



YOUR GUIDE TO THE
ASHRAE
ANNUAL
CONFERENCE

JUNE 25–29, 2016 • ST. LOUIS

- Included Inside:**
- Complete technical program
 - Social events schedule • All education courses
 - Maps of meeting areas

Your Guide to the ASHRAE Annual Conference

June 25–29, 2016

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ASHRAE EVENTS APP

Download or update the ASHRAE App for the Annual Conference to access the full meeting agenda with venue floor plans, a customizable personal schedule, and tips for your time in St. Louis. Aside from the complete conference program, the app also features the ability to view Virtual Conference presentations from your mobile device, digital speaker evaluations, and live in-session audience polling. Get it for your Android or Apple device today by visiting www.ashrae.org/app.

The app is made possible through support from the following sponsor:



Get the free mobile app at: www.ashrae.org/app

PERSONAL PROGRAM—PLAN YOUR OWN MEETING SCHEDULE!

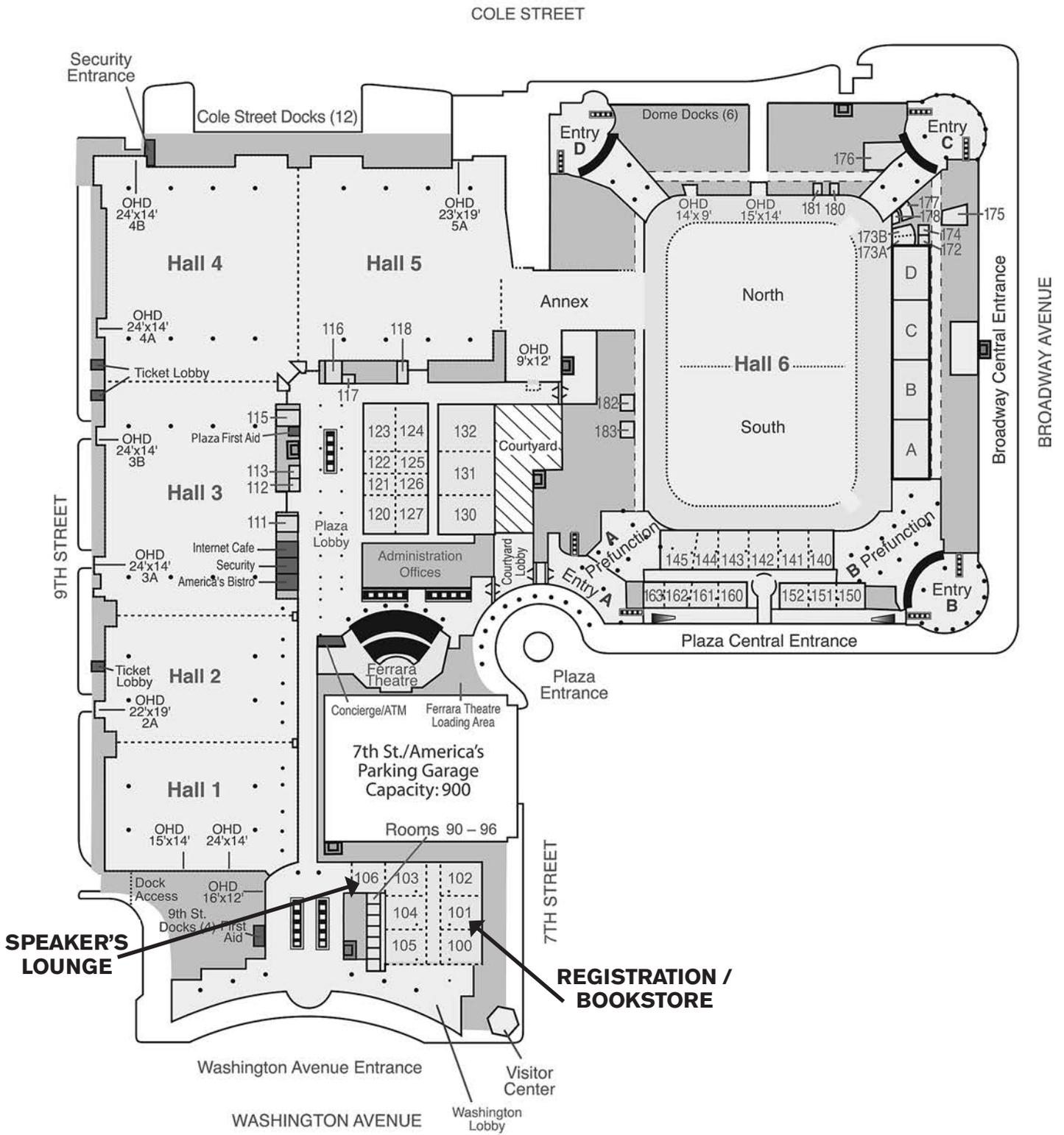
FRIDAY, JANUARY 24	SATURDAY, JANUARY 25	SUNDAY, JANUARY 26
8:00 am–12:00 noon	8:00 am–12:00 noon	8:00 am–9:30 am
1:00 pm–5:00 pm	8:00 am–3:00 pm	8:30 am–12:00 noon
5:00 pm–10:00 pm	1:00 pm–3:00 pm	9:45 am–10:45 am
	3:15 pm–5:00 pm	11:00 am–12:30 pm
		1:30 pm–3:00 pm
	6:30 pm–8:30 pm Welcome Party Missouri History Museum	3:00 pm–7:00 pm

NOTES:

PLAN YOUR OWN MEETING SCHEDULE!—PERSONAL PROGRAM

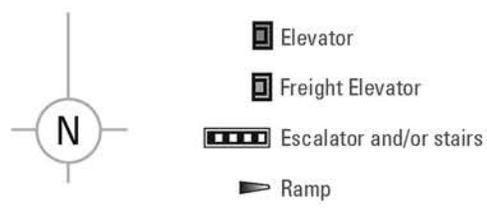
MONDAY, JANUARY 27	TUESDAY, JANUARY 28	WEDNESDAY, JANUARY 29
8:00 am–9:30 am	8:00 am–9:00 am	8:00 am–9:30 am
9:45 am–10:45 am	9:45 am–10:45 am	9:45 am–10:45 am
11:00 am–12:00 noon	11:00 pm–12:30 pm	11:00 am–12:30 pm
12:15 pm–2:00 pm President’s Lunch Marriott Majestic Ballroom D/E	1:00 pm–3:30 pm	1:00 pm–5:00 pm
2:15 pm–4:15 pm	3:30 pm–6:00 pm	
4:15 pm–6:30 pm	6:15 pm–10:30 pm Members’ Night Out Marriott Majestic Ballroom D/E	

AMERICA'S CENTER – LEVEL 1

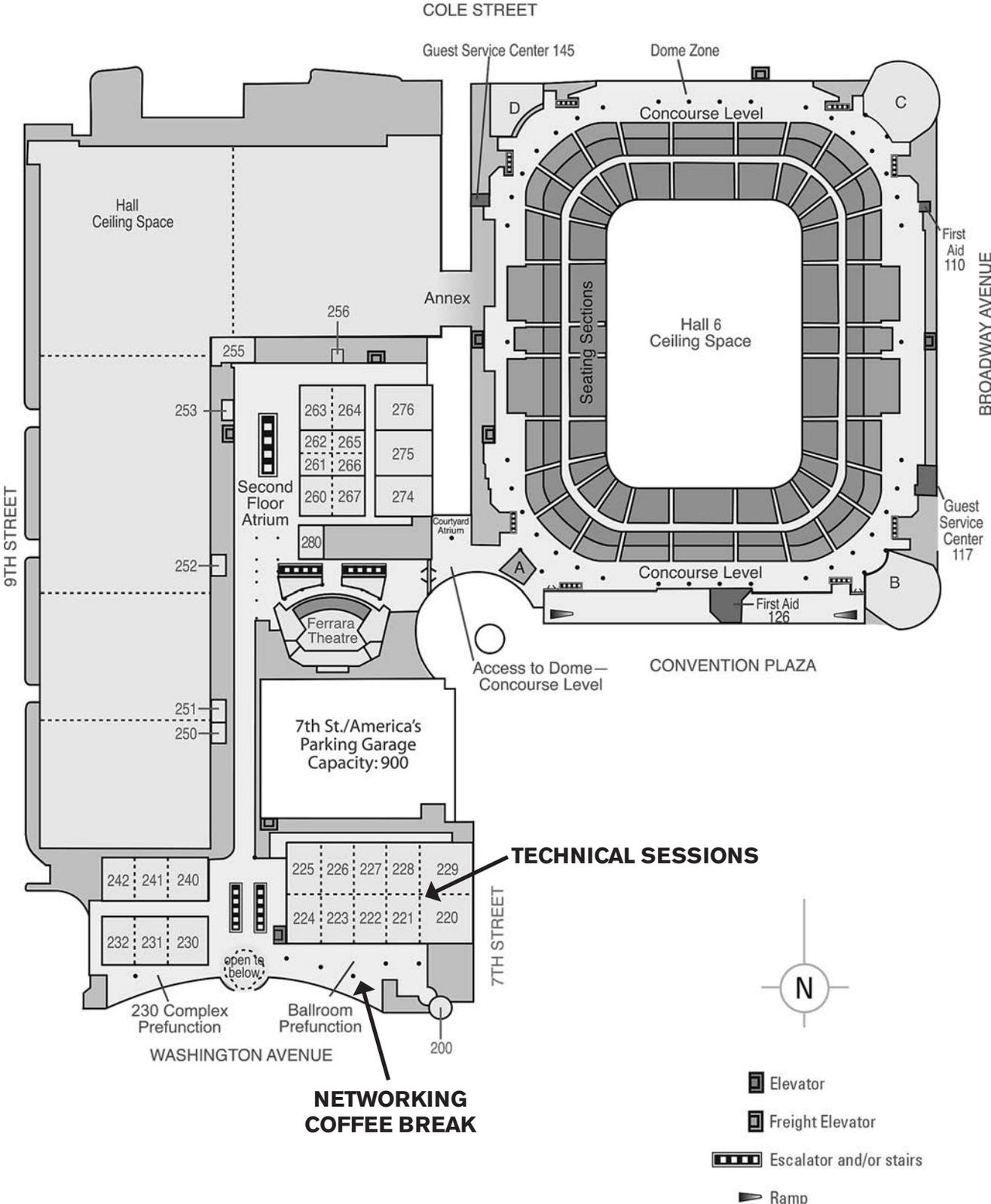


SPEAKER'S LOUNGE

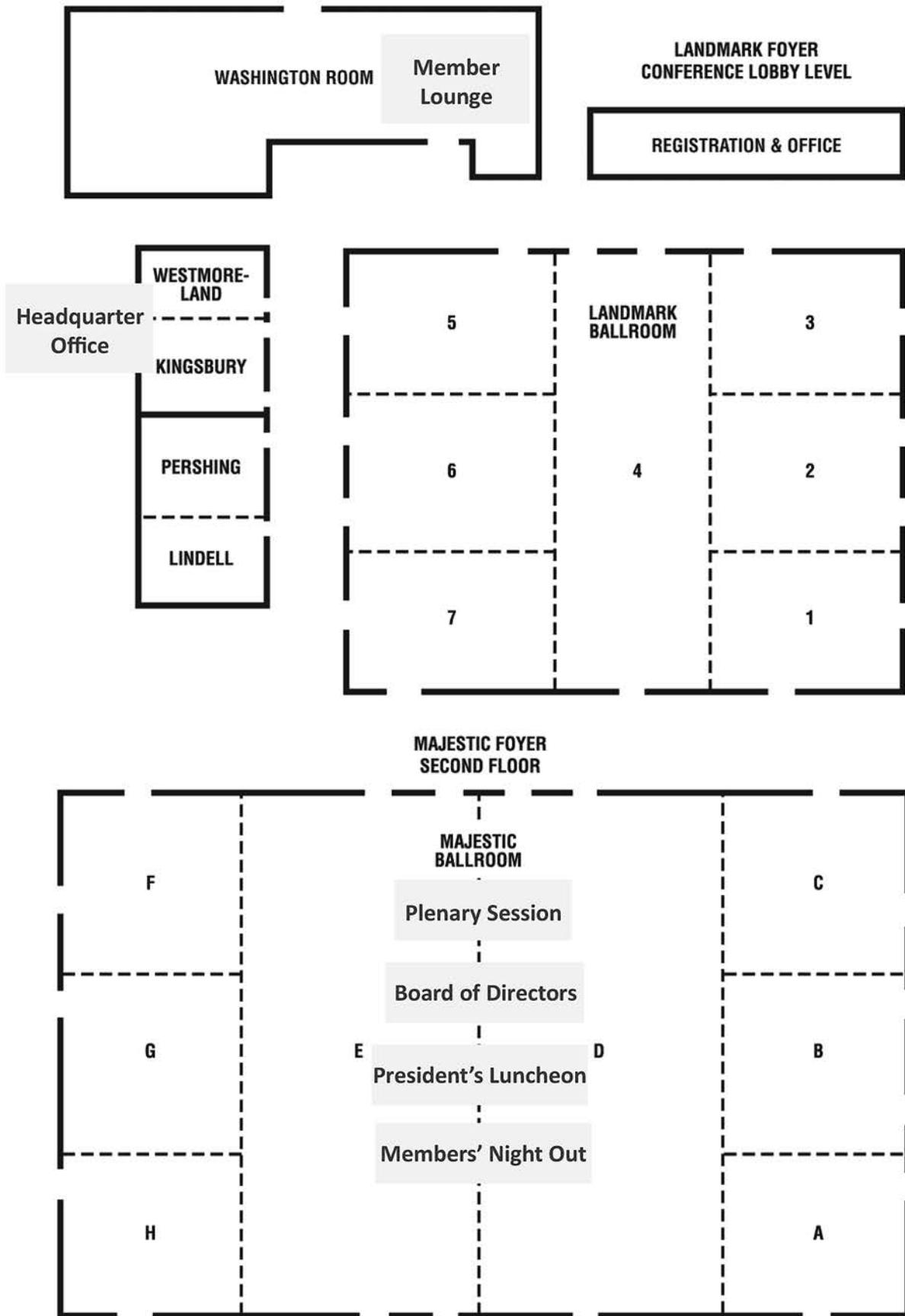
REGISTRATION / BOOKSTORE



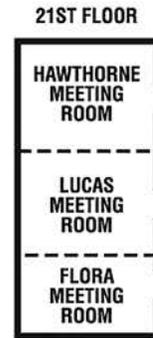
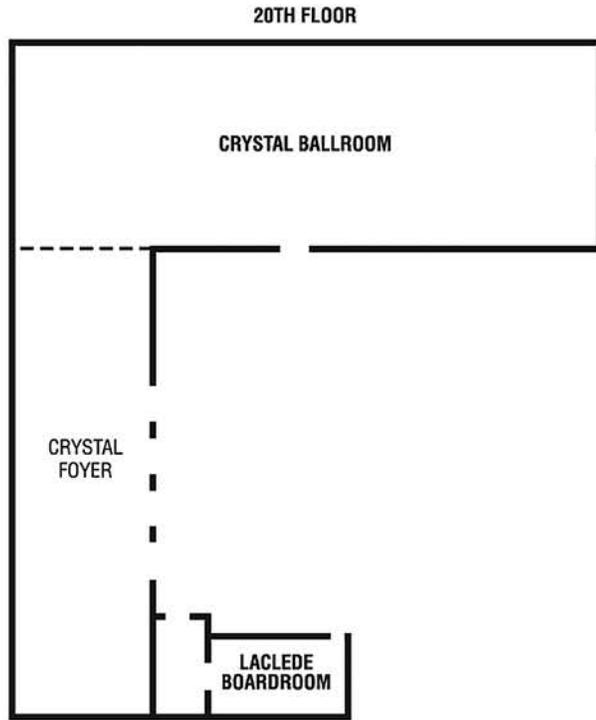
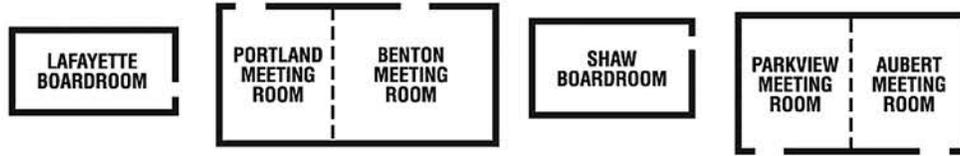
AMERICA'S CENTER – LEVEL 2



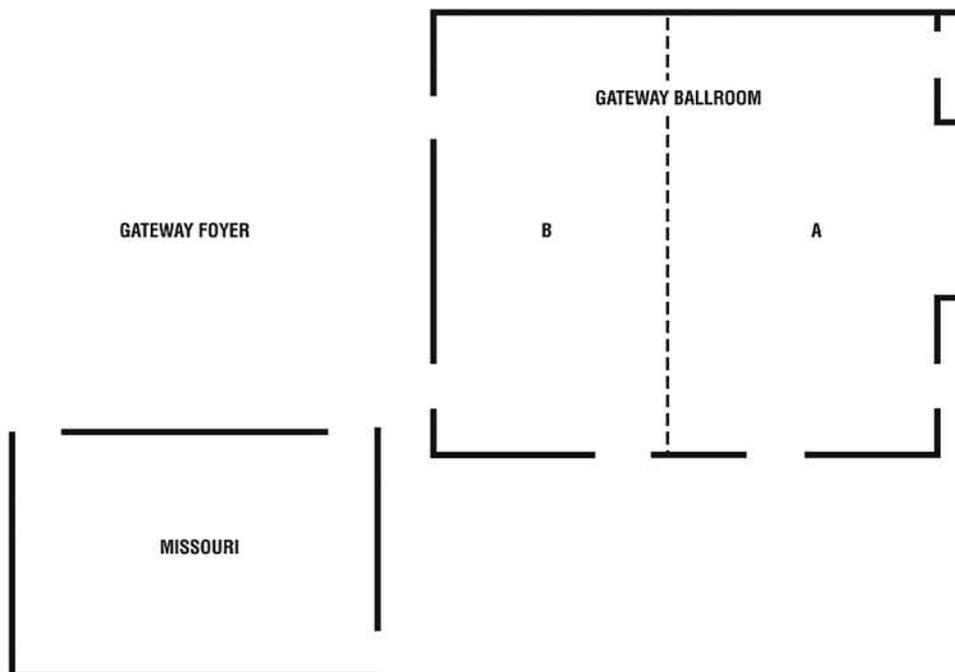
ST. LOUIS MARRIOTT – CONFERENCE PLAZA



ST. LOUIS MARRIOTT – MEZZANINE LEVEL



GATEWAY LEVEL



WASHINGTON AVENUE MAP

Dining, Nightlife & Entertainment

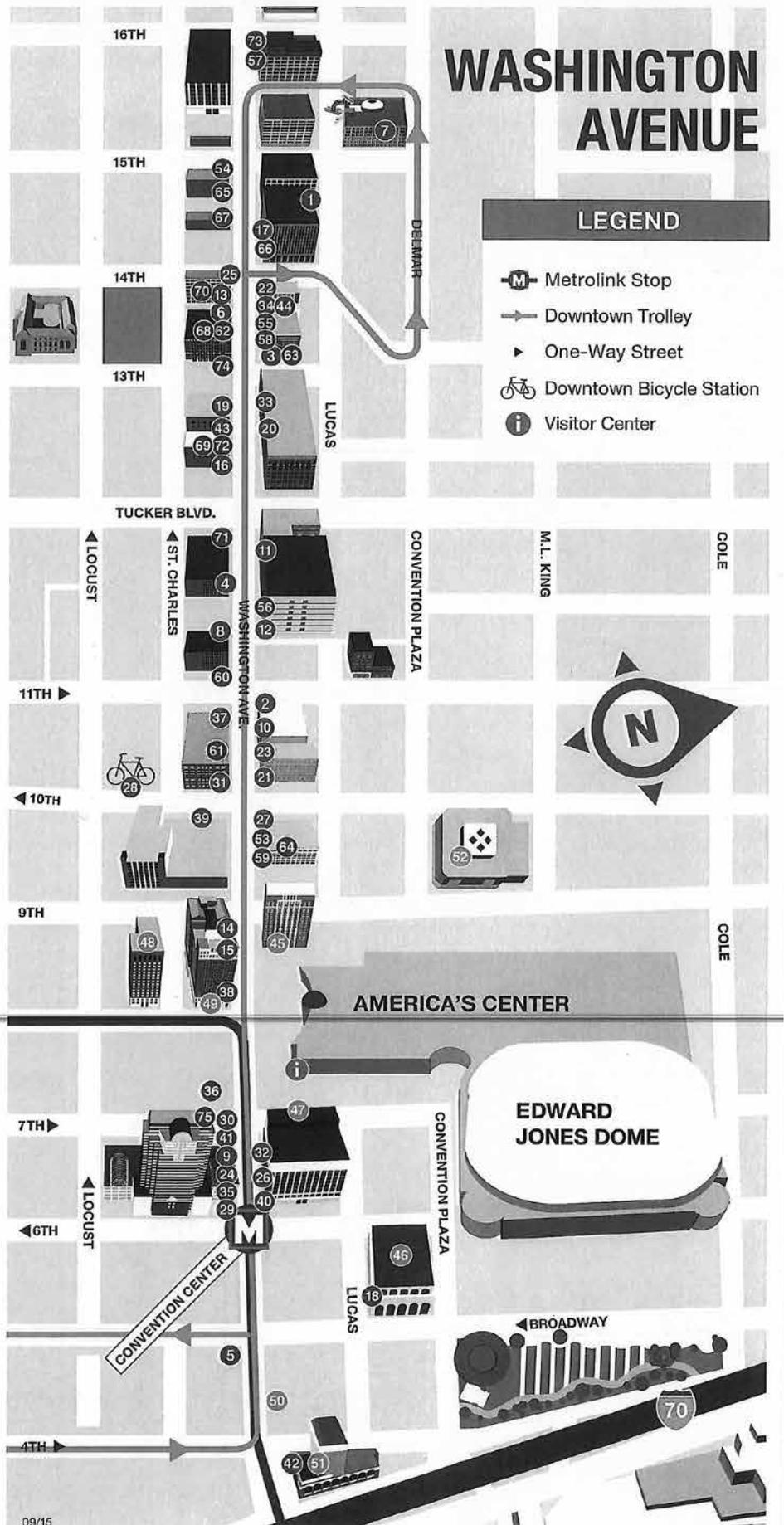
1. Alpha Brewing Company
2. Bella's Frozen Yogurt Cafe
3. Blondie's Coffee & Wine Bar
4. Bobby's Place
5. Café Cornucopia
6. Caruso's Deli
7. City Museum
8. Copia Restaurant & Wine Garden
9. Crazy Bowls & Wraps
10. Dubliner Irish Pub & Bistro
11. Empire Deli & Pizza Co.
12. Flamingo Bowl
13. Flannery's Pub
14. Grand Bar (Marriott)
15. Great Room Restaurant (Marriott)
16. Hair of the Dog
17. Hiro Asian Kitchen
18. J.F. Sanfilippo's
19. Lucas Park Grille
20. Lucky's Dueling Piano Bar
21. Mango Peruvian Cuisine
22. Medina Mediterranean Grill
23. Mizu Sushi Bar
24. MX Movies
25. Nara Café & Hookah Lounge
26. National Blues Museum (Fall 2015)
27. Over/Under Bar & Grill
28. Park Avenue Coffee
29. Pi Pizzeria
30. Porano Pasta & Gelato (Fall 2015)
31. Prime 1000 Steakhouse
32. Robust Wine Bar & Café
33. Rosalita's Cantina
34. The Side Bar
35. Snarf's Sandwiches
36. Skywalk Cafe
37. The Charles P. Stanley Cigar Company & Lounge
38. Starbucks (Marriott)
39. Stefano's Italian Bistro
40. Sugarfire Smokehouse
41. Tazé Mediterranean Street Food
42. Tigin Irish Pub
43. Wasabi Sushi Bar
44. Washington Avenue Post Coffee Bar & Urban Market

Hotels

45. Courtyard by Marriott Downtown Convention Center
46. Drury Inn & Suites St. Louis Convention Center
47. Embassy Suites St. Louis - Downtown
48. Magnolia Hotel St. Louis
49. Marriott St. Louis Grand Hotel
50. Missouri Athletic Club
51. Hampton Inn Gateway Arch
52. Holiday Inn St. Louis Downtown - Convention Center

Shopping

53. AIA Bookstore
54. Band Box Cleaning & Laundry
55. Beverly's Hill
56. Blades on Washington Hair Salon
57. The Blowout Bar Hair Salon
58. Boxers
59. Ceci Unique Gallery
60. Copia Wine Shop & Bodega
61. Dapper Gents
62. DNA Street Wear Boutique
63. Great Cuts
64. La Buena Salud LLC Health Food Store
65. Lè Divine Collection
66. Levin's
67. Levine Hat Company
68. MacroSun International
69. Natural Napps Hair Salon
70. Self Inflicted Studios Tatoo Shop
71. Sprint
72. STL Foodmart
73. Studio 16 Hair Salon
74. Taba-Co
75. Trova



CONFERENCE SPONSORS

ASHRAE thanks the following sponsors for their support of the 2016 Annual Conference

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Sponsor of the lanyards

CHAPTER AND SOCIETY OFFICIALS

A special thanks to all the members in the St. Louis Chapter who helped make the conference a success!

ST. LOUIS CHAPTER OFFICERS

Jim Rosick, President
Christopher H. Swallow, President-Elect/Treasurer
Jessica Mangler, Secretary

ST. LOUIS HOST COMMITTEE

General Chair: Vinny Stanec
Vice Chair/Sustainability Mentor: Pat O'Brien
Sessions:
 Stephen Duda, Chair
 Chris Pelton, Vice Chair
Entertainment:
 Scott Blackmore, Chair
 Greg Hoekstra, Vice Chair
Transportation: Brian Ingenthron
Tours: Chuck Dale-Derks
Sustainability/Humanitarian Project Chair: Paul Cefaratti

ASHRAE OFFICERS

T. David Underwood, P.Eng., President
Timothy G. Wentz, P.E., President-Elect
Bjarne W. Olesen, Ph.D., Treasurer
Walid Chakroun, Ph.D., Vice President
Patricia Graef, P.E., Vice President
Charles E. Gullede, III, P.E., Vice President
James K. Vallort, Vice President
Jeff H. Littleton, Executive Vice President

CONFERENCES AND EXPOSITIONS COMMITTEE

Sarah E. Maston, Chair
Jon J. Cohen, Vice Chair
Thomas H. Kuehn, St. Louis Conference Chair
Abderrazak "Rocky" Alazazi
Dennis Alejandro
Chris A. Balbach
Dimitris Charalambopoulos
David E. Claridge
Michael M. Collarin
Carrie Ann Crawford
Charlie D. Curlin, Jr.
Gary Debes
Jason W. DeGraw
Kevin B. Gallen
Jennifer Leach
James F. Liston, Jr.
Kevin L. Marple
Corey B. Metzger
Cynthia Moreno
Robert A. Neely
Ann J. Peratt
Rachael Romero
Frank Schambach
Leon Shapiro
Jeffrey D. Spitler
Samir R. Traboulsi
Wade H. Conlan, Consultant

GENERAL INFORMATION

BADGES MUST BE WORN FOR ADMISSION TO SESSIONS

Your ASHRAE Conference badge is required for admission to the technical program. Room monitors will be checking and scanning badges at the rooms. The scanning process will provide you with a summary of all sessions attended at the conclusion of the conference and will be sent directly to you by email. Session and speaker evaluations are available through the event app. In addition, the room monitors will also distribute evaluation forms for each session. Please complete the form and return it to the monitor when you leave the session. Room monitors will also distribute and collect comment cards on which attendees are encouraged to submit written questions regarding papers presented in the technical paper sessions. Questions are given to the authors for reply and published in ASHRAE Transactions.

HOTEL ADDRESS, TELEPHONE

Marriott St. Louis Grand
800 Washington Avenue
(314) 621-9600

INTERNET ACCESS

Internet access and computers for e-mail are available in the Cyber Café located in the registration area during operating hours. Please be considerate to others and limit your usage to five minutes.

Internet is also available for \$1.00 in your sleeping room in the Marriott.

Log in instructions:

1. Select Marriott Guest as the WI-FI name
2. Enter in the last name on the reservation and your room number (there's also an option for an access code, but don't use that)
3. Accept the charges for the speed you would like to use, one is \$9.95 and one is \$13.95. If you accept the \$9.95, you will be charged a \$1 on your guest room folio. If they select the premium option at \$13.95, you will be charged \$5.00 on your guest room folio.

Log in for Marriott meeting rooms:

Network name – Marriott Conference
Password – ashrae16

Log in for America's Convention Center Complex meeting rooms:

Network name – ASHRAE
Password – ashrae16

All passwords are case sensitive.

ASHRAE will be working with the internet provider to manage the bandwidth so that member expectations of accessibility and speed are fulfilled. We would like to request that everyone limit their usage to functions that do not use excessive bandwidth such as Facebook, YouTube, streaming video, etc.

CONFERENCE APP

Update your ASHRAE App for the Annual Conference to access the full meeting agenda with venue floor plans, social events, and tips for your time in St. Louis. The event app also features exclusive registrant-only features like the capability to view Virtual Conference presentations from your mobile device, a customizable personal schedule, an interactive attendee list, and digital speaker evaluations.

To download the app, visit www.ashrae.org/app.

MEMBERSHIP BALLOT

Eligible Members will have the opportunity to cast online ballots for Society officers in the conference registration area (America's Center Convention Complex across the street from the Marriott, Rooms 101/102). Polls will be open during registration hours on Friday, June 24 through Sunday, June 26 at 5:00 p.m. EDT. New Officers and Directors will be installed at the President's Luncheon on Monday, June 27.

NOTICE

ASHRAE regards the materials presented at these sessions to be the unique work of ASHRAE and exercises control over the dissemination and/or use of such products in the future. Accordingly, videotaping and recording of this program are not allowed without ASHRAE's prior written consent.

CELL PHONES/PAGERS

Please be considerate and turn off your phones and pagers in committee meetings and in technical program sessions.

COMPANY-SPONSORED HOSPITALITY SUITE POLICY

Hospitality suite hours must not conflict with ASHRAE meetings or social functions. Product displays, literature handouts, posting of signs in hotel lobbies or hallways, and commercial advertising or recruiting are not allowed in the Marriott Grand, ASHRAE's headquarters hotel.

SALE OF MERCHANDISE

Sale of merchandise, or the solicitation to sell merchandise, of any type at the Annual and Winter Conferences will only be permitted by prior approval of the Conferences and Expositions Committee and any surplus will go to the Society.

SIGNS/DISPLAY OF AFFILIATE MEETING INFORMATION

Signs and information concerning affiliate or related organizations must be approved by the Society prior to display. No signs are to be attached to walls, and all signs must be professionally printed.

PHOTO RELEASE

Photographs will be taken at the ASHRAE Annual Conference. By registering for this conference, you agree to allow ASHRAE to use your photo in any ASHRAE-related publications or Web site.

WHAT TO WEAR

Business-casual attire is appropriate for meetings and social events. The Welcome Party and Members' Night Out are casual.

LOST AND FOUND

Items found during the conference should be turned in to the staff in the ASHRAE headquarters room, Westmoreland/Kingsbury of the Marriott or ASHRAE registration in America's Center Convention Complex. If you have misplaced something during the conference please check these two locations as well as security with the hotel.

TECHNICAL PROGRAM PDHs

All of the sessions presented in the technical program are approved for professional development hours (PDHs). PDHs recognized by most U.S. states, AIA LUs and LEED®AP credits are available. In order to report your attendance at the session, please sign the PDH sign-in sheets that are in each room and include your license number for Florida. See program listing for specific information. Sessions are approved for 1, 1.5 or 2 PDHs depending on the length of the session. ASHRAE Certified Professionals may earn Professional Development Hours (PDHs) to meet recertification requirements by attending Tech Program sessions in a content area related to their certification. Send questions to certification@ashrae.org.

Badges are required for attendance at any of the technical sessions. Scanners will be used to capture the information located on your badge. Upon conclusion of the conference you will be able to get a complete record of all the sessions you attended.

CONFERENCE PAPERS

Abstracts of all sessions are included in this program. During the conference, papers presented at the technical paper and conference paper sessions can be purchased in the ASHRAE Bookstore as individual preprints or on the 2016 ASHRAE Annual Conference Papers (online). After the conference, papers will be posted in the online ASHRAE Bookstore. Papers are not available for seminars, workshops, or forums. Technical paper session papers will be published with discussion in ASHRAE Transactions. Prior meeting papers can be purchased in the online Bookstore at www.ASHRAE.org or searched online in Abstract Center. The Abstract Center is a searchable database of abstracts on everything ASHRAE has published since 1980. This service is free to ASHRAE members, but a subscription fee will be charged to nonmembers. For ordering information, contact ASHRAE Customer Service at 1-800-527-4723.

VIRTUAL CONFERENCE

Free for Paid Conference Registrants

ASHRAE is offering a virtual conference option so you won't miss the state-of-the-art concepts and latest design techniques presented in the Society's technical program. The St. Louis Virtual Conference allows you to view presentations and to interact with an online audience through a discussion board. All conference attendees paying the full registration fee will receive an email notification when sessions are available for viewing. The email will include a link to the St. Louis Virtual Conference, www.ashrae.org/StLouisonline, and your login information. Virtual Conference registration includes:

- Synced audio and PowerPoint presentations from all technical paper sessions, conference paper sessions, seminars and workshops.
- Ability to post comments and rate presentations.
- Print presentation slides in notes format.
- Ability to post questions or answers for selected sessions through Wednesday, July 6. Presentations available online through January 2018.
- A full slate of technical programs will be posted beginning Monday, June 27, of the sessions that were presented the previous day, with additional content posted through Thursday, June 30.

Access to the St. Louis Virtual Conference is free with your paid conference registration. To register only for the Virtual Conference, go to ASHRAE Registration, America's Center. \$249 ASHRAE member; \$445 non member or register online.

MEMBERS' NIGHT OUT RESERVED SEATING

Members' Night Out will be in the St. Louis Marriott on Tuesday, June 28. If you have purchased a ticket for this event, you will receive an exchange coupon. Take this coupon to the Reserved Seating desk, located in the ASHRAE registration and exchange it for a reserved seat ticket by 2:00 p.m., Monday, June 27. Each table seats ten. A seating chart is available to help in deciding table preference. Seats are available on a first-come, first-served basis. When reserving your seat, please advise us of any special dietary requirements at that time to ensure that we are able to accommodate your requests during the evening. Attire is casual.

Detailed information on the entertainment for Members' Night Out is located in this program.

MEDICAL EMERGENCY

Medical emergencies should be directed to the hotel operator.

Closest Hospital:

Barnes-Jewish Hospital is one block north of the I-64/US40 and Kingshighway Boulevard intersection.

ROOMS/HOURS

FINDING YOUR ASSIGNED MEETING ROOM

To assist you in finding your meeting room at the Annual Conference, please refer to the floor plans located in this program. Meeting space is located in the Marriott Grand and America's Center Convention Complex.

The Marriott's meeting space is located in the main hotel and across the street in the Conference Building which is called Conference Plaza. Access to the Conference Plaza is via an underground tunnel that can be accessed from the Gateway level via either elevator or escalator. Escalators to Gateway level are located just past Zenia Bar & Grille on the lobby level. Codes for this level are (CL) which is Conference Plaza street level and (CP2) which is Conference Plaza 2nd level.

CONFERENCE REGISTRATION

America's Convention Center Complex,
Rooms 101/102, Level 1

Registration is required for all conference participants. Official badges must be worn at all functions and for admission into the technical sessions. ASHRAE conference registration will be open during the following hours:

Friday, June 24 10:00 a.m.–5:00 p.m.
Saturday, June 25 7:15 a.m.–6:00 p.m.
Sunday, June 26 7:00 a.m.–5:00 p.m.
Monday, June 27 7:30 a.m.–5:00 p.m.
Tuesday, June 28 7:30 a.m.–4:30 p.m.
Wednesday, June 29 7:30 a.m.–10:00 a.m.

ASHRAE BOOKSTORE

America's Convention Center Complex,
Room 100, Level 1

More than 300 books, conference papers, and other recent publications will be available for purchase in the ASHRAE Bookstore. The bookstore provides HVAC&R technical literature from ASHRAE and other publishers, and ASHRAE logo items. The ASHRAE Bookstore will be open during the following hours:

Friday, June 24 10:00 a.m.–5:00 p.m.
Saturday, June 25 7:15 a.m.–6:00 p.m.
Sunday, June 26 7:00 a.m.–5:00 p.m.
Monday, June 27 7:30 a.m.–5:00 p.m.
Tuesday, June 28 7:30 a.m.–4:30 p.m.
Wednesday, June 29 7:30 a.m.–1:00 p.m.

ASHRAE's eLearning system, from the ASHRAE Learning Institute, will be demonstrated at the bookstore. Take a hands-on demonstration and learn more about new ways to earn PDHs/CEUs, on demand, online.

SPEAKERS' LOUNGE

America's Convention Center Complex,
Rooms 103/106, Level 1

The Speakers' Lounge will be open during the following hours:

Saturday, June 25 1:00 p.m.–3:00 p.m.
Sunday, June 26 7:00 a.m.–5:00 p.m.
Monday, June 27 7:00 a.m.–12:15 p.m.
. and 1:30 p.m.–5:00 p.m.
Tuesday, June 28 7:00 a.m.–5:00 p.m.
Wednesday, June 29 7:00 a.m.–1:00 p.m.

MEMBERSHIP INFORMATION DESK

America's Convention Center Complex,
Rooms 101/102, Level 1

The membership information desk is available for paying dues, applying for membership, updating membership information. This desk is open during the same hours as registration, so feel free to stop by if you have any questions concerning your ASHRAE membership.

HEADQUARTER OFFICE

Marriott, Kingsbury/Westmoreland
(Conference Bldg. Street Level)

The ASHRAE Headquarter Office offers members complimentary copying, services of a typist, and access to printers for laptop computers.

Friday, June 24 Noon–5:00 p.m.
Saturday, June 25 8:00 a.m.–5:00 p.m.
Sunday, June 26 8:00 a.m.–5:00 p.m.
Monday, June 27 8:00 a.m.–5:00 p.m.
Tuesday, June 28 8:00 a.m.–5:00 p.m.
Wednesday, June 29 8:00 a.m.–1:00 p.m.

YEA ACTIVITY

YOUNG ENGINEERS IN ASHRAE (YEA) HOSPITALITY SUITE

Marriott, Majestic Ballroom A (Conference Bldg, 2nd floor)

Attention young professional members age 35 and younger! You are invited to visit the YEA Hospitality Suite on Sunday, June 26, from 4:00 p.m. – 6:00 p.m. The suite offers social and networking opportunities and light refreshments will be served.

LEADERSHIP U

At each ASHRAE conference, the Leadership U program gives four future ASHRAE leaders the opportunity to shadow an ASHRAE Board member, providing a high level conference experience and unique networking opportunity. This program is operated by the Young Engineers in ASHRAE (YEA) Committee and more information can be found at www.ashrae.org/yea. The Leadership U participants for the 2016 ASHRAE Annual Conference are:

Pamela Duffy, Dallas Chapter, Region VIII
Madison Schultz, Central Oklahoma Chapter,
Region VIII
Susan Nagel, Kansas City Chapter, Region IX
Anoop Peediyakkan, Kuwait Chapter, RAL

ASHRAE LOUNGE

Marriott, Washington (Conference Bldgs. Street Level)

The ASHRAE Lounge offers an opportunity to network with friends or stop for a cup of coffee between technical sessions. Coffee will be offered throughout the day and anyone who is registered for the conference is welcome in the lounge. Pastries served from 7:30 to 9:30 a.m.

The lounge will be open to all registered attendees during the following hours:

Saturday, June 25 7:30 a.m.–3:00 p.m.
Sunday, June 26 7:30 a.m.–4:00 p.m.
Monday, June 27 7:30 a.m.–4:00 p.m.
Tuesday, June 28 7:30 a.m.–4:00 p.m.
Wednesday, June 29 7:30 a.m.–1:00 p.m.

ST. LOUIS DESK

America's Convention Center Complex,
Rooms 101/102, Level 1

Information about the city of St. Louis will be available.

