3, others summarized in an overview presentation

- Overview of IEQ at ASHRAE (Pawel Wargocki)
- SGPC10 (Carl Grimes)
- GPC45P (Hyojin Kim)
- GPC42P (Don Weekes)
- GPC43P ()
- EHC (Nick Clements)
- PD on Health and Wellness (Charlene Bayer)
- TC2.1 (Shichao Liu)

MOTION 6 PASSES: 12-0-0 CNV

2. ASHRAE Journal IEQ Applications Column
   - Status (Burley)

     An article was published each month over entire SY. There are many in queue and many related to 241P. A number of new article ideas were brainstormed:

     - Bohanon/McNulty on ventilation effectiveness. Ev in 62.1-2019
     - 241P column ongoing (may be feature article, may have column ongoing on 241P would allow this column to explore other topics)
     - ETF retrospective to be considered later
     - IEQ and decarbonization (Zaatari/Sherman) Zaatari's previous article touched on this so it can be dropped from list
     - Owen – applying air cleaners in 241 or IAQP – (Lee to help) (Burley to add to list – see below)
     - IAQ in educational facilities (Weekes/Metzger) – based on recent publication on topic

- Clements on IEQ and environmental justice communities
- What do we need to make Artificial Intelligence (proposed author interested but lacking time to develop right now). Anticipate this Fall having draft. Zultan, Clayton Miller (Taylor offered to help participate)
- 241P WG chairs to comment on key points in their sections
- McNulty/Conlan – case study/real world 241 implementation/use
- trends article (Weekes/Horner)
- cost/benefit analysis of increased energy of 241P
- Ben Jones on 241 calcs
- metric on equivalent clean air
- Taylor – case studies – Return on Investment of properly managing IAQ in senior living communities (for 2024)

EHC thanked Burley for his work on the IEQ column and he agreed to continue as lead in developing these articles in the next Society Year.

3. Handbook Chapter
   - Next revision due in 2024 for 2025 publication. Topics needing update are identified (**Attachment I)** The next step will be to identify experts to make the revisions.

C. Coordination and Outreach Subcommittee (Weekes)
1. IEQ2025
   - Jennifer Isenbeck & Iain Walker will co-chair the ASHRAE's IEQ2025 Conference. Formal CEC approval is pending but the plan is for a September 24-26, 2025 Conference in Montreal Quebec with a theme of "Rising to New Challenges: Connecting IEQ with Sustainable Buildings". AIVC, ISIAQ, IEQ-GA are expected to be involved. CEC is anticipated to vote for support at their next meeting.

2. Current EHC sponsored or co-sponsored research
   - WS *1928, Improving test methods to measure air cleaner performance against airborne pathogen*

(7) It was moved (Weekes) and seconded (Metzger) that EHC co-sponsor WS 1928.

BACKGROUND: RAC approved this Work Statement. EHC previously co-sponsored this project (**Attachment J**) as an RTAR

MOTION 7 PASSES: 12 -0-0 CNV

D. ETF Transition Subcommittee
The draft final report is prepared, and the final report will be submitted within 4 weeks for submission to Tech Council. EHC thanked the subcommittee for their work.

9. LIAISON ACTIVITIES

A. CTTC
Constantinide spoke about the Distinguished Lecturer program. The aim is to determine how to get technical content from EHC to chapters.
Sherman suggested DL programs on 241 for chapters in Fall. Constantinide suggested preparing canned presentation and suggesting DLs that would be well suited to present to chapters. The timeline is quick and EHC should aim for abstract and speakers by July 15 (**Action Item #7**). The final presentation would have to be finalized September 1. DL nominations are due Dec. 1.

Tech Hours are a great way to get information out as well. They have some programs in the queue but are always seeking more programs. Constantinide encouraged more submissions.

B. GAC (McNulty/Persily)
ASHRAE Staffer Karson summarized recent efforts noting there were 38 pieces of legislation related to IAQ. There are efforts to comment on AHJs allowing smoking in casinos and racing tracks.
He noted there is training for members to help them in communicating with local legislation. Chapter GAC chairs can assist also. Karson suggested asking Washington office for one-on-one training, talking points, canned presentations, and other resources.

C. Standard 62.1 (Burley)
Focus currently is on interpretations and continuous maintenance proposals (CMP). Guideline 42P (enhanced IAQ guide) is very close to approval. This guideline will also be on continuous.

D. Standard 188 (Lucas)
The committee is processing some CMPs. One for mandatory testing /flushing is being considered, but not yet approved. A PTAR is in the works to develop a list of state requirements as a resource for members. SPC 514 voted to publish and is expected this fall. Publication will trigger effort to harmonize the related standards.

E. Standard 62.2 (Sherman)
Developing a scope proposal to comply with ROB and ASHRAE PD on smoking, that you can't comply with 62.2 in multifamily if you allow smoking.

F. Standard 189.1
Persily noted this committee is meeting tomorrow. The focus now is on the 2023 publication which will be content of IgCC.

G. Guideline 10 (Clements)
2023 update is published. The guideline continues to incorporate new interaction information as it comes available and is published. Marks noted SGPC seeks research literature that may be of interest on interaction of IAQ factors. One area in particular is an addendum on occupant centric control – how to incorporate feedback in control algorithms.

H. Standard 170 (Burley)
SSPC is meeting later today and tomorrow in Tampa. The are considering various CMPs on diffusers in operating rooms, exhaust fan requirements, operation during construction and other possible modifications.

I. Guideline 44P
Guideline in working to move forward with publication public review

J. Guideline 45P (Mead/Bohanon)
This guideline is related to IEQ audits. Mead is the EHC liaison. This evolved from PMP documents several years ago into IAQ.

K. MTG.ACR Air Change Rate
Mead noted they finished report. Report was accepted and should be available soon.
Seminar for Tampa – Is it time to abandon mixing factors?

L. MTG.VIC Ventilation for Infection Control (Hermans)
Staff was asked to determine if this is still an active MTG (**Action Item #8**).

M. TG2.RAST (Zaatari)
Owen noted she is Vice-Chair of this group; a new chair was appointed recently. The focus now is on SPC 185.5, but the next goal is to develop surface treatment test method for non UV devices. Meeting tomorrow in Tampa.

N. TC 2.1 (Yang)
TC 2.1 research subcommittee has met, but the full TC 2.1 has not met yet. 1837-RP on ventilation in bedrooms and sleep quality is underway.

O. 185.3 (Lee)
A public review developed ~124+ comments that were responded to. A 30 day comment period getting underway. The standard will be referenced in Standard 241 when published. The Idea is for technology agnostic performance measure for in room air cleaners used in commercial and industrial applications.

P. Others
McNulty commented on IEQ of ASHRAE conference venues. An informal working group continues to meet. For the Tampa the host committee did tour of the facilities and offered two conference registrations to facility operators. There is IEQ monitoring going on at the conference with stats on app showing results from eight monitors throughout conference venue. Trend data is being collected with real time data shown on app. If interested in seeing trend data, let McNulty know.

10. NEW BUSINESS

A. NEXT MEETING
1. Monthly meeting – date and time to be determined
2. 2024 Winter Meeting, Chicago, IL. Jan. 20-24, 2024

11. HANDOVER TO NEW CHAIR –Bahnfleth (Chair), Zaatari (Vice-Chair)

A. Recognize Outgoing Members
- Brendan Burley, Claressa Lucas, Jon Cohen, Junjing Yang, Stephanie Taylor, Nick Clements

B. Recognize Incoming Members
- Benjamin Jones, Howard Kipen, Dimitris Charalambopoulos, Conor Murray, Max Sherman, Lisa Ng

C. Subcommittee Assignments/2023-2024 MBOs (Bahnfleth)
a. Chair/VC will be in touch following annual meeting to kickoff SY planning

12. ADJOURNMENT

Clements adjourned meeting at approximately 11:45 AM EDT.

MBO Submission to Planning 6/25/2023

Council: Technology Council **Chair:** Nicholas Clements
Committee: Environmental Health **Vice-cl** Bill Bahnfleth

MBO #		Description	Metric (how do we determine	Initiative #	Goal #	Completion % / Date	Financial Assist	MBO Comments	Strategic Plan Tally: Initiative # 1	2	3	4	Goal 1 a	b	Goal 2 a	b	c	Goal 3 a	b	c	Presidential Initiatives: Making ASHRAE more Transparent	Encouraging Greater Participation	Making ASHRAE Truly Diverse	Harnessing the Power of our Relationships	Harvesting Information in the Service of our Members	Embracing Change by Streamlining
1		**Execute the Environmental Health Strategic Plan as Coordinated with Tech Council**																								
Policy Subcommittee (Metzger)																										
a		Strategically pursue MTG.HWBE report recommendations for ASHRAE regarding IEQ in the built environment (Metzger).	1. Establish the Health and Wellbeing in the Built Environment PD committee. 2. Pursue establishing an IEQ audit MTG. 3. Coordinate with PD committes to complete updates to PD on Infectious Aerosols and PD on Filtration and Air Cleaning.	1, 2, 3	1a, 2b, 3a	100%	No	*1. Committee established and work started. 2. Established liaison and involvement with GPC45P instead of establishing new MTG. 3. Infectious Aerosols PD is complete. Filtration and Air Cleaning PD is in progress. Multiple PDs reaffirmed after updating to new format.*	x	x			x			x		x						x	
b		Strategically pursue Epidemic Task Force (ETF) recommendations for ASHRAE (Metzger).	1. Coordinate with Vice Chair to establish an ad hoc committee to determine distribution of ETF responsibilities and recommendations to other committees. 2. Assess performance of "Task Force" approach and provide recommendations to Tech Council.	1, 2	1a, b; 2b, c; 3a, b	100%	No	*1/2. ETF Transition Subcommittee established, MBO assigned to them. Will include development of page of key recommendations and reports to Tech Council (4a).*	x	x			x	x		x		x	x						x	
c		Prepare emerging issue briefs (EIB's) related to environmental health (Metzger).	1. Publish two new EIB's. 2. Assess relevance of old EIB's and update or remove old EIB's. 3. Coordinate with Government Affairs Committee (GAC) regarding need for adapting EIB's to PPIB's.	1, 2	1a, b; 2c; 3a, b, c	75%	No	*1. ROS EIB draft in review. 2. Archivable EIBs identified and recommended. 3. Complete, no EIBs identified in need of adapting to PPIBs.*	x	x			x	x			x	x	x	x					x	
d		Prepare annual report for Tech Council identifying major trends impacting environmental health (Metzger, Weekes).	1. Short (<3 page) report prepared and distributed to Tech Council.	1, 2	1a, b; 3a, c	100%	No	*1. Complete, report submitted to Tech Council during Annual Meeting.*	x	x								x		x			x		x	
2		**Lead Health Discussion and Educational Programs**																								
Education Subcommittee (Taylor)																										
a		Increase awareness and understanding of emerging environmental health topics within EHC and within ASHRAE as a whole (Taylor).	1. Schedule at least two internal EHC webinars from external experts on emerging environmental health concerns. 2. Propose at least two sessions on environmental health topics for the ASRHAE conferences.	2, 4	1a, b; 2a, b, c; 3a	75%	No	*1. Webinar topics and speakers identified during winter meeting. Engagement with CTTC for recommending speakers started, will be pursued next SY. CTTC presented to EHC at Annual Meeting. 2. One co-sponsored session approved for 2023 winter meeting. One panel for annual meeting approved during 2023 winter meeting. At least one session supported for 2024 winter meeting.*		x		x	x	x	x	x	x	x				x			x	