LAS VEGAS WINTER CONFERENCE INFORMATION

America's Convention Center Complex,
Rooms 101/102, Level 1

Information on the upcoming Winter Conference scheduled for January 28 – February 1, 2017 at the Caesar's Palace will be available in the registration area. AHR Expo dates are January 30 – February 1, 2017 and will be held at the Las Vegas Convention Center.

ST. LOUIS WELCOME PARTY

Saturday, June 25

6:30 – 8:30 pm

Missouri History Museum

Located in Forest Park, the site of the 1904 World's Fair, the Missouri History Museum houses countless treasures from St. Louis history. Three galleries are available for viewing at the Welcome Party, including "Route 66: A Saint Louis Street," "Little Black Dress" and "the World's Fair."

Menu includes:

Fresh fruit kebabs

New potato basket with bacon & chive mousseline

Trio of grilled paninis

Caesar Salad

Pasta station

Tunisian chicken skewers

Shuttle service begins at 6:10 pm from St. Charles Street which is located right behind the Front Desk. There is a side door that leads out or you can go out the Front Doors of the hotel and turn right. Buses will begin boarding for the return to the hotel at 8:15 pm.

Cost: \$60

PRESIDENT'S LUNCHEON

Monday, June 27

12:15 p.m.–2 p.m. (Doors open at 12:00)

Marriott Majestic Ballroom D/E

2016–17 ASHRAE President **Tim Wentz, P.E.**, Fellow ASHRAE, HBDP, presents his presidential theme, "Adapt Today to Shape Tomorrow," which is based upon the Society goal to Adapt found in our Strategic Plan. Together, we can create our future by adapting our resources, investments and technology to shape a more sustainable world.

Certificates of appreciation to retiring Board members are presented, and the 2016–17 officers and Board of Directors installed.

Attire: Business casual

Cost: \$50

SPOUSE/GUEST GUIDE

The ASHRAE Lounge is open daily for all individuals who are registered for the meeting. Refreshments are available from 7:30 to 9:30 a.m. each day and beverages are available all afternoon. Members of the St. Louis Host Committee will be present to answer questions about local activities. Detailed information on the city including brochures and maps can be found at the Host Committee Desk located in the ASHRAE Registration area in the America's Convention Center Complex.

Lounge Location: Marriott Grand, Washington Room, Convention Plaza Building, Street level

Hours

Saturday, June 25 7:30 a.m.–3:00 p.m.

Sunday, June 26 7:30 a.m.–4:00 p.m.

Monday, June 27 7:30 a.m.–4:00 p.m.

Tuesday, June 28. 7:30 a.m.–4:00 p.m.

Wednesday, June 29 7:30 a.m.–1:00 p.m.

MEET AND GREET

Marriott Grand, Monday, June 27

Crystal Ballroom

(Elevator to Crystal is off the lobby level near escalators past Zenia's Bar and Grill)

20th Floor

9:30 a.m.–11 a.m.

Please plan to attend the Meet and Greet to see the beautiful soaps made by Dr. King.

Dr. Eva King is the Founder & Soap Chef of Dr. King's Little Luxuries. Eva has enjoyed making artisan soaps for a long time, and has experimented with many different ingredients and techniques over the years. Over the years, more and more people asked her why she didn't sell her soaps, so in 2013 she started "Dr. King's Little Luxuries" to do just that: Provide her creations to more than "just" friends and family.

All of Dr. King's luxury soaps are handmade from high-quality vegetarian or vegan ingredients, in small batches under strict quality control. She uses food-grade vegetable oils and butters as the basis for her soaps – mainly coconut oil, canola oil, olive oil, avocado oil, and shea butter –, and uses the cold-process method of soap making. A word of caution: Many of our soaps look and smell really yummy, but please do not try to eat them! Take our words for it: taking a bite would be a very disappointing experience indeed... Just don't do it!

In her "other life", Eva is a PhD-level scientist, is on the Board of Directors of the Indoor Air Quality Association; and works with researchers and families to help solve problems with allergies, asthma and the indoor environment. Eva and her husband live on a little farm in Keswick, Virginia. They share their space with a friendly backyard contingent of free-range chickens, pigs, goats, dogs and cats, and a few bee hives. There is never a dull moment at "The Kings' Menagerie"!

Light refreshments will be served.

SCHEDULE

LOCATION OF MEETINGS

To assist you in finding your meeting room at the Annual Conference, please refer to the floor plans located in the front of this program. Meetings are scheduled in the St. Louis Marriott and America's Convention Center Complex (ACCC).

The Marriott Grand has meeting space in the main hotel and in the Conference Plaza Building which is connected to the main hotel via a tunnel. Access to the Conference Plaza Building is from the Gateway level. From the main hotel lobby level take escalators or elevator down to Gateway. Escalators/elevators are located just past the hotel restaurant, Zenia's Bar and Grill.

The America's Convention Center Complex is across the street from the Marriott. Exit the Marriott to the left and walk across the street.

Conference Schedule

FRIDAY, JUNE 24

- 8:00 am–5:00 pm **Committee Meetings**
See listing on pages 53–68.
- 10:00 am–5:00 pm **Registration**, America's Convention Center Complex, Rooms 101/102, Level 1
- 10:00 am–5:00 pm **ASHRAE Bookstore**, America's Convention Center Complex, Room 100, Level 1

SATURDAY, JUNE 25

- 7:30 am–3:00 pm **ASHRAE Lounge**, Marriott, Washington Room, Conference Plaza Building, Street level
- 7:15 am–6:00 pm **Registration**, America's Convention Center Complex, Rooms 101/102, Level 1
- 7:15 am–6:00 pm **ASHRAE Bookstore**, America's Convention Center Complex, Room 100, Level 1
- 8:00 am–5:00 pm **Committee Meetings**
See listing on pages 53–68.
- 1:00 pm–3:00 pm **Speakers' Lounge**, America's Convention Center Complex, Rooms 103/106, Level 1

Special Event

- 3:15 pm–5:00 pm **Meeting of the Members**
- Plenary Session**, Marriott, Majestic Ballroom D/E, Conference Plaza, Level 2
- Opening and Welcoming Remarks by ASHRAE President **T. David Underwood**
- Welcome by Director and Chair, Region VI, **Mark F. Miller**
- Secretary's Report by Executive Vice President **Jeff H. Littleton**
- Awards Presentation
See page 16 for details.
- Keynote Speaker **Jeff Henderson**
See page 21 for details.

Special Event

- 6:30 pm–8:30 pm **Welcome Party**
Missouri History Museum

Note: \$60 ticket per person required. Tickets may be purchased/picked up at the ASHRAE Registration Desk; advance-purchase tickets may be picked up at the door if after registration hours. Shuttle service to the History Museum will begin at 6:10 pm. Buses will depart from St. Charles Street which is located right behind the Front Desk. There is a side door that leads out or you can go out the Front Doors of the hotel and turn right.

See page 13 for details.

SUNDAY, JUNE 26

- 7:00 am–5:00 pm **Speakers' Lounge**, America's Convention Center Complex, Rooms 103/106, Level 1
- 7:00 am–5:00 pm **Registration**, America's Convention Center Complex, Rooms 101/102, Level 1
- 7:00 am–5:00 pm **ASHRAE Bookstore**, America's Convention Center Complex, Room 100, Level 1
- 7:30 am–4:00 pm **ASHRAE Lounge**, Marriott, Washington Room, Conference Plaza Building, Street level
- 8:00 am–4:45 pm **Technical Sessions (ACCC)**
See Technical Program on pages 27–51.
- 8:00 am–5:00 pm **Committee Meetings**
See listing on pages 53–68.
- 11:30 am–5:30 pm **Tour: A Little Taste of St. Louis Tour**
- 3:00 pm–5:30 pm **Technical Tour: Center Ethanol Company, LLC**
See descriptions on pages 18–20.

Tours will depart from St. Charles Street which is located right behind the Front Desk. There is a side door that leads out or you can go out the Front Doors of the hotel and turn right.

- 4:00 pm–6:00 pm **Young Engineers in ASHRAE (YEA) Networking Event**, Marriott, Majestic Ballroom A, Conference Plaza Building, 2nd level

Attention members age 35 and younger—you are invited to participate in the YEA Networking Event, offering social and networking opportunities.

MONDAY, JUNE 27

- 7:00 am–12:15 pm and 1:30 pm–5:00 pm **Speakers' Lounge**, America's Convention Center Complex, Rooms 103/106, Level 1
- 7:30 am–5:00 pm **Registration**, America's Convention Center Complex, Rooms 101/102, Level 1
- 7:30 am–5:00 pm **ASHRAE Bookstore**, America's Convention Center Complex, Room 100, Level 1
- 7:30 am–4:00 pm **ASHRAE Lounge**, Marriott, Washington Room, Conference Plaza Building, Street level

8:00 am– 4:00 pm **Technical Sessions (ACCC)**
See Technical Program on pages 27–51.

8:00 am–5:00 pm **Committee Meetings**
See listing on pages 53–68.

Special Event

12:15 pm–2:00 pm **President’s Luncheon** (doors open at noon), Majestic Ballroom D/E

President-Elect Timothy G. Wentz, presents his 2016–2017 presidential theme. Certificates of Appreciation will be presented to retiring Board members and the 2016–2017 Officers and new Board members will be installed. Spouses and guests are cordially invited to attend. Note: Ticket required and may be purchased at the ASHRAE Registration desk for \$50.

2:30 pm–5:30 pm **Technical Tour:** Convention Center Chiller Plant, Tour assembles at the main entrance of the America’s Conference Center Complex

2:30 pm–5:30 pm **Tours:**
St. Louis Baseball
Anheuser-Busch Brewery & Ted Drewes
See descriptions on pages 18–20.

Tours will depart from St. Charles Street which is located right behind the Front Desk. There is a side door that leads out or you can go out the Front Doors of the hotel and turn right.

Regional Dinners
Sign up in ASHRAE registration area.

TUESDAY, JUNE 28

7:00 am–5:00 pm **Speakers’ Lounge**, America’s Convention Center Complex, Rooms 103/106, Level 1

7:30 am–4:30 pm **Registration**, America’s Convention Center Complex, Rooms 101/102, Level 1

7:30 am–4:30 pm **ASHRAE Bookstore**, America’s Convention Center Complex, Room 100, Level 1

7:30 am–4:00 pm **ASHRAE Lounge**, Marriott, Washington Room, Conference Plaza Building, Street level

8:00 am–4:45 pm **Technical Sessions (ACCC)**
See Technical Program on pages 27–51.

8:00 am–5:00 pm **Committee Meetings**
See listing on pages 53–68.

8:15 am–12 Noon **Tours:**
Beautiful Blooms & Historic Homes
Gateway to St. Louis Introductory Tour
See descriptions on pages 18–20.

Noon–1:30 pm **Life Members’ Luncheon**, Marriott, Majestic Ballroom C, Conference Plaza Building, Level 2

Note: Ticket required and may be purchased at the ASHRAE registration desk for \$30.

1:15 pm–5:15 pm **Technical Tour:** St Louis Sheet Metal Workers Apprentice and Training

1:15 pm–5:15 pm **Tour:** Microbrewery Madness
Tours will depart from St. Charles Street which is located right behind the Front Desk. There is a side door that leads out or you can go out the Front Doors of the hotel and turn right.

See descriptions on pages 18–20.

Special Event

6:15 pm–7:15 pm **Reception, Marriott**, Majestic Ballroom Foyer

7:15 pm–11:00 pm **Members’ Night Out**, Dinner
Majestic Ballroom D/E,

Note: Ticket required and may be purchased at the ASHRAE registration desk for \$60.

See below for details.

WEDNESDAY, JUNE 29

7:00 am–1:00 pm **Speakers’ Lounge**, America’s Convention Center Complex, Rooms 103/106, Level 1

7:30 am–10:00 am **Registration**, America’s Convention Center Complex, Rooms 101/102, Level 1

7:30 am–1:00 pm **ASHRAE Bookstore**, America’s Convention Center Complex, Room 100, Level 1

7:30 am–1:00 pm **ASHRAE Lounge**, Marriott, Washington Room, Conference Plaza Building, Street level

8:00 am–12:30 pm **Technical Sessions (ACCC)**
See Technical Program on pages 27–51.

8:00 am–1:00 pm **Committee Meetings**
See listing on pages 53–68.

MEMBERS’ NIGHT OUT

Tuesday, June 28
Marriott Grand, Majestic Ballroom, D/E

Reception, cash bar
6:15 p.m. – 7:15 p.m.
Majestic Ballroom Foyer
A Jazz trio will begin playing at 6:15 in the Ballroom

Dinner and Entertainment

7:00 p.m. - 11:00 p.m.

Push the Limit band will be the entertainment for the evening. As their name suggests, this band pushes all limits to take every event to its highest potential with their high-energy and non-stop show with choreographed moves – guaranteed to entertain everyone. Voted #1 Party Band in Saint Louis!

Cost: \$60

AWARDS PRESENTATION

Saturday, June 25, 3:15-5:30 p.m.
Plenary Session, Majestic Ballroom D/E

LINCOLN BOUILLON AWARD

“Given in recognition of outstanding work in increasing the membership of the Society.”

Jessica Mangler, P.E., St. Louis, MO
St. Louis Chapter

WILLIAM J. COLLINS, JR. RP AWARD

“Given in recognition of the chapter RP Chair who excels in raising funds for ASHRAE’s RP Campaign.”

Kimberly M. Thompson, P.E., Houston, TX
Houston Chapter

RALPH G. NEVINS PHYSIOLOGY AND HUMAN ENVIRONMENT AWARD

“Given to a promising investigator for significant accomplishment in the study of physiology and human response to the environment.”

Jovan Pantelic, Ph.D., Berkeley, CA
Singapore Chapter

ENVIRONMENTAL HEALTH AWARD

“Given in recognition of excellence in volunteer service focused on environmental health issues”

Francis J. Offermann, P.E., San Francisco, CA
Golden Gate Chapter

GOVERNMENT ADVOCACY AWARD

“Given in recognition to an individual for outstanding effort and achievement in state, provincial, and local government activities in connection with technical issues important to the Society.”

Arthur D. Hallstrom, P.E., Crestview, FL
West Virginia Chapter

LOU FLAGG HISTORICAL AWARD

“Given in recognition of a Chapter Gold Ribbon Award winner for compiling information on outstanding historical projects or persons related to HVAC&R.”

Faye C. McQuiston, Ph.D., P.E., Stillwater, OK
Central Oklahoma Chapter

STANDARDS ACHIEVEMENT AWARD

“Given in recognition for excellence in volunteer service for developing ASHRAE standards/ guidelines.”

Jerry M. Sipes, Ph.D., P.E., Suwanee, GA
Atlanta Chapter

STUDENT ACTIVITIES ACHIEVEMENT AWARD

“Given to a Chapter Student Activities Chairman for service related to the goals and growth of student activities at all levels.”

Ather Naseem Siddiqui, Islamabad, Pakistan
Northern Pakistan Chapter

2015 TECHNICAL PAPER AWARD

“Given in recognition of the best paper presented at a Technical Paper Session at a Society Conference in 2015.”

James W. VanGilder, Andover, MA; **Zachary M. Pardey**, Andover, MA; **Dustin W. Demetriou, Ph.D.**, Poughkeepsie, NY; **H. Ezzat Khalifa, Ph.D.**, Syracuse, NY; **Hamza Salih Erden, Ph.D.**, Istanbul, Turkey; **Roger R. Schmidt, Ph.D., P.E.**, Syracuse, NY, for authoring *“Proposal for Standard Compact Server Model for Transient Data Center Simulations”*

David Pommerenke, Ph.D., Rolla, MO; **Xu Gao**, Cupertino, CA; **Atieh Talebzadeh**, Rolla, MO; **David E. Swenson**, Round Rock, TX; **Mahdi Moradian, Ph.D.**, Isfahan, Iran; **Yunan Han, Ph.D.**, Beijing, China, for authoring *“Dependence of ESD Charge Voltage on Humidity in Data Centers: Estimation of ESD Related Risk in Data Centers Using Voltage Level Extrapolation and Chebyshev’s Inequality”*

Michael P. Case, Ph.D., Champaign, IL; **Justine Yu**, Champaign, IL; **Richard J. Liesen, Ph.D.**, Champaign, IL; **Alexander Zhivov, Ph.D.**, Champaign, IL; **Matthew M. Swanson, Ph.D.**, Houghton, MI, for authoring *“Integration of Master Planning and Energy Planning: From Detailed to Conceptual Analysis”*

Dennis L. O’Neal, Ph.D., P.E., Waco, TX; **Douglas Damon Ingram**, Waco, TX; **Carl L. Reid**, Austin, TX for authoring *“Modeling Fan-Powered Terminal Unit Fan/Motor Combinations Controlled by Silicon-Controlled Rectifiers”*

WILLIS H. CARRIER AWARD

“Given in recognition of the best paper presented at a Society Conference in 2015 by a member thirty-two years of age or less.”

Dustin W. Demetriou, Ph.D. and **Hamza Salih Erden, Ph.D.**, for co-authoring *“Proposal for Standard Compact Server Model for Transient Data Center Simulations”*

ASHRAE JOURNAL PAPER AWARD

“Given in recognition of the best article published in the ASHRAE Journal in 2015.”

Philip Bartholomew, P.E., Cherry Hill, NJ

CROSBY FIELD AWARD

“Given in recognition of the highest rated paper presented at a Technical Session or Symposium in 2015.”

John A. Shonder, Washington, D.C.; **Cyrus H. Nasser**, Washington, D.C. for authoring *“Achieving Deeper Energy Savings in Federal Energy Performance Contracts”*

DISTINGUISHED FIFTY-YEAR MEMBER AWARD

“Given in recognition of fifty years of membership and performing outstanding service for the Society.”

Herman F. Behls, P.E., Arlington Heights, IL
Charles E. Bullock, North Syracuse, NY
Eileen Duignan-Woods, P.E., Silver Spring, MD
Paul J. Halyard, P.E., Orlando, FL
Norman W. Johnson being recognized posthumously
Ping Ki Kwok, Happy Valley, Hong Kong
Denis J. Morris, P.E., Halifax, NS, Canada
Charles J. Procell, P.E., Hartsdale, NY
James A Scriven, P.Eng., Halifax, NS, Canada
J. Thomas Sobieski, Johnstown, PA
Tseng-Yao Sun, P.E., Rancho Palos Verdes, CA
Carl A. Swenson, P.E., Golden, CA
Gordon B. Weld, P. Eng., Halifax, NS, Canada
John W. Welsh being recognized posthumously
Gary L. Wingfield, P.E., Sapphire, NC

DISTINGUISHED SERVICE AWARD

“Given in recognition of faithful and distinguished service on behalf of the Society.”

Omar A. Abdelaziz, Ph.D., Oak Ridge, TN
James Bochat, Phoenix, AZ
Wade H. Conlan, P.E., Maitland, FL
John D. Cowan, P.Eng., Toronto, ON, Canada
Chuck Dale-Derks, P.E., St. Louis, MO
Drake H. Erbe, Rockland, MA
Robert H. Fuller, P.E., Columbus, OH
Robert J. Hitchcock, Ph.D., Sacramento, CA
Walter D. Horn, P.E., Richardson, TX
Carl F. Huber, P.E., Fort Wayne, IN
Bruce D. Hunn, Ph.D., Raleigh, NC
Robert A. Jones, P.E., Washington, MO
Dennis R. Landsberg, Ph.D., P.E., Clifton Park, NY; Henderson, NV
Karine Leblanc, City of Industry, CA
Mark M. MacCracken, P.E., Fair Lawn, NJ
Michael F. Mamayek, P.E., West Allis, WI
Timothy P. McDowell, Madison, WI
Alex McGowan, P.Eng., Victoria, BC, Canada
Gregory L. Meeuwsen, La Crosse, WI
Matthew C. Middlebrooks, York, SC
Barbara Haviland Minor, Wilmington, DE

Ronald L. Petersen, Ph.D., Fort Collins, CO
Heather L. Platt, P.E., Greensboro, NC
Daniel R. Rogers, P.E., Tampa, FL
Steven Rosenstock, P.E., Washington, DC
Anand K. Seth, P.E., North Reading, MA
Frank Shadpour, P.E., San Diego, CA
Harris M. Sheinman, P.E., Atlanta, GA
Som S. Shrestha, Ph.D., Oak Ridge, TN
Benjamin A. Skelton, P.E., Chicago, IL
Robert C. Sonderegger, Ph.D., Oakland, CA
Bodh R. Subherwal, P.E., Huntington Beach, CA
Scott Wayland, P.E., San Ramon, CA
Christopher K. Wilkins, P.E., Medford, MA

EXCEPTIONAL SERVICE AWARD

“Given in recognition of faithful service with exemplary effort on behalf of the Society, in excess of that required for the Distinguished Service Award.”

Pradeep Kumar Bansal, Ph.D., Knoxville, TN
Piotr A. Domanski, Ph.D., Gaithersburg, MD
Chad B. Dorgan, Ph.D., P.E., Newport Beach, CA
Brian A. Fricke, Ph.D., Oak Ridge, TN
Victor W. Goldschmidt, Ph.D., Northport, MI
A. Damon Gowan, Presidential Member, Galveston, TX
John L. Harrod, P.E., Edmond, OK
T. Randall Jones, Mt. Pleasant, SC
Dennis J. Wessel, P.E., Hudson, OH
Craig P. Wray, P.Eng., Winnipeg, MB, Canada

ANDREW T. BOGGS SERVICE AWARD

“Given to a past Exceptional Service Award recipient in recognition of continuing, unselfish, dedicated and distinguished work on behalf of the Society.”

H.E. “Barney” Burroughs, Presidential Member, Johns Creek, GA

LOUISE AND BILL HOLLADAY DISTINGUISHED FELLOW AWARD

“Given to a Fellow of the Society in recognition of continuing preeminence in engineering or research work.”

Steven T. Taylor, P.E., Alameda, CA

ST. LOUIS GENERAL TOURS

Stand-by tour tickets will be distributed at ASHRAE registration after a tour sells out. Stand-by tickets are provided to ensure that a tour is filled in the event of no-shows or last minute cancellations. If you have a stand-by ticket, please be prepared to pay by credit card at the bus. Tour tickets may be purchased at the ASHRAE registration desk, America's Center Convention Complex, Room 101, Level 1.

All tours depart from St. Charles Street which is located right behind the Front Desk. There is a side door that leads out or you can go out the Front Doors of the hotel and turn right.

A Little Taste of St. Louis Tour

Sunday, June 26 • 11:30 a.m.–5:30 p.m. • \$95

Explore the original tastes of St. Louis, during a driving overview of most historic neighborhoods that feature delectable delights. Begin with a tour of “The Loop,” a historic district on the National Register of Historic Places. The Loop, a six-block area complete with restaurants, shopping, art and entertainment, is named after the old streetcar turn-around that was once a part of the Delmar line. A taste of a Loop staple, Fitz's Root Beer, is included.

Enjoy a seated lunch on The Hill, home of a large Italian community in the southwest part of the city. The Hill features many elegant and moderately priced Italian restaurants, groceries, bakeries and bocce alleys.

While onboard the motor coach, en route to the next neighborhood, enjoy a savory sweet treat from Ted Drewes Frozen Custard, a St. Louis tradition since 1929. Enjoy a specialty “concrete” shake – so thick you can turn it upside down.

Next, visit the Soulard neighborhood that boasts the oldest farmer's market west of the Mississippi, and is home to Anheuser-Busch Brewery and local favorite Gus' Pretzels. Enjoy a taste of Gus' with an oven baked pretzel. Founded in 1836, Lafayette Park is St. Louis' oldest public park located in the historic Lafayette Square neighborhood. Many of the homes in this area date back to the 1870s and have been painstakingly renovated. A taste of St. Louis' Goopy Butter cake and lunch are included.

St. Louis Baseball

Monday, June 27 • 2:30 p.m.–5:30 p.m. • \$65

The first stop is Busch Stadium, home to the 2011 World Series Champions, the St. Louis Cardinals. With seating for more than 40,000 fans, this field of dreams is like no other. The design of the ballpark takes into account the beautiful skyline of downtown St. Louis and the colorful history of the Cardinals.

From the classic arched openings echoing the nearby Cupples Station warehouses, to the rich warm colors of the Wainwright building, this ballpark is inspired by the traditions that St. Louisans love. The creative use of old and new materials, from brick and concrete to exposed steel and glass, creates an architectural statement that stands on its own. With its modern sensibility, the stadium is appropriate for the 21st century. Enjoy a walking tour of the home of St. Louis Cardinals.

Next, explore the Cardinals Hall of Fame and Museum inside Cardinals Nation, which is located across from Busch Stadium. Few franchises have the acclaim and heritage of the St. Louis Cardinals, and that history lives here, in the new Cardinals Museum. Featuring players and championship moments, the Cardinals Museum boasts one of the largest team-specific collections of artifacts and memorabilia in the world. The Museum's seven galleries take you on a chronological journey through the rich history of the Cardinals, allowing you to learn about the birth of the franchise, relive special memories and interact with great exhibits.

Anheuser-Busch Brewery & Ted Drewes

Monday, June 27 • 2:30 p.m.–5:30 p.m. • \$40

Learn about the rich history of the colorful Busch family en route to the King of Beers – the Anheuser-Busch Brewery. Situated in a 100-acre complex with over 70 red brick structures, the Brewery buildings are known for their unique architecture and several are National Historic Landmarks.

The tour includes a look at the world famous Clydesdales, the Beechwood Aging Cellar and the Brew House. No visit would be complete without sampling the family of Anheuser-Busch products!

After leaving Anheuser-Busch, you're in for a sweet treat at Ted Drewes Frozen Custard, a St. Louis tradition since 1929. Enjoy a specialty 'concrete' shake – so thick you can turn it upside down.

Beautiful Blooms & Historic Homes

Tuesday, June 28 • 8:15 a.m.–noon • \$60

Enjoy nature at its finest at the Missouri Botanical Garden. The oldest botanical garden in the country and a National Historic Landmark, the Garden has been internationally recognized for horticulture, education and scientific research since its founding in 1859.

A guided private tram tour winds its way through the 79 acres of flora from a variety of diverse climates. Visit the Climatron, the first geodesic dome greenhouse based on Buckminster Fuller's futuristic design. Included is a visit to the 14-acre Japanese Garden, considered one of the finest outside Japan. There also is time to explore your favorite areas on your own.

Next, explore the real character of St. Louis through three of its most historic neighborhoods. The first neighborhood, Compton Heights, was developed in the late nineteenth century by the newly wealthy German beer barons. Lafayette Square features renovated Victorian mansions and row houses which surround Lafayette Park, the oldest public park west of the Mississippi River. Soulard is a delightful, old working-class neighborhood, which boasts the oldest continuous farmer's market west of the Mississippi River. You will also see the 100-acre Anheuser-Busch Brewery Complex with over 70 red brick buildings, several of which are listed on the National Historic Registry.

Gateway to St. Louis Introductory Tour

Tuesday, June 28 • 8:15 a.m.–noon • \$55

Trace the history of St. Louis beginning with the city's original settlement, Laclede's Landing. It is now a nine-block historic district filled with renovated turn-of-the-century buildings housing shops, eateries and offices.

Visit the famous Gateway Arch, the nation's tallest monument, which commemorates the gateway to the west for thousands of 19th century pioneers. Take a tram ride to the top of this 630 foot stainless steel architectural wonder and get a bird's-eye view of St. Louis. Those not wanting to ride the tram may enjoy Monument to the Dream, the film documenting the construction of the Arch.

Enjoy a view of the Old Cathedral, the oldest cathedral west of the Mississippi. Across the street is the Old Courthouse, the setting for cases involving slavery, the fur trade and equal rights. Of these cases, the Dred Scott Freedom Trial is the most notable. Other sights include Busch Stadium, home of the 2011 World Champion St. Louis Cardinals; Market Street; several civic buildings and plazas; as well as Citygarden, a unique urban oasis blending art, architecture and landscape. St. Louis Union Station, once the busiest rail terminal in the world, has undergone renovation and is home to a luxury hotel and restaurants.

At the Cathedral Basilica of St. Louis, also known as the New Cathedral, glimpse one of the largest collections of mosaics in the world – 84,000 square feet in 8,000 shades of tiny pieces of color! The tiny pieces of tesserae and glass portray scenes from both the Old and New Testaments, the life of Saint Louis IX, King of France, and many men and women prominent in the history of St. Louis.

Microbrewery Madness

Tuesday, June 28 • 1:15 p.m.–5:15 p.m. • \$65

Start with beer the way it used to be made. Schlafly was the first new bottling brewery to open in St. Louis after the end of Prohibition. Now craft beer fans can see where and how their beer is made, just minutes from downtown St. Louis. This private tasting will teach you how Schlafly beer is handcrafted. From the milling and mashing of grains, to the production and fermentation of wort, to the filtration and bottling of beer, you'll witness the fascinating art of brewing.

The next stop of the day is Square One Brewery & Distillery, which began operations as a Brewery & Restaurant in 2006. In 2008, it became the first micro distillery/restaurant in the state and one of the first in the country. Square One strives to produce the highest quality and unique flavors that are by combining the expertise of the distiller and master brewer. The possibilities for flavor combination are endless and like craft beer; with emphasis on small batches, quality ingredients and attention to detail will make fine tasting spirits for you to enjoy.

If time permits, explore Urban Chestnut Brewing Company Bierhall on your own. Urban Chestnut Brewing Company (UCBC) is an unconventional-minded, yet tradition-oriented brewer of craft beer. UCBC operates a unique brewing

philosophy known as beer divergency where a new world meets old world brewing approach wherein the company contributes to the revolution of craft beer with artisanal creations of modern American beers, and pays reverence to the heritage of beer with classically-crafted offerings of timeless European beer styles.

Architectural St. Louis Tour

Tuesday, June 28 • 1:15 p.m.–5:15 p.m. • \$45

This tour guide traces the history of St. Louis beginning with the city's original settlement, Laclede's Landing. It is now a nine-block historic district filled with renovated turn-of-the-century buildings housing shops, eateries and offices. View the famous Gateway Arch, the Nation's tallest monument, which commemorates the gateway to the west for thousands of 19th century pioneers. Just east of the Arch, pass the excursion riverboats that call the Mississippi River home.

Enjoy a view of the Old Cathedral, the oldest cathedral west of the Mississippi. Across the street is the Old Courthouse, the setting for cases involving slavery, the fur trade and equal rights. Of these cases, the Dred Scott Freedom Trial is the most notable. You will pass Busch Stadium, home of the 2011 World Champion St. Louis Cardinals. Continuing west on Market Street, you will pass several of St. Louis' civic buildings and plazas, as well as Citygarden, a unique urban oasis blending art, architecture and landscape.

Your first stop today will be one to remember. After an expansive \$75 million renovation, the St. Louis institution formerly known as Kiel Opera House reopened as the Peabody Opera House. Take in the historic building, its grand architecture, classic design and modern amenities as you get to glimpse in backstage dressing rooms, take the same stage as well-known celebrities such as The Rolling Stones and Johnny Carson and marvel at the beauty in the details of the Grand Lobby and ballrooms (pending show schedule).

Enjoy an in-depth guided tour of the newly restored Central Library, the crown jewel of the St. Louis Public Library system. Following a two-year and \$70 million restoration, the space now boasts a beautiful blend of old world and contemporary design. Natural light and inviting atmosphere elements seem like a working piece of art masterfully dedicated to housing an incredible collection of diverse literary works.

Your final stop of the day is at St. Louis Union Station, once the busiest rail terminal in the world. Today, the Grand Hall has undergone a magnificent renovation, returning the space to its original splendor. A most impressive feature of the Grand Hall is the "Allegorical Window," a hand-made stained glass window with hand-cut Tiffany glass strategically positioned above the Station's main entryway. The window features three women representing the main U.S. train stations during the 1890s -- New York, St. Louis and San Francisco. When touring, note architect Theodore Link's use of light as a decorative tool, the breathtaking 65-foot barrel-vaulted ceiling is actually suspended over the hall and the stained glass is original.

TECHNICAL TOURS

Stand-by tour tickets will be distributed at ASHRAE registration after a tour sells out. Stand-by tickets are provided to ensure that a tour is filled in the event of no-shows or last minute cancellations. If you have a stand-by ticket, please be prepared to pay by credit card at the bus. Tour tickets may be purchased at the ASHRAE registration desk, America's Convention Complex, Room 101, Level 1.

All tours depart from St. Charles Street which is located right behind the Front Desk. There is a side door that leads out or you can go out the Front Doors of the hotel and turn right.

Center Ethanol Company

Sunday, June 26 • 3:00–5:30 p.m. • \$30

Center Ethanol Company, LLC, was established in 2006 for the purpose of constructing an ethanol plant in the city of Sauget, Illinois on approximately 57 acres of land strategically located with access to road, river, and rail transportation systems. Production began in April of 2008. Forty-two employees work at the plant which is operational about 350 days per year on a 24 hour basis. Using approximately 19.2 million bushels of corn annually, the plant produces approximately 54 million gallons per year of ethanol. In addition, the plant produces approximately 150,000 tons of dry distillers grain ("DDGs") and 2 million gallons of corn oil. The plant is engineered for expansion of production to 108 million gallons of ethanol per year.

Convention Center Chiller Plant

Monday, June 27 • 2:30 – 5:30 p.m. • \$15

A walking tour of Convention Center Chiller Plant. America's Center, a convention center totaling over 1,000,000 square feet, including five exhibition halls, thirty-four meeting rooms, a theatre, and a full-service kitchen. The Center took on a \$48 million, 3-year project to upgrade the facility. The improvements were completed in 2011 and include chiller, cooling tower, AHU, boiler, and movable air wall replacement. Particular emphasis was placed on the implementation of a user-friendly and accurate user interface for the building's HVAC and lighting control systems.

The facility replaced three boiler plants in the South expansion, and installed 13 new modular style boilers totaling 23,600 BTU. Upgrades to the energy efficient cooling plant included two new 1,100-ton capacity chillers, a new 360 ton chiller for low cooling load conditions and five new cooling towers with total capacity of 4,960 tons.

St Louis Sheet Metal Workers Apprentice and Training

Tuesday, June 28 • 1:15–5:15 p.m. • \$30

Sheet Metal Workers' Local 36 and the St. Louis chapter of the Sheet Metal and Air Conditioning Contractors' National Association (SMACNA) created the Sheet Metal Workers' Training School. This Department of Labor, Office of Apprenticeship registered school is a state-of-the-art 56,000-square-foot facility, equipped with a service lab, welding lab, extensive architectural mockups, computer/CAD lab, and T.A.B. training, giving apprentices and journeymen alike a first-class education.

Each of these apprentices receives five years of instruction combined with jobsite experiences to equal 10,000 training hours in the following areas:

- Testing and air balancing (T.A.B.)
- Service
- Layout
- Computer-aided drafting (CAD)
- Foreman training
- AWS-certified welding
- Blueprint reading
- Drafting
- Architectural sheet metal
- Safety
- Codes
- Professional Educational Units (PEUs) for St. Louis County Mechanical License

LIFE MEMBERS' LUNCHEON

Tuesday, June 28

12:00 Noon

Marriott Majestic Ballroom C

Enjoy lunch, share ideas about the future of technology and swap memories of the Society while dining with Life Members. This member grade is for members who have completed 30 years of continuous membership and are at least 65 years of age.

Cost: \$30

FUTURE ASHRAE SPECIALTY CONFERENCES

2016

Aug. 10–12: **ASHRAE and IBPSA-USA SimBuild 2016: Building Performance Modeling Conference** – Salt Lake City, UT

Sept. 12–14: **IAQ 2016 Defining Indoor Air Quality: Policy, Standards and Best Practices** co-organized by AIVC – Alexandria, VA

Sept. 15–16 (tentative date): **Residential Stakeholders Workshop** – Alexandria, VA

Sept. 22–23: **2nd International Conference on Efficient Building Design** – Beirut, Lebanon

2017

Jan. 11–13: **Sustainable Management of Refrigeration Technologies in Mobile Marine and Fisheries Sectors** – Bangkok, Thailand

Feb. 26–27: **2nd International Conference on High Ambient (Hot Climates)** – Qatar

Sept. 27–29 (tentative date): **ASHRAE Building Modeling Conference** – Atlanta, GA

November: **ASHRAE Developing Economies Conference** – Delhi, India

KEYNOTE SPEAKER – CHEF JEFF HENDERSON

Inspiring Celebrity Chef, Food Network TV Star & Bestselling Author

Saturday, June 25

3:15 – 5:30, Majestic Ballroom D/E, Conference Plaza Building, 2nd level

Chef Jeff Henderson discovered his passion and gift for cooking in a most unlikely place—prison. Now an award-winning chef, bestselling author and Food Network television star, he is one of the most influential role models in the country. Drawing from his personal journey of redemption—from imprisoned drug dealer to renowned celebrity chef and TV star—he provides audiences with inspiration, real life strategies and unique life lessons to help others reboot their own dreams, expand their perspective and gain a new foothold on the ladder to success.

Chef Jeff is the creator of the Food Network’s reality series, *The Chef Jeff Project*, the host of *Family Style with Chef Jeff*, and the star of the popular current series, *Flip My Food with Chef Jeff*, in which he meets with guests from across the country and teaches them how to “flip” their favorite dishes and guilty food pleasures into healthier culinary masterpieces.

The bestselling author of two books, his most recent, *If You Can See It, You Can Be It* outlines his 12 street-smart recipes for success, helping readers discover their hidden business aptitudes, make life-changing decisions and strive for new levels of personal and professional success.

A frequent media guest, Chef Jeff has appeared on leading outlets, including *The Today Show*, *Good Morning America* and *CNN*, and has been featured in *USA Today*, the *Wall Street Journal* and the *Washington Post*. His inspiring life story is being adapted for a major feature film by Will Smith and Jada Pinkett Smith.

From effectively harnessing adversity to identifying one’s own personal gifts, Chef Jeff reveals his unique life lessons and real life roadmap to reinvention as he takes audiences through his journey of redemption from the streets to the stove.



CHAPPEE COTTAGE CHOSEN FOR SUSTAINABILITY PROJECT

An updated HVAC&R system will be provided to a home for adults and children with developmental disabilities under the Sustainable Footprint chosen by the Southern Illinois University Edwardsville (SIUE) Student Branch.

ASHRAE’s Sustainable Footprint Project was launched in 2008 by the Utah Chapter. The goals of the program are to leave a legacy representing ASHRAE’s commitment to sustainability and to offset the environmental impact from holding the Annual Conference. It is now customary for the Annual Conference host city to select a project with some funding provided by ASHRAE as seed money.

The SIUE branch has been given the opportunity to gain rare undergraduate engineering experience in taking on this project with professional engineers Pat O’Brien, vice chair/sustainability mentor of the St. Louis Host Committee, and Vinny Stanec, who is general chair of St. Louis Host Committee, as advisors.

The branch has chosen Chappee Cottage on the Beverly Farm Campus (www.beverlyfarm.org/) in

Godfrey, Ill. The Beverly Farm Foundation provides a loving, caring home for adults with developmental disabilities, providing each individual with physical and emotional security and a dignified quality of life, with opportunities and challenges, within each individual’s functional capabilities. Chappee Cottage houses about 25 women and children. Their building currently has an old inefficient multi-zone system with radiant floor heating which has been all but disabled as a result of a grossly inefficient boiler.

The branch has selected three HVAC options and are currently looking into other ways to save energy in the building, such as the building envelope, windows, lighting and controls. The most viable option for this project is a single zone residential split system with a dedicated outdoor air system. There are plans to replace the current boiler with one that is more efficient and continue to use the radiant flooring in the space. This will allow for the most energy efficient usage of the equipment while maintaining comfort in the space.

ASHRAE 2016 ANNUAL CONFERENCE TRAINING

Full-Day Seminars & Half-Day Courses for In-Depth Instruction

ASHRAE Learning Institute (ALI) full-day seminars and half-day courses will be held at the America's Center Convention Complex. Choose from two full-day seminars and eight half-day short courses to help you stay current on the latest HVAC technology. Each seminar and course carries Continuing Education Units (CEUs), Professional Development Hours (PDHs), and/or American Institute of Architects Learning Units (AIA LUs) which can be applied toward maintaining your P.E. licensure.

Register at www.ashrae.org/stlouis/courses or onsite at the ASHRAE registration booth at the Marriott St. Louis Grand Hotel.

Please refer to the map in this program to assist in finding the rooms for the ALI courses.

FULL-DAY PROFESSIONAL DEVELOPMENT SEMINARS

Registration fees: \$510 per course; \$415 for ASHRAE members. Completion of each seminar earns 6 PDHs/AIA LUs or 0.6 CEUs (*check with your state for their continuing education credit requirements*)

SATURDAY, JUNE 25, 2016

Introduction to Building Enclosure Commissioning (code 60)

(Co-Sponsored by Building Enclosure Commissioning Collaborative)

8:00 am – 3:00 pm, America's Center Convention Complex, Room: 261/262

This seminar introduces the Building Enclosure Commissioning (BECx) process by outlining key quality-based activities that achieve a successful building enclosure. The seminar includes an overview on such design phase BECx activities as developing the Owner's Project Requirements, the BECx plan, and critical building science and architectural issues to address in the design review and specifications, and construction phase BECx activities such as construction observation and performance testing. The seminar aids in understanding how BECx contributes towards commissioning goals and requirements and LEED®.

Instructors: Fiona Aldous, Member ASHRAE and William Nash, P.E., Member ASHRAE

Energy Modeling Best Practices and Applications (code 61)

(Co-sponsored by IBPSA-USA)

8:00 am – 3:00 pm, America's Center Convention Complex, Room: 260

This seminar focuses on topics critical to the effective delivery of energy modeling services, including modeling fundamentals, modeling best practices and quality control, modeling to inform design, measurement and verification. This seminar presents case studies and discusses modeling tools for streamlining quality control procedures and the development of input data for building characterization.

Instructors: Drury Crawley, Ph.D., AIA, Member ASHRAE, BEMP and Sam Mason, P.E., Member ASHRAE, BEMP

HALF-DAY SHORT COURSES

Registration fees: \$184 per course; \$139 for ASHRAE members. Completion of each course earns 3 PDHs/AIA LUs or 0.3 CEUs (*check with your state for its continuing education credit requirements*)

SATURDAY, JUNE 25, 2016

Energy Management Best Practices (code 62) **12:00 pm – 3:00 pm, America's Center Convention Complex, Room: 263**

Buildings use 41% of US energy, of which one-third can be practically saved. This course discusses the principles of energy management, and also includes example problems, which are solved collaboratively by the class. This reinforces key points in the presentation, and results in a more in-depth learning experience. Students will learn emissions factors in different geographic regions, and how to develop the carbon footprint of a building. At the completion of the course, students are prepared to evaluate a reduced emissions program and the cost effectiveness produced by key energy management practices.

Instructor: Richard Pearson, P.E., Fellow/Life Member ASHRAE

SUNDAY, JUNE 26, 2016

Variable Refrigerant Flow System Design & Application (code 63)



3:30 pm – 6:30 pm, America's Center Convention Complex, Room: 260

Variable Refrigerant Flow (VRF) systems are now being used in many buildings across North America. This course provides non-manufacturer-specific concepts of how to apply VRF systems to a wide range of building types. The course supplements the fundamental technology introduction presented in the 2012 ASHRAE HVAC Systems and Equipment Handbook offering consulting engineers who already have a basic knowledge of VRF technology a comprehensive system design and application guidance using building-specific scenarios.

Instructor: Dermot McMorro, P.Eng., Member ASHRAE

Troubleshooting Humidity Control Problems (code 64)

3:30 pm – 6:30 pm, America's Center Convention Complex, Room: 261/262

This course puts attendees on the fast track to understanding the effects of successful humidity control. It includes an in-depth discussion of moisture load calculations and how humidity control can be added to HVAC designs for seven different types of commercial buildings. The course also covers the effects of different humidity levels on thermal comfort, corrosion, mold growth and airborne microorganisms – information that helps the owner and designer define the optimal humidity control level for each application.

Instructor: Lew Harriman, Fellow ASHRAE

MONDAY, JUNE 27, 2016

Commissioning for High-Performance Buildings (code 65)

2:30 pm – 5:30 pm, America’s Center Convention Complex, Room: 260

This course presents the defining characteristics of the building commissioning process as expressed in *ASHRAE Guideline 0*. Guideline 0 has been well received by the North American design community and has spurred the development of numerous supporting guidelines and standards for the commissioning process. The course explores the implications of employing the ASHRAE commissioning process for high-performance buildings. Particular emphasis is placed on the value of developing a strong Owner’s Project Requirements document that can successfully guide verifications in the design, construction and operation phases for buildings with high expectations for performance.

Instructor: Walter Grondzik, P.E., Fellow/Life Member ASHRAE, LEED® AP

ASHRAE Standard 188-2015 – Successfully Managing the Risk of Legionellosis (code 66)



2:30 pm – 5:30 pm, America’s Center Convention Complex, Room: 261/262

Legionellosis is a health and safety concern for facility owners and operators, and those who manage and oversee a building’s water cooling system. *ASHRAE Standard 188-2015* establishes the minimum legionellosis risk management requirements for the design, construction, installation, commissioning, operation, maintenance and service of centralized building water systems and components. This course describes the environmental conditions that promote the growth of *Legionella* in water systems and the locations where *Legionella* control measures can be applied in new and existing buildings. A comprehensive management strategy for the prevention of Legionellosis is also discussed. The course focuses on the compliance with *Standard 188-2015* to provide a safer and healthier building environment.

Instructors: Michael Patton, Member ASHRAE and William Pearson, Member ASHRAE

TUESDAY, JUNE 28, 2016

Designing Tall, Supertall and Megatall Building Systems (code 67)



8:00 am – 11:00 am, America’s Center Convention Complex, Room: 260

This course provides substantial new information and design assistance on tall, supertall and megatall building systems. The course covers the main topics in the new ASHRAE Design Guide for Tall, Supertall, and Megatall Building Systems including: analyzing/optimizing the thermal performance of the building envelope; calculating the stack effect; selecting appropriate mechanical systems and central plant alternatives; ventilation and thermal comfort; code compliance; chilled and

heating water distribution systems; evaluating pumping systems; fire and life safety systems; vertical transportation systems; high-rise residential design; and mechanically and naturally ventilated conditioning solutions. Also, energy modeling and Energy Use Index (EUI) are presented to enable designers to assess the efficiency of the building and its systems.

Instructor: Peter Simmonds, Ph.D., Fellow ASHRAE

Complying with Standard 90.1-2013: HVAC/Mechanical (code 68)

8:00 am – 11:00 am, America’s Center Convention Complex, Room: 261/262

In 2007, ASHRAE determined that the 2010 version of Standard 90.1 would show a 30% reduction in energy use when compared to the 2004 edition. In 2013, ASHRAE asked for an additional 20% reduction, setting a target for a Standard that is 50% below that required for a 2004-compliant building. Design professionals, code officials and building owners must keep up with the new, more stringent requirements to comply with this quickly evolving Standard. This course describes the new and updated Mandatory and Prescriptive requirements, along with insights on how to comply during building design and construction.

Instructor: McHenry Wallace, P.E., Member ASHRAE, LEED® AP

Designing High-Performance Healthcare HVAC Systems (code 69)

12:00 pm – 3:00 pm, America’s Center Convention Complex, Room: 260

This advanced course provides an in-depth discussion of system design, control sequences and psychrometrics to meet the needs of high-performance healthcare facilities. The course covers the relationship of infection control and HVAC design, the key elements of high-performance in healthcare applications including, control sequences and setpoints, energy conservation strategies, and temperature / relative humidity requirements.

Instructor: Donald Burroughs, P.E., Member ASHRAE

notes

HOW AND WHY TO JOIN AN ASHRAE PROJECT COMMITTEE

WHAT IS A PROJECT COMMITTEE?

ASHRAE Project Committees (PCs) develop ASHRAE standards and guidelines. ASHRAE PCs consist of people who have a recognized expertise in a specific field of interest. Standards produced by ASHRAE are used as authoritative documents throughout our industry and are used either in total or in part as guides for state and municipal codes, for United States and Canadian government specifications, and as source documents for foreign countries. ASHRAE voluntary standards, like ASHRAE Handbooks, are a source of recommended practices that are accepted by a consensus of affected parties working in the areas covered by the standards. Consensus standards are developed and published to define minimum values or acceptable performance, whereas other documents, such as design guides, may be developed and published to encourage enhanced performance.

APPLYING FOR MEMBERSHIP ON A PROJECT COMMITTEE

ASHRAE welcomes new members to its project committees. With the exception of PC Chairs and Vice Chairs, it is not necessary to be a member of ASHRAE to participate on any of ASHRAE's Standard Project Committees (SPC), Guideline Project Committees (GPC), or Standing Standard/Guideline Project Committees (SSPC, SGPC). However, ASHRAE has strict requirements for the submission of the required paperwork for a person to be considered for PC membership. Unlike ASHRAE Technical Committees, ASHRAE PCs do not have corresponding members. However, some PCs may have non-voting members or consultants.

To be considered for project committee membership, you must:

- Submit a PC Application for Membership to ASHRAE staff at Standards.Section@ashrae.org
- Submit a Bias/Conflict of Interest Statement to ASHRAE staff.
- Update or complete an ASHRAE Bio online

After you correctly submit all necessary paperwork:

- ASHRAE staff processes the application and provides the membership package to the PC chair
- The PC Chair reviews the membership package and accepts or declines each applicant
- ASHRAE's Standards Project Liaison Subcommittee approves new members

More details on applying for PC membership including forms and details are available online at <https://www.ashrae.org/standards-research--technology/standards-forms--procedures>.

ATTENDING PROJECT COMMITTEE MEETINGS

A PC member is expected to attend meetings and pay attention to correspondence. All members are expected to bring to the standard relevant facts and to compromise at times in order for the PC to reach consensus on the requirements in the standard. The PC Chair may recommend removal of a PC member for lack of participation such as failing to attend at least half of the scheduled PC meetings in a year.

The ASHRAE Project Committees meet at each Society Winter and Annual Conference. Attendance at these meetings is open to everyone. Some PCs schedule meetings (in-person or conference call) between Society Conferences – those meetings will be announced in the ASHRAE Standards Actions (available at www.ashrae.org/standards-research--technology/standards-actions). You are encouraged to attend any of these meetings in which you have a technical interest. PC chairs are reminded prior to each meeting to make a special effort to welcome visitors (potential members) to PC meetings – A PC can never have too many willing and able volunteers.

notes

WHAT IS A TECHNICAL COMMITTEE?

The technical expertise of ASHRAE is concentrated in its **Technical Committees (TCs), Task Groups (TGs), Technical Resource Groups (TRGs) and Multidisciplinary Task Group (MTGs)**. These groups are responsible in various degrees for:

- preparing the text of ASHRAE Handbook chapters
- originating, coordinating, and supervising Society-sponsored research projects
- presenting programs at ASHRAE meetings
- reviewing technical papers
- evaluating the need for standards
- and advising the Society on all aspects of the technology it embraces

ASHRAE TCs consist of people who have a recognized proficiency in a specific field of interest. TGs, similar to TCs, are formed when a subject of current interest is not covered in the scope of an existing TC or when the subject encompasses the scope of more than one TC. A TG is usually the first step towards becoming a TC when the TG's scope is not covered under a TC. TRGs are similar to TCs except that their responsibilities are limited to preparing, reviewing, or revising technical material. They do not have responsibility for programs, research, or standards. MTGs are different from TCs, TGs, and TRGs. A MTG is formed when the Society has determined a need for limited activity in a broad field of interest that encompasses the expertise of TCs from two or more sections and/or from non-TC groups such as Standing Standard Project Committees (SSPCs) or outside organizations. The functions of a MTG may include Handbook, Program, Publications, Research and Standards to various degrees, but the customary function of the MTG will be to coordinate those activities within the TCs and other groups, and organizations represented on the MTG.

APPLYING FOR MEMBERSHIP ON A TECHNICAL COMMITTEE

ASHRAE welcomes new members to its technical committees.

To be considered for technical committee membership, you must:

- Notify ASHRAE staff at TCStaff@ashrae.net of your interest in a particular TC, TG, TRG, or MTG.
- “Manage Your Membership” link from the ASHRAE Web site

Please note:

If you do not have an ASHRAE ID, are or not applying for ASHRAE membership, and are applying for a position that requires an ASHRAE bio to be on file, please go to www.ashrae.org and click on the Log In tab at the top of the page. Next click on need a login? to request an ID and PIN. You may also use that link if you already have an ASHRAE ID as a non-member, but you do not have a record of what that number is.

You will immediately be assigned as a Provisional Corresponding Member. The acceptance of provisional corresponding membership implies participation in committee activities through correspondence or in-person involvement. Provisional corresponding members serve 2 year terms. Although provisional corresponding members are not voting members, at the end of your term and based on participation in the committee, you may be considered for future voting membership.

Notification of acceptance to a TC is emailed upon your appointment.

ATTENDING TECHNICAL COMMITTEE MEETINGS

During the Annual and Winter Conference

The ASHRAE Technical Committees, Task Groups and Technical Resource Groups meet at each Society Winter and Annual Conference. Attendance at these meetings is open to all society members, to all registered guests at scheduled Society Conferences, and to those invited by the chair at the request of a member. You are encouraged to attend any of these meetings in which you have a technical interest. TC chairs are reminded prior to each meeting to make a special effort to welcome visitors (potential members), particularly international members, to TC meetings – A TC can never have too many willing and able volunteers.

ASHRAE ANNUAL CONFERENCE TECHNICAL PROGRAM

St. Louis – June 2016

Earn Professional Development Hour (PDH) credits by attending sessions listed in the Technical Program. Each hour attended in a session equals one PDH. For forums and other one-hour sessions, you must be present for the entire 50-minute program to earn a PDH. Sign-in sheets will be available in all session rooms for attendees to complete. State PDHs, AIA LUs and LEED AP credits are awarded for select sessions. Also, certain sessions may be acceptable for ASHRAE certification renewal. Send questions to certification@ashrae.org. Your badge will be scanned as you enter the session and a summary of sessions attended will be emailed to you upon conclusion of the conference.

Technical sessions are in the America's Center Convention Complex.

All sessions listed as starting at the same time are concurrent.

ASHRAE'S CONFERENCES AND EXPOSITIONS COMMITTEE WELCOMES YOU TO THE 2016 ANNUAL CONFERENCE

Five types of sessions are presented:

Technical Paper Sessions. These sessions present papers on current applications or procedures, as well as papers resulting from research on fundamental concepts and basic theory. Papers presented in these sessions have successfully completed a rigorous peer review. You are invited to comment on these papers. Forms for written comment are available at each session, and if received by July 5, 2016, comments will be sent to respective authors for reply and publication in ASHRAE Transactions. PowerPoint presentations with audio descriptions of the presentations are posted online in the Virtual Conference. Preprints of papers and an online papers collection are available for purchase in the ASHRAE Bookstore.

Conference Paper Sessions. These sessions present papers on current applications or procedures, as well as papers reporting on research in process. These papers differ from technical papers in that they are shorter in length and undergo a much less stringent peer review. PowerPoint presentations with audio descriptions of the presentations are posted online in the Virtual Conference. Preprints of conference papers and an online papers collection are available for purchase in the ASHRAE Bookstore.

Seminars. Seminars feature presentations on subjects of current interest. Papers are not available from the Society; however, seminar PowerPoint presentations with audio descriptions of the presentations are posted online in the Virtual Conference. Access is free for attendees who purchase a conference registration. Additional Virtual Conference registrations can be purchased in the ASHRAE Registration. For a permanent record of the seminar presentations, the Seminar DVD will be available. Orders can be taken in the ASHRAE Bookstore.

Forums. Forums are “off-the-record” discussions held to promote a free exchange of ideas. Reporting of forums is limited to allow individuals to speak confidentially without concern of criticism. There are no papers attached to these forums.

Workshops. Workshops enable technical committees and other ASHRAE committees to provide a series of short presentations on a topic requiring specific expertise. These short presentations are provided with an increased emphasis on audience participation and training in a specific set of skills. PowerPoint presentations with audio descriptions are posted online in the Virtual Conference.

VIRTUAL CONFERENCE

Free for Paid Conference Registrants

ASHRAE is offering a virtual conference option so you won't miss the state-of-the-art concepts and latest design techniques presented in the Society's technical program. The St. Louis Virtual Conference allows you to view presentations and to interact with an online audience through a discussion board. All conference attendees paying the full registration fee will receive an email notification when sessions are available for viewing. The email will include a link to the St. Louis Virtual Conference, www.ashrae.org/stlouisonline, and your login information..

Virtual Conference registration includes:

- Synced audio and PowerPoint presentations from all technical paper sessions, conference paper sessions, seminars and workshops.
- Ability to post comments and rate presentations.
- Print presentation slides in notes format.
- Ability to post questions or answers for selected sessions through Wednesday, July 6. Presentations available online through January 2018.
- A full slate of technical programs will be posted beginning Monday, June 27, of the sessions that were presented the previous day, with additional content posted through Thursday, June 30.
- Access to the St. Louis Virtual Conference is free with your paid conference registration. To register only for the Virtual Conference, go to ASHRAE Registration, America's Center Convention Complex. \$249 ASHRAE member; \$445 non member or register online.



2016 ASHRAE Annual Conference—Papers (online)

Technical Paper and Conference Paper Session papers as presented at this Conference \$79 (includes five FREE hard copies of preprint papers)

Available at the Conference Bookstore



Conference Seminars DVD

64 Seminars (PowerPoint files synced with speakers' audio)

\$119 (ships September 2016)



Conference Preprints (individual papers, in print)

Technical Paper and Conference Paper Session papers as presented at this Conference \$6 each

Available at the Conference Bookstore



ASHRAE Transactions (Print Volume)

Technical Paper Session papers with discussion questions and answers for papers in bound, library-quality form.

\$79 (ships October 2016)



Approved for New York State Professional Development Hours (PDHs) and American Institute of Architects Learning Units (LUs)



GBCI LEED AP CE Credits

Packages

1. 2016 ASHRAE Annual Conference – Papers (online) and Seminars DVD

Get five FREE hard copies of preprint papers when you purchase this package.

\$149 – Purchase in the Conference Bookstore

2. 2016 ASHRAE Annual Conference – Papers (online) and ASHRAE Transactions

(See description at left.)

Get five FREE hard copies of preprint papers when you purchase this package.

\$124 – Purchase in the Conference Bookstore

3. Complete Annual Conference Content Package (2016 ASHRAE Annual Conference – Papers (online), Seminars DVD, and ASHRAE Transactions)

\$174 – Purchase in the Conference Bookstore

All prices are special conference-only prices.

Sunday, June 26

8:00 AM-9:00 AM

CONFERENCE PAPER SESSION 1 (INTERMEDIATE)

Advances in Absorption Refrigeration

Track: *Advances in Refrigeration Systems and Alternative Refrigerants*

Room: 225

Chair: *Hyojin Kim, Ph.D., Member, Catholic University of America, Washington, DC*

Vapor absorption chillers may be a viable alternative to vapor compression chillers and may provide significant energy savings. However, vapor absorption chillers may not be as competitive due to size and cost issues. This session explores various ways in which vapor absorption chillers can be designed and operated in a more efficient manner.

1. Modeling and Analysis of Bubble Pump Parameters for Vapor Absorption Refrigeration Systems (ST-16-C001)

Julia Aman, Student Member, Paul Henshaw, Ph.D., P.E., Associate Member and David S-K Ting, Ph.D., P.E., Turbulence and Energy Laboratory, Centre for Engineering Innovation, University of Windsor, Windsor, ON, Canada

2. Experimental Investigation on the Surface Tension of LiBr/H2O Solutions with Additives at Low Pressure (ST-16-C002)

Federico Lonardi and Andrea Luke, Dr.Ing., University of Kassel, Kassel, Germany



8:00 AM-9:00 AM

CONFERENCE PAPER SESSION 2 (INTERMEDIATE)

Airflow Requirements and Modeling Approaches

Track: *Indoor Environment: Health, Comfort, Productivity*

Room: 221

Chair: *Joy Altwies, University of Wisconsin-Madison, Madison, WI*

Different space applications and uses often dictate widely varying air flow and ventilation requirements. This session explores different and unique methods to model these requirements in three different applications: data center, laboratory and kitchens with multiple cooking appliances.

1. Experimental Study on Ventilation Requirements of Exhaust Hoods for Multiple Cooking Appliances (ST-16-C003)

Toshiya Iwamatsu, Ph.D., Associate Member¹ and Wataru Urabe², (1) Central Research Institute of Electric Power Industry, Komae, Japan, (2)Central Research Institute of Electric Power Industry, Tokyo, Japan

2. Analysis of Contaminant Flow Path and Laboratory Ventilation Effectiveness (ST-16-C004)

Kishor Khankari, Ph.D., Fellow ASHRAE, AnSight LLC, Ann Arbor, MI

3. A Hybrid Turbulence Model Coupling Strategy for CFD Simulation of a Data Center Model (ST-16-C005)

Cheng-Xian Lin, Ph.D., Member, Long Phan, Student Member and Bin Liu, Florida International University, Miami, FL



8:00 AM-9:00 AM

SEMINAR 1 (BASIC)

A Better Writer is a Better Engineer: TC 7.3 O&M Management Perspective on Good Communication

Track: Professional Skills Beyond Engineering

Room: 224



Sponsor: 07.03 Operation and Maintenance Management

Chair: Mina Agarabi, P.E., CPMP, Member, Agarabi Engineering PLLC, New York, NY

Successful engineers require many communication skills. This seminar focuses on the value and importance of good writing skills for both experienced engineers and YEA, the requirement as engineers to communicate technical ideas and data to non-technical people, ASHRAE O&M Management perspective on good communication and how to achieve improved communication.

1. Effective Communication Skills for Success as an Engineer

Tom Sahagian, Retired, New York, NY

2. ASHRAE Operations & Maintenance Management Perspective

Mina Agarabi, P.E., CPMP, Member, Agarabi Engineering PLLC, New York, NY

8:00 AM-9:00 AM

SEMINAR 2 (ADVANCED)

Results of RP-1651 Development of Maximum Technically Achievable Energy Targets for Ultra-Low Energy Use Commercial Buildings

Track: Renewable Energy Systems and Net Zero Buildings

Room: 223



Sponsor: MTG.ET Energy Targets

Chair: Don Brandt, Member, Trane, Inc. (Retired), Phoenix, AZ

Now that the research and final report are complete for RP-1651, this seminar presents an overall summary of the research results and the most promising future technically. The results include a comprehensive suite of advanced technologies packaged to achieve the maximum technically achievable energy efficiency levels across a wide range of commercial building types.

1. Results of RP-1651: Development of Maximum Technically Achievable Energy Targets for Ultra-Low Energy Use Buildings

Jason Glazer, P.E., Member, GARD Analytics, Inc., Arlington Heights, IL

2. Background on Energy Targets MTG Scope and the Reference Buildings Used in RP-1651

Drury Crawley, Ph.D., BEMP, Fellow ASHRAE, Bentley Systems, Inc., Washington, DC

8:00 AM-9:00 AM

SEMINAR 3 (INTERMEDIATE)

U.S. EPA Guidance for Protecting Indoor Air Quality during School Building Upgrades

Track: Indoor Environment: Health, Comfort, Productivity

Room: 222



Sponsor: 09.07 Educational Facilities

Chair: Dawen Lu, P.E., OPMP, HFDP, HBDP, BEMP, BEAP, Member, Lu + Smith ENGINEERS, PLLC, Richmond, VA

A school's indoor environment can have significant impacts on health and learning. It is important to protect IAQ during school building upgrades, including energy-efficiency upgrades. There can be a mistaken impression that energy efficiency and IAQ are at odds with each other. When energy efficiency and IAQ protection goals are integrated, schools can achieve strong results in both areas. Alternatively, if careful attention is not paid to the interaction between energy management and IAQ, occupant health can suffer. The U.S. EPA recently released Energy Savings Plus Health: IAQ Guidelines for School Building Upgrades, and this new guidance is presented.

1. Energy Savings Plus Health: IAQ Guidelines for School Building Upgrades

Gregory Brunner, U.S. Environmental Protection Agency, Washington, DC

2. Energy Savings Plus Health: School Building Checklist Generator

Gregory Brunner, U.S. Environmental Protection Agency, Washington, DC

8:00 AM-9:00 AM

WORKSHOP 1 (INTERMEDIATE)

Are Rumors of MERV's Death Exaggerated?



Track: HVAC Systems and Equipment

Room: 227

Sponsor: 02.04 Particulate Air Contaminants and Particulate Contaminant Removal Equipment, SSPC 52.2

Chair: Donald Thornburg Jr., Member, Camfil USA, Riverdale, NJ

ISO 16890 the global filtration standard is due to be published in 2016 and could replace ASHRAE 52.2 as the air filtration laboratory test method. What is ISO 16890, how does it work and how does it affect ASHRAE Standards (62.1, 62.2, 90, 170, etc), members, users and the industry?

1. How Do ISO 16890 and ASHRAE 52.2 Compare?

Bruce McDonald, P.Eng., Member, Consultant, Minneapolis, MN

2. Impact of ISO 16890 on ASHRAE Standards and Guidelines

Anja Coenen, Ph.D., Associate Member, Freudenberg Filtration Technologies, Hopkinsville, KY

8:00 AM-9:00 AM

WORKSHOP 2 (BASIC)

ASHRAE's Strategic Plan for Mobile and Web Apps

Track: Fundamentals and Applications

Room: 226



Sponsor: 01.05 Computer Applications

Chair: Stephen Roth, P.E., Member, Carmel Software Corp., San Rafael, CA

This workshop discusses ASHRAE's strategic plan for the development of mobile and web apps based upon the various standards and HoF chapters. Feedback is also solicited from Society about the types of mobile/web-based apps that ASHRAE should be offering. A representative from ASHRAE Publications solicits the following information: What do ASHRAE members think about the current list of apps offered on the ASHRAE bookstore? What types of apps should ASHRAE be offering that are not currently available? What are members' thoughts about the new ASHRAE 90.1 app? How should apps be priced?

1. ASHRAE's Mobile and Web App Agenda

Steve Comstock, ASHRAE, Atlanta, GA

8:00 AM-9:00 AM

WORKSHOP 3 (INTERMEDIATE)

Developing the Business Case for Submetering: Leveraging GSA's Portfolio to Demonstrate Submeter Functionalities, Range of Benefits and Cost Savings

Track: Smart Building Systems/Remote Monitoring and Diagnostics

Room: 228



Sponsor: 07.06 Building Energy Performance

Chair: Kinga Hydras, Member, U.S. General Services Administration, Washington, DC

The session provides an overview of current standards and Federal mandates around submetering and explores energy conservation opportunities through the usage of granular energy data. Recent industry trends show that installation of metering devices after the primary utility meter that measure actual resource consumption are bringing multiple benefits to commercial building owners. The GSA developed a Submeter Framework that provides a standardized means to map submeter functionalities to a range of benefits. The Framework is the basis of the

newly introduced SFTool Submetering module and the interactive Submetering Wizard.

1. Developing the Business Case for Submetering: Leveraging GSA's Portfolio to Demonstrate Submeter Functionalities, Range of Benefits and Cost Savings

Kinga Hydras, Member, U.S. General Services Administration, Washington, DC

2. Developing the Business Case for Submetering: Standards and Mandates

Martin Weiland, P.E., Member, US General Services Administration, Washington, DC

9:00 AM-9:30 AM

NETWORKING COFFEE BREAK

America's Center Convention Complex (ACCC),
Ballroom Foyer, Level 2

Grab some coffee and network with your fellow ASHRAE conference attendees after the opening sessions. This is a great chance to discuss the program and form connections to make the most of your time in St. Louis.

9:45 AM-10:45 AM

CONFERENCE PAPER SESSION 3 (INTERMEDIATE)

Novel Modeling Approaches

Track: Research Summit

Room: 225

Chair: Ramesh Tiwari, Ph.D., University of Maryland, College Park, MD

The session addresses modern energy modeling methods to better compare the operation of commercial buildings with self-learning modeling techniques and time-series auto regression. The session also discusses the development of baseline models for industrial facilities.

1. The Dynamic Modeling of Chilled Water HVAC Systems Using System Identification (ST-16-C006)

Jasmine Buford, Member and **Nabil Nassif, Ph.D., P.E., Member**, North Carolina A&T State University, Greensboro, NC

2. Development and Testing of Building Energy Model Using Non-Linear Auto Regression Neural Networks (ST-16-C007)

Nabil Nassif, Ph.D., P.E., Member, North Carolina A&T State University, Greensboro, NC

3. Gaussian Process Baseline Regression Models in Industrial Facilities (ST-16-C008)

Joseph Carpenter, Zheng O'Neill, Ph.D., P.E., Member and **Keith Woodbury, Ph.D., P.E.**, University of Alabama, Tuscaloosa, AL

9:45 AM-10:45 AM

CONFERENCE PAPER SESSION 4 (INTERMEDIATE)

Radiant Cooling Systems

Track: HVAC Systems and Equipment

Room: 228

Chair: Helen R. Cerra, Member, ChemTreat, Inc., Glen Allen, VA

This session explores three applications of radiant cooling systems to reduce energy consumption to meet building cooling demands. The first presentation evaluates three applications of radiant cooling in various Indian climate zones compared to an all air system. The second discusses the possibilities of passive cooling panels to lower water temperatures below ambient dry-bulb temperatures. Lastly, the session evaluates nighttime cooling of office building with radiative cooling panels, based on studies performed in Copenhagen, Milan and Athens.

1. Passively Cooling Water below the Ambient Temperature during the Day via Radiative Sky Cooling (ST-16-C009)

Eli Goldstein, Ph.D., Student Member, **Aaswath Raman, Ph.D., Member** and **Shanhui Fan, Ph.D.**, Stanford University, Stanford, CA

2. Analysis of Different Configuration of Radiant Cooling System Integrated with Cooling Tower for Different Indian Climatic Zones (ST-16-C010)

Mahabir Bhandari, Ph.D., Member¹, **Jyotirmay Mathur, Dr.Eng., Member²**, **Robin Jain²**, **Yasin Khan, P.E.²** and **Prateek Srivastava²**, (1) Oak Ridge National Laboratory, Oak Ridge, TN, (2)Malaviya National Institute of Technology, Jaipur, India

3. Simulation Study of Discharging PCM Ceiling Panels through Nighttime Radiative Cooling (ST-16-C011)

Eleftherios Bourdakis, Student Member, **Ongun B. Kazanci, Student Member**, **Bjarne W. Olesen, Ph.D.**, Fellow ASHRAE and **Fabio Grossule**, Technical University of Denmark, Kongens Lyngby, Denmark

9:45 AM-10:45 AM

CONFERENCE PAPER SESSION 5 (INTERMEDIATE)

Recent Developments with Windows

Track: Indoor Environment:

Health, Comfort, Productivity

Room: 224

Chair: Marilyn Listvan, Ph.D., Member, Listvan & Assoc., Consulting, Edina, MN

As buildings continue to strive to reduce energy consumption we must look at building fenestration to minimize building heat loss and heat gain. This session evaluates options to improve window u-factor and solar heat gain while comparing occupant satisfaction based on comfort, control and visibility. This session also discusses a method for determining cost effective building envelopes for passive house applications, including glazing, insulation and window to wall ratio.

1. Benefits of Interior Installed High Performance Insulating Glass for Commercial Retrofit Applications: A Case Study (ST-16-C012)

Tracy Rogers, Quanex Building Products, Cambridge, OH

2. Occupants' Preferences and Satisfaction with the Visual Environment in Perimeter Zone Offices: A Field Study in a Building with Advanced Technology (ST-16-C013)

Seyed Amir Sadeghi, Student Member, Purdue University, West Lafayette, IN

9:45 AM-10:45 AM

SEMINAR 4 (ADVANCED)

Energy Use Index (EUI): Breakdown of Energy Components of Tall, Supertall and Megatall Buildings Both Domestic and International

Track: Renewable Energy Systems and Net Zero Buildings

Room: 226

Sponsor: 09.12 Tall Buildings

Chair: Peter Simmonds, Ph.D., Fellow ASHRAE, Building and Systems Analytics LLC, Marina Del Rey, CA

Based on a very successful seminar held in Orlando, this session provides a breakdown of energy components for the buildings being presented. This seminar illuminates energy components of tall, supertall and megatall buildings which can be optimized to reduce energy consumption and provide opportunities for net zero buildings.

1. EUI Breakdown for Tall Buildings in Chicago and Internationally

Mehdi Jalayerian, P.E., Member, ESD, Chicago, IL

2. Specifics of EUI for Selected Buildings around the World

Stephen Ray, Ph.D., P.E., Member, North Park University, Chicago, IL

3. Energy Breakdown of Tall Buildings in the Bay Area

Robert Henderson, ARUP, San Francisco, CA

9:45 AM-10:45 AM

SEMINAR 5 (ADVANCED)

Innovative Absorption System Applications for Both Heating and Cooling

Track: HVAC Systems and Equipment

Room: 223

Sponsor: 08.03 Absorption and Heat Operated Machines

Chair: Ersin Gercek, P.E., CPMP, Associate Member, Real Engineering Services LLC, Totowa, NJ

Absorption systems can be used in a variety of cooling and heating applications often simultaneously to improve overall system efficiency. This session introduces dual and triple lift (not stage) absorption systems with a case study. The session also covers modern absorption systems on district heating and cooling commercial water heating applications.

1. Practical Application of an Absorption Heat Pump to Commercial Water Heating

Patrick Geoghegan, Ph.D., Member, Oak Ridge National Laboratory, Oak Ridge, TN

2. Using Double and Triple Lift Single Stage Absorption to Save Energy

Douglas A. Davis, Associate Member, Broad USA, Hackensack, NJ

3. Absorption Heat Pumps for District Heating Applications

Rajesh Sinha, Thermax Inc., Houston, TX



11:00 AM-12:30 PM

CONFERENCE PAPER SESSION 6 (INTERMEDIATE)

Diverse HVAC Applications

Track: Fundamentals and Applications

Room: 224

Chair: Neil P. Leslie, P.E., Member, Gas Technology Institute, Des Plaines, IL



Unique facilities often require unusual design strategies in order to achieve acceptable IAQ and energy efficiency. This session reviews three distinctive uses of CHP, liquid-to-air heat exchange and demand control ventilation to accomplish the HVAC goals in three unique applications.

1. Practical Approach and Method of Demand Control Ventilation in an Animal Facility with 50% HVAC Energy Saving (ST-16-C014)

Masaya Ishihara, Member, Azbil Corporation Building Systems Company, Tokyo, Japan

2. Mechanical Ventilation and Air Conditioning for Underground Science Facility (ST-16-C015)

Cillian Brown, Member, Deepak Kandra, P.E. and Richard Potter, P.E., Arup, New York, NY

3. Decreasing the Primary Energy Demand in the Industrial Sector by Modifying and Linking the Energy Flows in a Plastic Factory (ST-16-C016)

Long Phan, Student Member¹, Johannes Wagner², Heiko Dunkelberg³, Conrad Hannen³, Alexander Schluter⁴, Jens Hesselbach² and Cheng-Xian Lin, Ph.D., Member¹, (1)Florida International University, Miami, FL, (2)University of Kassel, Kassel, Germany, (3)IdE Institute Decentralized Energy Technologies gGmbH, Hesse, Germany, (4)3E. ON Kundenservice GmbH, Hamburg, Germany

9:45 AM-10:45 AM

SEMINAR 6 (INTERMEDIATE)

Latest Technologies in Air-to-Air Energy Recovery

Track: Fundamentals and Applications

Room: 222

Sponsor: 05.05 Air-to-Air Energy Recovery

Chair: Ronnie Moffitt, P.E., Member, Trane, Lexington, KY

Total energy recovery devices transfer both temperature and moisture between the airstreams. Two types of these newer technologies are membrane exchangers and liquid desiccant systems. This session covers the science of membrane exchangers and how they transfer water vapor and heat. It also reviews a liquid desiccant system and how this too can be used to transfer water vapor and heat between exhaust and outside airstreams.

1. Science of Polymeric Membranes Used in Energy Recovery

Ryan Huizing, P.Eng., dPoint Technologies, Vancouver, BC, Canada

2. Liquid Desiccant Total Enthalpy Recovery

Mark Piegay, Member, Alfa Laval - Kathabar, Tonawanda, NY



11:00 AM-12:30 PM

CONFERENCE PAPER SESSION 7 (INTERMEDIATE)

Examples of Smart Controls

Track: Smart Building Systems/Remote Monitoring and Diagnostics

Room: 225

Chair: Michael Sherber, P.Eng., BEAP, HBDP, Member, The Firma Group, Inc., Rocky Hill, CT



Smart (or smarter) control systems play an increasingly important role in optimizing all aspects of an HVAC system. This session examines four different uses of smart controls to substantially improve the operation of fan systems, valve operation, a district cooling system and an aquifer thermal energy storage system.

1. Demonstration of Energy Saving and Control Performance of Tiered Trim and Respond Method in AHU Static Pressure Reset (ST-16-C017)

Xiaohui (Joe) Zhou, Ph.D., P.E., Member, Iowa Energy Center, Ames, IA

2. Smart Buildings Model Predictive Control of an Aquifer Thermal Energy Storage System (ST-16-C018)

Wim Zeiler¹, Jasper Hoving² and Gert Boxem², (1)Eindhoven University of Technology, Eindhoven, Netherlands, (2)TU Eindhoven, Eindhoven, Netherlands

3. Minimizing Primary Energy Consumption in District Cooling System: A Showcase of the Impact of Online Optimization Control (ST-16-C019)

Kenichi Matsuoka, CEng¹ and Khin Zaw, Ph.D.², (1)Azbil Corporation, Ohi 6-10-19-105, Sinagawa, Tokyo, Japan, (2)Keppel DHCS Pte Ltd, 1 HarbourFront Avenue, #05-05 Keppel Bay Tower, Singapore

4. Improving Valve Operation Using Cascade Control in Single Zone Air Handling Units (ST-16-C020)

Kaustubh Phalak and Gang Wang, Ph.D., P.E., University of Miami, Coral Gables, FL

9:45 AM-10:45 AM

WORKSHOP 4 (INTERMEDIATE)

DDC for Smart Buildings and Smart Grid

Track: Smart Building Systems/Remote Monitoring and Diagnostics

Room: 227

Sponsor: 01.04 Control Theory and Application, 07.05 Smart Building Systems

Chair: Cynthia Moreno, T&M Mechanical Sales Company, Solana Beach, CA

Not all energy dashboards are created equally. This seminar reviews the established classification of energy dashboards. Energy dashboards are a graphical user interface that resembles an automobile dashboard. A web-based energy dashboard allows for display of real-time building performance and external information. This workshop discusses the latest technology in energy dashboards and DDC monitoring. Learn about smart metering and how its integration into energy dashboards can become an invaluable tool for today's high performance green buildings.

1. Criteria for Building Automation Dashboards

Frank Shadpour, P.E., HFDP, Fellow ASHRAE, SC Engineers, Inc., San Diego, CA

2. Smart Metering through Controls

Larry J. Fisher, Member, ECT Services, Louisville, KY



11:00 AM-12:30 PM

SEMINAR 7 (INTERMEDIATE)

Building Water Systems: Issues and Insights from Outbreaks of Legionnaires' Disease



Track: Indoor Environment: Health, Comfort, Productivity
Room: 223

Sponsor: 03.06 Water Treatment

Chair: Joshua Ince, P.Eng., Member, Eldon Water Inc, West Chester, OH

This session delves into understanding issues that are associated with recent and past outbreaks. It dispels popular myths of Legionella bacteria and Legionnaires' Disease, while introducing insights to aid system designers, facility managers and public health inspectors to collectively lower the risk of Legionella amplification within building water systems. Improved understanding of this disease's root causes will allow the usage of appropriate legislation that is effective in reducing human exposure to Legionella. The expert panel answers questions regarding lessons learned from first-hand outbreak investigation experience, issues with conflicting code requirements and actions required to minimize incidence of Legionnaires' disease.