b		Start planning handbook Chapter 10 updates (Taylor).	1. Identify person to lead update effort. 2. Identify authors for topic areas that need new material prepared.	2	1a, b; 2c	100%	No	*1. Complete, next chair will make author recommendation based on roster for next SY (Updates planned 2024-2025).* *2. Complete.*		x			x	x			x								x	
c		Regularly publish IEQ Column articles in the ASHRAE Journal related to environmental health (Burley).	1. At least 9 articles are published or submitted to be published. 2. Maintain planning list of future article topics and authors.	2	1a, 1b, 2c	100%	No	*1/2. Complete, multiple months of articles planned in advance.*		x			x	x			x								x	
3	**Tighten the Connections with External and Internal Health Related Entities**																										
Outreach Subcommittee (Weekes)																											
a		Formalize how to engage with external expert list and leverage in committee tasks (Weekes).	1. Establish MOP for engaging with external experts. 2. Update list with new experts identified by the committee and remove experts as needed. 3. Leverage external expert list in document preparation (EIB's, PD's) and conference session organization.	1, 2, 4	1b, 2a, b; 3a, c	100%	No	*1. Reference manual updated.* *2. Complete.* *3. Complete.*	x	x		x		x	x	x		x		x						
b		Planning for the next IAQ conference (Weekes).	1. Provide recommendations to Conferences and Exposition Committee regarding theme, location, chair, steering committee for the next Indoor Air Quality Conference. 2. Assess the inclusion of other organizations (e.g., IEQ-GA) in organizing the IAQ conference. 3. Recommend changes to the EHC MOP related to IAQ conference organization, as needed.	1, 2, 3	2b, c; 3b, c	100%	No	*1. MBO scope reduced to co-chairs. Chairs recommended to CEC (I. Walker and J. Isenbeck). Conference proposal submitted to CEC for July 2023 vote of support.* *2. IEQ-GA, AIVC, and ISIAQ organization involvement are being pursued.* *3. Complete.*	x	x	x				x	x		x	x							
c		Recommend changes to EHC MOP to define responsibilities related to IEQ-GA (Weekes).	1. Propose motion to update MOP defining, at least: how to designate the ASHRAE liaison (and back-up) to IEQ-GA, mechanisms of communication between organizations.	1, 2, 3	2b, c; 3b, c	50%	No	*1. No udpates. Refer to BOD approved motions for guidance for EHC MOP. Assure BOD is referring to guidance/procedures for these appointments. Will be completed next SY.*	x	x	x				x	x		x	x						
d		Review recent/new EIB's and pass recommendations to cognizant TC's (Weekes).	1. Dynamic Thermal Enviornment (e.g., SSPC 55). 2. Controlling Indoor PM2.5 (e.g., TC2.4). 3. Any new EIB's during SY 2022-23.	1, 2, 4	1a, b; 2c; 3a	100%	No	*1/2/3. Complete.*	x	x		x	x	x			x	x							
e		Coordinate with policy subcommittee in preparation of the annual report on environmental health trends and distribute to cognizant TC's (Weekes, Metzger).	1. Environmental health trends shared with cognizant TC chairs.	2, 4	1a, b; 2c; 3a	100%	No	*1. Complete.*		x		x	x	x			x	x				x	x		x	
4	**Improvments to Management and Procedures**																										
Administration (Clements/Bahnfleth/Hammerling)																											

a		Review the EHC Scope and Manual of Procedures, recommend to maintain or to revise, present recommendation for new language at annual meeting (Clements, Bahnfleth).	1. Prepare suggested changes to MOP, as needed.	2,3	3b	**100%**	No	*1. Complete.*		x	x								x							
b		Streamline EHC meetings at Winter and Annual Conferences (Clements).	1. Aim to have most subcommittee business complete prior to Winter and Annual meetings. 2. Reduce length of meeting time by at least 1 hour (3 hours instead of 4).	2	3b	**100%**	No	*1. Complete.* *2. Winter meeting completed in 3 hours, aiming for the same during annual meeting.*		x									x							x
c		Coordinate monthly EHC meetings (Clements).	1. Hold at least 9 virtual meetings during SY 2022-23.	3, 4	3b	**100%**	No	*1. Complete.*			x	x							x							x
5	**Transition the Epidemic Task Force**																									
ETF Transition Subcommittee (Conlan)																										
a		Strategically pursue Epidemic Task Force (ETF) recommendations for ASHRAE (Conlan).	1. Coordinate with Vice Chair to establish an ad hoc committee to determine distribution of ETF responsibilities and recommendations to other committees. 2. Assess performance of "Task Force" approach and provide recommendations to Tech Council.			**100%**	No	*1/2. ETF Transition Subcommittee established and report prepared, to be submitted to Tech Council within one month after the Annual Meeting.*																		

ASHRAE Environmental Health Committee

6/25/2023

Technical Topic Areas for Development Committee

#	Topic
1	Indoor Chemistry Resulting from Air Cleaning Devices
2	Indoor Air Quality and Resilience in the Era of Changing Climate
3	Economics of Indoor Environmental Quality
4	Impact of Indoor Environmental Quality on Productivity and Performance
5	Equity in the Built Environment
6	Biometrics and Biomarkers of Indoor Health

-IEQ and sleep?

Funding Institutions

1. NSF
2. Sloan Foundation (no related programs at this time)
3. DOE
4. EPA
5. GSA

-medical societies (AHA, PCORI, American Lung assoc., NIH, American Thoracic Society)

OSHA

SBIRs - funding for specific

Consumer Product Safety Commissions

California CARB, etc.)

Part 4 Operations

A4.1 This committee shall maintain a long-range plan for Indoor Air/Environmental Quality conferences and submit this plan to Technology Council at the Annual Meeting. (ROB 2.406.003.1)

EHC Subcommittees

Sub-Committee	Charge	Interaction between Subcommittees	Task Description
Education	IEQ Column		Lead the ~~IAQ~~ IEQ column Brainstorm for programs to team with other Comm or TC - not necessarily for us to create unless we feel it is needed and we are the experts Lead the update of the chapter, pull from the Policy for new ideas
	Potential Conference Programs		
	Handbook Chapter		
	Educational courses		
Coordination and Outreach	Interact with ASHRAE committees	Understand the RP from Policy, Understand the programs from Education	Take the concepts from Policy and PDs to find leads for those items that we can help support internal and external to ASHRAE. Review RTARs to see if we want to support / take RP from Policy to other groups for them to lead
	Interact with outside organizations that impact EH or IAQ		
	~~IAQ~~ IEQ Conferences		
	IEQ-GA		
	Research RTAR Review and New RP Development with other groups		
	Epidemic Task Force interface		
ExCom	Developing report to Tech Council per MOP		Try to find candidates for the Award, Promote the winner
	Submit Long Range Plan for ~~IAQ~~ IEQ Conferences to Tech Council		
	Create MBOs that align with Strategic Plan		
	EH Award	Ask entire EHC to think of candidates	
	Assign Mentors to new members		
	EHC Budget		
	Review ROB, MOP, and Ref Manual		

~~**ENVIRONMENTAL HEALTH AWARD**~~

~~EHC Education Sub-Committee will annually review all eligible nominations received and make a recommendation to the Environmental Health Committee for its consideration prior to the ASHRAE Winter Meeting based on the following procedures~~

PROCEDURES FOR THE DONALD BAHNFLETH ENVIRONMENTAL HEALTH AWARD

7. Criteria for Selecting Recipients. Following is an outline of how points are awarded.

B. IAQ/IEQ-Conference experience	
Chair of an IAQ/IEQ conference	2 points / conference
Member of an organizing committee	1 point / conference
Presentation at a conference	1 point / conference

Sample Insight Article about EHC Award

Criteria for Selecting Recipients
B. IAQ/IEQ-Conference experience
Chair of an IAQ/IEQ conference 2 point per tour
Member of an organizing committee 1 point per tour
Presentation at a conference 1 point per tour

PURPOSE OF EXTERNAL EXPERT PANEL

The ASHRAE Environmental Health Committee may form and manage an informal discussion group of external experts which may be called upon from time to time to meet informally. One of the possible outcomes of these meetings would be to discuss and share the latest technical information on environmental and occupational health, and to discuss the latest trends on what is on the horizon for the EHC to consider at its committee meetings. These periodic meetings of the expert panel could result in policy suggestions, papers, conference programs, research ideas, etc. It is noted that the setting up of the external expert panel was completed by the Communication and Outreach subcommittee of EHC in 2021-22.

Described below is the purpose of the expert panel and its informal meetings in relation to EHC.

1) Sharing of latest research

It is expected that EHC will contact the expert panel when there is an indication that the panelists can supplement the information and details about ongoing research. This additional research info will help EHC formulate its emphasis on specific environmental health issues going forward.

2) Presentations at EHC Meetings

It has been the practice of EHC to have presentations by experts in the field and on research during its in-person meetings. The expert list can be used to determine what will be the next presentation topic and who will make the presentation.

3) Review of EHC Presentations and Documents

Select members of the expert panel can be requested to provide reviews of pre-published documents such as Position Documents, research papers from RAC, Emerging Issue Briefs, environmental health articles in ASHRAE publications such as the ASHRAE Journal, etc. The value of the expert panel will be to expand the capabilities and capacity of EHC to respond to these documents in a timely manner.

4) Future EHC Members

It is expected that the current external experts will be asked to join EHC in the future as vacancies occur. These experts will have had experience with requests from EHC to provide reviews and comments on documents, etc. The selection of individuals and organizations listed in the list to be on the EHC will help to increase the diversification of EHC membership.