1. Why Legionella Is a Problem in Building Water Systems: Keys to Prevention

Janet Stout, Ph.D., Member, Special Pathogens Laboratory, Pittsburgh, PA

2. Lessons Learned from Potable Water Outbreak Investigations: Issues with Public Health and Plumbing Codes

Tim Keane, Member, Legionella Risk Management Inc, Chalfont, PA

3. Policy Consequences of Outbreaks: Who Got It Right?

Sarah Ferrari, Evapco Inc, Taneytown, MD

11:00 AM-12:30 PM

SEMINAR 8 (INTERMEDIATE)

Comfort Challenges in Commercial Kitchens



Track: Indoor Environment: Health, Comfort, Productivity
Room: 226

Sponsor: 05.10 Kitchen Ventilation, 04.01 Load Calculation Data and Procedures

Chair: Russell Robison, Member, Gaylord Industries, Tualatin, OR

With today's intense focus on energy efficiency in our commercial buildings, kitchens present perhaps the greatest challenge of all. Balancing the most energy intense segment of our buildings with the oftentimes overlooked comfort of our kitchens must be a focus moving forward. This seminar presents the findings illustrating some of the current obstacles in this area and what our community is doing to bring back the balance.

1. Thermal Comfort in Commercial Kitchens: a Real-World Perspective!

Donald Fisher, P.Eng., Life Member, Fisher Consultants, Danville, CA

2. Latent and Sensible Loads in Commercial Kitchens and Dishrooms

Richard T. Swierczyna, Associate Member, Food Service Technology Center, San Ramon, CA

3. Considering Additional Loads Associated with Un-Tempered Kitchen Makeup Air

Jimmy Sandusky, Associate Member, Halton Company, Scottsville, KY

4. Dew Point Designs for Commercial Kitchens

Greg DuChane, Member, Trane, Columbus, OH

11:00 AM-12:30 PM

SEMINAR 9 (BASIC)

Gender Diversity: Will ASHRAE Lead or Lag?



Track: Professional Skills Beyond Engineering
Room: 227

Sponsor: 01.07 Business, Management & General Legal Education, Women in ASHRAE, YEA

Chair: Chris Gray, Ph.D., P.E., Member, Georgia Power Company, Columbus, GA

While the demographics of our industry are changing, there are still many groups of people that are underrepresented in ASHRAE. This seminar looks into how unconscious bias has affected our decision-making process over the years and how that has caused our industry to develop to its current make-up. A data analysis of ASHRAE's membership is discussed and compared to membership data from our partner organizations in the built environment. The seminar discusses the significant benefits of changing these demographics and including personal accounts of diversity issues and successes in the workplace.

1. Beyond the Comfort Zone: Unconscious Bias for the Analytical Mind

Erin McConahey, P.E., HBDP, Fellow ASHRAE, Arup, Los Angeles, CA

2. Women in ASHRAE, By the Numbers

Jessica Mangler, P.E., Member, Ross & Baruzzini, St. Louis, MO

3. Personal Experiences of Diversity in the Workplace and in Your ASHRAE Chapter

Karine Leblanc, Member, US Air Conditioning Distributors, Los Angeles, CA

11:00 AM-12:30 PM

SEMINAR 10 (INTERMEDIATE)

Performance Monitoring and Systems Testing Per ASHRAE Standards 184, 30 and the 41 Series



Track: Fundamentals and Applications
Room: 221

Sponsor: 08.02 Centrifugal Machines

Chair: Frederick Betz, P.E., Life Member, Hall Consultants, LLC, Worthington, OH

In order to be able to evaluate and maintain the efficiency of a chilled water system, you must know how to measure the many variables for comparing the operation. ASHRAE has developed standard methods of testing field performance and test stand performance of liquid chilling equipment and systems. These Standards are Standard 184 and 30. The 41 Series of Standards describes methods for testing system variables such as liquid and airflow, temperature and humidity. The presenters in this seminar describe these Standards and their development and use.

1. ASHRAE Standard 30

Phillip Johnson, P.E., Member, Daikin Applied, Staunton, VA

2. ASHRAE Standard 184

Robert Blanton, P.E., Member, Johnson Controls, Inc., York, PA

3. 41 Series Standards

Richard Hall, Member, Hall Consultants, LLC, Worthington, OH

11:00 AM-12:30 PM

SEMINAR 11 (INTERMEDIATE)

Smart Grid in the Heartland:



See What Happens Next

Track: Smart Building Systems/Remote Monitoring and Diagnostics
Room: 228

Sponsor: 07.05 Smart Building Systems

Chair: Richard Hackner, P.E., Member, GDS Associates, Madison, WI

This seminar introduces ASHRAE members to the rapidly developing world of smart grid implementation by utilities and others in the Midwest. Building owners, operators and designers will need to know what options and opportunities they will have in the not too distant future to manage and control their energy use and costs. The seminar also discusses what resources will be available for them in the future.

1. Where's the Data?

Christopher DeMarco, Ph.D., University of Wisconsin - Madison, Madison, WI

2. Ameren Smart Grid Implementation

Bruno Stopka, Ameren Illinois, Marion, WI

3. Demand Response through Advanced Lighting Controls

Scott Schuetter, P.E., Member, Seventhwave, Madison, WI

4. Smart Grid Implementation in Michigan

Glenn Remington, Member, CMS Energy, Jackson, WI

11:00 AM-12:30 PM

SEMINAR 12 (BASIC)

The ABCs of UVC

Track: HVAC Systems and Equipment

Room: 222

Sponsor: 02.09 Ultraviolet Air and Surface Treatment

Chair: Sam Guzman, American Ultraviolet Company, Hackettstown, NJ

This session covers the following UVC related topics: Why use UVC and how does UVC work? Designing/engineering a proper UVC system for your HVAC unit (understanding the levels of UVC dose necessary for different Pathogens), installation and commissioning a UVC system, and Operation & Maintenance.

1. Design Understanding the Levels of UVC Dose Necessary for Different Pathogens

Ashish Mathur, Ph.D., UVDI, Valencia, CA

2. Operation and Maintenance of a UVC System

Scott Sherwood, Eco Care Corporation, New York, NY

3. Commissioning a UVC System in an HVAC Unit

John Putnam, CPMP and HFDP, Member, IEQ Health, Washington, DC

12:30 PM-1:30 PM

FORUM 1 (BASIC)

Behind the Curtains: A Discussion about How to Submit a Program, Mini-Track or Track Suggestion for the ASHRAE Biannual Conferences

Track: Fundamentals and Applications

Room: 224

Sponsor: Conferences and Expositions Committee

Chair: Jon Cohen, Member, ChemTreat, Inc., Richmond, VA

The Conference and Expositions Committee is responsible for selecting the technical programs for the Biannual ASHRAE Conferences. If you have had difficulty submitting a program in the past, have a great track suggestion for a future conference, or just have questions on the process, please join us for a look into our selection process and learn how technical committees and members alike can proactively support the Technical Program. Speakers include Sarah Maston, CEC Chair; Jon Cohen, CEC Vice Chair; and Dave Claridge, incoming CEC Chair.

1:30 PM-3:00 PM

TECHNICAL PAPER SESSION 1 (ADVANCED)

Airflow Measurements and Predictions

Track: Fundamentals and Applications

Room: 224

Sponsor: 05.06 Control of Fire and Smoke

Chair: Paul Turnbull, Member, Siemens Building Technologies, Inc., Buffalo Grove, IL

Air velocity can impact a number of situations including the minimum duct wall thickness required for handling the reduced commercial kitchen exhaust velocity now allowed by NFPA 96. The results of an important CFD study on the impact of make-up air velocity used to control smoke in atriums is reported. Full scale fire tests show the influence of pressure compensating systems for stairwells. The results of a CFD study on ventilated patient isolation rooms show that portions of a room are not well ventilated when the standard ventilation rate is used. A simpler and

more precise method has been developed to predict the necessary separation distance between a variety of exhaust configurations and make-up air inlets. An additional presentation on this topic will be held during the TC 5.06 meeting, Monday, June 27, 4:15 pm - 4:30 pm in room 227.

1. Analyzing the Performance of a Kitchen Exhaust Air Duct with Regards to Recent Standards: A CFD/Thermal Stress Simulation (ST-16-001)

Ali M. Hasan, CEng, Member, KEO International Consulting Engineers, Doha, Qatar

2. A CFD Study to Identify Methods to Increase Maximum Velocity of Make-up Air for Atrium Smoke Control (RP-1600) (ST-16-002)

James Milke, Ph.D., P.E.¹, Christine Pongratz² and Arnaud Trouve¹, (1) University of Maryland, College Park, MD, (2) Arup Group Limited, London, United Kingdom

4. Assessing Effectiveness of Ceiling Ventilated Mock Airborne Infection Isolation Room in Preventing Hospital Acquired Influenza Transmission to Health-Care Workers (GIA 15-16) (ST-16-004)

Deepthi Sharan Thatiparti, Student Member¹, Urmila Ghia, Ph.D.¹ and Kenneth R. Mead, Ph.D., P.E., Member², (1) University of Cincinnati, Cincinnati, OH, (2) CDC- National Institute for Occupational Safety and Health (NIOSH), Cincinnati, OH

5. Simplified Procedure for Calculating Exhaust/Intake Separation Distances (RP-1635) (ST-16-005)

Ronald Petersen, Ph.D., Member¹ and Jared Ritter², (1) CPP Inc., Fort Collins, CO, (2) CPP Wind Engineering and Air Quality Consultants, Fort Collins, CO

1:30 PM-3:00 PM

CONFERENCE PAPER SESSION 8 (ADVANCED)

System Design, Diagnostics and Operation

Track: Smart Building Systems/Remote Monitoring and Diagnostics

Room: 225

Chair: David E. Claridge, Ph.D., P.E., Fellow ASHRAE, Texas A&M University, College Station, TX

This session discusses different methods to evaluate fault readings within a building HVAC system. The first study evaluates water and air system faults with system head and power to minimize computational down time, while another looks at a hazard and operability analysis (HAZOP) for the whole building and a third study looks at incorporating fundamental psychometric equations in the DDC control logic to locate defective sensors. Lastly, this session evaluates the importance of ongoing commissioning on smart building systems to help operators maintain energy efficiency.

1. No-Cost Air Conditioning System Diagnostics Using Fundamental Equations and Existing Controls (ST-16-C021)

Maribella Ibarra, P.E., Associate Member, Vermont Energy Investment Corporation, Burlington, VT

2. Handling Discrepancies in Building Reactive Management Using HAZOP and Diagnosis Analysis (ST-16-C022)

Mahendra Singh, KIC-innoenergy, Grenoble, France

3. Evaluation of Fault Detection and Diagnosis Methods for Air and Water Distribution Systems Using Virtual Flow Meters (ST-16-C023)

Koosha Kiamehr¹, Alejandro Rivas Prieto², Wesley M. Thomas², Gang Wang, Ph.D., P.E.³ and Li Song, Ph.D., P.E.², (1) University of Miami, Coral Gables, FL, (2) University of Oklahoma, Norman, OK, (3) University of Miami, Coral Gables, FL

4. Smart Building Systems Help Maintain the Sustainable Edge of an Award Winning Laboratory (ST-16-C024)

Donald L. Walker, P.E. and G. Brendan Gardes, P.E., HBDP, Member, Newcomb & Boyd, Atlanta, GA

1:30 PM-3:00 PM

SEMINAR 13 (INTERMEDIATE)

Advancements in Compressor Design, Testing and Performance Modeling for New Efficiency Standards and Alternative Refrigerants



Track: Advances in Refrigeration Systems and Alternative Refrigerants
Room: 221

Sponsor: 08.01 Positive Displacement Compressors, Refrigeration Committee

Chair: Georgi Kazachki, Ph.D., Fellow ASHRAE, Dayton Phoenix Group, Inc., Dayton, OH

The industry is driving toward lowering the carbon footprint of air-conditioning and refrigeration systems through more stringent efficiency standards and lower GWP refrigerants. This is creating a strong demand from compressor manufacturers to produce more data regarding the operation of the compressors without sacrificing accuracy. Adapting compressor standards and more economical test methods are needed for developing compressor performance maps. The proper assessment of the actual compressor performance in a system or unit derived from the compressor performance maps that are developed at standardized rating conditions is a key prerequisite for a successful system design and operation.

1. Analysis of the Performance Rating Standards of Positive Displacement Refrigerant Compressors

Joe Sanchez, Member, Bitzer US, Inc., Flowery Branch, GA

2. Representation of a Positive Displacement Compressor Map with Vapor Injection

Gordon Powell, Ingersoll Rand, La Crosse, WI

3. A Study of Methods to Represent Compressor Performance Data over an Operating Envelope Based on a Finite Set of Test Data

Vikrant Aute, Ph.D., Member, University of Maryland, College Park, MD

4. Sizing Low and High Compression Stages of Reciprocating Compressor for Optimum Vapor Injection Performance in Economized Cycle

Alex Lifson, P.E., Member, Carrier Corporation, Syracuse, NY

1:30 PM-3:00 PM

SEMINAR 14 (INTERMEDIATE)

Ammonia and CO2: Advances in Application

Track: Advances in Refrigeration Systems and Alternative Refrigerants



Room: 222

Sponsor: 10.01 Custom Engineered Refrigeration Systems, 10.05 Refrigerated Distribution and Storage Facilities

Chair: Tom Wolgamot, P.E., CPMP, DC Engineering, Missoula, MT

Ammonia and CO2 are considered alternative refrigerants in some sectors. This seminar presents the background behind the movement to natural refrigerants, successful design approaches employed in Europe and North America using ammonia. An end-user's perspective, experience and decision-making parameters that affect the choice of refrigerants, including the use of low-charge ammonia systems is presented. Lessons learned about the design, installation and operation of a transcritical CO2 system in a Refrigerated Distribution Center are also discussed. The overall objective of this session is to demonstrate the benefits of natural refrigerants and ways to employ them cost effectively.

1. The Transition to Natural Refrigerants

Brandon France, Stellar, Jacksonville, FL

2. Low Charge Ammonia Case Studies

Caleb Nelson, P.E., Associate Member, Azane, Inc., Missoula, MT

3. An Owner's Perspective: Electronic Refrigerant Injection Control (ERIC) Ammonia Applications

John Scherer, LA Cold Storage, Los Angeles, CA

4. Transcritical CO2 in a Refrigerated Warehouse

John Gallaher, Hill Phoenix, Atlanta, GA

1:30 PM-3:00 PM

SEMINAR 15 (INTERMEDIATE)

Energy Guideline for Historical Buildings

Track: Fundamentals and Applications

Room: 223

Sponsor: GPC 34

Chair: Constantin A. Balaras, Ph.D., Fellow ASHRAE, Group Energy Conservation (IERSD-NOA), Athens, Greece



Historic building retrofit projects offer unique challenges to improving energy performance while preserving the historic nature of the building. This seminar introduces the new ASHRAE Guideline 34 "Energy Guideline for Historical buildings," which is in the final stages of development. Presentations provide an overview of relevant guidance and regulations published around the world, summarize the new Guideline 34 and provide insight into specific technical issues that should be considered during historic building retrofit projects.

1. Energy Guidelines for Historic Buildings: Reviewing the Regulatory Context and Recent Trends

Amanda L. Webb, Student Member, Pennsylvania State University, University Park, PA

2. An Introduction to ASHRAE's New Energy Guideline for Historical Buildings

Janice Means, P.E., Life Member, Lawrence Technological University, Southfield, MI

3. Key Historic Building Recommendations in ASHRAE Guideline 34

Michael C. Henry, P.E., Member, Watson & Henry Associates, Preservation Architects & Engineers, Bridgeton, NJ

1:30 PM-3:00 PM

SEMINAR 16 (INTERMEDIATE)

Energy Saving and Thermal Comfort Comparison of Different Heating Distribution Systems in Commercial and Residential Buildings



Track: Indoor Environment: Health, Comfort, Productivity

Room: 228

Sponsor: 04.10 Indoor Environmental Modeling

Chair: Reza Ghias, Ph.D., Member, Southland Industries, Dulles, VA

The air distribution systems play an important role in thermal comfort and energy consumption in commercial and residential buildings. The flow rate, temperature and location of the supply air affect the thermal comfort, temperature stratification and particle transportation in a room. Owners and engineers are more encouraged to improve the indoor air quality (IAQ) as its impact on human performances and energy saving is getting more important for the companies. The speakers compare different types of the heating distribution systems and show how computational fluid dynamics (CFD) can address their design challenges and efficiencies.

1. Building Dynamic Modeling and CFD Analysis of Thermal Comfort in Chinese Residential Buildings

Mahroo Eftekhari, Ph.D., Member, Loughborough University, Loughborough, United Kingdom

2. Air Distribution and Ventilation Effectiveness with All-Air Heating Systems

Atila Novoselac, Ph.D., Member, University of Texas at Austin, Austin, TX

3. Using Stratified Air Systems for Heating Mode

Mikhail Koupriyanov, P.Eng., Price Industries Limited, Winnipeg, MB, Canada

1:30 PM-3:00 PM

SEMINAR 17 (INTERMEDIATE)

Plumbing System Design Criteria to Minimize the Potential for Legionella Growth



Track: *Indoor Environment: Health, Comfort, Productivity*

Room: 227

Sponsor: *06.06 Service Water Heating Systems, 03.06 Water Treatment*
Chair: *Tim Keane, Member, Legionella Risk Management Inc, Chalfont, PA*

ASHRAE 188-2015 provides legionella risk management requirements for the design and operation of plumbing systems. ASHRAE Guideline 12, being updated, provides direction on how to accomplish them. Legionnaires' disease, a disease of plumbing systems, is frequently caused by issues related to plumbing system design. Misperceptions are all too common and many think it is an accident that can't be avoided. This seminar focuses on the design, construction and commissioning of building potable water systems. A discussion from three different perspectives, the key factors impacting Legionella growth in piping systems: velocity, turnover, temperature, materials and complexity of components is held.

1. Are Energy Efficiency and Legionella Risk Mitigation at Odds?

Gary Klein, Associate Member, Gary Klein and Associates, Inc., Rancho Cordova, CA

2. The Role Materials Can Play in Legionella Risk Mitigation

Domenic DeCaria, Lubrizol Advanced Materials Inc., Cleveland, OH

3. Lessons Learned from Failure Analysis

Tim Keane, Member, Legionella Risk Management Inc, Chalfont, PA

1:30 PM-3:00 PM

SEMINAR 18 (BASIC)

Water Treatment Programs: Designing for Asset Management and Long-Term Efficiency

Track: *HVAC Systems and Equipment*



Room: 226

Sponsor: *03.06 Water Treatment, 08.06 Cooling Towers and Evaporative Condensers*

Chair: *William E. Pearson II, Associate Member, Southeastern Laboratories, Raleigh, NC*

Designing a cooling water system to provide proper water treatment is a fundamental aspect of design to provide long term asset management and maintaining efficiency over the life of the system. Current system design for energy efficiency and commissioning for proper operation must be maintained over the life of the equipment and designing and operating the water treatment program to enhance these efforts is necessary. This session provides the engineer, commissioning agent and owner the tools necessary to accomplish these goals.

1. Water Treatment Fundamentals and Performance Metrics

Jon Cohen, Member, ChemTreat, Inc., Richmond, VA

2. Control and Monitoring Equipment for Cooling Tower Water Treatment

Patrick Racine, Klenzoid Canada, Mississauga, ON, Canada

3. Water Treatment for HVAC Specifications

Jeff Boldt, P.E., HBDP, Member, KJWW Engineering Consultants, Madison, WI

3:15 PM-4:45 PM

SEMINAR 19 (INTERMEDIATE)

Energy Management for Multi-Building Portfolios from the Owner-Operator and the Consultant Perspectives

Track: *Fundamentals and Applications*

Room: 226

Sponsor: *07.06 Building Energy Performance*

Chair: *Annie Smith, Associate Member, Ross & Baruzzini, St. Louis, MO*

When it comes to energy management of large commercial and institutional multi-building portfolios, owner-operators have a lot of questions to answer: Where to start with energy upgrades? What energy

projects should be implemented and which buildings should they be implemented in? What goes in an energy master plan and why is one necessary? How valuable are energy audits and how many should be paid for? How can a central plant be optimized? This seminar focuses on answering these questions, using case studies and providing insights into successful energy management through the experiences of both consultants and owner-operators.

1. Implementing an Integrated Sustainability Energy Master Plan

Darryl Boyce, P.Eng., Fellow ASHRAE, Carleton University, Ottawa, ON, Canada

2. 8760 Hours of Campus Energy Data

Ryan Corrigan, P.E., Affiliate and Eric Utterson, P.E., Affiliate, 8760 Engineering, St. Louis, MO

3. Phased Implementation for Reducing Energy Consumption on a Commercial Campus

Gwenn Ivester, Affiliate, Cushman & Wakefield, St. Louis, MO

Monday, June 27

8:00 AM-9:30 AM

TECHNICAL PAPER SESSION 2 (INTERMEDIATE)

Challenges and Opportunities with Refrigerants

Track: *Fundamentals and Applications*

Room: 224

Sponsor: *03.02 Refrigerant System Chemistry*

Chair: *Neil P. Leslie, P.E., Member, Gas Technology Institute, Des Plaines, IL*



Current phase out programs to transition away from higher global warming potential refrigerants have not come without their own challenges: high ambient temperature environments, contaminants in new and reclaimed refrigerants and instances of counterfeit refrigerants to name a few. The mixing of counterfeit refrigerants with R134a has been reported in mobile refrigeration units around the world, causing violent and unexpected explosions, resulting in multiple fatalities. In addition, counterfeit refrigerants have caused system reliability issues in numerous air-conditioning applications. On the flip side, there are opportunities in improving the performance of heat pumps in cold climates by applying refrigerant mixtures.

1. Evaluation of Refrigerant Mixtures in Three Different Cold Climates Residential Air-Source Heat Pumps (ST-16-006)

Ali Hakkaki-Fard, Ph.D.¹, Zine Aidoun, Ph.D.¹ and Parham Eslami-nejad², (1)CanmetENERGY, Varennes, QC, Canada, (2)Natural Resources Canada, Varennes, QC, Canada

2. Examination of the Reactions of R40 with R134a and POE Refrigeration System Materials (RP-1665) (ST-16-007)

Stephen Kujak, Member, Trane, Ingersoll Rand, La Crosse, WI

3. Effects of Halogenated Unsaturated Contaminants on the Reliability of HVAC&R Equipment (RP-1641) (ST-16-008)

Ngoc Dung (Rosine) Rohatgi, Ph.D., Member, Spauschus Associates, Inc., Clyde, NC

8:00 AM-9:30 AM

TECHNICAL PAPER SESSION 3 (INTERMEDIATE)

Efficiency Gains for Refrigeration and Chilled Water Systems

Track: *HVAC Systems and Equipment*

Room: 225

Chair: *David Yashar, Ph.D., P.E., Member, NIST, Gaithersburg, MD*



Commercial and industrial refrigeration systems consume a significant portion of electrical energy costs and can represent a high capital cost to an owner. These papers look at optimizing operating conditions and components to improve efficiency, improve the overall life cycle of the equipment and discuss the different available methodologies for measuring and verifying the efficiencies in chilled water system upgrades.

1. Quantifying Efficiency Gains of Refrigeration Systems Using Advanced Expansion Valve Technology (ST-16-009)

Kaimi Gao and Bryan Rasmussen, Texas A&M University, College Station, TX

2. Control and Optimization of Vapor Compression Systems Using Recursive Estimation (ST-16-010)

Christopher Bay, Student Member¹, Avinash Rani² and Bryan Rasmussen¹, (1)Texas A&M University, College Station, TX, (2) Aquamarine Subsea, Houston, TX

3. WITHDRAWN: Improvement of Life Cycles of a 580-Ton Water-Cooled Centrifugal Chiller (ST-16-011)

Ali Haider and Addnan Qayyum, MIA Technical Services Corporation, Islamabad, Pakistan

8:00 AM-9:30 AM

CONFERENCE PAPER SESSION 9 (INTERMEDIATE)

Ground Coupled Heat Pumps

Track: Research Summit

Room: 221

Chair: Alamelu Brooks, BEAP, HBDP, ICF International, Columbia, MD

Accurately designing a ground source heat pump system is dependent on the site conditions and well field layout. This session discusses low cost options to determine the site soil condition, proposes improvements to past vertical borehole sizing and evaluates the life cycle cost of hybrid ground source systems and coupling GSHP with supermarket refrigeration systems.

1. Hybrid Ground Source Heat Pumps: Life Cycle Costs Compared to Non-Hybrids (ST-16-C025)

Kent Beason, P.E., BEMP, Associate Member, Estes McClure & Associates, Tyler, TX

2. Operational and Economic Analysis of GSHP Coupled with Refrigeration Systems in UK Supermarkets (ST-16-C026)

Pietro Dalpane, Salvador Acha, Ph.D. and Nilay Shah, Ph.D., Imperial College London, London, United Kingdom,

3. Accounting for Borehole Thermal Capacity When Designing Vertical Geothermal Heat Exchangers (ST-16-C027)

Laurent Gagné-Boisvert, Student Member and Michel Bernier, Ph.D., P.E., Member, Ecole Polytechnique de Montreal, Montreal, QC, Canada

4. A Simple Process for Testing the Properties of the Ground for the Design of Geothermal Heat Pump Systems (ST-16-C028)

Kyle Larsen, Ph.D., P.E. and Kayleen Teachman, Eastern Washington University, Cheney, WA

8:00 AM-9:30 AM

SEMINAR 20 (ADVANCED)

Computer Aided Renewable Energy System Design with Case Studies

Track: Renewable Energy Systems and Net Zero Buildings

Room: 227

Sponsor: 04.10 Indoor Environmental Modeling, 06.07 Solar Energy Utilization

Chair: Wangda Zuo, Ph.D., Member, University of Miami, Coral Gables, FL

Renewable energy is essential for the realization of net zero buildings. This seminar invites researchers from both architecture and engineering disciplines to demonstrate how to use modeling technologies such as computational fluid dynamics to improve the design of the renewable energy systems in buildings. The researchers introduce the applications of modeling technologies in the design of building envelopes and building systems such as the heating system with various renewable energy sources. The impacts of the renewable energy on the building energy performance, CO₂ emission and the indoor thermal comfort are also discussed.

1. Zero Coal and Low Emission Heating in Rural Houses: What Does It Mean to Energy and Environment in China?

Xudong Yang, Ph.D., Fellow ASHRAE, Tsinghua University, Beijing, China

2. Utilizing CFD for Passive Solar Design Validation

Shan He and Ulrike Passe, AIA, Associate Member, Iowa State University, Ames, IA

3. Semitransparent PV Glazed Second Façade in Building's Refurbishment: Indoor and Outdoor CFD Analysis

Marija Todorovic, Ph.D., P.E., Fellow ASHRAE, University of Belgrade, vea-invi.ltd director, Belgrade, Serbia

8:00 AM-9:30 AM

SEMINAR 21 (INTERMEDIATE)

Evolving Research on Embedded Tube Radiant Applications

Track: Research Summit

Room: 228

Sponsor: 06.05 Radiant Heating and Cooling

Chair: Devin Abellon, Member, Uponor, Apple Valley, MN

As engineers and building owners look to embedded-tube radiant heating and cooling applications to maximize energy efficiency while providing optimum occupant comfort, additional research is underway to prove the system's effectiveness and provide better understanding. This seminar covers three different studies that help provide deeper insight into how radiant systems can be applied on both residential and commercial buildings.

1. The System-Wide Effects of Heating System Cost in High Bay Spaces

Omar Hawit, P.E., Member and Trevor Jaffe, P.E., Member, Westlake Reed Leskosky, Washington, DC

2. Phase Change Materials in Radiant Heating and Cooling Applications

Eleftherios Bourdakis, Student Member, Technical University of Denmark, Kongens Lyngby, Denmark

3. Application of Radiant Heating and Cooling in Plus-Energy Houses

Ongun B. Kazanci, Student Member, Technical University of Denmark, Kongens Lyngby, Denmark

8:00 AM-9:30 AM

SEMINAR 22 (INTERMEDIATE)

Large-Scale Computing

Track: Fundamentals and Applications

Room: 222

Sponsor: 04.07 Energy Calculations

Chair: Harshul Singhal, Associate Member, Performance Systems Development, Ithaca, NY

Although building energy modeling has been common for many years, tools that support large-scale modeling analysis by leveraging vast cloud computing power are now both affordable and accessible. While these approaches make it easy to analyze tens of thousands of model variants, they may not take the shortest path to lead users to the answers they seek. In this session, presenters share case studies involving large scale modeling and results analysis. Attendees learn how to effectively efficiently design a large scale simulation study.

1. Design of Experiments: Statistical Confidence with Fewer Simulations

New Joshua, Ph.D., Member, Oak Ridge National Laboratory, Oak Ridge, TN

2. Exercising Occam's Razor: Sensitivity Screening Methods as Applied to Building Energy Models

David Bosworth, Member, BUILDlab, LLC, Dryden, NY

3. How to Do Energy Model Uncertainty Analysis with Correlated Input Variables

Ralph Muehleisen, Ph.D., P.E., Member and Joshua Bergerson, Ph.D., Argonne National Laboratory, Lemont, IL

8:00 AM-9:30 AM

SEMINAR 23 (BASIC)

Parting the Clouds to See the Future of Residential Load Calculations

Track: Fundamentals and Applications

Room: 226

Sponsor: 04.01 Load Calculation Data and Procedures

Chair: Glenn Friedman, P.E., Fellow ASHRAE, Taylor Engineering, Alameda, CA



No one can afford the risk of getting load calculations wrong. If load calculations are too fat you lose the job, and if too skinny you have a liability you don't want. This session presents important information about residential loads calculations including their science, the art, their code requirements and their state of the art. The session also presents information about residential load calculation methods in wide use today, explores the impact of technology on how these methods are applied and speculates on the techniques that may underlie "next generation" procedures.

1. Code Requirements for Residential Load Calculations and Manual J

Luis Escobar, Associate Member, Home Innovation Research Labs, Upper Marlboro, MD

2. Residential Load Calculations Using the Heat Balance Method

Charles S. Barnaby, BEMP, Life Member, Retired, Moultonborough, NH

3. How New Technologies Are Changing the Way HVAC Residential Load Calcs Are Performed

Stephen Roth, P.E., Member, Carmel Software Corp., San Rafael, CA

8:00 AM-9:30 AM

SEMINAR 24 (INTERMEDIATE)

Using ASHRAE Performance Measurement Protocols for Measuring and Benchmarking Commercial Building Performance

Track: Fundamentals and Applications

Room: 223

Sponsor: 07.06 Building Energy Performance

Chair: Bruce Hunn, Ph.D., Fellow ASHRAE, Retired, Raleigh, NC



ASHRAE published the Performance Measurement Protocols for Commercial Buildings (PMP) for building operators, facility managers, engineers and architects with respect to measuring and benchmarking commercial building performance. The PMP aims to provide a standardized set of protocols for a range of cost/accuracy (i.e., Basic, Intermediate and Advanced levels), to facilitate the appropriate comparison of measured energy, water and indoor environmental quality (thermal comfort, indoor air quality, lighting and acoustics) performance. This seminar introduces the PMP and their use with example case studies that show the various applications of the protocols to real buildings.

1. PMP Energy Protocols

Jeff S. Haberl, Ph.D., BEMP, Fellow ASHRAE, Texas A&M University, College Station, TX

2. Measurement and Conservation of Water Use

Jim Bochat, Member, Commissioning Concepts, Phoenix, AZ

3. PMP Indoor Environmental Quality Protocols: Overall Application

Hyojin Kim, Ph.D., Member, Catholic University Of America, Washington, DC

4. Thermal Comfort Measurement, Evaluation and Practical Applications Using PMP

David Heinzerling, Associate Member, Taylor Engineering, Alameda, CA

9:45 AM-10:45 AM

TECHNICAL PAPER SESSION 4 (ADVANCED)

Measurements and Modeling of Heat and Mass Transfer

Track: Fundamentals and Applications

Room: 224

Chair: Dennis O'Neal, Ph.D., P.E., Fellow ASHRAE, Baylor University, Waco, TX



Three papers dealing with experimental methodology and optimization of heat and mass transfer applications. Laboratory experiments were conducted in paper one to investigate the frosting conditions for two geometrically identical air-to-air cross-flow plate exchangers. Active mechanisms as a potential effective means to achieve the enhancement of heat and mass transfer in sorption fluids to improve the overall performance of an absorption chiller were posed in paper two. And in paper three, the application of Robust Design Engineering Methodology (RDEM) is used to assess minimum temperature and cold mass fraction gradient for the performance of Counter flow Vortex Tube.

1. Optimizing Excess Air in Relation to Energy, Temperature and Reduction of Emissions of Methane Gas in a Combustion Nozzle: Using Numerical Combustion Modeling (ST-16-012)

Ali M. Hasan, CEng, Member, KEO International Consulting Engineers, Doha, Qatar

2. Experimental Setup and Methodology on Active Mechanisms for Enhancing Heat and Mass Transfer in Sorption Fluids (RP-1462) (ST-16-013)

Yuebin Yu, Ph.D., Associate Member, Ziqi Shen and Josephine Lau, Ph.D., Member, University of Nebraska-Lincoln, Omaha, NE

9:45 AM-10:45 AM

TECHNICAL PAPER SESSION 5 (INTERMEDIATE)

Advances in VFD Control and Building Operations and Maintenance

Track: HVAC Systems and Equipment

Room: 225

Sponsor: 07.05 Smart Building Systems

Chair: Li Song, Ph.D., P.E., University of Oklahoma, Norman, OK



Variable frequency drives (VFDs) are widely applied on induction motors in various HVAC applications. However, field studies and research shows that few variable flow systems are optimally controlled and never realize their full potential savings. These papers examine various factors and use simulations, experimental data and field measurements to unlock greater potential savings when using variable frequency drives.

1. Data and Interfaces for Advanced Building Operations and Maintenance (RP-1633) (ST-16-014)

Dr. Nicholas T. Gayeski, Ph.D., KGS Buildings, LLC, Cambridge, MA

2. Improving Variable Speed Pumping Control to Maximize Savings (ST-16-015)

Kathleen Sturtevant, Student Member¹, Alexandra Brogan², Vijay Gopalakrishnan³, Zachary Valigosky¹ and Kelly Kissock, Ph.D., P.E.¹, (1)University of Dayton, Dayton, OH, (2)Plug Smart, Columbus, OH, (3)Energy and Resource Solutions, North Andover, MA

3. Simulated Energy Efficient Voltage-Frequency Ratios of Variable Frequency Drives on Induction Motors (ST-16-016)

Gang Wang, Ph.D., P.E.¹ and Koosha Kiamehr², (1)University of Miami, Coral Gables, FL, (2)University of Miami, Coral gables, FL

9:45 AM-10:45 AM

CONFERENCE PAPER SESSION 10 (BASIC)

Residences and Moisture

Track: Renewable Energy Systems and Net Zero Buildings

Room: 221

Chair: Kimberly Pierson, Moser Mayer Phoenix Associates, Greensboro, NC



This session compares the modeled energy consumption with utility bills of two houses and provides steps to yield more accurate modeled data; including construction materials, equipment performance curves, roof elevation and weather data. Secondly this session addresses the thermal comfort of multi-family facilities based on ASHRAE Standard 55-2013 and compare to occupant surveys and their perception of the space.

1. Pre-Retrofit Assessment of Thermal Comfort and Excess Moisture in Post-War Multi-Unit Residential Buildings in Toronto (ST-16-C029)

Daniel Haaland, Student Member¹, Ekaterina Tzekova, Ph.D., Student Member² and Jeffrey Siegel, Ph.D.¹, (1)University of Toronto, Toronto, ON, Canada, (2)Toronto Atmospheric Fund, Toronto, ON, Canada

2. Development and Use of the Energy Model of a Research and Demonstration House with Advanced Design Features (ST-16-C030)

Vicente Bortone, P.E.¹ and Nelson Fumo, Ph.D., Associate Member², (1)Johnson Controls, Inc., Lenexa, KS, (2)University of Texas at Tyler, Tyler, TX

9:45 AM-10:45 AM

SEMINAR 25 (BASIC)

Designing for a Net-Zero 1740ft (530m) Super High Rise Building

Track: Renewable Energy Systems and Net Zero Buildings

Room: 228

Chair: Sergio Sádaba, P.E., BEMP, Member, Skidmore Owings & Merrill, Chicago, IL



This seminar explains the various methods high performance designers follow during the high performance design process. It particularly focuses on the design methodology used in a 1740-ft (530m) supertall net zero building on a 3,450,000-ft² campus in the heart of Jakarta, Indonesia. Pertamina's new headquarters and campus are a mixed use development for the more than 20,000 employees and visitors expected to work daily on the campus. Low enthalpy geothermal system in a combined heat and power scheme using binary cycle technology as a primary source of energy will make Pertamina's Energy Tower the tallest net-zero building in the world.

1. Designing for a Net-Zero 1740ft (530m) Super High Rise Building

Sergio Sádaba, P.E., BEMP, Member, Skidmore Owings & Merrill, Chicago, IL

9:45 AM-10:45 AM

SEMINAR 26 (INTERMEDIATE)

Dos and Don'ts for Residential Radiant Systems for Heating and Cooling

Track: HVAC Systems and Equipment

Room: 223

Sponsor: 06.05 Radiant Heating and Cooling, Residential Building Committee, SSPC 55

Chair: Devin Abellon, Member, Uponor, Apple Valley, MN



Radiant heating and cooling systems are being installed in many residences as a way of improving occupant comfort. But how do these systems respond to owners' expectations and even more important do contractors understand the complexities of installing and operating radiant systems?

1. Residential Case Study: Project Lessons Learned from Designing a Hybrid Radiant Based HVAC System.

Robert Bean, Member, Indoor Climate Consultants Inc., Calgary, AB, Canada

2. Dos and Don'ts for Residential Radiant Heating and Cooling Systems

Peter Simmonds, Ph.D., Fellow ASHRAE, Building and Systems Analytics LLC, Marina Del Rey, CA

9:45 AM-10:45 AM

SEMINAR 27 (INTERMEDIATE)

Energy Savings via ASHRAE Level III Auditing, Retrofit and Recommissioning: A Case Study at Hameetman Science Center, Occidental College I

Track: Fundamentals and Applications

Room: 222

Sponsor: 07.03 Operation and Maintenance Management

Chair: Robyn Ellis, Associate Member, City of Hamilton - Public Works, Hamilton, ON, Canada



An HVAC systems assessment and HVAC retrofit was required and completed on a science building just 10 years old. Using ASHRAE Level III Auditing combined with a unique test method of installed HVAC system approach assessing the building generating a unique and surgical approach to improving building efficiency. The project was supported through the efforts of the Occidental maintenance professionals as well as the local LADWP utility. Past ASHRAE fellow Bob Baker contributed guidance for this project. This data was then used to diagnose the systems and create a scope of work for the project.

1. Utilities Perspective

Mel Johnson, Associate Director, Los Angeles, CA

2. Energy Perspective

Rob Falke, Member, National Comfort Institute, Avon Lake, OH

9:45 AM-10:45 AM

SEMINAR 28 (BASIC)

Engineering Licensure in the U.S.

Track: Professional Skills Beyond Engineering

Room: 227

Sponsor: Young Engineers in ASHRAE (YEA)

Chair: Richard Hayter, Ph.D., P.E., Presidential Fellow Life Member, Kansas State University Retired, Manhattan, KS



In the U.S. engineering licensure is required in each state or territory in which an engineer is providing design services. This seminar provides insight as well as details of the licensure process.

1. Personal Experience in Becoming Licensed

Jacob Taylor, P.E., Member, Heapy Engineering, Columbus, OH

9:45 AM-10:45 AM

SEMINAR 29 (INTERMEDIATE)

Why Be Concerned with Indoor Carbon Dioxide Concentration?

Track: Indoor Environment:

Health, Comfort, Productivity

Room: 226

Sponsor: SSPC 62.1

Chair: Hoy Bohanon, P.E., BEAP, Member, Hoy Bohanon Engineering, PLLC, Clemmons, NC



Indoor carbon dioxide (CO₂) has long been discussed in the context of ventilation and indoor air quality (IAQ), focusing on the impacts of CO₂ on building occupants, how CO₂ concentrations relate to perception of bioeffluents, the use of indoor CO₂ to estimate ventilation rates and demand control ventilation. While measured indoor CO₂ concentrations are rarely close to health guidelines, much confusion has resulted regarding CO₂ in ventilation and IAQ standards. Is there anything in recent research that indicates that we should revise ASHRAE's approach to CO₂ in standards and guidelines?