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-Septembe**r.
- 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

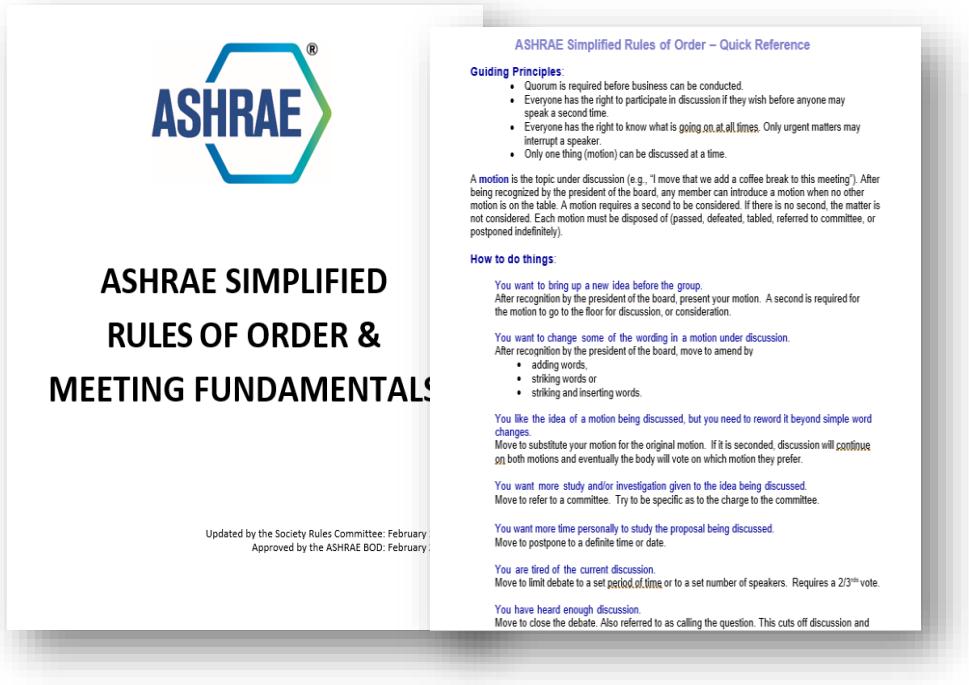
ASHRAE's awards fall into one of six categories:

- 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



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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President

Farooq Mehboob, P.E.
Fellow ASHRAE,
Life Member
Karachi, Pakistan

President-Elect

Ginger Scoggins, P.E.
Raleigh,
North Carolina

Treasurer

Dennis Knight, P.E.
Fellow ASHRAE
Mt. Pleasant,
South Carolina

Secretary

Jeff Littleton
Peachtree
Corners, Georgia

Vice Presidents

Dunstan Macauley,
P.E., HBDP
Arlington, Virginia

Billy Austin, P.E.,
BCxP, BEAP, BEAP,
HBDP, HFDP, OPMP
Charlotte, North Carolina

Sarah E. Maston,
P.E., BCxP
Hudson,
Massachusetts

Ashish Rakheja
Noida, Uttar Pradesh,
India

2022-23 Board of Directors

Director and Regional Chairs

Region I

Steven C. Sill
Sterling, New York

Region II

Ronald Gagnon
Quebec, Canada

Region III

Mark Tome, P.E., HFDP
Harrisburg, Pennsylvania

Region IV

Bryan Holcomb
Oak Ridge, North Carolina

Region V

James Arnold, P.E.
Dublin, Ohio

Region VI

Susanna Hanson
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Region VII

Chris M. Gray, Ph.D., P.E.
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Randy C. Schrecengost, P.E., BEAP
Austin, Texas

Region IX

Tyler J. Glesne, BCxP, BEAP
Omaha, Nebraska

Region X

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Los Angeles, California

Region XI

Eileen Jensen, P.E.
Vancouver, Washington

Region XII

John Constantinide, P.E.,
Merritt Island, Florida

Region XIII

Cheng Wee Leong, P.E.,
Singapore

Region XIV

Andres J Sepulveda
Madrid, Spain

Region-at-Large

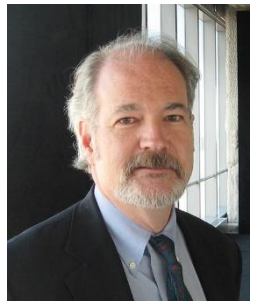
Richie Mittal
New Delhi, India

2022-23 Board of Directors

Directors-at-large

Wade Conlan, P.E., BCxP
Maitland, Florida

Blake Ellis, P.E.
Overland Park, Kansas



Dru Crawley, Ph.D., BEMP
Washington, D.C.

Kenneth Fulk
Allen, Texas

Art Giesler
Colleyville, Texas

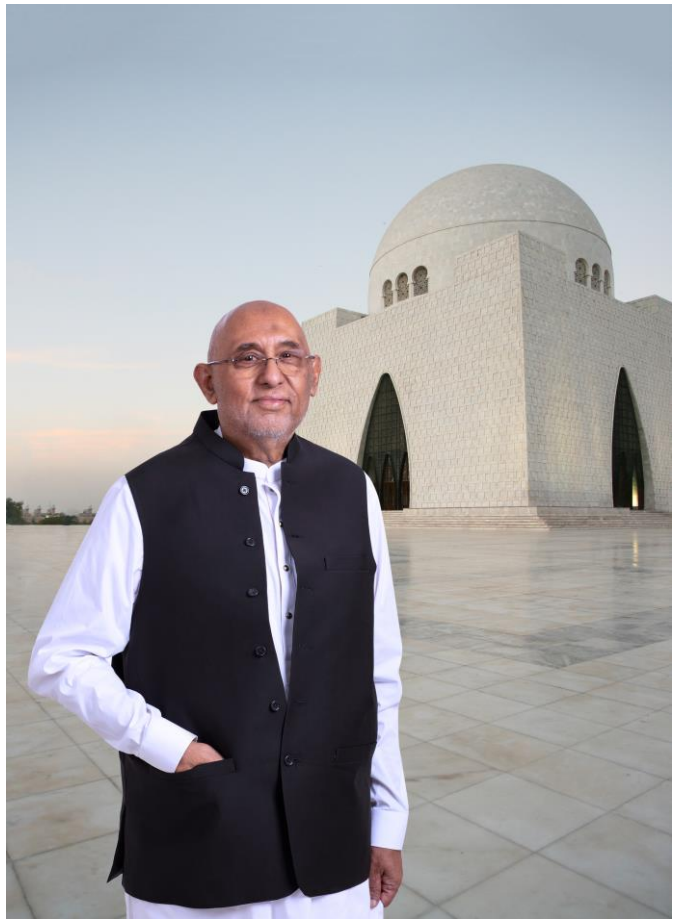
Wei Sun, P.E.
Ann Arbor, Michigan

Kishor Khankari, Ph.D.
Ann Arbor, Michigan

Luke Leung, P.E
Clarendon Hills, Illinois

Adrienne Thomle
Reno, Nevada

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

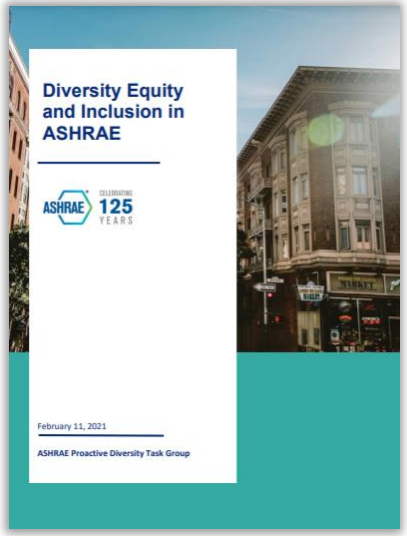
Board of Directors Meetings

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:

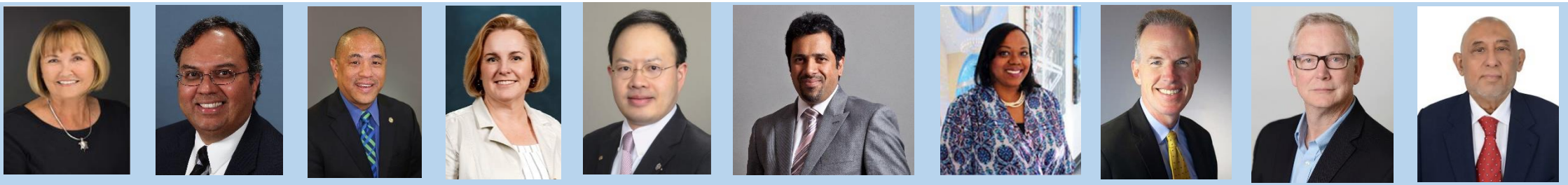
- All matters relating to diversity, equity and inclusion - with a view to improving organizational awareness and performance in these areas amongst both staff and the Society membership
- The establishment of annual budgets for DEI program and ongoing initiatives
- The prioritization of inclusivity 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

ashrae.org/DiversityEquityInclusion

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)



Task Force for Building Decarbonization

Through its Working Groups with over 100 volunteers from around the world the **Task Force For Building Decarbonization** (TFBD) is working to implement strategy, direction, and successful products and services for the industry relating to building decarbonization.

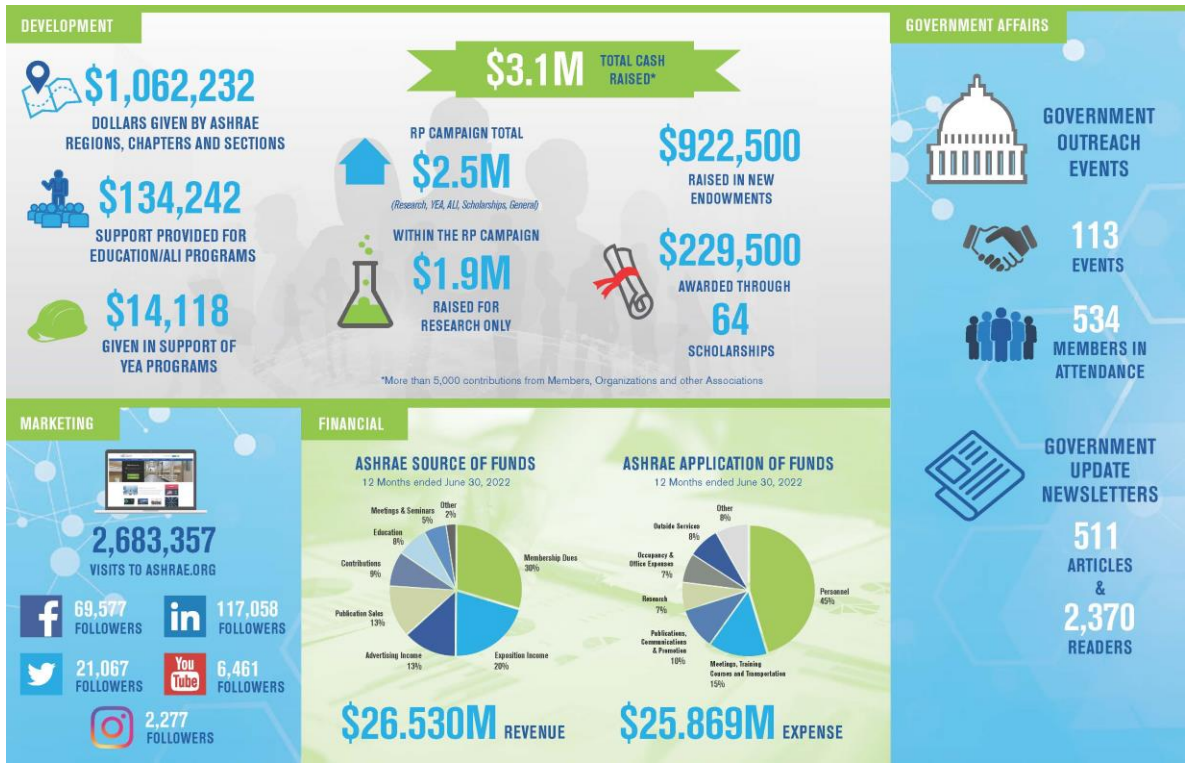
Products and Services Include:

- Seven Guides
- Creating content for a Knowledge Hub on ashrae.org
- Establishing relevant training & education

Email questions or input to decarb@ashrae.org

ashrae.org/decarb

Society Snapshot



ashrae.org/society-snapshot

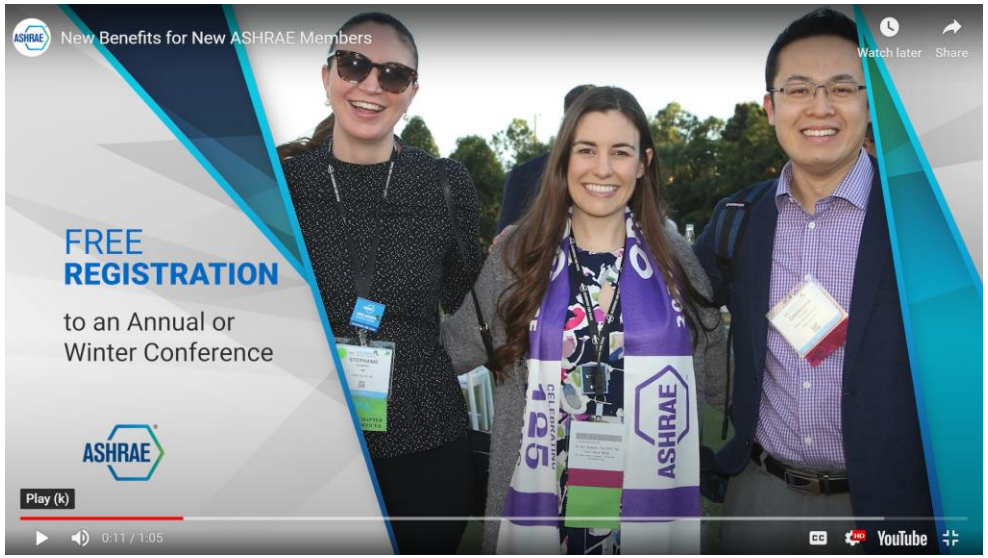
Membership & Communities

10% Discount for Five New Employees

Employers who submit 5 or more new membership applications in a single transaction receive a 10% discount on Society dues owed.

Free Winter or Annual Conference Registration

New full dues paying members receive one complimentary registration to a Winter or Annual Conference.



New! Quick video highlighting benefits on ASHRAEvideo YouTube channel and ashrae.org/benefits.

ashrae.org/membership

Supporting ASHRAE's Mission

Thank You to all the **donors and volunteers** for your support

$3.1M Total Cash Raised*

$1M Raised for Endowments

$235,500 Awarded via 65 Scholarships

Research Promotion Campaign Total $2.5M
(Research, YEA, ALI, Scholarships, General)

Within the RP Campaign
$1.9M Raised for Research

$1.1M Given by ASHRAE Regions, Chapters and Sections

More than 5,000 contributions from Members, Organizations and other Associations

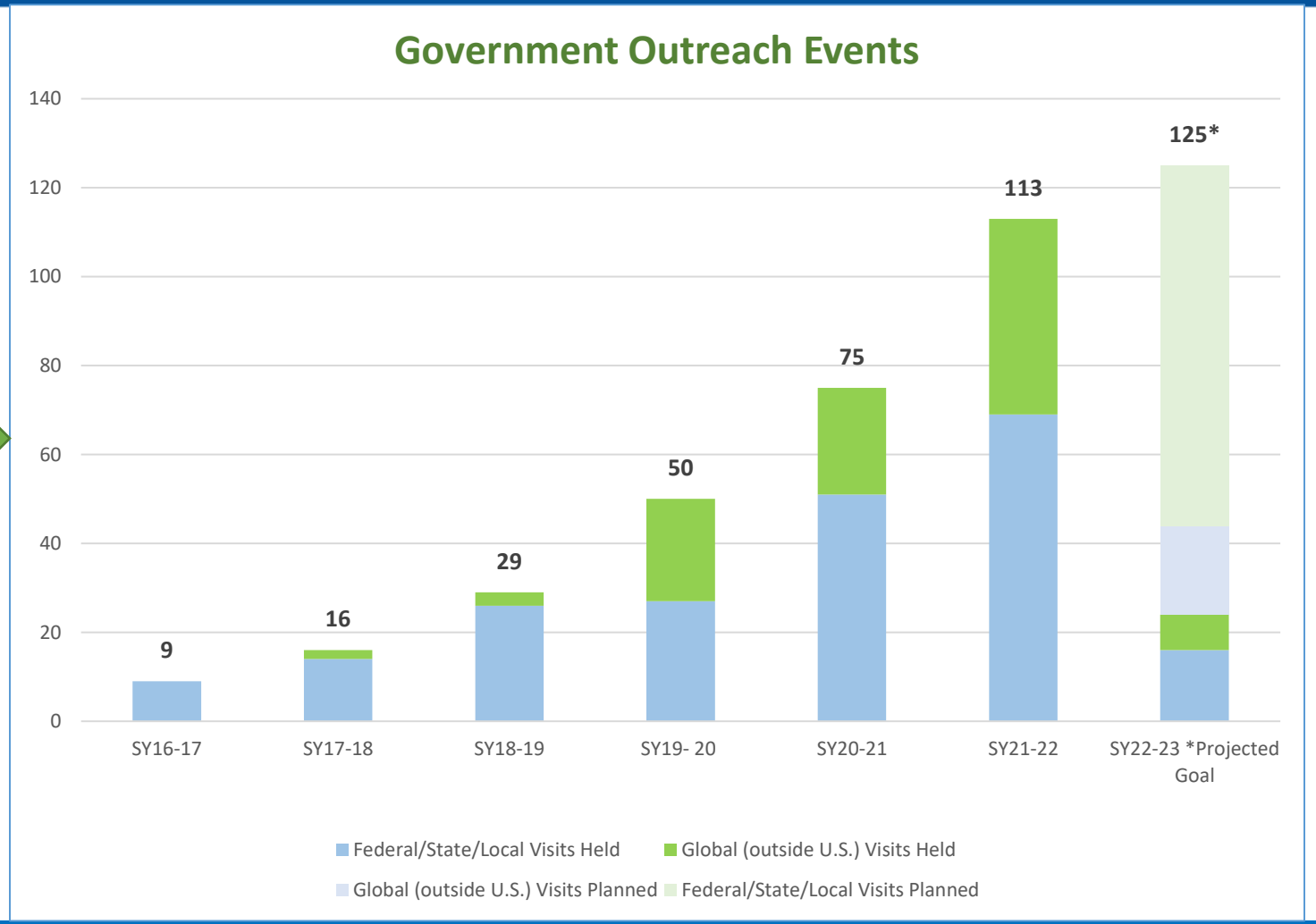
Donate, Volunteer and Learn More at ashrae.org/support

Government Affairs

Government Affairs Update: **Subscribe** online or by emailing GovAffairs@ashrae.org. 511 GAU articles were published in SY21-22; 249 published to date.

Government Outreach Events connect ASHRAE volunteers with policy-makers.

Letters, briefings, testimony, and comments are sent in support of ASHRAE's Public Policy Priorities: 39 sent in SY21-22; 10 sent in SY22-23.



Get Involved + Get Resources at ashrae.org/governmentaffairs

Professional Development

eLearning

90+ online courses starting at **$42** for members, and group rates are available.

elearningcatalog.ashrae.org

ASHRAE Learning Institute (ALI)

New schedule for 2023

In-person and virtual HVAC Design courses

- Level I – Essentials
- Level II – Applications

NEW courses added to the Instructor-led Online Series **ashrae.org/onlinecourses**

ASHRAE Certifications

Building Design

- Energy Modeling (BEMP)
- Healthcare Facility Design (HFDP)
- High-Performance Building Design (HBDP)
- HVAC Design (CHD)

Building Performance

- Commissioning (BCxP)
- Energy Assessment (BEAP)

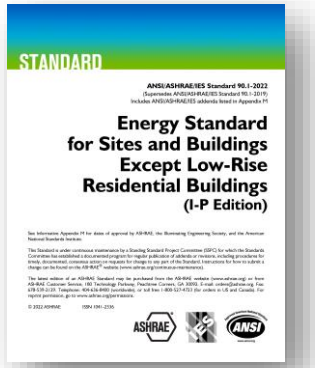
Building Operations

- Operations & Performance Maintenance (OPMP)

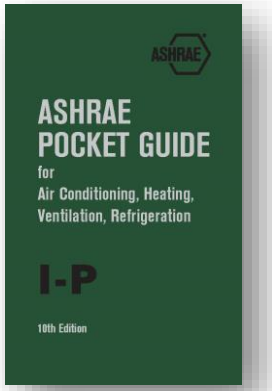
Sign Up for a Monthly Update at ashrae.org/professionaldevelopment

Publications

Recently published items available at ashrae.org/bookstore



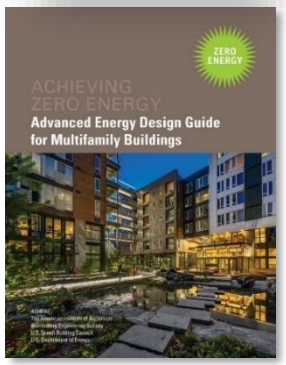
ANSI/ASHRAE Standard 90.1-2022, *Energy Standard for Sites and Buildings Except Low-Rise Residential Buildings*



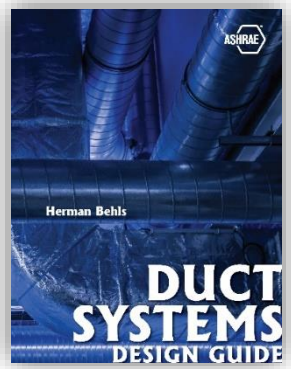
***ASHRAE Pocket Guide for Air Conditioning, Heating, Ventilation, Refrigeration,* 10th Ed.**