1. Indoor Carbon Dioxide Concentrations in Ventilation and Indoor Air Quality Standards

Andrew Persily, Ph.D., Member, National Institute of Standards and Technology, Gaithersburg, MD

2. Indoor Carbon Dioxide Concentration: Effects on Subjective and Physiological Responses and Mental Work

Pawel Wargocki, Technical University of Denmark, Kongens Lyngby, Denmark

11:00 AM-12:00 PM

TECHNICAL PAPER SESSION 6 (INTERMEDIATE)

Ground Source Heat Pumps

Track: HVAC Systems and Equipment

Room: 225

Chair: William Murphy, University of Kentucky

These papers address various aspects of ground source heat pumps including field measurements and predictions of utilizing water from abandoned mines as the heat source and sink. A hybrid system that included both ground source and air source features was compared with strictly ground source or air source units for a residence in a northern climate. Improved water pump control was shown to substantially decrease the pumping energy required for large distributed ground source heat pump systems.

1. Performance Analysis of a Ground Source Heat Pump System Using Mine Water as Heat Sink and Source (ST-16-017)

Mini Malhotra, Associate Member¹, Xiaobing Liu, Ph.D., Member², Adam Walburger, Member³, Donald Blacketter, Ph.D., P.E.⁴ and Jack L. Skinner, Ph.D., P.E.⁴, (1)Oak Ridge National Laboratory, Roane County, TN, (2)Oak Ridge National Laboratory, Oak Ridge, TN, (3) CDH Energy Corp., Cazenovia, NY, (4)Montana Tech, Butte, MT

2. Assessment of Ground Source, Air Source and Hybrid Heat Pumps for a Single Family Building in Cold Climates (ST-16-027)

Parham Eslami Nejad, Ph.D.¹, Ali Hakkaki-Fard, Ph.D.², Zine Aidoun, Ph.D.² and Mohamed Ouzzane³, (1)CanmetENERGY-NRC, Varennes, QC, Canada, (2)CanmetENERGY, Varennes, QC, Canada, (3)Canmet Energy Technology centre-Varennes, Varennes, QC, Canada

3. A Simulation-Based Study on Different Control Strategies for Variable Speed Pump in Distributed Ground Source Heat Pump Systems (ST-16-018)

Xiaobing Liu, Ph.D., Member¹, Zheng O'Neill, Ph.D., P.E., Member² and Fuxin Niu, Student Member², (1)Oak Ridge National Laboratory, Oak Ridge, TN, (2)University of Alabama, Tuscaloosa, AL

11:00 AM-12:00 PM

CONFERENCE PAPER SESSION 11 (INTERMEDIATE)

Airflow Measurements

Track: Fundamentals and Applications

Room: 221

Chair: David E. Claridge, Ph.D., P.E., Fellow ASHRAE, Texas A&M University, College Station, TX

Improving the accuracy of air flow measurements in commercial and residential HVAC systems can result in better IAQ, thermal comfort and improved energy efficiency. This session explores different methods of improving air flow measurement as well as verification of their accuracy.

1. Verification of the Accuracy of Air Flow Measurement Using the Multi-Nozzle Chamber Method (ST-16-C031)

Patrick Collins, P.E., Member¹, Terry Beck, Ph.D., Member² and James Schaefer, P.E., Member³, (1)Johnson Controls, Inc., Ventura, CA, (2) Kansas State University, Manhattan, KS, (3)Jacobs Engineering, Houston, TX

2. A Method of Efficacy Estimation for ECM Blowers in Residential Gas Furnaces by Using Blower Rotational Speed (ST-16-C032)

Peng Yin, Ph.D., Student Member¹, Michael Pate, Ph.D., P.E., Member² and James F. Sweeney, Associate Member², (1)Baylor University, Waco, TX, (2)Texas A&M University, College Station, TX

3. Uncertainty Studies of Airflow Measurements in Non-Ideal Conditions in Variable Air Volume Air Handling Units (ST-16-C033)

Alejandro Rivas Prieto, Student Member¹, Jesus Elizondo¹, Gang Wang, Ph.D., P.E.² and Li Song, Ph.D., P.E.¹, (1)University of Oklahoma, Norman, OK, (2)University of Miami, Coral Gables, FL

11:00 AM-12:00 PM

CONFERENCE PAPER SESSION 12 (INTERMEDIATE)

Heat Pumps, Combined Heat and Power

Track: HVAC Systems and Equipment

Room: 222

Chair: Henry A. Becker, Member, H-O-H Water Technology, Inc., Palatine, IL

This session evaluates ways to improve efficiency in air to water heat pumps, through improved heat exchanger micro-channel, refrigerant type and optimizing fan and compressor operation. The session also examines the feasibility of bio-methane combined heat and power (CHP) systems in commercial buildings and micro fuel cell CHP systems for residential applications and evaluates the energy and emission reduction for each system.

1. Greenhp: Design and Performance of the Next-Generation Heat Pump for Retrofitting Buildings (ST-16-C034)

Andreas Zottl¹, Thomas Fleckl¹ and Björn Palm², (1)AIT (Austrian Institute of Technology), Vienna, Austria, (2)KTH Royal Institute of Technology, Stockholm, Sweden

2. Opportunities and Obstacles in Residential, Fuel Cell Based, Micro-CHP: A Review and Analysis (ST-16-C035)

Ryan Milcarek, Student Member, Jeongmin Ahn, Ph.D. and Jianshun Zhang, Ph.D., Fellow ASHRAE, Syracuse University, Syracuse, NY

3. Optimal Technology Selection and Operation of Bio-Methane CHP Units for Commercial Buildings (ST-16-C036)

Dagoberto Cedillos, Salvador Acha, Ph.D., Associate Member and Nilay Shah, Ph.D., Imperial College London, London, United Kingdom

11:00 AM-12:00 PM

CONFERENCE PAPER SESSION 13 (BASIC)

Occupant Predictions and Thermal Comfort

Track: Indoor Environment:

Health, Comfort, Productivity

Room: 226

Chair: Helen R. Cerra, Member, ChemTreat, Inc., Glen Allen, VA

This session addresses the difference in modeled occupancy behavior and actual building usage. The session also evaluates the perception of space temperature and thermal comfort and how one's climate and culture may alter this perception.

1. An Agent-Based Occupancy Simulator for Building Performance Simulation (ST-16-C037)

Yixing Chen, Ph.D., Associate Member¹, Xuan Luo², Tianzhen Hong, Ph.D., Member¹ and Sarah Taylor-Lange, Ph.D.¹, (1)Lawrence Berkeley National Laboratory, Berkeley, CA, (2)Carnegie Mellon University, Pittsburgh, PA

2. An Evaluation of Recent Models in Demand Side Flexibility: The Case of Thermal Comfort Systems in Office Buildings (ST-16-C038)

Wim Zeiler and Kennedy O. Aduda, Eindhoven University of Technology, Eindhoven, Netherlands

3. Thermal Comfort and Perception inside Air-Conditioned Areas (ST-16-C039)

Kyle Reed, Ph.D., Ahmad Manasrah, Student Member and Rasim Guldiken, Ph.D., University of South Florida, Tampa, FL

11:00 AM-12:00 PM

CONFERENCE PAPER SESSION 14 (BASIC)

Ventilation Requirements in Healthcare

*Track: Indoor Environment:
Health, Comfort, Productivity*
Room: 223
Chair: Roger Lautz, P.E., HFDP, Member, Affiliated Engineers,
Madison, WI



The first two papers in this session compare ventilation standards from four countries, the U.S., Germany, The United Kingdom and Spain, for both operating rooms and patient bed areas. The third presentation discusses ventilation requirements in outpatient facilities in the context of both patient protection and energy use.

1. Minimum Ventilation Requirements in Operating and Procedure Rooms: A Comparison of International Standards (ST-16-C040)

Travis R. English, P.E., Member and Maya Salabasheva, P.E., Member, Kaiser Permanente, Oakland, CA

2. Minimum Ventilation Requirements in Patient Bed Areas: A Comparison of International Standards (ST-16-C041)

Travis R. English, P.E., Member and Maya Salabasheva, P.E., Member, Kaiser Permanente, Oakland, CA

3. Application of Health Care Ventilation Standards to Outpatient Facilities (ST-16-C042)

Maya Salabasheva, P.E., Member and Travis R. English, P.E., Member, Kaiser Permanente, Oakland, CA

11:00 AM-12:00 PM

SEMINAR 30 (BASIC)

It's Official: ANSI/ASHRAE Standard 55 Thermal Environmental Conditions for Human Occupancy is for Residential Buildings

*Track: Indoor Environment:
Health, Comfort, Productivity*
Room: 227



Sponsor: 06.05 Radiant Heating and Cooling, Residential Building Committee, SSPC 55, 02.01 Physiology and Human Environment
Chair: Devin A. Abellon, P.E., Member, Uponor, Phoenix, AZ

In a 2014 official interpretation ASHRAE ruled that Standard 55 is applicable to houses. It has been referenced in ASHRAE 62.2 for many years and is listed as a residential resource at the ASHRAE website. Thermal comfort is becoming a front and center issue in residential buildings. Leading the way in research and Standard develop is ASHRAE SSPC 55 and cognizant committee T.C. 2.1. This seminar gives those interested in using Standard 55, a background in its development, current available modelling tools and how to use it for housing projects.

1. A Practitioner's Guide to ASHRAE Standard 55 in Residential Buildings

Abhijeet Pande, Member, TRC Solutions, Kensington, CA

2. Case Study: Using ASHRAE Standard 55 to Solve Potential Comfort Problems in a Cold Climate Residence

Robert Bean, R.E.T., P.L.(Eng.), Member, Indoor Climate Consultants Inc., Calgary, AB, Canada

11:00 AM-12:00 PM

FORUM 2 (BASIC)

A Discussion of 185.1 & 185.2: The New Standards

Track: Fundamentals and Applications
Room: 224

Sponsor: 02.09 Ultraviolet Air and Surface Treatment

Chair: Sam Guzman, American Ultraviolet Company, Hackettstown, NJ

SPC 185 was organized in 2005 to develop a method of test to determine inactivation rates of airborne microorganisms in air-handling units and air ducts. In 2007 it was divided into SPC-185.1 which deals with Airborne Microorganisms while SPC-185.2 deals with Microorganisms on Irradiated Surfaces. These test method standards, are

used to compare UVGI equipment on a standardized basis irrespective of their application. Results are used to give the design engineer an easy-to-use basis for specifying UV devices or estimating the relative performance of UVGI for a given application. This forum discusses the practical application of the new standards.

11:00 AM-12:00 PM

WORKSHOP 5 (BASIC)

Answering the Call: How ASHRAE Standards Can Meet State and Local Demand for High Performance Green Building

Track: Renewable Energy Systems and Net Zero Buildings
Room: 228



Sponsor: Grassroots Government Advocacy Committee

Chair: Andrew Persily, Ph.D., Member, National Institute of Standards and Technology, Gaithersburg, MD

States and cities around the world are promoting construction of net zero energy and high performance green buildings as part of larger national and global efforts to reduce atmospheric emissions in pursuit of climate change mitigation efforts. ASHRAE standards, such as Standard 189.1 can help meet this demand. This workshop presents attendees with hands-on tools for educating policymakers and effecting positive change in the built environment based on sound technical research.

1. Standard 189.1: A Pathway to Achieving Emissions Reductions Goals

Andrew Persily, Ph.D., Member, National Institute of Standards and Technology, Gaithersburg, MD

2. European Activities on High Performance Green Buildings

Martin Dieryckx, Member and Andrea Voigt, The European Partnership for Energy and the Environment, Brussels, Belgium

2:15 PM-3:00 PM

FORUM 3 (INTERMEDIATE)

Financing for HVAC & Home Energy Improvements: Picking a Program That Works for You and Your Customers

Track: Professional Skills Beyond Engineering
Room: 226

Chair: Emeline Minor, Spruce Finance, San Francisco, CA

Homeowners often put off home improvements such as upgrading an HVAC unit because they lack financing options. The right financing program can help you close more sales. This session looks at various financing options available to HVAC contractors and anyone working in the home environment industry, and explain how to pick a financing program that supports your business and helps you close more deals.

3:15 PM-4:00 PM

WORKSHOP 6 (INTERMEDIATE)

The Leadership Advantage: Achieving Greater Effectiveness through Influence

Track: Professional Skills Beyond Engineering
Room: 226



Chair: Jon Cohen, Member, ChemTreat, Inc., Richmond, VA

Many of us are talented and skilled in our professions but our effectiveness can only go so far if we cannot influence others. Talent, skills, and educational background are not enough for success but with improved leadership, one has the ability to become more effective. Leadership is all about influence; developing and raising one's influence results in a multiplying effect on success, helps one stand out amongst the rest and enhances one's ability to have a greater impact. The workshop covers the basics of leadership, the benefits and five steps to becoming a person of influence.

1. The Leadership Advantage

Kemi Sorinmade, The Growth Studio, Easton, MA

4:15 PM-4:30 PM

TC TECHNICAL PAPER SESSION (ADVANCED)

Airflow Measurements and Predictions II

Track: *Fundamentals and Applications*

Room: 227

Sponsor: **05.06 Control of Fire and Smoke**

Chair: Paul Turnbull, Member, Siemens Building Technologies, Inc., Buffalo Grove, IL

This presentation is a continuation of Airflow Measurements and Predictions I, held Sunday, June 26, 1:30 pm - 3:00 pm. Air velocity can impact a number of situations including the minimum duct wall thickness required for handling the reduced commercial kitchen exhaust velocity now allowed by NFPA 96. The results of an important CFD study on the impact of make-up air velocity used to control smoke in atriums is reported. Full scale fire tests show the influence of pressure compensating systems for stairwells. The results of a CFD study on ventilated patient isolation rooms show that portions of a room are not well ventilated when the standard ventilation rate is used. A simpler and more precise method has been developed to predict the necessary separation distance between a variety of exhaust configurations and make-up air inlets.

1. Performance of Stairwell Pressurization System with Open Stairwell Doors (RP-1447) (ST-16-003)

Yoon Ko, Ph.D., Member and Gary Lougheed, Ph.D., Member, National Research Council Canada, Ottawa, ON, Canada

8:00 AM-9:30 AM

SEMINAR 31 (BASIC)

Centrifugal Chiller Design: Back to Basics

Track: *HVAC Systems and Equipment*

Room: 222

Sponsor: **08.02 Centrifugal Machines**

Chair: Rick Heiden, Member, Trane, Inc., LaCrosse, WI

Centrifugal chillers are broadly employed in building air conditioning systems. Recent advances in chiller component performance have substantially reduced chiller power consumption, improved machine responsiveness and reduced footprint. This presentation provides HVAC professionals more technical insight into the chiller components along with design practices used by heat transfer, controls and systems engineers in developing state of the art equipment. This seminar builds on Seminar 21 from the 2015 ASHRAE Annual Conference in Atlanta, "Centrifugal Compressor Design: Back to Basics."

1. Chiller Heat Exchanger Components

Thomas Kelly, Carrier Corporation, Kirkville, NY

2. Chiller System Operation

Seth Gladfelter, Associate Member, Johnson Controls, Inc., York, PA

3. Chiller Controls

Scott Munns, Member, Ingersoll Rand, La Crosse, WI



Tuesday, June 28

8:00 AM-9:30 AM

CONFERENCE PAPER SESSION 15 (BASIC)

Enhancing Individual and Group Professionalism

Track: *Professional Skills Beyond Engineering*

Room: 224

Chair: Hyojin Kim, Ph.D., Member, Catholic University of America, Washington, DC

The profession of engineering is often perceived as a series of mathematical problem solving to achieve an end result. However, the dynamics of engineering and the growth of the profession extend much beyond that. This session provides a look at some unique ways to achieve that. From a presentation on business development that looks at engineering as a "relationship-based" business; to examining how the use of a multidisciplinary design team engaged in conceptual building design from the outset can achieve better results; to the IMPACT of role models in the U.K. to grow the engineering profession; to ways to incentivize women around the world to become engaged in refrigeration engineering.

1. Business Development: The Red-Headed Stepchild of Successful Engineering Business Practices (ST-16-C043)

Margaret Felts and Jeff Yirak, P.E., CPMP, Member, Wood Harbinger, Bellevue, WA

2. The IMPACT of Role Models on the Sustainability of the Engineering Profession in the UK: A Case Study (ST-16-C044)

Ina Colombo, Ph.D., London South Bank University, London, United Kingdom

3. Competences Beyond Engineering: A Mental Model of Conceptual Building Design (ST-16-C045)

Wim Zeiler, Eindhoven University of Technology, Eindhoven, Netherlands

4. Women in the Refrigeration Industry (ST-16-C046)

Ina Colombo, Ph.D., London South Bank University, London, United Kingdom



8:00 AM-9:30 AM

SEMINAR 32 (INTERMEDIATE)

HVAC Controls for Smart Grid Applications

Track: *Research Summit*

Room: 227

Sponsor: **Publishing and Education Council**

Chair: Reinhard Radermacher, Ph.D., Fellow ASHRAE, University of Maryland, College Park, MD

This session offers presentations based on a select group of recently published papers from the ASHRAE journal, "Science and Technology in the Built Environment," regarding the relevance of use of heat pumps in the smart grid context, and HVAC chiller control for power grid frequency regulation.

1. Smart Grid Energy Flexible Buildings through the Use of Heat Pumps in the Belgian Context

Gabrielle Masy, Ph.D.¹, Emeline Georges¹, Clara Verhelst, Ph.D.¹, Vincent Lemort¹ and Philippe André, Dr.Eng.², (1)University of Liège, Liège, Belgium, (2)University of Liège, Arlon, Belgium

2. Demonstration of HVAC Chiller Control for Power Grid Frequency Regulation

Leo Su, Associate Member¹ and Leslie Norford, Ph.D., Member², (1) eCurt, Cambridge, MA, (2)Massachusetts Institute of Technology, Cambridge, MA

3. Smart Grid Coordination in Building HVAC Systems: Computational Efficiency of Constrained Eloc

Donald Chmielewski, Ph.D.¹ and David Mendoza-Serrano, Ph.D., Illinois Institute of Technology, Chicago, IL



8:00 AM-9:30 AM

SEMINAR 33 (INTERMEDIATE)

Innovation in a Commercial Refrigeration System with Natural Refrigerants and Low GWP Synthetic Refrigerants

Track: *Advances in Refrigeration Systems and Alternative Refrigerants*

Room: 221

Sponsor: **10.07 Commercial Food and Beverage Cooling Display and Storage, MTG.LowGWP**

Chair: Shitong Zha, Ph.D., Member, HILLPHOENIX, Conyers, GA

This seminar presents the most recent study of commercial refrigeration system using natural refrigerants such as CO₂, ammonia propane, ammonia and R600a and low GWP synthetic blends. How to successfully convert light commercial refrigeration applications originally designed for R134a to natural refrigerants? What is performance and energy consumption of a



Low-charge ammonia chiller installation and a propane freezer compared to traditional HFC systems? How to improve the efficiency of stand-alone applications with low GWP synthetic refrigerants?

1. Natural, Low-GWP Refrigerants for Light Commercial Refrigeration: Examples of Successfully Converted Applications Using R290, R600a and R744

Stefan Elbel, Ph.D., Associate Member, Creative Thermal Solutions, Urbana, IL

2. Reducing GWP with a Low Charge Ammonia/CO2 Chiller

Scott Mitchell, Southern California Edison, Irwindale, CA

3. Decreasing Environmental Impact by Using Propane in Refrigerated Display Cases

Sean Gouw, P.E., Associate Member, Southern California Edison, Irwindale, CA

4. Advanced Low-GWP Alternatives for Stand-Alone Refrigeration Systems

Michael Petersen, Associate Member, Honeywell - Buffalo Research Laboratory, Buffalo, NY

8:00 AM-9:30 AM

SEMINAR 34 (ADVANCED)

Low-Cost High-Performance Building Simulation: Is That Too Good to Be True?

Track: Research Summit

Room: 228

Sponsor: 04.07 Energy Calculations

Chair: Wangda Zuo, Ph.D., Member, University of Miami, Coral Gables, FL



Building simulation can be used to help achieve energy efficient buildings. However, contemporary building simulation tends to be computationally intensive, which prevents building simulation from being widely applied in the real building process such as building design and operation. This seminar invites experts from both academic and industrial field to share ideas regarding how they improve the performance of different building simulations in terms of the computing demand and cost by taking full advance of cutting-edge computing technologies.

1. Fast Answers to Complex Problems for Dummies

Nathaniel Jones, MIT, Boston, MA

2. Building Energy Simulation Workflows in the Age of Low Cost Computing

David Bosworth, Member, BUILDlab, LLC, Dryden, NY

3. Using High Performance Computers to Improve Foundation Heat Transfer Calculations

Neal Kruis, Ph.D., Student Member, Big Ladder Software, Denver, CO

8:00 AM-9:30 AM

SEMINAR 35 (INTERMEDIATE)

Air Change Rates: Philosophy and Practice

Track: Fundamentals and Applications

Room: 225

Sponsor: 09.11 Clean Spaces, 9.6, 09.10 Laboratory Systems

Chair: Kishor Khankari, Ph.D., Fellow ASHRAE, AnSight LLC, Ann Arbor, MI



Air Change Rates (ACR) are often specified in standards, codes and design guidelines as supply airflow requirements for healthcare, cleanrooms, laboratories and other similar facilities. This legacy practice has been implemented for several decades. With increased awareness of energy efficiency and cost of HVAC operations it is essential now to review this philosophy. This seminar provides historical perspective; current practices and recommendations; and pros and cons of ACR philosophy in the three major industry sectors. In addition the importance of supply airflow path and the distribution of the supply air on effectiveness of contaminant removal will also be presented.

1. ACR Philosophy and Practice: Health-Care Facilities

Travis R. English, P.E., Member, Kaiser Permanente, Oakland, CA

2. ACR Philosophy and Practice: Laboratory Systems

Thomas Smith, Member, Exposure Control Technologies, Inc., Cary, NC

3. ACR Philosophy and Practice: Cleanrooms

Philip Naughton, Applied Materials Inc, Austin, TX

4. Analysis of Airflow Paths and Contaminant Removal Effectiveness

Kishor Khankari, Ph.D., Fellow ASHRAE, AnSight LLC, Ann Arbor, MI

8:00 AM-9:30 AM

SEMINAR 36 (INTERMEDIATE)

Standard 62.2-2016 Revisions and Impacts

Track: Indoor Environment: Health, Comfort, Productivity

Room: 223

Sponsor: Residential Building Committee

Chair: Max H. Sherman, Lawrence Berkeley Laboratory, Berkeley, CA

Standard 62.2 is the most used and only ANSI-approved residential ventilation standard in the country. It has continuously evolved to meet the needs of the residential market since 2003. The latest version is just hitting the streets now. It covers a larger span of the market than before, includes new flexibilities and provides a host of small improvements. This seminar teaches the new compliance requirements, discusses what has changed, examines the application of the revised standard in existing homes and describes ongoing initiatives and options being explored by the committee.

1. Standard 62.2-2016: Overview and Major New Changes

Paul W. Francisco, Member, University of Illinois at Urbana-Champaign, Champaign, IL

2. Tips and Traps for Existing Home Ventilation Strategies Under 62.2

Richard Karg, Residential Energy Dynamics, Bethel, ME

3. Equivalence and Superposition in ASHRAE 62.2

Iain Walker, Ph.D., Fellow ASHRAE, Lawrence Berkeley National Laboratory, Berkeley, CA

8:00 AM-9:30 AM

SEMINAR 37 (INTERMEDIATE)

The Impact of Net Zero Energy Buildings on the Electric Grid

Track: Renewable Energy Systems and Net Zero Buildings

Room: 226

Sponsor: 07.05 Smart Building Systems

Chair: Kristen Cetin, Ph.D., P.E., Associate Member, Iowa State University, Ames, IA

In recent years there have been significant efforts to implement net zero energy (NZE) buildings throughout the United States. This seminar covers several of these recent efforts, highlighting various alternative energy systems and new design strategies to reach NZE as well as how these buildings interact with the electric grid.

1. Net Zero Energy: What Metric to Use?

Jon McHugh, P.E., McHugh Energy Consultants Inc., Fair Oaks, CA

2. The Net Zero Roadmap: The Net Zero Plus Electrical Training Institute

Brett Moss, Electrical Training Institute, Los Angeles, CA

3. Reaching Net Zero Energy: Single-Family Home Retrofit Strategies

Carlos Haiad, P.E., Member, JCH Energy Management Solutions, Inc., Phillips Ranch, CA

9:45 AM-10:45 AM

TECHNICAL PAPER SESSION 7 (INTERMEDIATE)

Climate Prediction and Load Shifting

Track: Fundamentals and Applications

Room: 225

Chair: Alamelu Brooks, BEAP, HBDP, ICF International, Columbia, MD

The results of numerical modeling and observed data are shared in these two papers. The first paper provides the results of ASHRAE Research Project RP-1561, "Procedures to Adjust Observed Climatic Data for Regional or Mesoscale Variations" and the latter shows that



precooling strategies in residential buildings in the Phoenix, Arizona climate offer significant peak energy demand savings.

1. Mesoscale Climate Modeling Procedure Development and Performance Evaluation (RP-1561) (ST-16-019)

Xin Qiu, Ph.D., Member¹, Michael Roth, Ph.D.², Hamish Corbett-Hains¹ and Fuquan Yang, Ph.D.¹, (1)Novus Environmental Inc., Guelph, ON, Canada, (2)Klimaat, Guelph, ON, Canada

2. Modeling and Testing Multiple Precooling Strategies in Three Residential Building Types in the Phoenix Climate (ST-16-020)

Reza Arababadi, Student Member and Kristen Parrish, Ph.D., Arizona State University, Tempe, AZ

9:45 AM-10:45 AM

CONFERENCE PAPER SESSION 16 (INTERMEDIATE)

Advances in Desiccant Technology

Track: HVAC Systems and Equipment

Room: 221

Chair: Kyle Knudten, CPMP, McClure Engineering, St. Louis, MO

Desiccant systems, both liquid and dry, can be effective in increasing the use of outside air for improved IAQ without degrading energy efficiency. This session explores advancements in desiccant technology as well as improvement in system design and modeling through the use of hybrid systems combining desiccant and evaporative components.

1. Achieving Comfort and Energy Savings Using Desiccant Technologies (ST-16-C047)

Mark Piegay, Member, Alfa Laval - Kathabar, Tonawanda, NY

2. A Variable Volume and Temperature (VVT) Control Strategy for a Liquid-Desiccant and Dew Point Evaporative Cooler-Assisted 100% Outdoor Air System (LDEOS) (ST-16-C048)

Sang-Woo Ham, Student Member, Hui-Jeong Kim, Student Member, Sang-Hyeon Cho, Student Member and Jae-Weon Jeong, Ph.D., Member, Hanyang University, Seoul, South Korea

3. Energy Performance of a Liquid Desiccant and Evaporative Cooling-Assisted 100% Outdoor Air System in Commercial Ships (ST-16-C049)

Joonyoung Park, Ph.D., Student Member, SungJoon Lee, M.D., Student Member, Dongseob Yoon, M.D., Student Member and Jae-Weon Jeong, Ph.D., Member, Hanyang University, Seoul, South Korea

9:45 AM-10:45 AM

SEMINAR 38 (INTERMEDIATE)

ASHRAE Research: Airflow and Ducts

Track: Research Summit

Room: 223

Sponsor: 01.02 Instruments and Measurements, Publishing and Education Council

Chair: Reinhard Radermacher, Ph.D., Fellow ASHRAE, University of Maryland, College Park, MD

This session offers presentations based on a select group of recently published papers from the ASHRAE journal, "Science and Technology in the Built Environment," regarding the influence of single-path and multiple-path duct disturbances on volumetric air flow rate measurements, and the development of guidelines for more accurate volumetric airflow measurements in rectangular ducts during test and balance operations of rectangular ducts during test and balance operations.

1. Effect of Fittings on Volumetric Airflow Measurements (RP-1245): Single-Path Duct Disturbances

Craig Hickman¹, Terry Beck, Ph.D., Member² and Bruce Babin³, (1) SPX Cooling Technologies, Inc., Overland Park, KS, (2)Kansas State University, Manhattan, KS, (3)Highland Park High School, Topeka, KS

2. Effect of Fittings on Volumetric Airflow Measurements (RP-1245): Multiple-Path (tee) Duct Disturbances

Terry Beck, Ph.D., Member¹, Craig Hickman, Associate Member² and Bruce Babin³, (1)Kansas State University, Manhattan, KS, (2)SPX Cooling Technologies, Inc., Overland Park, KS, (3)Highland Park High School, Topeka, KS

9:45 AM-10:45 AM

SEMINAR 39 (INTERMEDIATE)

Data Sources toward Urban-Scale Energy Modeling, Part 1

Track: Smart Building Systems/Remote Monitoring and Diagnostics

Room: 226

Sponsor: 01.05 Computer Applications

Chair: Joshua New, Ph.D., Member, Oak Ridge National Laboratory, Oak Ridge, TN



Development of urban-scale building energy models is becoming of increased interest for many applications including city-wide energy supply/demand strategies, urban development planning, electrical grid stability and urban resilience. This seminar has assembled several leaders in the field of urban-scale energy models to discuss an overview of the field as well as the data, algorithms, workflow and practical challenges addressed to create useful models of individual buildings at the scale of a city.

1. Improving Urban Building Energy Models (UBEM) through Building Archetype Calibration

Carlos Davila, Ph.D., MIT, Cambridge, MA

2. Urban-Scale Energy Analyses of the Built Environment

Yeonsook Heo, Ph.D. and Ruchi Choudhary, University of Cambridge, Cambridge, United Kingdom

9:45 AM-10:45 AM

SEMINAR 40 (BASIC)

Facebook and Social Media: Guidelines and Best Practices for Groups

Track: Professional Skills Beyond Engineering

Room: 222

Sponsor: Electronic Communications Committee

Chair: Heather Schopplein, P.E., Member, Haldeman Inc, San Diego, CA

Social media is always changing and evolving, with new sites and tools being added constantly. With so many options, how does one determine which tool or site will work best for their group or business? This presentation covers best practices of some of the most common social media forums (Facebook, Twitter, LinkedIn, Pinterest, Instagram and YouTube) with emphasis on social media tools for ASHRAE chapters. Learn some dos and don'ts for using social media to market your group and increase your online presence.

1. Facebook and Social Media

Heather Schopplein, P.E., Member, Haldeman Inc, San Diego, CA

2. Facebook and Social Media: Guidelines and Best Practices for Groups

Pamela Duffy, P.E., Lennox International, Dallas, TX



9:45 AM-10:45 AM

WORKSHOP 7 (BASIC)

Answering the Call: Encouraging Code Adoption and Enforcement with Policy Leaders

Track: Renewable Energy Systems and Net Zero Buildings

Room: 228

Sponsor: Grassroots Government Advocacy Committee

Chair: Keith H. Reihl, P.E., Member, Reihl Engineering, Cypress, TX

Within the past several years legislation has been introduced in virtually every state which would extend current code cycles beyond the traditional three year cycle. It is important for ASHRAE members to work with policymakers to stress the importance of maintaining the three-year code cycle to ensure that states and local jurisdictions incorporate the latest techniques and practices into their minimum codes, while providing ease of application. This workshop informs members and conference attendees how they can educate policymakers at the state and local levels.

1. Demystifying State and Local Code Development and Adoption

Sara Yerkes, International Code Council, Washington, DC

2. Best Practices for Working with State Energy Officials

David Terry, National Association of State Energy Officials, Arlington, VA



9:45 AM-10:45 AM

WORKSHOP 8 (BASIC)

How to Predict the Long-Term Success of Your Green Design: The Five Characteristics that Determine Technology Adoption

Track: Professional Skills Beyond Engineering
Room: 227



Sponsor: 02.08 Building Environmental Impacts and Sustainability, 01.07 Business, Management & General Legal Education
Chair: Kevin Brown, HBDDP, The Linc Group, Atlanta, GA

Have you ever wondered why a new technology is readily accepted by some but resisted by others? In this workshop, discover the five characteristics of any technology or strategy that will determine its chances of being adopted successfully on projects. Based on technology adoption research from Everett Roger's "Diffusion of Innovations," learn to be more strategic when selecting design options for projects. The goal of this simple technique is to choose the best options for clients – ones that will be embraced and maintained for the life of the building.

1. How to Predict the Long-Term Success of Your Green Design: The Five Characteristics that Determine Technology Adoption
Joy Altwies, University of Wisconsin-Madison, Madison, WI

2. Facilitator for Session

E. Mitchell Swann, P.E., Member, MDC Systems, Paoli, PA

10:30 AM-12:00 PM

TC SEMINAR (BASIC)

Safeguarding Critical Facility Operation: Hardening Essential Equipment to Survive Seismic Wind and Flood

Track: HVAC Systems and Equipment
Room: 230

Sponsor: 02.07 Seismic and Wind Restraint Design

Chair: Robert E. Simmons, P.E., Member, Petra Seismic Design, LLC, Houston, TX

OPEN SESSION: no badge required; no PDHs awarded; presented during the TCs meeting. This seminar provides a practical guide in planning, testing and design considerations to help ensure equipment will meet IBC requirements to keep critical facilities up and running. Jim Carlson, Seismic-Source International, presents "FEMA P-1019 Emergency Power Systems for Critical Facilities: A Best Practice Guide to Improving Survival." John Giuliano, Vibration Mountings & Controls, presents "Lessons Learned From Shake Table Testing." Steve Stoyanac, Chillicothe Metal Company, Inc., presents "Certifying Your Genset Will Work after an Earthquake or Storm."

11:00 AM-12:30 PM

TECHNICAL PAPER SESSION 8 (ADVANCED)

Heat Transfer through Novel Envelope and Heat Exchanger Designs

Track: Fundamentals and Applications
Room: 224



Chair: Ratmesh Tiwari, Ph.D., University of Maryland, College Park, MD

This session presents an experimental methodology suited to the determination of the SHGC of STPV windows; the numerical heat transfer performance and flow development in three different corrugated channels using different rib shapes (Trapezoidal, Triangle and semi-circular); a field monitoring study and numerical modeling investigation of the performance of vacuum insulation panels as a high-efficiency wall insulation system for use in retrofit construction applications; and the effects of nanoparticle dispersion in melting of a phase change material (PCM) in a triplex-tube heat exchanger heated under constant surface temperature conditions.

1. Evaluation of Convective Heat Transfer and Pressure Loss in Channel with Different Groove Shapes (ST-16-021)

Mohamed Sakr Fadl, Coventry University, Coventry, United Kingdom

2. First US Commercial Building with Walls Retrofitted Using Vacuum Insulation Panels (VIPs): Results of Field Performance Study of VIP-Based Exterior Wall Insulation System (WITHDRAWN)

Ali Fallahi¹, Jan Kosny, Ph.D., Member², Nitin Shukla³, Tony Fontanini¹, Alliston Watts¹, Lawrence D Carbary⁴ and Roland Serino⁵, (1)Fraunhofer CSE, Boston, MA, (2)Sustainable Energy Systems, Cambridge, MA, (3)Fraunhofer CSE, Cambridge, MA, (4)Dow Corning, Midland, MI, (5)Dryvit Systems, Inc., West Warwick, RI

3. Melting of PCM with Nanoparticles in a Triplex-Tube Thermal Energy Storage System (ST-16-022)

Emmanuel C. Nsofor, CEng and Jasim M. Mahdi, Student Member, Southern Illinois University, Carbondale, IL

11:00 AM-12:30 PM

SEMINAR 41 (INTERMEDIATE)

Fellows Debate: Productivity is the Measure of Indoor Air Quality

Track: Indoor Environment: Health, Comfort, Productivity
Room: 226

Sponsor: College of Fellows, Indoor Air Quality Association
Chair: Larry Spielvogel, P.E., Fellow Life Member, Consulting Engineer, Bala Cynwyd, PA



In the Fellows Debate both sides of a controversial subject are debated. Can productivity be measured? Does perception of comfort increase productivity, or is it irrelevant? The science of indoor air quality is implied in the requirements of standards and other guidance documents. Can the designer and commissioning engineer apply the science effectively? Are comfort, sense of well-being and of health a measure of productivity? Is personal productivity a true measure in buildings such as operating theaters and data centers? Can existing science support performance-based definitions? Legally, can the designer or operator be liable for health or productivity or any other such outcome?

Debaters: William Bahnfleth, Ph.D., P.E., Presidential Fellow ASHRAE, Pennsylvania State University, University Park, PA; Bjarne Wilkens Olesen, Ph.D., Fellow ASHRAE, Technical University of Denmark, Lyngby, Denmark; Don Beaty, P.E., Fellow ASHRAE, DLB Associates, Eatontown, NJ; Richard Rooley, FREng, OPMP, Presidential Fellow ASHRAE, Project Management Partnership, Stoke Poges, United Kingdom; Derrick A. Denis, Clark Seif Clark, Inc. (CSC), Tempe, AZ; and Donald Weekes, Member, InAIR Environmental Ltd., Ottawa, ON, Canada

11:00 AM-12:30 PM

SEMINAR 42 (INTERMEDIATE)

Heat and Cooling with Woody Biomass for Sustainable and Resilient Buildings and Communities

Track: Renewable Energy Systems
and Net Zero Buildings

Room: 223

Sponsor: 09.08 Large Building Air-Conditioning Applications, 6.09 8.03 and 6.02

Chair: Frank Mills, Member, Low Carbon Design Consultants, Liverpool, United Kingdom

Combining a high capacity factor renewable heat source, thermal storage and absorption cooling expands Near-Net-Zero building and district energy opportunities. Woody biomass offers solar-derived heat on demand; implemented together, these three technologies assure comfort, with savings in power consumption, cost and emissions. Engineers add resilience potential by adapting thermal systems to support safe occupancy during and after disruptive events, like wide-area weather caused grid failure and disrupted delivery of petroleum based fuels for emergency generators and HVAC. Functional buildings data illustrates qualitative and economic value opportunities for efficient, low impact daily operation and resilience in the face of adversity.



1. Role of Thermal Storage in Solving Emissions and Building Overheat Problems with Wood-Fired HVAC

Khaled A. Yousef, P.E., Member, Pyramid Energy Engineering Services, PLLC, Albany, NY

2. Renewable Heat On-Demand: A Clean Source That's Too Valuable to Waste

John Karakash, Member, Resource Professionals Group, Harford, PA

3. The Proof Is in the Performance: Experiences and Data from Real-World Facilities

Jürgen Scharfe, P.E., Member, JS Energie & Beratung GmbH, Erding, Germany

11:00 AM-12:30 PM

SEMINAR 43 (ADVANCED)

Lubrication Effects Beyond the Compressor

Track: Advances in Refrigeration Systems and Alternative Refrigerants

Room: 225

Sponsor: 03.04 Lubrication, 03.03 Refrigerant Contaminant Control

Chair: Joseph A. Karnaz, Member, CPI Fluid Engineering/Lubrizol, Midland, MI

Lubricants are an essential component to effective operation of air conditioning and refrigeration compressors which are exhaustively studied by compressor engineers and tribology experts. But there are other aspects to lubrication effects beyond the compressor which can also be key to effective operation and performance of air conditioning and refrigeration systems. This seminar presents examples of how the lubricant circulated from the compressor into the system can affect system components, oil management and overall system performance with existing and alternate refrigerants.

1. Managing Lubricants in a Large Commercial Refrigeration System

Danny Halel, Member, Hussman Corporation, Bridgeton, MO

2. Lubricant Management Heuristics and Impacts on System Chemistry, Valves and Other System Components

Christopher Reeves, Associate Member, Sporlan Valve Division of Parker Hannifin, Washington, MO

3. Lubricants in Heat Exchangers: A Slippery Slope

Scott Wujek, Ph.D., Member, Creative Thermal Solutions, Urbana, IL

4. Oil Separator Efficiency Rating Dilemma

Kok-Hiong Kee, Emerson Climate Technologies, Inc., St. Louis, MO

11:00 AM-12:30 PM

SEMINAR 44 (ADVANCED)

Optimization of Air-to-Refrigerant Heat Exchangers

Track: HVAC Systems and Equipment

Room: 222

Sponsor: 01.03 Heat Transfer and Fluid Flow, TC 1.13, 08.04 Air-to-Refrigerant Heat Transfer Equipment

Chair: Raymond Rite, Ph.D., Member, Ingersoll Rand - Trane, Tyler, TX

In the quest to reduce energy consumption and the amount of refrigerant in systems, the air-to-refrigerant heat exchanger is a prime area of interest. Although reducing heat exchanger cost and maximizing performance have always been of great interest to the HVAC community, recently new thoughts on tube size, materials, manufacturing processes, as well as computational analysis methodologies have been gaining traction. This program presents all of these facets of modern heat exchanger optimization.