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*



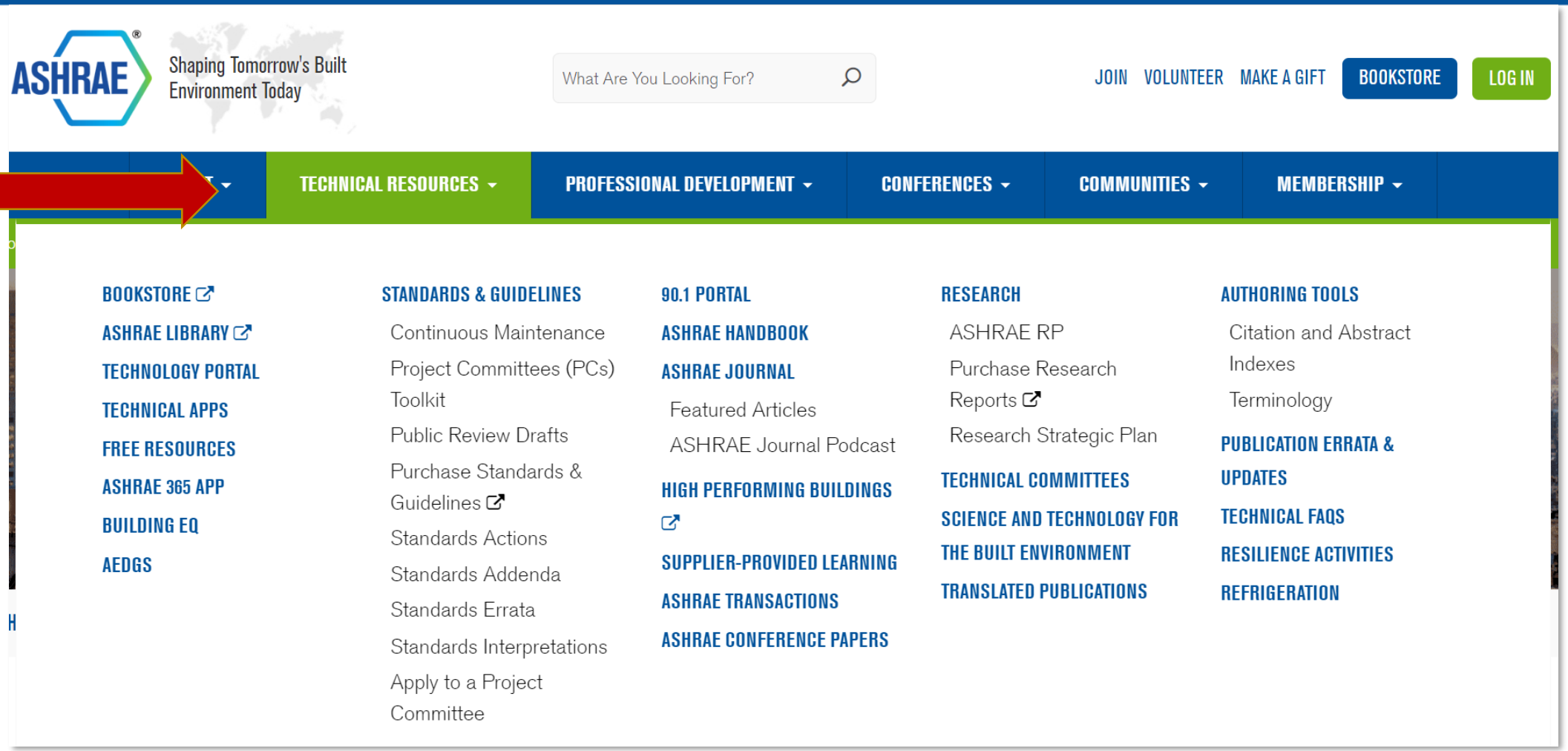
Advanced Energy Design Guide for Multifamily Buildings – Achieving Zero Energy (AEDG)



Duct Systems Design Guide

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

Resources

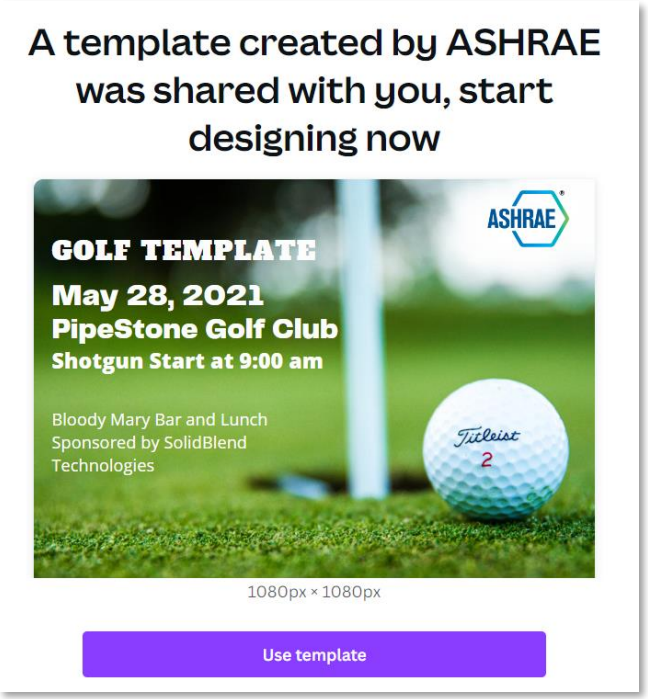


Find these resources and more at ashrae.org

Marketing Central

Created for the busy volunteer

Templates for all your Communication Needs



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Flyers & Brochures | Videos | Toolkits | Tradeshows | Graphics

ashrae.org/marketingcentral

Upcoming Tradeshows

WHAT?	WHEN?	WHERE?
AHR Expo	February 6-8, 2023	Atlanta, GA
ACREX	March 14-16, 2023	Bombay
AHR Mexico	September 19-21, 2023	Mexico City
Greenbuild	September 26-29, 2023	Washington DC

- Educational Resources
- Discounts on Publications
- Free ASHRAE Giveaways

Come to the AHR Expo!
Your (paid) ASHRAE Winter Conference badge gets you into the show. Visit the **ASHRAE Booth B1638 & Bookstore C6043**.

Learn More and Find Resources for Tradeshows ashrae.org/marketingcentral

ASHRAE Conferences

MAR 2023

ASHRAE SCANVAC HVACC Cold Climate Conference
Mar 6-8, 2023| Anchorage, AK
Mar 9-10, 2023| Fairbanks, AK

MAY 2023

Developing Economies Conference 2023
May 11-12, 2023| Mumbai, India

OCT 2023

2023 Decarbonization Conference for the Built Environment
October 25-27, 2023| Washington, DC

2023 ASHRAE Annual Conference

June 24-28, 2023 | Tampa, FL

Registration opens in March!

ashrae.org/conferences

Thank you!
Questions or Comments?

Environmental Health Committee (EHC) Emerging Issue Brief

~~December 14~~~~January~~June ~~13~~24, 202~~3~~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]

Indoor Particle-Bound Reactive Oxygen Species

Measurement of ~~total~~particle-bound 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 ~~particulate~~particle-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~~ significantly 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] Measurements of ozonolysis of a film composed of a mixture of lipids representing skin lipids and cooking oils showed depletion of about half of the ozone reacting to form ROS within the first few hours of exposure, and about half of the formed ROS persisted on the surface film. ROS production continued during the 24 hours following ozonolysis, suggesting other mechanisms for ROS production in surface films, such as autoxidation.[13]

Indoor Gaseous Reactive Oxygen and Nitrogen Species

Gas-phase OH has been measured in a classroom (reaching up to 1.8x10^6 molecules/cm^3),[14,15] during cleaning with limonene (4x10^6 molecules/cm^3),[16] with an electronic air cleaning running (1.8x10^7 molecules/cm^3),[16] 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.[14,17–19] Combustion is a significant indoor source of NO_x and HONO, including unvented combustion appliances (e.g., gas stoves), smoking, and kerosene heaters.[20] For example, NO_x and HONO concentrations increased from 15 and 4 ppb to 135 and 40 ppb during cooking with oil on a natural gas stove.[17] When cleaning with chlorine-based solutions, reactive chlorine species can be produced through reactions with OH.[5] Photocatalytic paints can reduce NO_2 concentrations, though significant HONO concentrations may be generated as a result.[21]

Due in part to being a US EPA criteria pollutant, indoor NO_{2x} 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.[22] 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.[23] ~~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.~~

Indoor Sources and Control of ROS and RNS

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),[10,24,25] cooking,[4,26] oxidation of gas-phase terpenes (e.g., from surface cleaning),[16,27] nitrous acid (HONO) photolysis,[14,16,17,28] electronic/additive air cleaners,[9,16,29–32] disinfectant spraying/fogging,[32,33] laser printers,[34] and potentially through germicidal UV photolysis of ozone and volatile organic compounds.[35,36] ~~Due to the limited number of studies directly measuring gas- and particle-phase ROS reactive species emissions from human activities and air management technologies, a~~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, such as by reducing indoor ozone concentrations, should result in reduced partitioning of such compounds to the particle-phase. Reduction, source control, 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, such as secondary organic aerosols (SOA).[17] 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 of and control approaches for ~~reducing particle- and gas-phase~~ ROS and RNS indoors.
- ~~•~~ Reactive species~~OS~~ generation should be included in testing and validation of certain air quality control methodologies, such as additive air cleaner technologies~~.~~
- ~~ROS generation should be assessed for~~ and germicidal UV ~~applications~~.[35]
- Identify knowledge gaps and support research, including but not limited to:
    - The health implications and toxicological responses to ROS exposure.
    - The measurement and modeling of ~~semi-volatile~~ ROS in particles and indoor surface films ~~and the extent to which semi-volatile ROS partition to the particle-phase~~.
    - Physicochemical modeling of ROS and RNS production and reaction with indoor gases and surfaces.
    - Assess the effectiveness of gas- and particle-phase ROS and RNS removal approaches, including filtration and adsorption.

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Spring 2023

Environmental Health Committee (EHC) Report to ASHRAE Technology Council

Recent Trends in Environmental Health

This report is prepared as a part of a MBO (Management by Objectives) assigned to Environmental Health Committee (EHC). Based on the feedback from the members of EHC a list of recent trends in the environmental health and its impact on HVAC&R industry is prepared. Additionally, research needs related to these trends are listed.

1. *Enhanced Indoor Air Quality.* Due to the ongoing pandemic over the last three years, the demand for better IAQ has been increasing. There has also been a paradigm shift in expectations for IAQ – towards health/productivity focus, including infection control outside healthcare environments. There is a need to formulate practical metrics for evaluating IAQ. Currently our ventilation standard is based on bioeflluence. Consider switching to ventilation base on "health" and research required to define "healhty air".
2. *Increasing use of air cleaners*. There are many associated issues regarding their effectiveness, safety, and a clear need for relevant methods of testing and certification. How effective are they on different viruses, and impacts of byproducts they emit. Microbial - research to understand antimicrobial products in air and surfaces and the forming of superbugs. Research on test standard for the removal of ultrafine particles (UFP). Research into how best to test or even the levels of efficacy that are common would help design a useful standard. (e.g. Std 185.1, 2, & 3) Use of higher efficiency filters in non-healthcare settings. There is movement towards MERV 13 as a minimum standard for new systems and as an upgrade for existing systems. Associated issues are the inability of some existing systems to accommodate this level of upgrade, and energy use impact. On the other hand, there is an opportunity to rethink system design and develop components that successfully achieve this level of performance.
3. *Unvented combustion.* Although this is not a new trend, the lack of standards on the effect of these appliances on residential IEQ is trending as an issue. Research quantifying the effect of combustion products in residences is indicated as a need going forward. Some helpful information can be found in the use of these products in the commercial and industrial built environment.
4. *IEQ as an aspect of resilience*. For a long time, discussions of resilience have revolved around protection of the building from earthquake, hurricane winds, flooding, etc. The emerging trend is to view protection of occupants during extreme outdoor and indoor events (e.g., wildfires and epidemics, respectively) as a core aspect of resilience. Cooking in general, gas cooking in specific, needs more research on its impact to IEQ. what extent can demand-controlled kitchen ventilation ("DCKV") address these issues. The primary research gap in acoustics is the correlation between performance and human perception in the built-environment. While the acoustical design

metrics are based on human perception, the application and refinement of these metrics and performance criteria has not been well correlated with user's experiences and other measures of health and well-being. With respect to acoustics many of our minimum requirements assume constant noise or intrusion, but do not take into consideration the changes in time, amplitude, or frequency of events. Understanding this would likely help create more tangible "minimum requirements".

5. *Ventilation rates.* There is a trend towards increasing the ventilation air rates and air changes per hour (ACH) for indoor spaces. A proper guidance is required to assess the effectiveness of increased ACH and associated impact on energy demand. Cooling – using general rule of thumb, but does not models actual air flow in the space. Lack the clarity on whether the spaces are actually "mixed" or not, especially for overhead systems.
6. *Infectious Aerosols.* Air infectious disease is not as focused compares to food and water. "There are, however, no ventilation guidelines or standards to specifically control the concentration of these pollutants indoors. None of the documents provide recommendations or standards for mitigating bacteria or viruses in indoor air, originating from human respiratory activities[i]", per recently published document, "A Paradigm Shift to Combat Indoor Respiratory Infection".
7. *Indoor agriculture.* Industrial indoor agriculture is a trending issue due to new market forces. Research on the impact of animals and plants on indoor environment can be enhanced. Many of the guidelines are lacking in information regarding these 2 aspects.
8. *Temporary Indoor Environments.* Temporary shelters - short term occupancy conditions (hurricanes, etc.) days to weeks, what is acceptable in short term conditions vs. conventional shelters. Also consider alternate accommodations (due to emergency) e.g. stadiums becoming shelters, etc. Is chronic exposure to certain indoor environments, even for short intervals, affecting health? Indoor air quality - chronic and short-term exposures at moderate levels of under ventilation and impact on health and performance, e.g., 1000-2000 ppm CO2 concentration equivalent.
9. *Climate Change.* Research on thermal comfort and chronic exposure - are we adapting to changing weather in any meaningful manner?
10. *Financial – Cost/Benefit*. Knowledge gap in developing solutions, best practice guidelines, assessment, diagnostic and EQ enhancement design tools, and economic models that can explicitly assign a monetary value to the costs and benefits of enhanced EQ.

Research Needs:

1) Development of new metrics for IEQ for spaces other than healthcare.
2) Development of testing and certification procedures for air cleaners.
3) Application of in-room air cleaners for consumers.
4) Efficacy of negative pressure spaces for non-healthcare environment.
5) Impact of air change rates on effectiveness of ventilation.
6) Renewed metrics for health, comfort and productivity measures.
7) Monetary benefits of health and wellness in built environment.

8) Real time measurement and monitoring of indoor and outdoor contaminants and indicators/design compounds.

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Occupant Health Must be Considered in Building Design, Operations and Maintenance

Title:
Occupant Health Must be Considered in Building Design, Operations and Maintenance

Track:
Future-Proofing the Built Environment

Session Abstract:
The MTG-HWBE report approved by EHC explicitly states that the purpose of most buildings is for human occupancy and elaborates on the multiple effects of the built environment on occupant health. One charge to the MTG was to survey how ASHRAE can promote Health and Wellness in the Built Environment. This session will review the effect of buildings on health, spotlight relevant ASHRAE history and recognize the value of better indoor environments relative to their cost. These three presentations will support ASHRAE efforts to strengthen standards (for example 62.1, 62.2, 189.1) to better protect occupants when adopted as code.

Learning Objectives:

1. 1. Review the history of ASHRAE activities related to healthy buildings
2. 2. Understand the shift in attitudes about buildings from ‘protection from the elements’ to ‘buildings impact health’.
3. 3. Acknowledge the factors of the built environment that impact occupant health
4. 4. Recognize that for ASHRAE standards to remain relevant, the standards need to address health impacts of the built environment

Other Sponsoring Committees:
Environmental Health Committee & SSPC62.1

Expected Attendance:
60

Submitted to Last Meeting:
Yes

Program Level:
Intermediate

Program Type:
Seminar

Length:
60

Methods of Assessment:

1. Apart from barns, garages and warehouses, is the salient purpose of most buildings for human occupancy?
   - **True**
   - False
2. Has ASHRAE historically considered occupant health the responsibility of others?
   - **True**
   - False
3. Has ASHRAE in the past specifically excluded health impacts from their remit?
   - **True**
   - False
4. Has ASHRAE in the past placed specific limits on how ASHRAE Standards could address IAQ?
   - **True**
   - False
5. The currently available evidence is sufficient to conclude that the built environment affects occupant health?
   - **True**
   - False
6. The impacts of the built environment on health can include both positive and negative impacts?
   - **True**
   - False
7. Are there features that can be written into design standards to promote occupant health?
   - **True**
   - False
8. Beyond design, are the operations procedures of a building important to occupant health?
   - **True**
   - False
9. Was the MTG for Health and Wellness in the Built Environment established as a presidential initiative?
   - **True**
   - False
10. There is agreement among sustainability rating systems for

what is an acceptable indoor environment?

- True
- **False**

Chair

Lan Chi Nguyen Weekes
La Cite, Applied Arts and Technology College
OTTAWA,
Canada
Email: LaNguye@lacitec.on.ca -- Will not be published

* Membership Number 5084960

Presentations

Contact Presenter	Presentation	Speakers	Presentation Review Status
andyp@nist.govstephanie@b4hinc.comLaNguye@lacitec.on.ca	33943 - What Ashrae Has Already Done for Health in the Built Environment	**Andrew K Persily, Member**[1], **Stephanie Taylor, Member**[2] and **Lan Chi Nguyen Weekes**[3], (1)NIST, Gaithersburg, MD, (2)Building 4 Health, Inc., (3)La Cite, Applied Arts and Technology College, OTTAWA, Canada	Unavailable
stephanie@b4hinc.com	33941 - Health Impacts from the Built Environment	**Stephanie Taylor, Member**, Building 4 Health, Inc.	Unavailable
LaNguye@lacitec.on.ca	33942 - Health and Wellness in the Built Environment: The MTG Findings	**Lan Chi Nguyen Weekes**, La Cite, Applied Arts and Technology College,	Unavailable

		OTTAWA, Canada	

If necessary, you can make changes to your session between now and the deadline of Wednesday, November 30, 2022.

> To access your submission in the future, use the direct link to your session submission from one of the automatic confirmation emails that were sent to you during the submission.
> *Or* point your browser to http://ashraem.confex.com/ashraem/reminder.cgi to have that URL mailed to you again. Your username/password are 33259/236923.

Any changes that you make will be reflected instantly in what is seen by the reviewers. You DO NOT need to go through all of the submission steps in order to change one thing. If you want to change the title, for example, just click "Title" in the session control panel and submit the new title.

When you have completed your submission, you may close this browser window.

Tell us what you think of the session submittal

Home Page

2.1	Particles in Nonindustrial Environments		Update the section on environmental tobacco smoke and electronic nicotine delivery systems.
2.1	Bioaerosols	Building Water System Sources	Update this section with Standard 188?
2.1	Bioaerosols	Health Effects	Update Table 4
2.1	Bioaerosols	Exposure Guidelines for Bioaerosols	Add a table for CFU limits
2.2	Nonindustrial Environments	Semivolatile organic compounds (SVOCs)	Update Tables 6 and 7 to remove banned substances, and revisit the control stretegies section that suggests that ventilation may be ineffective.
2.2	Nonindustrial Environments	Carbon monoxide	Update the section on deaths from CO exposure, data cited is from 2006.
2.2	Nonindustrial Environments	Carbon Dioxide	Update this section.
2.2	Nonindustrial Environments	Nitrogen Dioxide	Coordinate limits with Table 5
2.2	Nonindustrial Environments	Ozone	Rewrite this section in its entirety. Coordinate limits with Tables 5 & 8. We should also mention electronic air cleaners and photo catalytic oxidizers.
3.1	Climate Change		Update this section
3.1	Effects of Thermal Environment on Specific Diseases		Update this section
3.1			Add Section on Wildfires
3.4	Ionizing Radiation	Exposure Standards	Update Table 12
3.6			Rewrite section in its entirety to include recent work from SARS-CoV-2.

WORK STATEMENT COVER SHEET

Date: May 15, 2023

(Please Check to Insure the Following Information is in the Work Statement)

A. Title	X
B Executive Summary	X
C. Applicability to ASHRAE Research Strategic Plan	X
D. Application of the Results	X
E. State-of-the-Art (background)	X
F. Advancement to State-of-the-Art	X
G. Justification and Value to ASHRAE	X
H. Objective	X
I. Scope	X
J. Deliverables/Where Results will be Published	X
K. Level of Effort	
Project Duration in Months	X
Professional-Months: Principal Investigator	X
Professional-Months: Total	X
Estimated $ Value	X
L Proposal Evaluation Criteria & Weighting Factors	X
M. References	X
N. Other Information to Bidders (Optional)	

Title:
Improving efficiency test methods to measure in-room air cleaner performance against airborne particulate contaminants in a recirculating system.

WS# 1928
(To be assigned by MORTS - Same as RTAR #)

Results of this Project will affect the following Handbook Chapters, Special Publications, etc.:
Chapter 29 – Air Cleaners for Particulate Contaminants, HVAC Systems and Equipment Handbook.
Chapter 47 – Air Cleaners for Gaseous Contaminants, HVAC Applications Handbook.
Epidemic Task Force Publications and Recommendations
New Chapter in HVAC application for in-room air cleaners

Responsible TC/TG: **TC 02.09**

Date of Vote: **02/05/2023**

For		8
Against	*	1
Abstaining	*	0
Absent or not returning Ballot	*	2
Total Voting Members		11

This W/S has been coordinated with TC/TG/SSPC (give vote and date):
TC2.3 5/5/2022 EHC 4/28/2022
TC2.4 5/10/2022 TC9.6 5/2/2022

Has RTAR been submitted? **Yes**
Strategic Plan
Theme/Goals

Work Statement Authors: **

Lead: **Chrystal Jolliffe**
Others:
Kathleen Owen **Joe Pessa** **Ashish Mathur**
Chang-Seo Lee **Gemma Kerr** **Caitlin Naske**

Proposal Evaluation Subcommittee:
Chair: **Chrystal Jolliffe**
Members: **Kathleen Owen** **Joe Pessa**
Chang-Seo Lee **Gemma Kerr**
Brendon Burley

Project Monitoring Subcommittee:
(If different from Proposal Evaluation Subcommittee)

Recommended Bidders (name, address, e-mail, tel. number): **

Blue Heaven Technologies – Bobby Singer, Louisville/KY, info@blueheaventech.com, 502-357-0132

LMS Technologies – Kevin Kwong, Bloomington/MN, info@lmstechnology.com, 952-918-9060

ARE Labs, Inc. – Jamie Balarashti, Olathe/KS jbalarashti@arelabs.com, 913-850-6634

Illinois Institute of Technology – Brent Stephens PhD, Chicago, IL brent@iit.edu, 312-567-3629

(**Three qualified bidders must be recommended, not including WS authors.**)

Potential Co-funders (organization, contact person information):

	Yes	No	How Long (weeks)
Is an extended bidding period needed?		x	
Has an electronic copy been furnished to the MORTS?	X		
Will this project result in a special publication?		x	
Has the Research Liaison reviewed work statement?	X		

* Reasons for negative vote(s) and abstentions

Abstentions were only for Chair-Not-Voting

** Denotes WS author is affiliated with this recommended bidder
Use additional sheet if needed.

WORK STATEMENT# 1928

Title:

Improving efficiency test methods to measure air cleaner performance against airborne particulate contaminants in a recirculating system.