1. Optimization and Validation of Novel Designs for Air-to-Refrigerant Heat Exchangers

Vikrant Aute, Ph.D., Member, University of Maryland, College Park, MD

2. Numerical Study on Heat Transfer and Pressure Drop Characteristics of Water Cooled Mini-Channel Heat Exchangers

Man-Hoe Kim, Ph.D., Member, Kyungpook National University, Buk-gu, Daegu, South Korea

3. Metal Foam Heat Exchanger Design Optimization for Improved Thermal-Hydraulic Performance under Dry Operating Conditions

Kashif Nawaz, Ph.D., Johnson Controls, Inc., Norman, OK

11:00 AM-12:30 PM

SEMINAR 45 (INTERMEDIATE)

Planes, Trailers and Ships: Advances in Transport Refrigeration System Technologies



Track: Advances in Refrigeration Systems and Alternative Refrigerants
Room: 221

Sponsor: 10.06 Transport Refrigeration

Chair: Robert Chopko, Member, Carrier Transicold, Syracuse, NY

Advances in transport refrigeration and air-conditioning systems used in "Planes, Trailers and Ships" have evolved over many years. Today's systems must incorporate the latest available technologies, taking into consideration current and future regulatory requirements for refrigerants with low Global Warming Potential, energy efficiency, indoor air quality, food quality standards and customer expectations around total operating costs. A summary of transport refrigeration system technologies generally, along with marine air conditioning systems, are presented and includes associated technical challenges, trade-offs and potential design impacts.

1. Ships: Advances in Transport Refrigeration System Technologies

Glover Kevin, Member, United Technologies, Carrier Marine Systems, Syracuse, NY

2. Airplanes, Part 1: Advances in Transport Refrigeration System Technologies

Igor Vaisman, Ph.D., Member, Rolls-Royce North American Technologies, Indianapolis, IN

3. Airplanes, Part 2: Advances in Aerospace Galley Refrigeration System Technologies

Qiao Lu, B.E. Aerospace Inc., Placentia, CA

4. Trucks, Trailers: Advances in Transport Refrigeration System Technologies

Casey Briscoe, Ph.D., Member, Ingersoll Rand, Minneapolis, MN

11:00 AM-12:30 PM

SEMINAR 46 (INTERMEDIATE)

Regulatory Process Overview for Smart Grid, Smart Building and Demand Response Programs as Applicable to Building Owners and Utility Tariffs

Track: Smart Building Systems/

Remote Monitoring and Diagnostics

Room: 228

Sponsor: 07.05 Smart Building Systems, NA

Chair: Glenn Remington, Member, Consumers Energy, Jackson, MI

This seminar presents a top down overview of how smart grid and demand response federal policy and laws make their way through the Federal Energy Regulatory Commission to the various regional transmission authorities then to the state level and how it impacts building owner/operators and electricity tariffs.

1. Overview of the Regulatory Process Related to Smart Grid and Demand Response

Tom Lawrence, Ph.D., Member, University of Georgia College of Engineering, Athens, MI

2. Overview of Public Utilities Regulation at the State Level and Contested Case Tariff Process

Robert Schallenberg, Missouri Public Service Commission, Jefferson City, MO

3. The Role of Third Party Aggregators in Demand Response Programs

Greg Poulos, J.D., EnerNOC, Columbus, OH

11:00 AM-12:30 PM

SEMINAR 47 (BASIC)

Update on the ASHRAE Innovative Research Grant Program and Future Plans for It

Track: *Research Summit*

Room: 227

Sponsor: *Research Administration Committee*

Chair: *Kishor Khankari, Ph.D., Fellow ASHRAE, AnSight LLC, Ann Arbor, MI*



The ASHRAE Innovative Research Grant (IRG) was established in 2011 to provide seed funding for novel research deemed to have the potential to significantly advance the state-of-the-art in HVAC&R engineering. The idea is to encourage out-of-the-box research to complement the research proposed and guided by technical committees. This session provides an update on the results from the first two and only grants awarded from the program and RAC's plans for this program in the future.

1. Irg-021: Smart Nanolubricants for HVAC&R Systems

Lorenzo Cremaschi, Ph.D., Member, Auburn University, Auburn, AL

2. Irg-024, Biowall Research

William Hutzler, P.E., Member, Purdue University, West Lafayette, IN

3. Future Plans for the ASHRAE Irg Program

Kishor Khankari, Ph.D., Fellow ASHRAE, AnSight LLC, Ann Arbor, MI

1:30 PM-3:00 PM

SEMINAR 48 (BASIC)

The Philosophy and Ethics of the Different Building Industry Professionals

Track: *Professional Skills Beyond Engineering*

Room: 226

Sponsor: *01.07 Business, Management & General Legal Education*

Chair: *Richard Rooley, FREng, OPMP, Presidential Fellow ASHRAE, Project Management Partnership, Stoke Poges, United Kingdom*



Great buildings are created by constructive confrontation. Each commercial company in the process enters into a contract for its part of the work. Theoretically there is consistency among the many contracts. In the real world a lack of consistency combined with misunderstandings can create conflict. The team of building industry professionals people are drawn together for the project with different education, training, method of working, communication skills and membership of professional bodies who each have codes of ethics. In the education of each, a different philosophy is taught or implied. The audience has their own individual background.

1. The Philosophy and Ethics of the Architect

Leonard Sciarra, AIA, Gentler, Chicago, IL

2. The Philosophy and Ethics of the Design Engineer

Ginger Scoggins, P.E., Member, Engineering Designs, Cary, NC

3. The Philosophy and Ethics of the Contractor

Michael Cooper, P.E., Member, MCC, Metairie, LA

4. The Philosophy and Ethics of the Manufacturer

Tom Watson, P.E., Presidential Fellow ASHRAE, Daikin Applied, Staunton, VA

3:15 PM-4:45 PM

SEMINAR 49 (INTERMEDIATE)

Bringing a New Look and Energy to a Federal Building in Houston

Track: *HVAC Systems and Equipment*

Room: 226

Sponsor: *09.01 Large Building Air-Conditioning Systems*

Chair: *Alonzo Blalock, P.E., Member, Jacobs Engineering, Fort Worth, TX*



This program explains the multi-year project to provide new 'skin' to the existing 22 story Federal Office building in Downtown Houston – and the process of renovation of complete interior HVAC and lighting

systems; working thru two floors per cycle, while all other aspects of the building remained in use for occupants. The project includes: use of VAV diffusers for room air distribution; use of Fan Wall in the replacement AHUs; complete new DDC control that includes overlay control to the new lighting system; large PV system installed on remote parking structure; and the enhanced performance of new envelope.

1. Designing the New Look

Thomas Shelton, Gensler, Dallas, TX

2. Planning Renovation of an Occupied Building

James Penland, Gilbane Co., Houston, TX

3. Upgrades to the HVAC, Electrical and Plumbing Systems

Gary Poole, P.E., Member, Bury Inc., Houston, TX

Commissioning Testing of the VAV Diffusers and PV

Alonzo Blalock, P.E., Member, Jacobs Engineering, Fort Worth, TX

4. We Taught the Old Dog a New Trick

Kendall Waldie, P.E., Member, Greater Southwest Region GSA, Fort Worth, TX

3:30 PM-5:00 PM

TC SEMINAR (INTERMEDIATE)

Is Poor Bedroom Ventilation Affecting Your Next-Day Performance?

Track: *Indoor Environment: Health, Comfort, Productivity*

Room: 225

Sponsor: *02.01 Physiology and Human Environment, SSPC-55*

Chair: *Pawel Wargocki, Technical University of Denmark, Lyngby, Denmark*

OPEN SESSION: no badge required; no PDHs awarded; presented during the TC's meeting. This seminar discusses how poor air quality negatively affects sleep and reduces next-day performance. Dr. Dennis Loveday, Loughborough University presents "What's Been Happening to Thermal Conditions in UK Bedrooms over the Last Forty Years?" Chandra Sekhar, National University of Singapore, presents "Overnight Air Quality in Bedrooms in Hot and Humid Climates." Dr. Lan Li, Shanghai Jiao Tong University, presents "Sleeping Thermal Environment, Thermal Comfort and Sleep Quality." Pawel Wargocki, the Technical University of Denmark, presents "The Effects of Bedroom Air Quality on Sleep and Next-Day Performance."

5:00 PM-6:00 PM

TC SEMINAR (INTERMEDIATE)

Indoor Air Quality in Underground Stations and Tunnels: Development of a New ASHRAE Standard

Track: *Indoor Environment: Health, Comfort, Productivity*

Room: 223

Sponsor: *05.09 Enclosed Vehicular Facilities, SPC 217, 04.10 Indoor Environmental Modeling*

Chair: *Igor Maevski, Ph.D., P.E., Member, Jacobs Engineering, New York, NY*

OPEN SESSION: no badge required; no PDHs awarded; presented during the TC's meeting. This seminar introduces and discusses the development of a new ASHRAE Standard, "Non-Emergency Ventilation in Enclosed Road, Rail and Mass Transit Facilities." Robert Smith, Innerquest, LLC, presents "Ventilation System and Equipment Selection Issues in Underground Transit Stations and Tunnels." Yuan Li, Jacobs Engineering, presents "Non-Emergency Ventilation Standard for Road Tunnels." David G. Newman, Hatch Mott MacDonald, presents "Non-Emergency Ventilation Standard for Rail Tunnels." Mark Colino, Parsons Brinckerhoff, Inc. presents "Non-Emergency Ventilation Standard for Mass Transit Stations and Tunnels."

TECHNICAL PAPER SESSION 9 (INTERMEDIATE)

Fan and Airflow Diagnostics and Modeling

Track: *Fundamentals and Applications*

Room: 224

Chair: *Kimberly Pierson, Moser Mayer Phoenix Associates, Greensboro, NC*



Mathematical models, experimental data and field observations are used in various ways in these papers to characterize performance of fan-powered terminal units, determine system effects on plenum/plug fans, detect low evaporator airflow using fan power for rooftop units and model airflow through a perforated duct.

1. Modeling Airflow through a Perforated Duct (ST-16-023)

Jesse Maddren¹, John Farrell², Alan Fields³ and Cesar Jarquin⁴, (1) California Polytechnic State University, San Luis Obispo, CA, (2)MHC Engineers, Inc., San Francisco, CA, (3)Sungevity, Oakland, CA, (4) Glenair, Inc., Glendale, CA

2. Low Evaporator Airflow Detection Using Fan Power for Rooftop Units (ST-16-024)

Yunhua Li, Associate Member¹, Mingsheng Liu, Ph.D., P.E., Member¹ and Josephine Lau, Ph.D., Member², (1)Bes-Tech, Inc., Omaha, NE, (2)Univ of Nebraska-Lincoln, Omaha, NE

3. Characterizing the Performance of Fixed Airflow Series Fan-Powered Terminal Units Using a Mass and Energy Balance Approach (ST-16-025)

Dennis O'Neal, Ph.D., P.E., Fellow ASHRAE¹, Carl Reid² and Peng Yin, Ph.D., Student Member¹, (1)Baylor University, Waco, TX, (2)Bee, Austin, TX

4. Using a Mass and Energy Balance Approach to Model the Performance of Parallel Fan-Powered Terminal Units with Fixed Airflow Fans (ST-16-026)

Peng Yin, Ph.D., Student Member¹, Dennis O'Neal, Ph.D., P.E., Fellow ASHRAE¹ and Carl Reid², (1)Baylor University, Waco, TX, (2)Bee, Austin, TX

CONFERENCE PAPER SESSION 17 (INTERMEDIATE)

Field Data and Ensuing Recommendations

Track: *Research Summit*

Room: 225

Chair: *Juan-Carlos Baltazar, Ph.D., P.E., BEMP, Member, Texas A&M University, College Station, TX*



This session evaluates measured energy and water usage in residential buildings and the variations due to occupancy and users and the changes over six years. This session also looks at the performance of office and K-12 facilities that were designed to meet the ASHRAE 30% AEDG, and where they stand compared to code-minimum facilities. Lastly, this session discusses the development of benchmarking data for Army buildings based on metered data obtained from new construction facilities.

1. An Evaluation of the Actual Energy Performance of Small Office and K-12 School Buildings Designed in Accordance with the 30% ASHRAE Advanced Energy Design Guidelines (ST-16-C050)

Dennis Jones, P.E., Member, Group14 Engineering Inc, Denver, CO

2. Developing Benchmarks for US Army Buildings Using Data from the Metering Data Management System (ST-16-C051)

Rahul A. Athalye, Associate Member¹, Daniel Carpio² and Kim Fowler¹, (1)Pacific Northwest National Laboratory, Richland, WA, (2) US Army Corps of Engineers, Los Angeles, CA

3. Variations in Use of Household Electricity between Years: Measurements in 539 Apartments during Six Years (ST-16-C052)

Dennis Johansson, Ph.D., Associate Member and Hans Bagge, Ph.D., Associate Member, Lund University, Lund, Sweden

4. Correlations between Apartment Occupancy Levels and Use of Household Electricity and Domestic Hot Water (ST-16-C053)

Hans Bagge, Ph.D., Associate Member and Dennis Johansson, Ph.D., Associate Member, Lund University, Lund, Sweden

SEMINAR 50 (BASIC)

ASHRAE + STEM = ???

Track: *Professional Skills Beyond Engineering*

Room: 223

Sponsor: *01.07 Business, Management & General Legal Education, Student Activities Committee*

Chair: *Bill Simpson, BEAP, Member, Harrison Energy Partners, Little Rock, AR*



What is all the hype about STEM (Science, Technology, Engineering, Mathematics)? Why should ASHRAE members care about it? How do they talk to kids about it? What is the difference in dealing with K-12 or post-high? This session not only answers these questions but also shares what the society committee has developed for member use.

1. Why Should an Engineer Care about Talking to Kids?

Kristin Schaefer, P.E., Member, Schaefer Engineering, Katy, TX

2. What Does ASHRAE Have to Help You with Students?

Joe Chin, P.E., Western Allied Mechanical, Inc., Menlo Park, CA

3. How to Do a K-12 STEM Classroom Visit

Chuck Curlin, P.E., Member, Shultz Engineering Group, Charlotte, NC

SEMINAR 51 (INTERMEDIATE)

Passive Buildings and VRF: How Low Can You Go?

Track: *Renewable Energy Systems and Net Zero Buildings*

Room: 226

Sponsor: *08.07 Variable Refrigerant Flow*

Chair: *Christopher R. Laughman, Ph.D., Member, Mitsubishi Electric Research Laboratories, Cambridge, MA*



Passive buildings have attracted a great deal of interest because of their promise of reducing energy consumption and operating cost while maintaining occupant comfort. VRF is well suited to cooling and heating in these applications because of its high efficiency at the part-load conditions at which these buildings usually operate. This seminar includes presentations from manufacturers, mechanical engineers and architects on strategies and methods for designing and installing these systems in these buildings with their accompanying energy efficiency and ventilation requirements.

1. HVAC Design Considerations for Passive Buildings

Michael Ingui, AIA, Baxt/Ingui Architects, P.C., New York, NY

2. VRF Systems for Passive Buildings

Paul Doppel, Mitsubishi Electric, Suwanee, GA

3. System Specification for Passive Buildings

Cramer Silkworth, P.E., Baukraft Engineering, PLLC, Brooklyn, NY

SEMINAR 52 (INTERMEDIATE)

Residential Building Smart Devices and Data: Improving Energy Use Insights and Performance Evaluation

Track: *Smart Building Systems/*

Remote Monitoring and Diagnostics

Room: 227

Sponsor: *07.05 Smart Building Systems*

Chair: *Kristen Cetin, Ph.D., P.E., Associate Member, Iowa State University, Ames, IA*



The number of smart, connected technologies available and implemented in buildings has increased significantly in recent years, as have the number of types of devices and their capabilities to collect data on building performance, energy use and demand. This seminar presents opportunities to utilize these devices and data collected to more intelligently

assess current building performance and more intelligently operate building systems. This seminar covers various advances in the collection and use of residential building energy and performance data for more smart assessment and operation of buildings.

1. Energy Use Insights from Inverse Thermodynamic-Based Modeling of Residential Buildings

Kristen Cetin, Ph.D., P.E., Associate Member, Iowa State University, Ames, IA

2. Demand Prediction Using Connected Thermostat Residential Building Energy Models

Ratnesh Tiwari, Ph.D., University of Maryland, College Park, MD

3. Cornell Temperature Datalogger Project

Howard Chong, Ph.D., Cornell University, Ithaca, NY

8:00 AM-9:30 AM

SEMINAR 53 (INTERMEDIATE)

Smart Equipment: the Intelligent Buildings Revolution Is Happening in the Edge

Track: Smart Building Systems/

Remote Monitoring and Diagnostics

Room: 228

Sponsor: 01.04 Control Theory and Application, 06.01 Hydronic and Steam Equipment and Systems

Chair: Marcelo Acosta, P.E., Member, Armstrong Fluid Technology, Toronto, ON, Canada

Will highly efficient buildings intelligence reside in the Cloud or in the Edge? This session presents three examples of Smart Equipment already in the market, showing how in depth manufacturer knowledge of the equipment embedded in distributed intelligence surpasses generic and distant intelligence in energy savings, diagnostics, auto-commissioning, redundancy and reliability. The session also shows how full systems optimization and really useful user interfaces can be achieved with the addition of lightweight integration.

1. Smart Pumps Keep Your HVAC System Running High

David Lee, P.Eng., Member, Armstrong Fluid Technology, Toronto, ON, Canada

2. Smart Valves: the Cool New Kids Are Doing Flow Balancing and Control

Miha Kavcic, Member, Danfoss Trata Dd, Chicago, IL

3. Smart Compressors: Are They Magic? No...But They Are Amazing!

Jose Alvarez, Member, Danfoss Turbocor Compressors, Inc., Tallahassee, FL

4. Integrating Smart Equipment Made Easy

Marcelo Acosta, P.E., Member, Armstrong Fluid Technology, Toronto, ON, Canada

8:00 AM-9:30 AM

SEMINAR 54 (INTERMEDIATE)

Standard 100-2015 Overview and the Potential of Its High-Performance Existing Building Metrics

Track: Fundamentals and Applications

Room: 222

Sponsor: 07.06 Building Energy Performance, SSPC 100, 02.08 Building Environmental Impacts and Sustainability

Chair: Wayne H. Stoppelmoor Jr., Member, Schneider Electric, Cedar Rapids, IA

Existing building renovations comprise 86% of annual construction cost in the United States. Improving the energy performance of existing buildings represents one of our greatest opportunities for a more sustainable future. This seminar provides information on new provisions in Standard 100-2015. The revised standard provides comprehensive and detailed descriptions of the processes and procedures for the retrofit of existing residential and commercial buildings to achieve greater energy efficiency. Development and application of newly developed energy targets for compliance will be described, along with detailed energy audit procedures included in the standard.

1. Key Objectives and Provisions of a Major Revision to ASHRAE's Existing Buildings Energy Efficiency Standard

Gordon V. R. Holness, P.E., Fellow Life Member, Consulting Engineer, West Palm Beach, FL

2. Development and Application of Target Tables in Standard 100

Terry Sharp, P.E., Oak Ridge National Laboratory, Oak Ridge, TN

3. The Energy Audit Path in Standard 100

Jim Kelsey, P.E., BEAP, kW Engineering, Oakland, CA

8:00 AM-9:30 AM

SEMINAR 55 (ADVANCED)

System Efficiency Impacts of Low-GWP Refrigerants: Is This Our Fall from Grace?



Track: Advances in Refrigeration Systems and Alternative Refrigerants
Room: 221

Sponsor: 03.01 Refrigerants and Secondary Coolants

Chair: Christopher Seeton, Ph.D., Member, Shrieve, The Woodlands, TX

This session investigates the energy efficiency of several alternative Low Global Warming Potential refrigerant blends. The presentations address the thermodynamics of the blends, including the associated temperature glide in the heat exchangers. They also focus on the types of application whether the blend is intended for drop-in or near drop-in service or whether intensive changes are required to capture the best performance. Comparisons from the recent AHRI alternative refrigerants program are also presented to show the most recent developments and state of the art.

1. The Thermodynamic Efficiency of Refrigerants: a History of a Downhill Slide?

Kenneth Schultz, Ph.D., Member, Ingersoll Rand, La Crosse, WI

2. A Total System Analysis of Air and Water Cooled Lower GWP Refrigerants

Richard Lord, Fellow ASHRAE, United Technologies Carrier Corp, Murfreesboro, TN

3. Low GWP (A2L) Refrigerant Evaluation on a 10-Ton Rooftop Air-Conditioner

Zuojun Shi, United Technologies, Carrier Corporation, Syracuse, NY

4. Evaluation of a Lower GWP Refrigerant Option for R404A in Commercial Refrigeration Applications

Brian Fricke, Ph.D., Member, Oak Ridge National Laboratory, Oak Ridge, TN

9:45 AM-10:45 AM

CONFERENCE PAPER SESSION 18 (INTERMEDIATE)

3D Printer Emissions

Track: Indoor Environment: Health, Comfort,

Productivity

Room: 221

Chair: James F. Sweeney, Associate Member, Texas A&M University, College Station, TX

3D printers are being increasingly utilized in industrial, commercial, institutional and residential applications. These printers provide many beneficial applications and their use will grow exponentially in the near future. However, these printers emit nanoscale particulate for which current filtration methods may not be adequate to protect occupants from harmful effects of such particulates. This session assesses potential hazards to occupants of spaces where 3D printers are used, and also examines whether compliance standards are needed in order to protect occupants.

1. Fine Particulate and Chemical Emissions from Desktop 3D Printers (ST-16-C054)

Aika Davis, Ph.D.¹, Marilyn Black, Ph.D.¹, Qian Zhang², Jenny Wong, Ph.D.² and Rodney Weber, Ph.D.², (1)UL, Atlanta, GA, (2)Georgia Institute of Technology, Atlanta, GA

2. Field Investigations of Nanoscale Particle Dispersion and Deposition Emitted from 3D Printers in Ventilated Spaces (ST-16-C055)

Zheng O'Neill, Ph.D., P.E., Member and Charles O'Neill, Ph.D., University of Alabama, Tuscaloosa, AL

9:45 AM-10:45 AM

CONFERENCE PAPER SESSION 19 (INTERMEDIATE)

What's New in Water Heating

Track: HVAC Systems and Equipment

Room: 225

Chair: Henry A. Becker, Member, H-O-H Water Technology, Inc., Palatine, IL



The three papers in this session focus on various aspects of energy efficient and environmentally conscience water heating. Heating using sorbent technology is discussed that uses primary thermal energy bypassing the need to convert thermal energy into electrical power. Advanced heat pump technologies and system designs that sustain water storage tank stratification are also reported.

1. Bounding Limitations in the Practical Design of Adsorption Heat Pump Water Heaters (ST-16-C056)

Moonis Ally, Ph.D. and Kyle Gluesenkamp, Ph.D., Member, Oak Ridge National Laboratory, Oak Ridge, TN

2. Energy Factor Analysis for Gas Heat Pump Water Heaters (ST-16-C057)

Kyle Gluesenkamp, Ph.D., Member, Oak Ridge National Laboratory, Oak Ridge, TN

3. Impact on Water Heater Performance of Heating Methods That Promote Tank Temperature Stratification (ST-16-C058)

Kyle Gluesenkamp, Ph.D., Member¹ and John Bush, P.E., Member², (1)Oak Ridge National Laboratory, Oak Ridge, TN, (2)Electric Power Research Institute, Knoxville, TN

9:45 AM-10:45 AM

SEMINAR 56 (INTERMEDIATE)

Data Sources toward Urban-Scale Energy Modeling, Part 2

Track: Smart Building Systems/Remote Monitoring and Diagnostics

Room: 227

Sponsor: 01.05 Computer Applications

Chair: Joshua New, Ph.D., Member, Oak Ridge National Laboratory, Oak Ridge, TN



Development of urban-scale building energy models is becoming of increased interest for many applications including city-wide energy supply/demand strategies, urban development planning, electrical grid stability and urban resilience. This seminar assembles several leaders in the field of urban-scale energy models to discuss an overview of the field as well as the data, algorithms, workflow and practical challenges addressed to create useful models of individual buildings at the scale of a city.

1. Integration of Reduced Order Energy Model with Geographical Information for Urban-Scale Building Energy Modelling under Urban Context

Jason Brown and Qi Li, Georgia Institute of Technology, Atlanta, GA

2. Urban Microclimate for Building Energy Models

Melissa Allen, Ph.D., Oak Ridge National Laboratory, Oak Ridge, TN

3. Techniques for Rapid Generation of Urban-Scale Energy Models

David Scheer, Autodesk, San Francisco, CA

9:45 AM-10:45 AM

SEMINAR 57 (INTERMEDIATE)

Energy Savings via ASHRAE Level III Auditing, Retrofit and Recommissioning: A Case Study at Hameetman Science Center, Occidental College II

Track: Fundamentals and Applications

Room: 223

Sponsor: 07.03 Operation and Maintenance Management

Chair: Robyn Ellis, Associate Member, City of Hamilton - Public Works, Hamilton, ON, Canada



A previous related session was presented about the initial assessment and the creation of the scope of work of this project. This session focuses on the actual work completed and the obstacles and opportunities encountered. Data is presented detailing the deterioration effect of

distribution systems on equipment rated capacity and efficiency. An analysis of the impact of the completed scope of work on the energy, comfort and increased reliability of the buildings is offered in this segment of the seminar. The bearing of the improvements on peak load are also discussed.

1. Occidental College Hameetman Science Building HVAC Retrofit and Recommissioning

Rob Falke, Member, National Comfort Institute, Avon Lake, OH

2. Increases to Energy Efficiency, Reliability and Comfort

Ben Lipscomb, P.E., Associate Member, NCI, Sheffield Lake, OH

9:45 AM-10:45 AM

SEMINAR 58 (INTERMEDIATE)

Improved Modeling Characteristics of a Data Center without Compromising Physics or Breaking The Bank

Track: Fundamentals and Applications

Room: 222

Sponsor: 09.09 Mission Critical Facilities, Technology Spaces and Electronic Equipment, 04.10 Indoor Environmental Modeling

Chair: Nick Gangemi, Member, Northern Air Systems, Rochester, NY



CFD modeling is a powerful tool to simulate and analyze an existing data center or explore the multiple design parameters of a new data center. The challenge is the extreme run time required. Often times this necessitates making choices on what to leave in and what to take out. This session explores several ways to speed up run time for multiple options while preserving accuracy and not sacrificing the physics. The session also takes a look at stanchions and why they should not be excluded in any raised floor model and validated from actual measurements.

1. Improving Model Calculation Time without Sacrificing Physics

Mark Seymour, CEng, Member, Future Facilities Ltd, London, United Kingdom

2. The Compact Modeling of Raised-Floor Stanchions

Zachary Pardey, Schneider Electric, Andover, MA

3. Data Center Modeling Using Response Surface Methodology

Cheng-Xian Lin, Ph.D., Member, Florida International University, Miami, FL

9:45 AM-10:45 AM

SEMINAR 59 (INTERMEDIATE)

Solar Decathlon 2015: Lessons Learned from the Largest Student-Led Solar Powered Housing Competition

Track: Renewable Energy Systems and Net Zero Buildings

Room: 226

Sponsor: 07.05 Smart Building Systems

Chair: Joshua Rhodes, Ph.D., Student Member, University of Texas at Austin, Austin, TX



The U.S. Department of Energy Solar Decathlon challenges collegiate teams to design, build and operate solar-powered houses that are cost-effective, energy-efficient, net-zero and attractive. This seminar hosts two teams, including the overall winners as they talk about what worked and what didn't in the competition. Many teams tried moon-shot ideas including residential hydronic TES HVAC systems and fully connected, occupant-responding homes. This seminar gives the audience a deep look at some of the submissions to the competition.

1. SURE House: Winner of the 2015 U.S. Department of Energy Solar Decathlon

Ed May, Stevens Institute of Technology, Hoboken, NJ

2. Nexushaus: A Net-Zero Energy and Water Urban Infill Home

Charles Upshaw, Student Member, University of Texas at Austin, Austin, TX

9:45 AM-10:45 AM

FORUM 4 (INTERMEDIATE)

To Centralize or Decentralize a Thermal Energy System: The Great Debate Continues

Track: HVAC Systems and Equipment

Room: 224

Sponsor: 06.02 District Energy

Chair: Alan Neely, Member, Pittsburgh Corning Corporation, The Woodlands, TX

This forum panel comprised of a manufacturer, a design consultant and a district energy provider, provides a short presentation of their opinion on the pros/cons of the centralized vs a decentralized thermal system. A question and answer period will then follow. Questions presented by the moderator will be directed to get into the detail of the benefits of each system.

9:45 AM-10:45 AM

WORKSHOP 9 (ADVANCED)

The Busted BIM Building Blues

Track: Fundamentals and Applications

Room: 228

Sponsor: 07.02 HVAC&R Contractors and Design Build Firms, TC 1.07 Business, Management and General Legal Education, 07.01 Integrated Building Design

Chair: E. Mitchell Swann, P.E., Member, MDC Systems, Paoli, PA

BIM has become a growing industry practice over the past 10 years. Inconsistencies in approach, application and intended use have made the realization of the theoretical benefits of BIM uneven. The lure of BIM is fewer field conflicts, fewer RFIs, fewer change orders and a better project. What can you do with BIM when you have it? How should an engineer “do” BIM? A Contractor? An owner? Wouldn't you like to know? Well then, you had better come to this program to find out! (But remember, the blues can be happy too!)

1. You've Got Friends: the Successful Execution of BIM for MEP Work

Eli P. Howard, III, Member, SMACNA, Chantilly, PA

2. When You Believe in Things You Don't Understand, You Suffer

E. Mitchell Swann, P.E., Member, MDC Systems, Paoli, PA

11:00 AM-12:30 PM

CONFERENCE PAPER SESSION 20 (INTERMEDIATE)

Environmentally Conscious Building Designs

Track: Renewable Energy Systems and Net Zero Buildings

Room: 221

Chair: Kyle Knudten, CPMP, McClure Engineering, St. Louis, MO

HVAC modeling and design can take on some unique variations as engineers seek to make buildings more environmentally sound. This session examines better ways to integrate both building energy modeling and life cycle environmental impacts. It also provides a look at an earth-to-air heat exchange system used in a cold climate application; and reviews a hybrid system utilizing solar and geothermal for renewable energy.

1. Solar Hybrid and Geothermal Combined: New System Solution for Renewables (ST-16-C059)

Pernilla Gervind and Jessica Benson, SP Technical Research Institute of Sweden, Gothenburg, Sweden

2. Energy Performance of Concrete Earth Tubes for the Pre-Heating and Pre-Cooling of Supply Air in Cold Climate (ST-16-C060)

Michel Tardif, P.Eng., Natural Resources Canada, Ottawa, ON, Canada

3. Expansion in Number of Parameters: Simulation of Energy and Indoor Climate in Combination with LCA (ST-16-C061)

Aleksander P. Otovic, Lotte M. B. Jensen, Ph.D. and Kristoffer Negendahl, Technical University of Denmark, Kongens Lyngby, Denmark

4. Reducing Uncertainty in Predicting Life-Cycle Environmental Impacts of HVAC Systems (ST-16-C062)

Mike Medas¹, Andrew Cripps², John Connaughton³ and Dave Cheshire⁴, (1)AECOM & The University of Reading, London, United Kingdom, (2) AECOM, St. Albans, United Kingdom, (3)University of Reading, Reading, United Kingdom, (4)AECOM, London, United Kingdom

11:00 AM-12:30 PM

CONFERENCE PAPER SESSION 21 (ADVANCED)

Experience with Alternative Refrigerants



Track: Advances in Refrigeration Systems and Alternative Refrigerants
Room: 224

Chair: Michael Pate, Ph.D., P.E., Member, Texas A&M University, College Station, TX

Due to continuing regulatory pressures, the search for low-GWP alternative refrigerants is ongoing. This session provides results of extensive testing of various low-GWP refrigerants in various HVAC applications, including a high temperature heat pump.

1. Measured Performance of a High Temperature Heat Pump with HFO-1336mzz-Z as the Working Fluid (ST-16-C063)

Franz Helminger¹, Konstantinos Kontomaris, Ph.D., Member², Julian Pfaff³, Michael Hartl¹ and Thomas Fleckl¹, (1)AIT - Austrian Institute of Technology, Vienna, Austria, (2)Chemours Fluorochemicals, Wilmington, DE, (3)BITZER K hlmaschinenbau GmbH, Sindelfingen, Germany

2. Performance of a Four-Ton Rooftop Unit with Low GWP R410A Alternatives (ST-16-C064)

Kenneth Schultz, Ph.D., Member¹ and Stephen Kujak, Member², (1) Ingersoll Rand, La Crosse, WI, (2)Trane, Ingersoll Rand, La Crosse, WI

3. Drop-in Tests and Simulation Results of R410A and R32/1234ze Blend in a R32 Dedicated Mini-Split (ST-16-C065)

Osami Kataoka, Member¹ and Fumio Ota², (1)Daikin Industries, Ltd., Osaka, Japan, (2)Daikin Industries, Ltd., Sakai, Japan

4. Performance of R-410A Alternative Refrigerants in a Reciprocating Compressor Designed for Air Conditioning Applications (ST-16-C066)

Som Shrestha, Ph.D., BEMP, Member¹, Edward A. Vineyard, Fellow ASHRAE¹, James Lenz, Member² and Kevin Mumpower, Member², (1) Oak Ridge National Laboratory, Oak Ridge, TN, (2)Bristol Compressors International, Inc., Bristol, TN

5. Hot Surface Ignition Testing for 2L Class Refrigerants (ST-16-C067)

Mary E. Koban, Member and Patrick E. Coughlan, Chemours Fluoroproducts, Wilmington, DE

11:00 AM-12:30 PM

CONFERENCE PAPER SESSION 22 (INTERMEDIATE)

System Alternatives, Design Options and BIM Productivity

Track: HVAC Systems and Equipment

Room: 225

Chair: David Yashar, Ph.D., P.E., Member, NIST, Gaithersburg, MD

This session compares multiple HVAC systems, including water-based, air-based or refrigerant-based systems and the benefits they provide to a building. The session also addresses the concept of hybrid systems in large facilities with multiple types of occupancies, space operation and thermal loading. This session also reviews the benefits of integrating information into BIM for the use of design of these systems and improving quality control.

1. Evaluation of VRF Systems with Comparisons to Traditional HVAC Systems (ST-16-C068)

Guolian Wu, Ph.D., Member¹, Dochul Choi, Ph.D.¹, Wanyong Kim² and Gyoungtae Seo², (1)Samsung Electronics of America, Pine Brook, NJ, (2)Samsung Electronics, Suwon, South Korea

2. Hybrid Approaches to HVAC Systems Design of a R&D Complex to Achieve Green Building Certification and Optimal Comfort (ST-16-C069)

Guolian Wu, Ph.D., Member¹, Dochul Choi, Ph.D.¹, Wanyong Kim² and Jason Kim², (1)Samsung Electronics of America, Pine Brook, NJ, (2) Samsung Electronics, Suwon, South Korea

3. Energy and Exergy Performances of Air-Based vs. Water-Based Heating and Cooling Systems: A Case Study of a Single-Family House (ST-16-C070)

Ongun B. Kazanci, Student Member¹, Masanori Shukuya, Ph.D.² and Bjarne W. Olesen, Ph.D., Fellow ASHRAE¹, (1)Technical University of Denmark, Kongens Lyngby, Denmark, (2)Tokyo City University, Tokyo, Japan

4. Enhancing Mechanical Engineering Productivity with BIM *Blake Guither, P.E., BEMP, Associate Member, Gausman & Moore Engineers, St. Paul, MN*

11:00 AM-12:30 PM

SEMINAR 60 (INTERMEDIATE)

BIM and HVAC System Design

Track: Fundamentals and Applications

Room: 222

Sponsor: 01.05 Computer Applications, MTG.BIM Building Information Modeling

Chair: Stephen Roth, P.E., Member, Carmel Software Corp., San Rafael, CA

This seminar discusses how Building Information Modeling (BIM) tools are changing the way engineers perform HVAC system design including duct design, hot and cold water piping design, plumbing and fabrication. One speaker discusses how BIM authoring tools are helping to: Coordinate duct design, calculate duct/piping pressure drop, perform design validation and more. A second speaker discusses how conceptual HVAC design schematic tools work with BIM authoring tools. A third speaker discusses how these various tools from different vendors are able to communicate with one another using open source interoperability languages.

1. BIM Software and HVAC System Design

Martin Schmid, P.E., Autodesk, Boston, MA

2. HVAC Schematic System Design

Joe Simmons, P.E., Associate Member, HVAC Solution, Salt Lake City, UT

3. Sharing Information between BIM and HVAC Design Software Tools

Stephen Roth, P.E., Member, Carmel Software Corp., San Rafael, CA



11:00 AM-12:30 PM

SEMINAR 61 (INTERMEDIATE)

How Deep Can We Go? Designing and Drilling Deeper Geothermal Systems

Track: HVAC Systems and Equipment

Room: 223

Sponsor: 06.08 Geothermal Heat Pumps and Energy Recovery Applications

Chair: Scott Hackel, P.E., Member, Seventhwave, Madison, WI

Space limitations and other constraints are forcing engineers to design deeper boreholes for ground-source heat pump systems in buildings. There are advantages and disadvantages to doing deeper than typical boreholes, and there are specific limitations on depth in some circumstances. This seminar covers these considerations, both through calculation and design examples, as well as practical lessons learned from the field. The new, deep/ultradeep borehole, hydrostatic differential calculations from the 2015 ASHRAE Applications Handbook are also presented. The latest developments in non-cementitious grouts are introduced to help designers avoid pipe collapse in deeper boreholes without sacrificing performance.

1. Installation Practices and Hydrostatics of Deep Boreholes

Ryan Carda, P.E., Geo-Connections Inc, Elkton, SD

2. Swedish Practices and Experience with Deep Boreholes

Jose Acuna, Ph.D., Associate Member, KTH Royal Institute of Technology, Stockholm, Sweden

3. Evolution of High and Low Density Geothermal Grouts

Charles P Remund, Ph.D., Member, GeoPro, Inc., Elkton, SD



11:00 AM-12:30 PM

SEMINAR 62 (INTERMEDIATE)

Is It My Home or Is It Me? Latest Knowledge about IAQ in Homes



Track: Indoor Environment: Health, Comfort, Productivity

Room: 226

Sponsor: Environmental Health Committee

Chair: Kevin Kennedy, Children's Mercy Hospital and Clinics, Kansas City, MO

With increasing interest by homeowners in the role environmental exposure in their home might play in the health and well-being of themselves and their families, how much do we know about the role indoor environmental exposure from the building sources serves in causing chronic health conditions vs. the role human activity plays in indoor exposure? Which is more important? This seminar includes experts on different aspects of this discussion. Come and learn about the significant and complicated role both play in health.

1. It Is Definitely You: The Role of Human Activities

Jeffrey Siegel, Ph.D., University of Texas at Austin, Austin, TX

2. Indoor Environmental Exposure in Children: What We Know

Gary Adamkiewicz, Ph.D., Harvard School of Public Health, Boston, MA

3. Ventilation, Indoor Air and Health Outcomes

Dave Jacobs, National Center for Healthy Housing, Columbia, MD

4. Ventilation, Indoor Air Quality and Where the CO Comes from

Paul W. Francisco, Member, University of Illinois at Urbana-Champaign, Champaign, IL

11:00 AM-12:30 PM

SEMINAR 63 (INTERMEDIATE)

Moving Beyond Typical Year Weather Data

Track: Research Summit

Room: 228

Sponsor: 04.02 Climatic Information

Chair: Didier Thevenard, Ph.D., P.E., Member, Numerical Logics Inc., Waterloo, ON, Canada

The common practice in building performance modeling is to use "Typical Year" weather data. Such data is statistically selected from the long-term record based on representative statistics for solar radiation and dry bulb temperature. However, although the use of a single typical year is convenient, it often leads to severe inaccuracies in the estimation of building loads and energy consumption. It is time to rethink alternatives to the use of Typical Year files. This seminar provides a deeper understanding of the problems linked to the use of Typical Years and walks the audience through several alternatives.