Sponsoring TC/TG/MTG/SSPC:

TC 02.09

Co-Sponsoring TC/TG/MTG/SSPCs (List only TC/TG/MTG/SSPCs that have voted formal support)

TC 02.03, TC 02.04, EHC, TC 09.06

Plain English Abstract:

Existing industry test methods for air cleaners take one of two approaches – passing the air through the cleaner a single time in a sealed duct or endlessly recirculating the air through the cleaner in a sealed chamber. Neither reflects many office or home environments. This research will begin to explore the air cleaner performance in a combined system, with a circulating duct attached to a room-sized chamber. The results will highlight how this combination system can be operated and controlled to give meaningful and repeatable measurements of air cleaner performance.

Executive Summary:

The project goal is to provide data to existing and developing standards committees such as standard 145.4P on the feasibility, critical parameters, and best design for a recirculating duct and chamber system test method. Existing test methods for air cleaning devices use simplistic systems such as single-pass efficiency in ducts or single dose decay rates in chambers. Most applications involve more complex scenarios combining HVAC ducts and rooms (chambers). This research will investigate parameters that become critical with this new chamber with duct combination system testing so that new test methods will correctly accommodate these parameters. The recommended aerosol challenge serves as a surrogate for inert and biological particles as well as for gas-phase contaminants so that the lessons learned will be applicable, for the most part, to all three types of contaminants.

Applicability to the ASHRAE Research Strategic Plan:

This project will help address the needed research laid out in the ASHRAE Research Strategic Plan 2021, specifically in the IEQ Initiative:

"2. Human-centric and inclusive design and control, considering diversity.
   c. Development of sensing and control solutions to secure high IEQ at the environment level (building, space) and the personal level that considers preferences and behavior and allows adjustments based on occupants' continuous feedback."

"3. Requirements beyond the minimum design and development of engineering solutions for substantial improvement of IEQ in spaces occupied by people, plants, or animals.
   d. Development of engineering solutions for removing existing and new man-made and

persistent pollutants (trapping at source, air cleaning, etc.)."

"4. Protection against the transmission of infectious diseases and future pandemic outbreaks.

d. Developing advanced systems for improving protection against airborne transmission of infectious diseases and exposure to airborne pollutants, particularly eliminating infection risks at source (breathing zone), but also effective air cleaning technologies and the methods for their certification."

In addition, and relevant to ASHRAE's resilient buildings initiative, indoor air quality continues to be an important parameter in net-zero solutions. This initiative will provide a foundation for the development of test standards that better represent real world environments leading to innovation of better products for resilient buildings.

Application of Results:

Direct applications of results from this project include:

- Development of a realistic performance method of test for air cleaners that remove aerosols from air;
- Modification of this MOT to cover removal performance of air cleaners against biological aerosols and gaseous contaminants;
- Modification to other test methods based on data that crosses into related testing;
- Test results can be used by air-cleaner manufacturers to improve device performance;
- Results can be used to update HVAC Systems and Equipment Handbook Chapter 29 *Air cleaners for particulate contaminants* and the new chapter on in-room air cleaners accepted for the HVAC Applications Handbook.
- Determination of needed follow-on research whether for: additional parameters, contaminant specific needs, or additional modification of the test chamber/duct system.

This project will also lay groundwork for more realistic performance test methods for in-duct air cleaning devices including particulate and gaseous contaminant filters and electrically powered technologies.

State-of-the-Art (Background):

The COVID-19 crisis has highlighted the need for high quality data on the effectiveness of air cleaners. The sharp rise in marketing and sales of new devices without applicable standard testing leaves the ASHRAE community with no way to estimate the effectiveness of many air cleaners, and users with the potential for unexpected outcomes when installing unvetted air cleaners.

The existing industry and society test methods for testing air cleaners are based on simplified environmental situations, either ducts (with single-pass efficiency) or enclosed chambers (inject contaminant and measure "draw-down"). The duct tests have also predominantly excluded certain types of air cleaning devices, specifically those that use reactive species. For in-room units that do not remove a constant percentage of the contaminant, draw-down testing with the assumption of exponential decay of chamber concentration with time will not capture the removal rates correctly. In addition, byproduct species that are created by all air cleaners need to be identified and quantified as well as the removal rate for the injected contaminant (Siegel, 2016; Zhang et al., 2011). However, little work has been done

at full-scale levels to determine reliable, practical methods of test. While there is published literature on simple chamber testing, relevant published data is not available on full-scale chamber and side duct testing. Blue Heaven Technologies, an air cleaner test lab, have presented information on their test configuration at ASHRAE 52.2 meetings (see minutes).

See below for the most prominent existing air cleaner test methods:

Particles and Dust

ASHRAE 52.2 (duct, single-pass)
ISO 16890 (duct, single-pass)
AHAM AC-1 (chamber, draw-down)

Gases and Molecular Contaminants

ASHRAE 145.2 (duct, single-pass)
ISO 10121-2 (duct, single-pass)
AHAM AC-4 (chamber, draw-down)

Microbial Contaminants

ASHRAE 185.1 (duct, single-pass, UV-C devices only)
ASHRAE 52.2 Option (duct, single pass, all non-UVC devices)
AHAM AC-5 (chamber, draw-down)
ASHRAE 185.3P (chamber, draw down with no side duct, in development)

Advancement to the State-of-the-Art:

Given the current awareness of bioaerosol spread of disease, the many new and newly popular products coming to market in response, and the likelihood of future potential pandemics, ASHRAE and the Epidemic Task Force emphasize future preparedness. Access to air cleaner efficacy and safety information is crucial to this effort. This research project will move us toward having that information before the next pandemic and even to help fight recurring non-pandemic infections such as flu. Test results, improved based on the outcome of this project, will provide reliable data to enhance recommendations going forward, including the ASHRAE position documents on airborne infection control and air cleaners.

Justification and Value to ASHRAE:

The value to ASHRAE is a path forward towards developing new and improved test methods that are more applicable to actual applications and are appropriate for all air cleaning devices. Since a different test rig configuration and procedure is needed, we need data on how various parameters influence the testing and performance. This will allow us to provide test standards that give useful, understandable, and repeatable results. Parameters that need to be examined include device location, duct entry/exit specifics, airflow, chamber dimensions and duct sizes relative to the devices' intended usage, aerosol generation and injection schema, etc. Comparison of realistic results with different setups and different devices will allow better understanding of which parameters are important to specify and their influence on the data product resulting from the testing.

As discussed above, chamber testing is common for some types of in-room air cleaners via the AHAM-1 test with the result expressed as clean air delivery rate (CADR). Testing using a side duct attached to a similar chamber is currently being used and has been proposed for testing such as that proposed here (Burkhead, 2018). The PI will be expected to review these approaches and adapt useful portions to the work proposals for this research. Thus, the research will build on existing and understood test methods to enable new, test standards to cover devices that are not currently being tested. This research will also provide improvements to performance test methods for all types of air cleaners.

Objectives:

1. After identifying important parameters in the proposals, determine which parameters are key, then perform testing to understand key test parameters that affect the measurement of efficacy of air cleaners in recirculating chamber-duct combination system.
2. Using existing equipment with needed upgrades for this specific work, set up a test rig chamber (≥ 1000 ft^3) with side duct (composed of sections similar to ASHRAR 52.2's) and the needed generation and analytical equipment to perform the testing.
3. Set up and run a test sequence including at least the following; additional parameters maybe suggested in the proposal or become apparent during testing:
    a. Evaluate the impact in the chamber of different inlet and outlet locations from the side duct to the chamber.
    b. Measure particulate contamination level in the air and distribution within the chamber and duct.
    c. Explore measurement method and then analyze byproducts produced during testing including: particles, ultrafine particles, ozone, and others as agreed to by the PI and the PMS.
    d. Evaluate impact of location of aerosol introduction within the chamber and in the

duct.

e. Evaluate impact of aerosol introduction as a single event, intermittent injection, and continuous injection.
f. Evaluate impact of different air cleaner locations within the system.
g. Evaluate methods for controlling environmental conditions within the chamber (T, RH).
h. Evaluate the impact of ventilation rate of the chamber (compared to flow rate of the air cleaner).
i. Measure particulate contamination level in the air and distribution within the chamber and duct with 3-4 various air cleaning technologies.

Scope/Technical Approach:

This project is divided into multiple tasks. Some of the tasks need to be performed in sequence, while others may be performed in parallel. The task deliverables are spelled out in the next section. This section describes the needed work. Some leeway has been given to allow potential PIs to bring their expertise to the project. Many of the questions discussed below for the project will be reasonably addressed in the proposal including likely sampling and analysis techniques. The expectation is that the project will include the test plan development and not sampling or analysis technique development that the PI should already be versed in.

The overall project includes testing 3-4 types of air cleaning technologies against two or more aerosol challenge types with monitoring or testing for byproducts produced during testing including at least: particles, ultrafine particles, ozone, and VOCs (including formaldehyde) as appropriate based on the particle type. Testing variables will include aerosol injection locations and types (single dose, intermittent, and continuous).

Task 1. Test Rig Construction. Construct or modify a test rig to comprise a duct or duct sections as described in ASHRAE 52.2 connected to a chamber of at least 1000 cubic feet. Height of chamber must be at least 8 feet to accommodate upper room air cleaning devices, if chosen. The design of the chamber or modifications to an existing chamber, including location of the supply and returns, must be shared with the PMS either in the proposal or by email/virtual meeting/in-person meeting before the construction is done. PMS must be allowed to give advice and approve the final design before anything other than minor changes are made.

Task 2. Experimental Design. A test plan will be developed, inclusive of the above sections, and shared with the PMS for their input. This test plan may be done in sections to meet the needs of each layer of testing allowing building on what is learned or presented as one overall test matrix. This plan must include, at least, the choice of devices, aerosol type and size range, the locations for air cleaners in the system and the other necessary parameters. Generation and sampling methods, byproduct sampling and analysis plans, length of tests, sampling schema (# of replicates at each time, # of times, choice of times) must be determined and included. The test design should consider the air cleaner manufacturers' instructions for proper use.