1. How Much Does Energy Use Vary with 'Actual' Weather from Year to Year?

Drury Crawley, Ph.D., BEMP, Fellow ASHRAE, Bentley Systems, Inc., Washington, DC

2. How Much Do HVAC Loads Change Due to the Variability of Year-to-Year Weather?

Yu Joe Huang, BEMP, White Box Technologies, Moraga, CA

3. Understanding the Temporal and Spatial Variability of New Generation Gridded TMYs

Aron Habte, NREL, Golden, CO



SEMINAR 64 (INTERMEDIATE)**N-ZERO from Foundation to Financing: Residential Buildings***Track: Renewable Energy Systems and Net Zero Buildings*

Room: 227

Sponsor: 06.07 Solar Energy Utilization*Chair: Janice Means, P.E., Life Member, Lawrence Technological University, Southfield, MI*

This session discusses the strategies that can be implemented which will lead a home to become Near/Net Zero Energy Building. Also, financing models for the U.S. residential PV market are explored, including third-party power purchase agreements (PPAs) and lease based financing. In addition, review of The European Directive on the Energy Performance in Buildings (EPBD) that mandates nearly-zero energy new buildings by 2020 is discussed, including characteristics and benchmarks of NZEBs from within existing building stock.

1. NZEB Multidisciplinary Project Development to Reach a Zero CO2 Emission Sustainable Eco-Settlement: Technical, Physical, Legal, Financial and Regulatory Issues*Marija Todorovic, Ph.D., P.E., Fellow ASHRAE, University of Belgrade, vea-invi.ltd director, Belgrade, Serbia***2. NZEB Characteristics of European Residential Buildings and Assessment of Refurbishment Scenarios Using Building Typologies***Constantinos Balaras, Ph.D., Fellow ASHRAE, Group Energy Conservation (IERSD-NOA), Athens, Greece***3. What Does It Take for a Residential Home to be NZEB?***Khalid Nagidi, BEAP, Member, Energy Management Consulting Group, Wantagh, NY***4. Options, Trends and Regulatory Challenges in Residential Solar PV Finance and Ownership***James Leidel, Member, Oakland University, Rochester, MI*

notes

FUTURE ASHRAE MEETINGS

Winter	Date	Annual
Las Vegas	2017	Long Beach
January 28–February 1		June 24–28
Chicago	2018	Houston
January 20-24		June 23-27
Atlanta	2019	Kansas City
January 12-16		June 22-26

PAST ASHRAE MEETINGS

Los Angeles	1980	Denver
Chicago	1981	Cincinnati
Houston	1982	Toronto
Atlantic City	1983	Washington
Atlanta	1984	Kansas City
Chicago	1985	Honolulu
San Francisco	1986	Portland
New York	1987	Nashville
Dallas	1988	Ottawa
Chicago	1989	Vancouver
Atlanta	1990	St. Louis
New York	1991	Indianapolis
Anaheim	1992	Baltimore
Chicago	1993	Denver
New Orleans	1994	Orlando
Chicago	1995	San Diego
Atlanta	1996	San Antonio
Philadelphia	1997	Boston
San Francisco	1998	Toronto
Chicago	1999	Seattle
Dallas	2000	Minneapolis
Atlanta	2001	Cincinnati
Atlantic City	2002	Honolulu
Chicago	2003	Kansas City
Anaheim	2004	Nashville
Orlando	2005	Denver
Chicago	2006	Quebec City
Dallas	2007	Long Beach
New York	2008	Salt Lake City
Chicago	2009	Louisville
Orlando	2010	Albuquerque
Las Vegas	2011	Montreal
Chicago	2012	San Antonio
Dallas	2013	Denver
New York	2014	Seattle
Chicago	2015	Atlanta
Orlando	2016	St. Louis

STANDING COMMITTEE CHAIRS

As the 2015–16 Society year draws to a close, I want to thank you for serving as a standing committee chair. Your assistance over the past year has been invaluable.

This year, my presidential theme focused on Making Connections. It has been said that human connections are the “invisible threads that are the strongest ties.” Forging stronger connections amongst people working in the built environment is a priority for me.

Making Connections means connecting with industry, communities, governments and the public. ASHRAE’s mission is to advance the arts and sciences of heating, ventilating, air conditioning and refrigerating to serve humanity and promote a sustainable world. For us to succeed, we have to build connections. The members of the ASHRAE standing committees are most certainly among those strong connections.

The imaginations of people in our industry are literally changing the world. We’ve made decisions to invest in top talent – and big, bold ideas. Imagine improving the quality of life for everyone. John Lennon said “A dream you dream alone is only a dream. A dream you dream together is reality.” Our reality at ASHRAE is making connections that advance our world through viable, affordable, green technology.

We must all work together to make our dream for a sustainable future come true. ASHRAE cannot do its job without the creativity and passion from all its members, connecting colleagues within our industry and beyond. Again, thank you for your work over the past year and moving forward.

Sincerely,



David Underwood, P.Eng., Fellow ASHRAE, Life Member, CPMP
2015–16 ASHRAE President

Michael J. Brandemuehl, Chm
Building Energy Quotient Committee

Shanta L. Tucker, Chm
Certification Committee

Robert J. Laneve, Chm
Chapter Technology Transfer Committee

Sarah E. Maston, Chm
Conferences & Expositions Committee

T. Randall Jones, Chm
Development Committee

Cynthia A. Callaway, Chm
Electronic Communications Committee

Zuraimi Sultan, Chm
Environmental Health Committee

Bjarne W. Olesen, Chm/CO
Finance Committee

William P. Bahnfleth, Chm
Grassroots Government
Activities Committee

Christopher J. Ahne, Chm
Handbook Committee

Ronald P. Vallort, Chm
Historical Committee

Jennifer A. Isenbeck, Chm
Audit Committee

William W. Malphus, Chm
Honors and Awards Committee

Randy C. Schrecengost, Chm
Membership Promotion Committee

William P. Bahnfleth, Chm
Nominating Committee

Dennis J. Wessel, Chm
Planning Committee

Timothy G. Wentz, Chm
President-Elect Advisory Committee

Cameron R. Labunski, Chm
Professional Development Committee

Timothy C. Dwyer, Chm
Publications Committee

Christopher J. Seeton, Chm
Refrigeration Committee

Carl F. Huber, Chm
Research Administration Committee

Daniel R. Rogers, Chm
Research Promotion Committee

Arthur L. Giesler, Chm
Society Rules Committee

Douglas T. Reindl, Chm
Standards Committee

Joseph A. Chin, Chm
Student Activities Committee

Thomas M. Lawrence, Chm
Technical Activities Committee

Chris M. Gray, Chm
Young Engineers in
ASHRAE Committee

SOCIETY COMMITTEE MEETINGS

All society committee meeting rooms are located in the Marriott St. Louis Grand. The Marriott's meeting space is located in the main hotel and across the street in the Conference Building which is called Conference Plaza. Access to the Conference Plaza is via an underground tunnel that can be accessed from the Gateway level via either elevator or escalator. Escalators to Gateway level are located just past Zenia Bar & Grille on the lobby level. Codes for this level are (CL) which is Conference Plaza street level and (CP2) which is Conference Plaza 2nd level. Subcommittees are indented.

AEDG Steering Committee (10/10) Electric

Monday (6/27) 2:15 pm – 5:00 pm Landmark 3 (CL)

Appointments Roadmap (22/0)

Sunday (6/26) 7:00 am – 8:00 am Benton (M)

ASHRAE Foundation (25/10) Screen/Electric

Monday (6/27) 7:30 am – 9:45 am Majestic A (CP2)

ASHRAE Foundation Executive Subcommittee (10/5) Electric

Saturday (6/25) 1:30 pm – 3:00 pm Portland (M)

ASHRAE/UNEP Coordination Meeting (12/4)

Saturday (6/25) 1:00 pm – 3:00 pm Aubert (M)

Associate Society Alliance (30/30) Screen

Monday (6/27) 4:15 pm – 6:15 pm Landmark 4 (CL)

Audit Committee (5/3)

Friday (6/24) 3:30 pm – 5:00 pm Lafayette (M)

Building Energy Quotient Committee (15/15) Screen/Electric

Sunday (6/26) 8:30 am – 11:30 am Majestic G (CP2)

bEQ Marketing (5/5) Screen

Saturday (6/25) 12:30 pm – 1:30 pm Laclede (20)

bEQ Methodology (5/5) Screen

Saturday (6/25) 1:30 pm – 2:30 pm Laclede (20)

Board of Directors (41/100) Screen/Electric

Sunday (6/26) 1:30 pm – 5:30 pm Majestic D/E (CP2)

Wednesday (6/29) 2:00 pm – 6:00 pm Majestic D/E (CP2)

Broadcasting ASHRAE Impact and Key Constituency

Leadership Outreach Ad Hoc (30/6) Screen

Saturday (6/25) 8:00 am – 10:00 am Majestic F (CP2)

Building Performance Alliance Ad Hoc Committee (16/6)

Friday (6/24) 10:00 am – 11:00 am Lucas (21)

Certification (12/12) Screen/Electric

Saturday (6/25) 8:00 am – 2:00 pm Lafayette (M)

OPMP Exam Subcommittee (17/0) Screen/Electric

Friday (6/24) 7:30 am – 12:00 pm Majestic G (CP2)

CPMP Exam Subcommittee (14/0) Screen/Electric

Friday (6/24) 8:00 am – 5:00 pm Laclede (20)

BEMP Exam Subcommittee (17/0) Screen/Electric

Friday (6/24) 1:00 pm – 5:30 pm Majestic G (CP2)

Chapter Technology Transfer Committee (30/15) Screen/

Electric

Friday (6/24) 8:00 am – 12:00 pm Majestic F (CP2)

Saturday (6/25) 8:00 am – 12:00 pm Landmark 7 (CL)

Chapter Technology Transfer Executive (5/0)

Friday (6/24) 5:00 pm – 6:00 pm Majestic F (CP2)

Chapter Technology Transfer Member Services (12/10) Screen/ Electric

Friday (6/24) 1:00 pm – 5:00 pm Shaw (M)

Chapter Technology Transfer Operations (10/5) Electric

Friday (6/24) 1:00 pm – 5:00 pm Majestic F (CP2)

CTTC New Member Orientation (10/5) Screen/Electric

Saturday (6/25) 1:15 pm – 2:30 pm Landmark 7 (CL)

College of Fellows (25/10)

Sunday (6/26) 10:00 am – 12:00 pm Landmark 6 (CL)

College of Fellows: Advisory Committee (15/10)

Sunday (6/26) 9:00 am – 10:00 am Landmark 6 (CL)

Conferences and Expositions Committee (30/10) Screen/ Electric

Saturday (6/25) 8:00 am – 3:00 pm Majestic C (CP2)

Conferences and Expositions Executive (30/5)

Friday (6/24) 1:00 pm – 3:00 pm Majestic C (CP2)

Conferences and Expositions Annual and Winter Meetings (30/5)

Friday (6/24) 3:00 pm – 6:00 pm Majestic C (CP2)

CEC Training for TC Programs Subcommittee Chairs (30/5)

Tuesday (6/28) 11:15 am – 12:00 pm ACCC 220

Developing Economies (20/0) Screen

Monday (6/27) 8:00 am – 10:00 am Landmark 6 (CL)

Development Committee (24/10) Screen/Electric

Monday (6/27) 10:00 am – 12:00 pm Majestic A (CP2)

Director and Regional Chairs (15/20)

Friday (6/24) 11:00 am – 1:00 pm Landmark 6 (CL)

Wednesday (6/29) 12:00 pm – 2:00 pm Majestic A (CP2)

Electronic Communications Committee (13/10) Screen

Saturday (6/25) 11:00 am – 3:00 pm Benton (M)

Electronic Communications Subcommittees (13/10) Screen

Saturday (6/25) 8:00 am – 11:00 am Benton (M)

Energy Efficiency in Buildings Position Document Committee (10/10) Screen/Electric

Tuesday (6/28) 3:00 pm – 4:00 pm Lindell (CL)

Environmental Health (20/20) Screen/Electric

Monday (6/27) 2:15 pm – 6:15 pm Majestic H (CP2)

Environmental Health Executive (20/20) Screen/Electric

Monday (6/27) 7:00 am – 8:00 am Majestic H (CP2)

Environmental Health Handbook/Policy (20/20) Screen/Electric

Monday (6/27) 8:00 am – 10:00 am Majestic H (CP2)

Environmental Health Program/Research (20/20) Screen/Electric

Monday (6/27) 10:00 am – 12:00 pm Majestic H (CP2)

Executive Committee (12/20) Screen/Electric

Saturday (6/25) 8:30 am – 1:00 pm Parkview/Aubert (M)

Wednesday (6/29) 7:30 am – 9:00 am Benton (M)

Thursday (6/30) 7:30 am – 11:00 am Shaw (M)

Finance Committee (13/10) Electric

Friday (6/24) 8:00 am – 1:00 pm Landmark 7 (CL)

Finance Investment Subcommittee (4/0)

Thursday (6/23) 5:00 pm – 7:00 pm Benton (M)

Finance Planning Subcommittee (8/8) Electric

Thursday (6/23) 5:00 pm – 7:00 pm Aubert (M)

Grassroots Government Advocacy Committee (30/15)

Screen/Electric

Saturday (6/25) 8:00 am – 12:30 pm Landmark 2 (CL)

GGAC: New Member Orientation (15/10) Screen/Electric

Friday (6/24) 8:00 am – 10:00 am Landmark 2 (CL)

GGAC: Executive (15/10) Screen/Electric

Friday (6/24) 10:15 am – 12:00 pm Landmark 2 (CL)

GGAC: Active Outreach Subcommittee (15/10) Screen/Electric

Friday (6/24) 1:00 pm – 2:30 pm Landmark 2 (CL)

GGAC: Responsive Engagement Subcommittee (15/10) Screen/ Electric

Friday (6/24) 1:00 pm – 2:30 pm Landmark 1 (CL)

GGAC: Ad Hoc for MBO 1 (15/10) Screen/Electric

Friday (6/24) 2:45 pm – 4:15 pm Landmark 2 (CL)

GGAC: Ad Hoc for MBO 6 (15/10) Screen/Electric

Friday (6/24) 2:45 pm – 4:15 pm Landmark 1 (CL)

GGAC: Ad Hoc for MBO 2 (15/10) Screen/Electric

Friday (6/24) 4:30 pm – 6:00 pm Landmark 2 (CL)

GGAC: Ad Hoc for MBO 4 (15/10) Screen/Electric

Friday (6/24) 4:30 pm – 6:00 pm Landmark 1 (CL)

Handbook Committee (30/15) Screen

Sunday (6/26) 10:30 am – 1:00 pm Majestic C (CP2)

Handbook Excom (5/5)

Saturday (6/25) 1:00 pm – 2:00 pm Shaw (M)

Handbook Strategic Planning (5/5)

Saturday (6/25) 2:00 pm – 3:00 pm Shaw (M)

Handbook Training Workshop (50/0) Screen

Sunday (6/26) 8:00 am – 9:00 am Aubert (M)

Handbook Functional (5/0)
 Sunday (6/26) 8:00 am – 9:00 am Flora (21)
 Handbook International (5/5)
 Sunday (6/26) 8:00 am – 9:00 am Majestic H (CP2)
 Handbook Electronic Media (5/0)
 Sunday (6/26) 8:00 am – 9:00 am Majestic C (CP2)
 Handbook 2017 Fundamentals TCs/Volume Subcommittee (25/0)
 Sunday (6/26) 9:00 am – 10:00 am Majestic H (CP2)
 Handbook 2018 Refrigeration TCs/Volume Subcommittee (25/0)
 Sunday (6/26) 9:00 am – 10:00 am Majestic C (CP2)
 Handbook 2019 HVAC Applications TCs/Volume Subcommittee (25/0)
 Sunday (6/26) 9:00 am – 10:00 am Majestic B (CP2)
 Handbook Volume Subcommittees (25/0)
 Sunday (6/26) 10:00 am – 10:30 am Majestic C (CP2)

Historical Committee (20/0) Screen

Sunday (6/26) 8:30 am – 12:00 pm Lindell (CL)

Honors & Awards (15/0) Electric

Sunday (6/26) 1:30 pm – 5:00 pm Lindell (CL)
 Monday (6/27) 2:15 pm – 5:30 pm Lindell (CL)
 H&A New Member Orientation (5/5) Screen/Electric
 Sunday (6/26) 12:30 pm – 1:30 pm Lindell (CL)

IAQ 2016 Steering Committee (16/10) Screen

Tuesday (6/28) 3:00 pm – 4:00 pm Portland (M)

IEQ-GA (20/0) Screen/Electric

Tuesday (6/28) 4:00 pm – 5:30 pm Portland (M)

Indoor Air Quality PD (10/0) Screen/Electric

Tuesday (6/28) 9:00 am – 10:30 am Portland (M)

Journal Advertising Sales Subcommittee (8/0)

Sunday (6/26) 7:00 am – 8:00 am Flora (21)

Life Member Executive Board Meeting (10/0)

Tuesday (6/28) 9:00 am – 11:00 am Aubert (M)

Members Council (37/40) Screen/Electric

Tuesday (6/28) 8:15 am – 12:00 pm Landmark 4 (CL)
 Members Council Planning Subcommittee (12/10) Electric
 Saturday (6/25) 8:00 am – 12:00 pm Portland (M)
 Members Council Region Operations Subcommittee (12/10) Electric
 Sunday (6/26) 8:00 am – 12:00 pm Portland (M)
 Members Council Orientation (35/15) Screen

Tuesday (6/28) 2:00 pm – 4:00 pm Majestic G (CP2)

Membership Promotion (24/15) Screen/Electric

Saturday (6/25) 8:00 am – 3:00 pm Majestic H (CP2)
 Membership Promotion Subcommittees (20/10) Screen/Electric
 Friday (6/24) 8:00 am – 2:00 pm Majestic H (CP2)

Mobile Marine and Fisheries Conference Organizing

Committee (15/1)

Sunday (6/26) 3:00 pm – 4:00 pm Aubert (M)

Mobile Marine and Fisheries Conference Technical

Committee (15/1)

Sunday (6/26) 1:00 pm – 3:00 pm Aubert (M)

Nominating (48/0) Electric

Sunday (6/26) 7:30 am – 12:00 pm Landmark 4 (CL)

PEAC (20/20) Screen/Electric

Tuesday (6/28) 12:00 pm – 2:00 pm Landmark 5 (CL)

Planning (25/25) Screen/Electric/flipchart

Friday (6/24) 1:00 pm – 6:00 pm Majestic A (CP2)

Presidential Ad Hoc on TC Structure Review (10/6)

Saturday (6/25) 1:00 pm – 3:00 pm Majestic F (CP2)

Professional Development (15/15)

Monday (6/27) 8:00 am – 12:00 pm Landmark 3 (CL)

Publications Committee (15/10) Screen

Sunday (6/26) 8:00 am – 12:00 pm Landmark 7 (CL)
 Publications Planning Subcommittee (5/5)
 Saturday (6/25) 10:00 am – 12:00 pm Shaw (M)

Publishing and Education Council (35/30) Screen/Electric

Tuesday (6/28) 8:00 am – 12:00 pm Majestic F (CP2)

Publishing and Education Council E-Learning (12/0) Screen
 Saturday (6/25) 1:00 pm – 2:30 pm Lucas (21)
 Publishing and Education Council Research Journal Subcommittee (10/5)
 Monday (6/27) 11:00 am – 12:00 pm Flora (21)
 Publishing and Education Council Fiscal (17/8) Screen
 Monday (6/27) 2:00 pm – 3:30 pm Landmark 7 (CL)
 Publishing and Education Council Functional (17/8) Screen
 Monday (6/27) 3:30 pm – 5:00 pm Landmark 7 (CL)
 Publishing and Education Council Orientation (35/30) Screen/
 Electric
 Tuesday (6/28) 2:00 pm – 4:00 pm Majestic F (CP2)

Refrigeration Committee (20/20) Screen/Electric

Sunday (6/26) 8:00 am – 12:00 pm Pershing (CL)
 Refrigeration Excom (20/20) Screen
 Sunday (6/26) 7:00 am – 8:00 am Pershing (CL)

Refrigeration PMS for RP-1634 (15/0)

Monday (6/27) 4:30 pm – 6:30 pm Landmark 2 (CL)

Region Members Council Representative/Regional Vice

Chair Training (32/10) Screen

Friday (6/24) 3:00 pm – 5:00 pm Majestic H (CP2)

Region-at-Large (40/0) Screen

Monday (6/27) 2:15 pm – 4:15 pm Majestic C (CP2)

Research Administration Committee (25/20) Screen/Electric

Friday (6/24) 3:00 pm – 7:00 pm Majestic B (CP2)
 Saturday (6/25) 8:00 am – 3:00 pm Majestic B (CP2)
 Wednesday (6/29) 7:00 am – 11:00 am Majestic B (CP2)

RAC Excom (6/0) Screen

Friday (6/24) 1:00 pm – 2:30 pm Majestic B (CP2)

Research Promotion (25/5)

Saturday (6/25) 7:30 am – 1:00 pm Hawthorne (21)

Research Promotion Executive (10/0)

Friday (6/24) 9:30 am – 11:30 am Aubert (M)

Research Promotion RVC Training (25/5) Screen

Friday (6/24) 1:30 pm – 5:00 pm Aubert (M)

Research Promotion Subcommittee (10/0)

Saturday (6/25) 2:00 pm – 3:00 pm Hawthorne (21)

Residential Building Committee (16/20) Screen

Monday (6/27) 9:00 am – 12:00 pm Landmark 7 (CL)

Residential Building Committee: Programs Subcommittee (15/5)

Sunday (6/26) 8:30 am – 9:30 am Landmark 5 (CL)

Residential Building Committee: Conferences Subcommittee (15/5)

Sunday (6/26) 9:30 am – 10:30 am Landmark 5 (CL)

Residential Building Committee: Publications Subcommittee (15/5)

Sunday (6/26) 10:30 am – 11:30 am Landmark 5 (CL)

Residential Building Committee: Technical Subcommittee (15/5)

Sunday (6/26) 1:00 pm – 2:00 pm Landmark 5 (CL)

Residential Building Committee: Stakeholders Subcommittee (25/10)

Sunday (6/26) 2:00 pm – 4:00 pm Landmark 5 (CL)

Scholarship Trustees (10/5) Screen/Electric

Tuesday (6/28) 8:00 am – 12:00 pm Parkview (M)

Society Rules (12/6) Screen/Electric

Tuesday (6/28) 2:00 pm – 6:00 pm Parkview (M)

Standards Committee (30/20) Screen/Electric

Saturday (6/25) 8:00 am – 12:00 pm Landmark 1 (CL)

Wednesday (6/29) 8:00 am – 10:00 am Majestic D/E (CP2)

Standards: Executive Committee (10/10) Screen/Electric

Friday (6/24) 8:00 am – 12:00 pm Benton (M)

StdC Training Adhoc (10/10) Screen/Electric

Friday (6/24) 12:00 pm – 1:00 pm Benton (M)

Standards: ILS/ISAS (10/3) Screen/Electric

Friday (6/24) 1:00 pm – 4:00 pm Flora (21)

Standards: SPLS (20/20) Screen/Electric

Friday (6/24) 2:00 pm – 6:00 pm Portland (M)

Standards: PPIS (6/10) Screen/Electric

Friday (6/24) 2:00 pm – 6:00 pm Benton (M)

Standards: Code Interaction Subcommittee (CIS) (15/10) Screen

Sunday (6/26) 5:00 pm – 6:30 pm Landmark 1 (CL)

Standards PPIS (6/10) Screen/Electric
 Tuesday (6/28) 11:00 am – 2:00 pm Benton (M)
 Standards SPLS (20/10) Screen/Electric
 Tuesday (6/28) 2:00 pm – 4:00 pm Benton (M)
 Standards SRS (8/4) Screen/Electric
 Tuesday (6/28) 5:00 pm – 6:00 pm Benton (M)

Student Activities Committee (22/10) Screen/Electric

Saturday (6/25) 8:00 am – 3:00 pm Pershing (CL)
 Student Activities RVC Training (15/5) Screen/Electric
 Friday (6/24) 8:30 am – 9:30 am Pershing (CL)
 Student Activities Executive (25/5) Screen/Electric
 Friday (6/24) 9:30 am – 11:30 am Pershing (CL)
 Student Activities K-12/STEM (20/5) Screen/Electric
 Friday (6/24) 12:00 pm – 2:00 pm Pershing (CL)
 Student Activities ABET (15/5) Screen/Electric
 Friday (6/24) 2:00 pm – 4:00 pm Lindell (CL)
 Student Activities Post High (15/5) Screen/Electric
 Friday (6/24) 2:00 pm – 4:00 pm Pershing (CL)
 Student Activities Design Competition (15/5) Screen/Electric
 Friday (6/24) 4:00 pm – 6:00 pm Pershing (CL)
 Student Activities Grants (15/5) Screen/Electric
 Friday (6/24) 4:00 pm – 6:00 pm Lindell (CL)

TAC/Standing Committee Executive Interface (25/20)

Screen/Electric

Saturday (6/25) 7:00 am – 8:00 am Majestic A (CP2)

Technical Activities Committee (25/20) Screen /Electric

Saturday (6/25) 8:00 am – 3:00 pm Majestic A (CP2)
 Wednesday (6/29) 7:00 am – 10:00 am Majestic A (CP2)

Technology Council (37/20) Screen/Electric

Wednesday (6/29) 9:00 am – 12:00 pm Majestic H (CP2)
 Technology Council: Operations Subcommittee (25/15) Screen/
 Electric
 Tuesday (6/28) 7:30 am – 9:00 am Majestic H (CP2)
 Technology Council: Special Projects Subcommittee (10/10)
 Screen/Electric
 Tuesday (6/28) 9:00 am – 10:30 am Majestic H (CP2)
 Technology Council: Document Review Subcommittee (10/10)
 Screen/Electric
 Tuesday (6/28) 10:30 am – 12:00 pm Majestic H (CP2)
 Technology Council Planning (25/10) Screen/Electric
 Tuesday (6/28) 2:00 pm – 4:00 pm Majestic H (CP2)

Young Engineers in ASHRAE Committee (20/15) Electric

Saturday (6/25) 8:00 am – 3:00 pm Lindell (CL)

CHRONOLOGICAL

THURSDAY, JUNE 23

Finance Investment Subcommittee (4/0)

Thursday 5:00 pm – 7:00 pm Benton (M)

Finance Planning Subcommittee (8/8) Electric

Thursday 5:00 pm – 7:00 pm Aubert (M)

FRIDAY, JUNE 24

OPMP Exam Subcommittee (17/0) Screen/Electric

Friday 7:30 am – 12:00 pm Majestic G (CP2)

GGAC: New Member Orientation (15/10) Screen/Electric

Friday 8:00 am – 10:00 am Landmark 2 (CL)

**Chapter Technology Transfer Committee (30/15) Screen/
 Electric**

Friday 8:00 am – 12:00 pm Majestic F (CP2)

Standards: Executive Committee (10/10) Screen/Electric

Friday 8:00 am – 12:00 pm Benton (M)

Finance Committee (13/10) Electric

Friday 8:00 am – 1:00 pm Landmark 7 (CL)

**Membership Promotion Subcommittees (20/10) Screen/
 Electric**

Friday 8:00 am – 2:00 pm Majestic H (CP2)

CPMP Exam Subcommittee (14/0) Screen/Electric

Friday 8:00 am – 5:00 pm Laclede (20)

Student Activities RVC Training (15/5) Screen/Electric

Friday 8:30 am – 9:30 am Pershing (CL)

Research Promotion Executive (10/0)

Friday 9:30 am – 11:30 am Aubert (M)

Student Activities Executive (25/5) Screen/Electric

Friday 9:30 am – 11:30 am Pershing (CL)

Building Performance Alliance Ad Hoc Committee (16/6)

Friday 10:00 am – 11:00 am Lucas (21)

**Grassroots Government Advocacy Executive (15/10) Screen/
 Electric**

Friday 10:15 am – 12:00 pm Landmark 2 (CL)

Director and Regional Chairs (15/20)

Friday 11:00 am – 1:00 pm Landmark 6

StdC Training Adhoc (10/10) Screen/Electric

Friday 12:00 pm – 1:00 pm Benton (M)

Student Activities K-12/STEM (20/5) Screen/Electric

Friday 12:00 pm – 2:00 pm Pershing (CL)

**GGAC: Active Outreach Subcommittee (15/10) Screen/
 Electric**

Friday 1:00 pm – 2:30 pm Landmark 2 (CL)

GGAC: Responsive Engagement Subcommittee (15/10)

Screen/Electric

Friday 1:00 pm – 2:30 pm Landmark 1 (CL)

RAC Excom (6/0) Screen

Friday 1:00 pm – 2:30 pm Majestic B (CP2)

Conferences and Expositions Executive (30/5)

Friday 1:00 pm – 3:00 pm Majestic C (CP2)

Standards: ILS/ISAS (10/3) Screen/Electric

Friday 1:00 pm – 4:00 pm Flora (21)

**Chapter Technology Transfer Member Services (12/10)
 Screen/Electric**

Friday 1:00 pm – 5:00 pm Shaw (M)

Chapter Technology Transfer Operations (10/5) Electric

Friday 1:00 pm – 5:00 pm Majestic F (CP2)

BEMP Exam Subcommittee (17/0) Screen/Electric

Friday 1:00 pm – 5:30 pm Majestic G (CP2)

Planning (25/25) Screen/Electric/flipchart

Friday 1:00 pm – 6:00 pm Majestic A (CP2)

Research Promotion RVC Training (25/5) Screen

Friday 1:30 pm – 5:00 pm Aubert (M)

Student Activities ABET (15/5) Screen/Electric

Friday 2:00 pm – 4:00 pm Lindell (CL)

Student Activities Post High (15/5) Screen/Electric

Friday 2:00 pm – 4:00 pm Pershing (CL)

Standards: PPIS (6/10) Screen/Electric

Friday 2:00 pm – 6:00 pm Benton (M)

Standards: SPLS (20/20) Screen/Electric

Friday 2:00 pm – 6:00 pm Portland (M)

GGAC: Ad Hoc for MBO 1 (15/10) Screen/Electric

Friday 2:45 pm – 4:15 pm Landmark 2 (CL)

GGAC: Ad Hoc for MBO 6 (15/10) Screen/Electric

Friday 2:45 pm – 4:15 pm Landmark 1 (CL)

**Region Members Council Representative/Regional Vice
 Chair Training (32/10) Screen**

Friday 3:00 pm – 5:00 pm Majestic H (CP2)

**Conferences and Expositions Annual and Winter Meetings
 (30/5)**

Friday 3:00 pm – 6:00 pm Majestic C (CP2)

Research Administration Committee (25/20) Screen/Electric
Friday 3:00 pm – 7:00 pm Majestic B (CP2)

Audit Committee (5/3)
Friday 3:30 pm – 5:00 pm Lafayette (M)

Student Activities Design Competition (15/5) Screen/Electric
Friday 4:00 pm – 6:00 pm Pershing (CL)

Student Activities Grants (15/5) Screen/Electric
Friday 4:00 pm – 6:00 pm Lindell (CL)

GGAC: Ad Hoc for MBO 2 (15/10) Screen/Electric
Friday 4:30 pm – 6:00 pm Landmark 2 (CL)

GGAC: Ad Hoc for MBO 4 (15/10) Screen/Electric
Friday 4:30 pm – 6:00 pm Landmark 1 (CL)

Chapter Technology Transfer Executive (5/0)
Friday 5:00 pm – 6:00 pm Majestic F (CP2)

SATURDAY, JUNE 25

TAC/Standing Committee Executive Interface (25/20) Screen/Electric
Saturday 7:00 am – 8:00 am Majestic A (CP2)

Research Promotion (25/5)
Saturday 7:30 am – 1:00 pm Hawthorne (21)

Broadcasting ASHRAE Impact and Key Constituency Leadership Outreach Ad Hoc (30/6) Screen
Saturday 8:00 am – 10:00 am Majestic F (CP2)

Electronic Communications Subcommittees (13/10) Screen
Saturday 8:00 am – 11:00 am Benton (M)

Chapter Technology Transfer Committee (30/15) Screen/Electric
Saturday 8:00 am – 12:00 pm Landmark 7 (CL)

Members Council Planning Subcommittee (12/10) Electric
Saturday 8:00 am – 12:00 pm Portland (M)

Standards Committee (30/20) Screen/Electric
Saturday 8:00 am – 12:00 pm Landmark 1 (CL)

Grassroots Government Advocacy Committee (30/15) Screen/Electric
Saturday 8:00 am – 12:30 pm Landmark 2 (CL)

Certification (12/12) Screen/Electric
Saturday 8:00 am – 2:00 pm Lafayette (M)

Conferences and Expositions Committee (30/10) Screen/Electric
Saturday 8:00 am – 3:00 pm Majestic C (CP2)

Membership Promotion (24/15) Screen/Electric
Saturday 8:00 am – 3:00 pm Majestic H (CP2)

Research Administration Committee (25/20) Screen/Electric
Saturday 8:00 am – 3:00 pm Majestic B (CP2)

Student Activities Committee (22/10) Screen/Electric
Saturday 8:00 am – 3:00 pm Pershing (CL)

Technical Activities Committee (25/20) Screen /Electric
Saturday 8:00 am – 3:00 pm Majestic A (CP2)

Young Engineers in ASHRAE Committee (20/15) Electric
Saturday 8:00 am – 3:00 pm Lindell (CL)

Executive Committee (22/20) Screen/Electric
Saturday 8:30 am – 1:00 pm Parkview/Aubert (M)

Publications Planning Subcommittee (5/5)
Saturday 10:00 am – 12:00 pm Shaw (M)

Electronic Communications Committee (13/10) Screen
Saturday 11:00 am – 3:00 pm Benton (M)

bEQ Marketing (5/5) Screen
Saturday 12:30 pm – 1:30 pm Laclede (20)

Handbook Excom (5/5)
Saturday 1:00 pm – 2:00 pm Shaw (M)

Publishing and Education Council E-Learning (12/0) Screen
Saturday 1:00 pm – 2:30 pm Lucas (21)

Presidential Ad Hoc on TC Structure Review (10/6)
Saturday 1:00 pm – 3:00 pm Majestic F (CP2)

CTTC New Member Orientation (10/5) Screen/Electric
Saturday 1:15 pm – 2:30 pm Landmark 7 (CL)

bEQ Methodology (5/5) Screen
Saturday 1:30 pm – 2:30 pm Laclede (20)

ASHRAE Foundation Executive Subcommittee (10/5) Electric
Saturday 1:30 pm – 3:00 pm Portland (M)

Handbook Strategic Planning (5/5)
Saturday 2:00 pm – 3:00 pm Shaw (M)

Research Promotion Subcommittee (10/0)
Saturday 2:00 pm – 3:00 pm Hawthorne (21)

SUNDAY, JUNE 26

Appointments Roadmap (22/0)
Sunday 7:00 am – 8:00 am Benton (M)

Journal Advertising Sales Subcommittee (8/0)
Sunday 7:00 am – 8:00 am Flora (21)

Refrigeration Excom (20/20) Screen
Sunday 7:00 am – 8:00 am Pershing (CL)

Nominating (48/0) Electric
Sunday 7:30 am – 12:00 pm Landmark 4 (CL)

Handbook Electronic Media (5/0)
Sunday 8:00 am – 9:00 am Majestic C (CP2)

Handbook Functional (5/0)
Sunday 8:00 am – 9:00 am Flora (21)

Handbook International (5/5)
Sunday 8:00 am – 9:00 am Majestic H (CP2)

Handbook Training Workshop (50/0) Screen
Sunday 8:00 am – 9:00 am Aubert (M)

Members Council Region Operations Subcommittee (12/10) Electric
Sunday 8:00 am – 12:00 pm Portland (M)

Publications Committee (15/10) Screen
Sunday 8:00 am – 12:00 pm Landmark 7 (CL)

Refrigeration Committee (20/20) Screen/Electric
Sunday 8:00 am – 12:00 pm Pershing (CL)

Residential Building Committee: Programs Subcommittee (15/5)
Sunday 8:30 am – 9:30 am Landmark 5 (CL)

College of Fellows: Advisory Committee (15/10)
Sunday 8:30 am – 10:00 am Landmark 6

Building Energy Quotient Committee (15/15) Screen /Electric
Sunday 8:30 am – 11:30 am Majestic G (CP2)

Historical Committee (20/0) Screen
Sunday 8:30 am – 12:00 pm Lindell (CL)

Handbook 2017 Fundamentals TCs/Volume Subcommittee (25/0)
Sunday 9:00 am – 10:00 am Majestic H (CP2)

Handbook 2018 Refrigeration TCs/Volume Subcommittee (25/0)
Sunday 9:00 am – 10:00 am Majestic C (CP2)

Handbook 2019 HVAC Applications TCs/Volume Subcommittee (25/0)
Sunday 9:00 am – 10:00 am Majestic B (CP2)

Residential Building Committee: Conferences Subcommittee (15/5)
Sunday 9:30 am – 10:30 am Landmark 5 (CL)

Handbook Volume Subcommittees (25/0)
Sunday 10:00 am – 10:30 am Majestic C (CP2)

College of Fellows (25/10)
Sunday 10:00 am – 12:00 pm Landmark 6

Residential Building Committee: Publications Subcommittee (15/5)
Sunday 10:30 am – 11:30 am Landmark 5 (CL)

Handbook Committee (30/15) Screen

Sunday 10:30 am – 1:00 pm Majestic C (CP2)

H&A New Member Orientation (5/5) Screen/Electric

Sunday 12:30 pm – 1:30 pm Lindell (CL)

Residential Building Committee: Technical Subcommittee (15/5)

Sunday 1:00 pm – 2:00 pm Landmark 5 (CL)

Mobile Marine Fisheries Conference Organizing Committee (15)

Sunday 3:00 pm - 4:00 pm Aubert (M)

Mobile Marine and Fisheries Conference Technical Committee (15/1)

Sunday 1:00 pm – 3:00 pm Aubert (M)

Honors & Awards (15/0) Electric

Sunday 1:30 pm – 5:00 pm Lindell (CL)

Board of Directors (41/100) Screen/Electric

Sunday 1:30 pm – 5:30 pm Majestic D/E (CP2)

Residential Building Committee: Stakeholders Subcommittee (25/10)

Sunday 2:00 pm – 4:00 pm Landmark 5 (CL)

Standards: Code Interaction Subcommittee (CIS) (15/10)**Screen**

Sunday 5:00 pm – 6:30 pm Landmark 1 (CL)

MONDAY, JUNE 27**Environmental Health Executive (20/20) Screen/Electric**

Monday 7:00 am – 8:00 am Majestic H (CP2)

ASHRAE Foundation (25/10) Screen/Electric

Monday 7:30 am – 9:45 am Majestic A (CP2)

Developing Economies (20/0) Screen

Monday 8:00 am – 10:00 am Landmark 6

Environmental Health Handbook/Policy (20/20) Screen/Electric

Monday 8:00 am – 10:00 am Majestic H (CP2)

Professional Development (15/15)

Monday 8:00 am – 12:00 pm Landmark 3 (CL)

Residential Building Committee (16/20) Screen

Monday 9:00 am – 12:00 pm Landmark 7 (CL)

Development Committee (24/10) Screen/Electric

Monday 10:00 am – 12:00 pm Majestic A (CP2)

Environmental Health Program/Research (20/20) Screen/Electric

Monday 10:00 am – 12:00 pm Majestic H (CP2)

Publishing and Education Council Research Journal Subcommittee (10/5)

Monday 11:00 am – 12:00 pm Flora (21)

Publishing and Education Council Fiscal (17/8) Screen

Monday 2:00 pm – 3:30 pm Landmark 7 (CL)

Region-at-Large (40/0) Screen

Monday 2:15 pm – 4:15 pm Majestic C (CP2)

AEDG Steering Committee (10/10) Electric

Monday 2:15 pm – 5:00 pm Landmark 3 (CL)

Honors & Awards (15/0) Electric

Monday 2:15 pm – 5:30 pm Lindell (CL)

Environmental Health (20/20) Screen/Electric

Monday 2:15 pm – 6:15 pm Majestic H (CP2)

Publishing and Education Council Functional (17/8) Screen

Monday 3:30 pm – 5:00 pm Landmark 7 (CL)

Associate Society Alliance (30/30) Screen

Monday 4:15 pm – 6:15 pm Landmark 4 (CL)

Refrigeration PMS for RP-1634 (15/0)

Monday 4:30 pm – 6:30 pm Landmark 2 (CL)

TUESDAY, JUNE 28**Technology Council: Operations Subcommittee (25/15) Screen/Electric**

Tuesday 7:30 am – 9:00 am Majestic H (CP2)

Publishing and Education Council (35/30) Screen/Electric

Tuesday 8:00 am – 12:00 pm Majestic F (CP2)

Scholarship Trustees (10/5) Screen/Electric

Tuesday 8:00 am – 12:00 pm Parkview (M)

Members Council (37/40) Screen/Electric

Tuesday 8:15 am – 12:00 pm Landmark 4 (CL)

Indoor Air Quality PD (10/0) Screen/Electric

Tuesday 9:00 am – 10:30 am Portland (M)

Technology Council: Special Projects Subcommittee (10/10) Screen/Electric

Tuesday 9:00 am – 10:30 am Majestic H (CP2)

Life Member Executive Board Meeting (10/0)

Tuesday 9:00 am – 11:00 am Aubert (M)

Technology Council: Document Review Subcommittee (10/10) Screen/Electric

Tuesday 10:30 am – 12:00 pm Majestic H (CP2)

Standards PPIS (6/10) Screen/Electric

Tuesday 11:00 am – 2:00 pm Benton (M)

CEC Training for TC Program Subcommittee Chairs (30/5)

Tuesday 11:15 am – 12:00 pm ACCC 220

PEAC (20/20) Screen/Electric

Tuesday 12:00 pm – 2:00 pm Landmark 5 (CL)

Members Council Orientation (35/15) Screen

Tuesday 2:00 pm – 4:00 pm Majestic G (CP2)

Publishing and Education Council Orientation (35/30) Screen/Electric

Tuesday 2:00 pm – 4:00 pm Majestic F (CP2)

Standards SPLS (20/10) Screen/Electric

Tuesday 2:00 pm – 4:00 pm Benton (M)

Technology Council Planning (25/10) Screen/Electric

Tuesday 2:00 pm – 4:00 pm Majestic H (CP2)

Society Rules (12/6) Screen/Electric

Tuesday 2:00 pm – 6:00 pm Parkview (M)

Energy Efficiency in Buildings Position Document Committee (10/10) Screen/Electric

Tuesday 3:00 pm – 4:00 pm Lindell (CL)

IAQ 2016 Steering Committee (16/10) Screen

Tuesday 3:00 pm – 4:00 pm Portland (M)

IEQ-GA (20/0) Screen/Electric

Tuesday 4:00 pm – 5:30 pm Portland (M)

Standards SRS (8/4) Screen/Electric

Tuesday 5:00 pm – 6:00 pm Benton (M)

WEDNESDAY, JUNE 29**Technical Activities Committee (25/10) Electric**

Wednesday 7:00 am – 10:00 am Majestic A (CP2)

Research Administration Committee (25/6) Electric

Wednesday 7:00 am – 11:00 am Majestic B (CP2)

Executive Committee (12/20) Screen/Electric

Wednesday 7:30 am – 9:00 am Benton (M)

Standards Committee (30/20) Screen/Electric

Wednesday 8:00 am – 10:00 am Majestic D/E (CP2)

Technology Council (37/20) Screen/Electric
 Wednesday 9:00 am – 12:00 pm Majestic H (CP2)
Director and Regional Chairs (15/20)
 Wednesday 12:00 pm – 2:00 pm Majestic A (CP2)
Board of Directors (32/50) Screen/Electric
 Wednesday 2:00 pm – 6:00 pm Majestic D/E (CP2)

THURSDAY, JUNE 30

Executive Committee (9/10) Screen/Electric
 Thursday 7:30 am – 11:00 am Shaw (M)

TC/TG/SPC MEETINGS

The ASHRAE Technical Committees, Task Groups and Technical Resource Groups listed below usually meet at each Society Winter and Annual Conference. Attendance at these meetings is open to all society members, to all registered guests at scheduled Society Conferences, and to those invited by the chairman at the request of a member. You are encouraged to attend any of these meetings in which you have a technical interest.