Data analysis methods should also be discussed with the understanding that the data may change the needed analysis. Likely efficiencies for the chosen devices or technologies should be considered Once each test plan section that is required for each of the testing subtasks is approved by the PI and PMS, that testing may be performed.

Task 3. Baseline Testing. Test 3-4 air cleaning technologies which shall include media filters, "ionization," a combination unit and/or a second reactive type device. Devices should be tested in the chamber in the location(s)s approved through Task 2. The injection shall be an initial single dose. Data with plots shall be shared with the PMS as the data is available. Data analysis such as CADR or percent reduction calculations should also be done and shared with the PMS. This data set shall be discussed with the PMS to determine if it is adequate before moving to task 4.

Task 4. Advanced Testing. Test the air cleaning devices using a minimum of two injection locations – within the chamber or within the duct. Test the air cleaning devices using three modes of aerosol injection – single dose, intermittent dose, and continuous injection. Include testing to cover the items listed in the objectives section. The data from Task 3 may be counted as the single dose testing. Data will be shared with the PMS as it is received. Data analysis to determine that the individual runs are reasonable and other metrics which are developed based on the actual data shall be performed and shared with the PMS. PMS input shall be requested to help the PI determine that the data set is acceptable.

Task 5. Data Analysis and Reporting. Data analysis to determine the influence of the variables on the test results will be finished. For example, does intermittent or continuous injection provide equivalent or better results and whether the answer varies by the type of device. Produce a draft of recommendations that could be incorporated into a test method. As required by ASHRAE, a Final Report and a Journal Paper will be produced. The Final Report should be presented to the PMS at least a month before the end of the project for the report to be revised based on PMS input. In addition, the PI should review Chapter 29 – Air Cleaners for Particulate Contaminants, HVAC Systems and Equipment Handbook, Chapter 47 – Air Cleaners for Gaseous Contaminants, HVAC Applications Handbook, and the new accepted chapter for in-room air cleaners, HVAC applications handbook, and prepare suggested revisions based on this project. These recommendations may be included in the final report or presented separately.

Deliverables/Where Results Will Be Published:

Deliverables for the tasks include:

Task 1. Report on the design of the chamber or modifications to an existing chamber. Requires PMS approval of the final design before project continues.

Task 2. Test plans must be provided to the PMS and approved before work on that part of the experiments begins.

Task 3. Data and graphs from baseline testing must be shared with PMS. PMS must decide that data is acceptable before Task 4 begins.

Task 4. Data and graphs from main testing must be shared with PMS. PMS must decide that data is acceptable before this task is considered concluded. This should also occur before the Final Report, other than the introductory sections, are prepared.

Task 5. Final report, journal paper, and handbook chapter recommendations. The Final Report should include recommendations for further research, possibly including application to other aerosols and modeling.

In addition to the Final Report to be published by ASHRAE and the Journal Paper also published by ASHRAE, results from the project may be published in ASHRAE Chapter 29 – Air Cleaners for Particulate Contaminants, HVAC Systems and Equipment Handbook, Chapter 47 – Air Cleaners for Gaseous Contaminants, HVAC Applications Handbook, and the new accepted chapter on in-room air cleaners, HVAC Applications Handbook.

The results will also be presented to committees advancing chamber test methods which will likely result in incorporation, and publication, in ASHRAE (e.g., 145.4, 185.3, 185.5, TG2-RAST), AHAM (e.g., AC-1, AC-4, AC-5), ISO (e.g., TC142/WG11), and/or ASTM test methods. Additional journal articles and/or conference papers may result from the project, but this is to be determined by the data and the PI.

Progress, Financial and Final Reports, Technical Paper(s), and Data shall constitute the only deliverables ("Deliverables") under this Agreement and shall be provided as follows:

a. Progress and Financial Reports

Progress and Financial Reports, in a form approved by the Society, shall be made to the Society through its Manager of Research and Technical Services at quarterly intervals; specifically, on or before each January 1, April 1, June 1, and October 1 of the contract period.

Furthermore, the PI, subject to the Society's approval, shall, during the period of performance and after the Final Report has been submitted, report in person to the sponsoring Technical Committee/Task Group (TC/TG) at the annual and winter meetings, and be available to answer such questions regarding the research as may arise.

b. Final Report

A written report, design guide, test protocol, or manual, (collectively, "Final Report"), in a form approved by the Society, shall be prepared by the Institution and submitted to the Society's Manager of Research and Technical Services by the end of the Agreement term, containing complete details of all research carried out under this Agreement. Unless otherwise specified, six copies of the final report shall be furnished for review by the Society's Project Monitoring Subcommittee (PMS).

Following approval by the PMS and the TC/TG, in their sole discretion, final copies of the Final Report will be furnished by the Institution as follows:

- An executive summary in a form suitable for wide distribution to the industry and to the public;
- Two bound copies;
- One unbound copy, printed on one side only, suitable for reproduction; and
- Two copies on disks: one in PDF format and one in Microsoft Word.

c. Technical Paper

One or more papers shall be submitted first to the ASHRAE Manager of Research and Technical Services (MORTS) and then to the "ASHRAE Manuscript Central" website-based manuscript review system in a form containing such information as designated by the Society suitable for presentation at a Society meeting. The Technical Paper(s) shall conform to the instructions posted in "Manuscript Central" for a technical paper. The technical paper title shall contain the research project number (xxxx-RP) at the end of the title in parentheses, e.g., (1111-RP).

Note: A research or technical paper describing the research project must be submitted after the TC has approved the Final Report. Research or technical papers may also be prepared before the project's completion, if it is desired to disseminate interim results of the project. Contractor shall submit any interim papers to MORTS and the PMS for review and approval before the papers are submitted to ASHRAE Manuscript Central for review.

d. Data

All papers or articles prepared in connection with an ASHRAE research project, which are being submitted for inclusion in any ASHRAE publication, shall be submitted through the Manager of Research and Technical Services first and not to the publication's editor or Program Committee.

The Institution agrees to maintain true and complete books and records, including but not limited to notebooks, reports, charts, graphs, analyses, computer programs, visual representations etc., (collectively, the "Data"), generated in connection with the Services. Society representatives shall have access to all such Data for examination and review at reasonable times. The Data shall be held in strict confidence by the Institution and shall not be released to third parties without prior authorization from the Society, except as provided by GENERAL CONDITION VII, PUBLICATION. The original Data shall be kept on file by the Institution for a period of two years after receipt of the final payment and upon request the Institution will make a copy available to the Society upon the Society's request.

e. Project Synopsis

A written synopsis totaling approximately 100 words in length and written for a broad technical audience, which documents 1. Main findings of research project, 2. Why the findings are significant, and 3. How the findings benefit ASHRAE membership and/or society in general shall be submitted to the Manager of Research and Technical Services by the end of the Agreement term for publication in ASHRAE Insights. The Society may request the Institution submit a technical article suitable for publication in the Society's ASHRAE JOURNAL. This is considered a voluntary submission and not a Deliverable. Technical articles shall be prepared using dual units; e.g., rational inch-pound with equivalent SI units shown parenthetically. SI usage shall be in accordance with IEEE/ASTM Standard SI-10.

Level of Effort:

It is expected that the Tasks above will take approximately two (2) years to complete. The expected total cost for this work is $199,000.

Principal Investigator/ (~18 person weeks):	$50,000
Graduate Student/Technicians (~38 person weeks):	$90,000
Facility cost with upgrades (assuming have duct and chamber):	$20,000
Acquisition of test devices (and replaceable components):	$10,000
Other Equipment and Supplies (OPC, HVAC, etc.):	$23,800
Miscellaneous items (travel, etc.):	$5,200

Proposal Evaluation Criteria:

No.	Proposal Review Criterion	Weighting Factor
1	Contractor's understanding of Work Statement as revealed in proposal	15%
2	Quality of methodology proposed for conducting research	25%
3	Contractor's capability in terms of facilities (chamber, duct, aerosol generation, etc.)	15%
4	Qualification of personnel for this project.	20%
5	Student involvement	5%
6	Probability of contractor's research plan meeting the objectives of the Work Statement	15%
7	Performance of contractor on prior ASHRAE or other projects. (No penalty for new contractors)	5%

Project Milestones:

No.	Major Project Completion Milestone	Deadline Month
1	Test Rig Construction	4
2	Experimental Design	6
3	Baseline Testing	12
4	Organism and Injection Testing	20
5	Data Analysis and Reporting	23

Authors:

Lead:	Chrystal Jolliffe	
Others:	Kathleen Owen	Ashish Mathur
	Joe Pessa	Caitlin Naske
	Chang-Seo Lee	
	Gemma Kerr	

References:

AHAM 2020. Standard AC-1-2020: Method For Measuring Performance Of Portable Household Electric Room Air Cleaners.

AHAM 2022. Standard AC-5-2022: Method for Assessing the Reduction Rate of Key Bioaerosols by Portable Air Cleaners Using an Aerobiology Test Chamber

ASHRAE 2017. Standard 52.2-2017: Method of testing general ventilation air-cleaning devices for removal efficiency by particle size.

ASHRAE 2016. Standard 145.2-2016: Laboratory Test Method for Assessing the Performance of Gas-Phase Air Cleaning Systems: Air Cleaning Devices.

ASHRAE 2020. Standard 185.1-2020: Method of Testing UV-C Lights for Use in Air-Handling Units or Air Ducts to Inactivate Airborne Microorganisms.

Burkhead, R. 2018. Presentation to ASHRAE SSPC 52.2 on Side Duct Addition to a Chamber for testing duct-mounted devices' influence on in-room air.

ISO 2013. Standard 10121-2:2013 Test methods for assessing the performance of gas-phase air cleaning media and devices for general ventilation – Part 2: Gas-phase air cleaning devices (GPACD).

ISO 2016. Standard 16890(parts -1, -2, -3, -4, -5): 2016: Air filters for general ventilation.

Y. Zhang, J. Mo, Y. Li, J. Sundell, P. Wargocki, J. Zhang, J.C. Little, R. Corsi, Q. Deng, M.H.K. Leung, L. Fang, W. Chen, J. Li, Y. Sun, Can commonly-used fan-driven air cleaning technologies improve indoor air quality? A literature review, Atmospheric Environment 45 (2011) 4329-4343, 10.1016/j.atmosenv.2011.05.041.

J.A. Siegel, Primary and secondary consequences of indoor air cleaners, Indoor Air 26 (2016) 88-96, 10.1111/ina.12194.

P. Blondeau, M.O. Abadie, A. Durand, P. Kaluzny, S. Parat, A. Ginestet, D. Pugnet, C. Tourreilles, T. Duforestel, Experimental characterization of the removal efficiency and energy effectiveness of central air cleaners, Energy and Built Environment 2 (2021) 1-12, 10.1016/j.enbenv.2020.05.004.

Other Information for Bidders (Optional):

Feedback to RAC and Suggested Improvements to Work Statement Process

Now that you have completed the work statement process, RAC is interested in getting your feedback and suggestions here on how we can improve the process.