Description of Abbreviations:

GPS = Guideline Project Committee
 MTG = Multidisciplinary Task Group.
 RP = Research Project
 SPC = Standard Project Committee
 SSPC = Standing Standard Project Committee
 TC = Technical Committee
 TG = Task Group
 TRG = Technical Resource Group

Finding your Meeting Location:

Society technical committee meeting rooms are located in the Marriott St. Louis Grand, America's Convention Center Complex, or Embassy Suites. All rooms with a number, i.e. 280, are located in America's Convention Center Complex. The rooms at Embassy Suites are: Boardroom, Laurel A, B and C, and Mercantile N and S. All other rooms with names, i.e. Portland or Landmark 2, are located in the Marriott. The Marriott's meeting space is located in the main hotel and across the street in the Conference Building which is called Conference Plaza. Access to the Conference Plaza is via an underground tunnel that can be accessed from the Gateway level via either elevator or escalator. Escalators to Gateway level are located just past Zenia Bar & Grille on the lobby level. Codes for this level are (CL) which is Conference Plaza street level and (CP2) which is Conference Plaza 2nd level. (M) is Mezzanine which is in the main building. Rooms on the 20 and 21st floor are accessible via the elevator on the lobby level past Zenia Bar & Grille.

Otherwise, floor levels are indicated by numbers. Subcommittees are indented. Rooms will be set as indicated in the parenthesis beside the committee, i.e., (20/20) will accommodate 20 at the conference table and 20 chairs for the audience. Any audiovisual or electrical ordered will be listed. If a/v is not ordered in advance there is no guarantee it will be available on-site.

Color codes: If the meeting has not been listed in color it has not been confirmed.

TECHNICAL COMMITTEES (TC)

TC/TG Chair's Breakfast Section 1 (32/4)
Sunday (6/26) 6:30 am – 8:00 am Majestic H (CP2)

TC/TG Chair's Breakfast Section 2 (26/4)
Sunday (6/26) 6:30 am – 8:00 am Landmark 2 (CL)

TC/TG Chair's Breakfast Section 3 (17/4)
Sunday (6/26) 6:30 am – 8:00 am Landmark 3 (CL)

TC/TG Chair's Breakfast Section 4 (19/4)
Sunday (6/26) 6:30 am – 8:00 am Landmark 1 (CL)

TC/TG Chair's Breakfast Section 5 (31/4)
Sunday (6/26) 6:30 am – 8:00 am Majestic G (CP2)

TC/TG Chair's Breakfast Section 6 (23/4)
Sunday (6/26) 6:30 am – 8:00 am Landmark 6 (CL)

TC/TG Chair's Breakfast Section 7 (23/4)
Sunday (6/26) 6:30 am – 8:00 am Landmark 7 (CL)

TC/TG Chair's Breakfast Section 8 (34/4)
Sunday (6/26) 6:30 am – 8:00 am Majestic C (CP2)

TC/TG Chair's Breakfast Section 9 (24/4)
Sunday (6/26) 6:30 am – 8:00 am Majestic F (CP2)

TC/TG Chair's Breakfast Section 10 (18/4)
Sunday (6/26) 6:30 am – 8:00 am Landmark 5 (CL)

TC/TG Chair's Training Workshop (50/20)
Sunday (6/26) 9:45 am – 10:45 am 221 (2)

TC Program Subcommittee Training (30/0) Screen
Tuesday (6/28) 11:15 am – 12:00 pm 220 (2)

Research Subcommittee Chairs (137/0) Screen
Monday (6/27) 6:30 am – 9:00 am Majestic D/E (CP2)

TC 1.1 Thermodynamics & Psychrometrics (10/15)
Monday (6/27) 2:15 pm – 4:15 pm 200 (2)

TC 1.2 Instruments & Measurements (15/0)
Tuesday (6/28) 1:00 pm – 3:30 pm 265 (2)
Sponsoring: Seminar 38: ASHRAE Research: Airflow and Ducts
 TC 1.2 Handbook (Fundamentals) Chap. 36 (10/4)
 Monday (6/27) 4:15 pm – 6:30 pm 265 (2)

TC 1.3 Heat Transfer & Fluid Flow (25/25)
Tuesday (6/28) 1:00 pm – 3:30 pm 224 (2)
Sponsoring: Seminar 44: Optimization of Air-to-Refrigerant Heat Exchangers
 TC 1.3/8.5 Research Review (30/20) Screen
 Sunday (6/26) 3:00 pm – 7:00 pm 224 (2)
 Tuesday (6/28) 1:00 pm – 3:30 pm 228 (2)

TC 1.4 Control Theory & Application (20/80) Screen
Sponsoring: Workshop 4: DDC for Smart Buildings and Smart Grid;
Seminar 53: Smart Equipment: the Intelligent Buildings Revolution Is Happening in the Edge
 TC 1.4 YEA (20/10)
 Sunday (6/26) 2:30 pm – 3:00 pm Landmark 7 (CL)
 TC 1.4 Control Components and Applications (20/10)
 Sunday (6/26) 3:00 pm – 4:00 pm Landmark 7 (CL)
 TC 1.4 Programs (20/10)
 Sunday (6/26) 4:00 pm – 5:30 pm Landmark 7 (CL)
 TC 1.4 Education (20/10)
 Sunday (6/26) 5:30 pm – 6:30 pm Landmark 7 (CL)
 TC 1.4 1746-RP (10/0)
 Monday (6/27) 10:00 am – 11:00 am Pershing (CL)
 TC 1.4 Research (10/15)
 Monday (6/27) 2:15 pm – 4:15 pm 131 (1)

TC 1.4 Handbook (10/15)

Monday (6/27) 4:15 pm – 6:30 pm 131 (1)

TC 1.4 Executive (8/3)

Tuesday (6/28) 7:00 am – 8:00 am Lafayette (M)

TC 1.5 Computer Applications (25/25) Screen/Electric**Monday (6/27) 6:30 pm – 9:00 pm 240 (2)***Sponsoring: Workshop 2: ASHRAE's Strategic Plan for Mobile and Web Apps; Seminar 39: Data Sources toward Urban-Scale Energy Modeling, Part 1; Seminar 56: Data Sources toward Urban-Scale Energy Modeling, Part 2; Seminar 60: BIM and HVAC System Design***TC 1.5 DBOSS (20/10)**

Sunday (6/26) 3:00 pm – 4:00 pm Majestic F (CP 2)

TC 1.5 Cyber Security (20/10)

Sunday (6/26) 4:00 pm – 5:00 pm Majestic F (CP2)

TC 1.5 Emerging Applications (20/15) Electric

Sunday (6/26) 5:00 pm – 6:00 pm Majestic F (CP2)

TC 1.5 Research (20/15)

Sunday (6/26) 6:00 pm – 7:00 pm Majestic F (CP2)

TC 1.5 Program (20/15)

Sunday (6/26) 7:00 pm – 8:00 pm Majestic F (CP2)

TC 1.5 Handbook (20/10)

Monday (6/27) 6:00 pm – 6:30 pm 130 (1)

TC 1.6 Terminology (10/8)**Monday (6/27) 4:15 pm – 6:30 pm 200 (2)**

TC 1.6 Handbook, Terminology and STD-134 (6/4)

Monday (6/27) 8:00 am – 12:00 pm 127 (1)

TC 1.7 Business, Management & General Legal Education (20/5)**Monday (6/27) 10:15 am – 12:00 pm 230 (2)***Sponsoring: Seminar 9: Gender Diversity: Will ASHRAE Lead or Lag?; Seminar 48: The Philosophy and Ethics of the Different Building Industry Professionals; Seminar 50: ASHRAE + STEM = ???***TC 1.8 Mechanical Systems Insulation (6/6)****Monday (6/27) 4:15 pm – 6:30 pm 266 (2)****TC 1.8 Research (10/6)**

Sunday (6/26) 8:00 am – 9:00 am 231 (2)

TC 1.8 Handbook (10/6)

Sunday (6/26) 9:00 am – 11:00 am 231 (2)

TC 1.8 Program (10/6)

Sunday (6/26) 11:00 am – 12:00 pm 231 (2)

TC 1.9 Electrical Systems (8/4)**Tuesday (6/28) 3:30 pm – 6:00 pm Laclede (20)****TC 1.10 Cogeneration Systems (20/8)****Tuesday (6/28) 3:30 pm – 6:00 pm 264 (2)**

TC 1.10 Handbook, Program, Research, CTTC, Membership (20/8)

Tuesday (6/28) 1:00 pm – 3:00 pm 264 (2)

TC 1.11 Electric Motors and Motor Control (13/7)**Tuesday (6/28) 1:00 pm – 3:30 pm 121 (1)****TC 1.12 Moisture Management in Buildings (20/20) Screen/Electric****Saturday (6/25) 1:00 pm – 3:00 pm 240 (2)****TC 1.12 Research/Program/Standards (15/10) Screen/Electric****Saturday (6/25) 8:00 am – 12:00 pm 240 (2)****TC 1.13 Optimization (20/5)****Sunday (6/26) 1:00 pm – 3:00 pm 126 (1)****TC 2.1 Physiology & Human Environment (25/30)****Tuesday (6/28) 1:00 pm – 5:00 pm 225 (2)***Sponsoring: TC Seminar on 6/28 at 3:30 pm: Is Poor Bedroom Ventilation Affecting Your Next-Day Performance?***TC 2.1 Research (18/10)**

Sunday (6/26) 1:00 pm – 3:00 pm Pershing (CL)

TC 2.1 Programs (10/5)

Sunday (6/26) 5:00 pm – 6:00 pm Pershing (CL)

TC 2.1 Handbook (10/5)

Sunday (6/26) 6:00 pm – 7:00 pm Pershing (CL)

TC 2.2 Plant and Animal Environment (10/5) Screen/Electric**Monday (6/27) 4:15 pm – 6:30 pm 222 (2)****TC 2.3 Gaseous Air Contaminants /Removal Equip. (18/20) Screen****Tuesday (6/28) 1:00 pm – 3:30 pm Landmark 2 (CL)****TC 2.3 Research (20/10) Screen/Electric**

Sunday (6/26) 5:00 pm – 7:00 pm 231 (2)

TC 2.3 Standards (20/10) Screen/Electric

Monday (6/27) 2:15 pm – 4:15 pm Landmark 1 (CL)

TC 2.3 Publications (20/5) Screen/Electric

Monday (6/27) 3:15 pm – 4:15 pm Landmark 1 (CL)

TC 2.3 Handbook (5/5) Screen/Electric

Monday (6/27) 4:15 pm – 6:30 pm Landmark 1 (CL)

TC 2.3 Planning (15/5) Screen/Electric

Tuesday (6/28) 6:30 am – 8:00 am Landmark 2 (CL)

TC 2.3 Programs (20/10) Screen/Electric

Tuesday (6/28) 12:00 pm – 12:45 pm Landmark 2 (CL)

TC 2.4 Particulate Air Contaminants / Removal Equipment (18/40) Screen**Tuesday (6/28) 3:30 pm – 6:00 pm Landmark 2 (CL)***Sponsoring: Workshop 1: Are Rumors of MERV's Death Exaggerated?***TC 2.4 1649-RP PES (5/20) Screen**

Saturday (6/25) 1:30 pm – 2:30 pm 123 (1)

TC 2.4 Research (20/20) Screen

Sunday (6/26) 3:00 pm – 5:00 pm 231 (2)

TC 2.4 Standards (20/10) Screen/Electric

Monday (6/27) 2:15 pm – 4:15 pm Landmark 1 (CL)

TC 2.4 Publications (10/20)

Monday (6/27) 3:15 pm – 4:15 pm Landmark 1 (CL)

TC 2.4 Planning (20/10) Screen/flipchart

Tuesday (6/28) 8:00 am – 10:00 am 120 (1)

TC 2.4 Program (20/10)

Tuesday (6/28) 10:00 am – 11:00 am 120 (1)

TC 2.5 Global Climate Change (20/10)**Tuesday (6/28) 1:30 pm – 3:30 pm 132 (1)****TC 2.6 Sound and Vibration (20/30) Screen/Electric****Monday (6/27) 2:15 pm – 4:15 pm Landmark 2 (CL)****TC 2.6 Vibration Isolation (20/30) Screen/Electric**

Sunday (6/26) 9:00 am – 10:00 am Landmark 2 (CL)

TC 2.6 RP 1408 (20/30) Screen/Electric

Sunday (6/26) 10:00 am – 11:00 am Landmark 2 (CL)

TC 2.6 Programs (20/30) Screen/Electric

Sunday (6/26) 11:00 am – 12:00 pm Landmark 2 (CL)

TC 2.6 Hot Topic 1 (20/30) Screen/Electric

Sunday (6/26) 2:00 pm – 3:00 pm Landmark 2 (CL)

TC 2.6 Hot Topic 2 (20/30) Screen/Electric

Sunday (6/26) 3:00 pm – 4:00 pm Landmark 2 (CL)

TC 2.6 Executive Committee (20/30) Screen/Electric

Sunday (6/26) 4:00 pm – 5:00 pm Landmark 2 (CL)

TC 2.6 Publications (20/30) Screen/Electric

Monday (6/27) 9:00 am – 10:00 am Landmark 2 (CL)

TC 2.6 Research (20/30) Screen/Electric

Monday (6/27) 10:00 am – 11:00 am Landmark 2 (CL)

TC 2.6 Standards/Criteria (20/30) Screen/Electric

Monday (6/27) 11:00 am – 12:00 pm Landmark 2 (CL)

TC 2.7 Seismic and Wind Restraint Design (17/24) Screen/Electric**Tuesday (6/28) 3:30 pm – 6:00 pm 230 (2)***TC Seminar on 6/28 at 10:30 am: Safeguarding Critical Facility Operation: Hardening Essential Equipment to Survive Seismic Wind and Flood*

TC 2.7 Codes and Specifications (20/20) Electric
 Tuesday (6/28) 8:00 am – 10:00 am 230 (2)
 TC 2.7 Certification (20/75) Screen/Electric
 Tuesday (6/28) 10:00 am – 12:00 pm 230 (2)
 TC 2.7 Research, Publications, Programs and Long Range Plans
 (20/20) Electric
 Tuesday (6/28) 1:30 pm – 3:30 pm 230 (2)

TC 2.8 Building Environmental Impacts and Sustainability (20/50)

Sunday (6/26) 5:00 pm – 7:00 pm 130 (1)
Sponsoring: Workshop 8: How to Predict the Long-Term Success of Your Green Design: The Five Characteristics that Determine Technology Adoption

TC 2.8 International (12/6)
 Sunday (6/26) 11:30 am – 12:00 pm 130 (1)
 TC 2.8 Green Guide (15/8)
 Sunday (6/26) 12:00 pm – 1:15 pm 130 (1)
 TC 2.8 Water-Energy Nexus (8/8)
 Sunday (6/26) 1:15 pm – 1:45 pm 130 (1)
 TC 2.8 Research (10/6)
 Sunday (6/26) 1:45 pm – 2:45 pm 130 (1)
 TC 2.8 Handbook (10/4)
 Sunday (6/26) 2:45 pm – 3:45 pm 130 (1)
 TC 2.8 Programs (10/8)
 Sunday (6/26) 3:45 pm – 4:15 pm 130 (1)
 TC 2.8 Existing Buildings (8/8)
 Sunday (6/26) 4:15 pm – 4:45 pm 130 (1)

TC 2.9 Ultraviolet Air and Surface Treatment (10/20)

Monday (6/27) 10:00 am – 12:00 pm 120 (1)
Sponsoring: Seminar 12: The ABCs of UVC; Forum 1: A Discussion of 185.1 & 185.2, The New Standards

TC 2.9 Programs (8/5)
 Sunday (6/26) 8:00 am – 10:00 am 120 (1)
 TC 2.9 Handbook (5/5)
 Sunday (6/26) 10:00 am – 12:00 pm 120 (1)
 TC 2.9 Standards (6/6)
 Sunday (6/26) 1:00 pm – 3:00 pm 120 (1)
 TC 2.9 Research (10/8)
 Monday (6/27) 8:00 am – 10:00 am 120 (1)

TC 3.1 Refrigerants & Secondary Coolants (10/30) Screen/Electric

Monday (6/27) 4:15 pm – 6:30 pm Landmark 5 (CL)
Sponsoring: Seminar 55: System Efficiency Impacts of Low-GWP Refrigerants: Is This Our Fall from Grace?

TC 3.1 Research and Program (12/20) Screen/Electric
 Monday (6/27) 11:00 am – 12:30 pm Landmark 5 (CL)

TC 3.2 Refrigerant System Chemistry (12/40) Screen/Electric

Monday (6/27) 2:15 pm – 4:15 pm 227 (2)
Sponsoring: Technical Paper Session 2: Challenges and Opportunities with Refrigerants

TC 3.2 Research (12/20)
 Sunday (6/26) 4:00 pm – 5:00 pm 122 (1)

TC 3.3 Refrigerant Contaminant Control (14/25)

Tuesday (6/28) 3:30 pm – 6:00 pm 122 (1)
 TC 3.3 Research (12/20)
 Sunday (6/26) 5:00 pm – 5:30 pm 122 (1)

TC 3.4 Lubrication (20/40)

Tuesday (6/28) 1:30 pm – 3:30 pm 122 (1)
Sponsoring: Seminar 43: Lubrication Effects Beyond the Compressor
 TC 3.4 Research (12/20)
 Sunday (6/26) 5:30 pm – 6:00 pm 122 (1)

TC 3.6 Water Treatment (18/10)

Tuesday (6/28) 1:00 pm – 3:30 pm 125 (1)
Sponsoring: Seminar 7: Building Water Systems: Issues and Insights from Outbreaks of Legionnaires' Disease; Seminar 18: Water Treatment Programs: Designing for Asset Management and Long-Term Efficiency
 TC 3.6 Handbook/Program/Research (12/10)
 Sunday (6/26) 3:00 pm – 5:00 pm 125 (1)

TC 3.8 Refrigerant Containment (9/5)

Monday (6/27) 4:15 pm – 6:30 pm Shaw (M)

TC 4.1 Load Calculation Data and Procedures (20/10)

Monday (6/27) 2:15 pm – 4:15 pm Majestic G (2)
Sponsoring: Seminar 23: Parting the Clouds to See the Future of Residential Load Calculations

TC 4.1 RP 1729 Project Evaluation (15/10)
 Sunday (6/26) 10:00 am – 11:00 am 264 (2)
 TC 4.1 RP-1742 PMS (10/10)
 Sunday (6/26) 11:00 am – 12:00 pm 264 (2)
 TC 4.1 RP-1681 PMS (15/10)
 Sunday (6/26) 2:00 pm – 3:00 pm 264 (2)
 TC 4.1 Handbook (15/10)
 Sunday (6/26) 3:00 pm – 4:00 pm 264 (2)
 TC 4.1 Research (15/10)
 Sunday (6/26) 4:00 pm – 5:00 pm 264 (2)
 TC 4.1 Programs (15/10)
 Sunday (6/26) 5:00 pm – 6:00 pm 264 (2)
 TC 4.1 Standards (15/10)
 Sunday (6/26) 6:00 pm – 7:00 pm 264 (2)

TC 4.2 Climatic Information (20/10) Screen/Electric

Tuesday (6/28) 1:00 pm – 3:30 pm 231 (2)
Sponsoring: Seminar 63: Moving Beyond Typical Year Weather Data
 TC 4.2 1699-RP PMS/Handbook (10/0) Screen/Electric
 Sunday (6/26) 1:00 pm – 2:30 pm 240 (2)
 TC 4.2 Program (15/10)
 Sunday (6/26) 2:30 pm – 3:30 pm 240 (2)
 TC 4.2 Research (15/0)
 Monday (6/27) 4:15 pm – 6:30 pm 120 (1)

TC 4.3 Ventilation Requirements & Infiltration (10/20)

Monday (6/27) 4:15 pm – 6:30 pm 274 (2)

TC 4.4 Building Materials and Building Envelope Performance (40/10) Screen

Monday (6/27) 2:15 pm – 4:15 pm 229 (2)
 TC 4.4 PMS 1696-RP (20/10) Screen
 Sunday (6/26) 11:30 am – 1:00 pm 229 (2)
 TC 4.4 Research (40/10)
 Sunday (6/26) 1:00 pm – 3:30 pm 229 (2)
 TC 4.4 Handbook (40/10)
 Sunday (6/26) 3:30 pm – 4:30 pm 229 (2)
 TC 4.4 Program (20/10)
 Sunday (6/26) 4:30 pm – 5:00 pm 229 (2)
 TC 4.4 Standards (20/10)
 Sunday (6/26) 5:00 pm – 5:30 pm 229 (2)

TC 4.5 Fenestration (15/15)

Tuesday (6/28) 2:00 pm – 4:00 pm 220 (2)
 TC 4.5 Research (10/10)
 Monday (6/27) 2:15 pm – 3:15 pm 220 (2)
 TC 4.5 Program (10/10)
 Monday (6/27) 3:15 pm – 4:15 pm 220 (2)
 TC 4.5 Handbook (10/10)
 Monday (6/27) 4:15 pm – 5:30 pm 220 (2)
 TC 4.5 Calculation Methods (15/10)
 Tuesday (6/28) 1:00 pm – 2:00 pm 220 (2)

TC 4.7 Energy Calculations (25/50) Screen

Tuesday (6/28) 6:00 pm – 8:30 pm 132 (1)
Sponsoring: Seminar 22: Large-Scale Computing; Seminar 34: Low-Cost High-Performance Building Simulation. Is That Too Good to Be True?

TC 4.7 Simulation and Component Models (20/20) Screen		
Monday (6/27) 6:00 pm – 7:30 pm	Majestic G (CP2)	
TC 4.7 Data-Driven Models (20/20)		
Monday (6/27) 7:30 pm – 9:00 pm	Majestic G (CP2)	
TC 4.7 1588-RP PMS (8/2)		
Sunday (6/26) 6:45 pm – 8:15 pm	Flora (21)	
TC 4.7 Applications (20/10)		
Tuesday (6/28) 3:30 pm – 5:00 pm	132 (1)	
TC 4.7 Handbook (20/10)		
Tuesday (6/28) 5:00 pm – 6:00 pm	132 (1)	

TC 4.10 Indoor Environmental Modeling (20/20) Screen

Monday (6/27) 2:15 pm – 4:15 pm 132 (1)

Sponsoring: Seminar 16: Energy Saving and Thermal Comfort Comparison of Different Heating Distribution Systems in Commercial and Residential Buildings; Seminar 20: Computer Aided Renewable Energy System Design with Case Studies

TC 4.10 RP-1675 PMS (5/10)

Saturday (6/25) 2:00 pm – 3:00 pm 232 (2)

TC 4.10 Program (12/15) Screen

Sunday (6/26) 3:00 pm – 4:00 pm 132 (1)

TC 4.10 Handbook (12/15)

Sunday (6/26) 4:00 pm – 5:00 pm 132 (1)

TC 4.10 Research (12/15)

Sunday (6/26) 5:00 pm – 6:00 pm 132 (1)

TC 5.1 Fans (20/20) Screen

Monday (6/27) 4:15 pm – 6:30 pm 264 (2)

TC 5.1 Handbook (10/10) Screen

Sunday (6/26) 2:00 pm – 3:00 pm 267 (2)

TC 5.1 Research (10/10) Screen

Sunday (6/26) 3:00 pm – 4:00 pm 267 (2)

TC 5.1 Program (10/10) Screen

Sunday (6/26) 4:00 pm – 4:30 pm 267 (2)

TC 5.1 Hot Topics (15/15) Screen

Sunday (6/26) 4:30 pm – 5:30 pm 267 (2)

TC 5.2 Duct Design (12/20)

Tuesday (6/28) 3:30 pm – 6:00 pm 229 (2)

TC 5.2 Duct Design Guide (20/20)

Monday (6/27) 8:00 am – 12:00 pm 229 (2)

TC 5.3 Room Air Distribution (30/30) Screen/Electric

Tuesday (6/28) 1:00 pm – 3:30 pm 124 (1)

TC 5.3 Handbook (20/20) Screen/Electric

Friday (6/24) 12:00 pm – 5:00 pm Lucas (21)

TC 5.3 Handbook (20/20) Screen/Electric

Saturday (6/25) 8:00 am – 3:00 pm 124 (1)

TC 5.3 Fan Coils (30/20) Screen/Electric

Sunday (6/26) 8:00 am – 8:30 am 124 (1)

TC 5.3 Chilled Beams (30/20) Screen/Electric

Sunday (6/26) 8:30 am – 9:30 am 124 (1)

TC 5.3 Air Curtains (30/20) Screen/Electric

Sunday (6/26) 9:30 am – 10:15 am 124 (1)

TC 5.3 Underfloor Air Distribution (11/6) Screen/Electric

Sunday (6/26) 10:15 am – 11:45 am 124 (1)

TC 5.3 Research/Handbook/Program (30/20) Screen/Electric

Sunday (6/26) 12:00 pm – 2:00 pm 124 (1)

TC 5.4 Industrial Process Air Cleaning (11/6)

Monday (6/27) 2:15 pm – 4:15 pm 265 (2)

TC 5.5 Air-to-Air Energy Recovery (30/10)

Tuesday (6/28) 3:30 pm – 6:00 pm 123 (1)

Sponsoring: Seminar 6: Latest Technologies in Air-to-Air Energy Recover

TC 5.5 Handbook, Program, Research (30/10)

Sunday (6/26) 5:00 pm – 7:00 pm Majestic G (CP2)

TC 5.6 Control of Fire & Smoke (23/30)

Monday (6/27) 4:15 pm – 6:30 pm 227 (2)

Sponsoring: Technical Paper Session 1: Airflow Measurements and Predictions

TC 5.6 Program (13/20)		
Sunday (6/26) 3:00 pm – 4:00 pm	227 (2)	
TC 5.6 Research (13/20)		
Sunday (6/26) 4:00 pm – 5:30 pm	227 (2)	
TC 5.6 Handbook (13/20)		
Sunday (6/26) 5:30 pm – 7:00 pm	227 (2)	

TC 5.7 Evaporative Cooling (20/10)

Monday (6/27) 4:15 pm – 6:30 pm Parkview (M)

TC 5.8 Industrial Ventilation Systems (20/5) Screen/Electric

Monday (6/27) 4:15 pm – 6:30 pm 229 (2)

TC 5.8 Ventilation of Hazardous Spaces (5/5)

Tuesday (6/28) 3:30 pm – 6:00 pm 228 (2)

TC 5.9 Enclosed Vehicular Facilities (40/20) Screen

Tuesday (6/28) 3:30 pm – 6:00 pm 223 (2)

Sponsoring: TC Seminar on 6/28 at 5 pm: Indoor Air Quality in Underground Stations and Tunnels: Development of a New ASHRAE Standard

TC 5.9 Program, Standards, Handbook, Research (40/20) Screen/Electric

Tuesday (6/28) 1:00 pm – 3:30 pm 223 (2)

TC 5.10 Kitchen Ventilation (20/15) Screen

Monday (6/27) 6:00 pm – 7:00 pm 122 (1)

Sponsoring: Seminar 8: Comfort Challenges in Commercial Kitchens

TC 5.10 Handbook (20/15) Screen

Monday (6/27) 2:00 pm – 3:30 pm 122 (1)

TC 5.10 Program (20/15) Screen

Monday (6/27) 3:30 pm – 4:30 pm 122 (1)

TC 5.10 Research (20/15) Screen/

Monday (6/27) 4:30 pm – 6:00 pm 122 (1)

TC 5.11 Humidifying Equipment (10/5) Electric

Monday (6/27) 2:15 pm – 4:15 pm Lafayette (M)

TC 5.11 Research (10/5) Screen/Electric

Sunday (6/26) 3:00 pm – 5:00 pm Lafayette (M)

TC 6.1 Hydronic & Steam Htg. Equip & Sys (20/25) Screen

Tuesday (6/28) 1:00 pm – 3:30 pm 222 (2)

TC 6.1 Handbook (12/10) Screen

Sunday (6/26) 5:00 pm – 6:00 pm 222 (2)

TC 6.1 Chilled Water Plant (12/10) Screen

Sunday (6/26) 6:00 pm – 7:00 pm 222 (2)

TC 6.1 Program (12/8) Screen

Monday (6/27) 2:15 pm – 3:15 pm 222 (2)

TC 6.1 Research (12/8) Screen

Monday (6/27) 3:15 pm – 4:15 pm 222 (2)

TC 6.2 District Energy (20/10)

Sunday (6/26) 3:00 pm – 5:00 pm 123 (1)

Sponsoring: Forum 3: To Centralize or Decentralize a Thermal Energy System: The Great Debate Continues

TC 6.2 Programs, Research, Handbook (20/10) Screen/Electric

Sunday (6/26) 1:00 pm – 3:00 pm 123 (1)

TC 6.3 Central Forced Air Htg. & Cooling Sys (20/12)

Tuesday (6/28) 1:00 pm – 3:30 pm 131 (1)

TC 6.5 Radiant Heating and Cooling (17/10)

Monday (6/27) 2:15 pm – 4:15 pm 124 (1)

Sponsoring: Seminar 21: Evolving Research on Embedded Tube Radiant Applications; Seminar 26: Dos and Don'ts for Residential Radiant Systems for Heating and Cooling; Seminar 30: It's Official: ANSI/ASHRAE Standard 55 Thermal Environmental Conditions for Human Occupancy Is for Residential Buildings

TC 6.5 Research, Special Pubs, Journal, Program, Handbook (15/20)

Sunday (6/26) 3:00 pm – 5:00 pm 221 (2)

TC 6.5 Handbook Working Session (5/5)

Sunday (6/26) 5:00 pm – 6:00 pm 221 (2)

TC 6.6 Service Water Heating Systems (18/15)

Monday (6/27) 4:15 pm – 6:30 pm Portland (M)

Sponsoring: Seminar 17: Plumbing System Design Criteria to Minimize the Potential for Legionella Growth

TC 6.6 Programming, Research and Handbook (5/5)

Monday (6/27) 2:15 pm – 4:15 pm Portland (M)

TC 6.7 Solar Energy Utilization (20/55) Screen

Tuesday (6/28) 1:00 pm – 3:30 pm 227 (2)

Sponsoring: Seminar 64: N-ZERO from Foundation to Financing: Residential Buildings

TC 6.7 Research, Standards, Programs and Handbook (25/10)

Monday (6/27) 4:15 pm – 8:30 pm 132 (1)

TC 6.8 Geothermal Heat Pump and Energy Recovery Applications (16/25) Screen/Electric

Tuesday (6/28) 3:30 pm – 6:00 pm 232 (2)

Sponsoring: Seminar 61: How Deep Can We Go? Designing and Drilling Deeper Geothermal Systems

TC 6.8 Handbook, Research, Programs, Standards (20/15)

Sunday (6/26) 5:00 pm – 7:00 pm 124 (1)

TC 6.9 Thermal Storage (14/25) Screen/Electric

Monday (6/27) 4:30 pm – 6:00 pm 130 (1)

TC 6.9 Standards (14/25) Screen/Electric

Monday (6/27) 2:15 pm – 2:40 pm 130 (1)

TC 6.9 Programs (14/25) Screen/Electric

Monday (6/27) 2:40 pm – 3:10 pm 130 (1)

TC 6.9 Handbook (14/25) Screen/Electric

Monday (6/27) 3:10 pm – 3:30 pm 130 (1)

TC 6.9 Long Range Planning and Website (14/25) Screen/Electric

Monday (6/27) 3:30 pm – 3:50 pm 130 (1)

TC 6.9 Research (14/25) Screen/Electric

Monday (6/27) 3:50 pm – 4:10 pm 130 (1)

TC 6.10 Fuels & Combustion (20/10) Screen/ Electric

Tuesday (6/28) 3:30 pm – 6:00 pm 266 (2)

TC 6.10 Handbook (8/0) Screen/Electric

Monday (6/27) 2:15 pm – 4:15 pm 280 (2)

TC 7.1 Integrated Building Design (25/10)

Monday (6/27) 8:15 am – 10:30 am Landmark 1 (CL)

TC 7.1 Research, Program, Handbook (15/2) Screen/Electric

Sunday (6/26) 5:00 pm – 7:00 pm 241 (2)

TC 7.2 HVAC Construction and Design Build Technologies (10/5)

Sunday (6/26) 10:00 am – 12:00 pm Laclede (20)

Sponsoring: Workshop 9: The Busted BIM Building Blues

TC 7.3 Operations & Maintenance Management (25/7) Electric

Tuesday (6/28) 1:00 pm – 3:30 pm 240 (2)

Sponsoring: Seminar 1: A Better Writer is a Better Engineer: TC 7.3 O&M Management Perspective on Good Communication;

Seminar 27: Energy Savings via ASHRAE Level III Auditing, Retrofit and Recommissioning: A Case Study at Hameetman Science Center, Occidental College I; Seminar 57: Energy Savings via ASHRAE

Level III Auditing, Retrofit and Recommissioning: A Case Study at Hameetman Science Center, Occidental College II

TC 7.3 Standards/Program (10/2) Screen/Electric

Monday (6/27) 2:15 pm – 4:15 pm 231 (2)

TC 7.3 Research, Handbook, and Education & Training (10/2)

Screen/Electric

Monday (6/27) 4:15 pm – 6:30 pm 231 (2)

TC 7.4 Exergy Analysis for Sustainable Buildings (14/8)

Sunday (6/26) 8:00 am – 10:00 am 126 (1)

TC 7.5 Smart Building Systems (11/50) Screen

Tuesday (6/28) 3:30 pm – 6:00 pm 221 (2)

Sponsoring: Seminar 11: Smart Grid in the Heartland: See What Happens Next; Technical Paper Session 5: Advances in VFD Control and Building Operations and Maintenance; Seminar 37: The Impact of Net Zero Energy Buildings on the Electric Grid; Seminar 46: Regulatory Process Overview for Smart Grid, Smart Building and Demand Response Programs as Applicable to Building Owners and Utility Tariffs; Seminar 52: Residential Building Smart Devices and Data: Improving Energy Use Insights and Performance Evaluation; Seminar 59: Solar Decathlon 2015: Lessons Learned from the Largest Student-Led Solar Powered Housing Competition

TC 7.5 Fault Detection and Diagnostics (11/50)

Sunday (6/26) 2:30 pm – 3:15 pm 276 (2)

TC 7.5 Enabling Technologies (11/50)

Sunday (6/26) 3:15 pm – 4:00 pm 276 (2)

TC 7.5 Smart Grid (11/50)

Sunday (6/26) 4:00 pm – 4:45 pm 276 (2)

TC 7.5 Handbook (11/50)

Sunday (6/26) 4:45 pm – 5:30 pm 276 (2)

TC 7.5 Program (11/50)

Sunday (6/26) 5:30 pm – 6:00 pm 276 (2)

TC 7.5 Building Operations Dynamics (11/50) Screen

Monday (6/27) 4:30 pm – 5:15 pm 223 (2)

TC 7.5 Research (11/50) Screen

Monday (6/27) 5:15 pm – 7:15 pm 223 (2)

TC 7.6 Building Energy Performance (15/30)

Tuesday (6/28) 1:00 pm - 3:30 pm Landmark 3 (CL)

Sponsoring: Workshop 3: Developing the Business Case for Submetering: Leveraging GSA's Portfolio to Demonstrate Submeter Functionalities, Range of Benefits and Cost Savings; Seminar 19: Energy Management for Multi-Building Portfolios from the Owner-Operator and the Consultant

Perspectives; Seminar 24: Using ASHRAE Performance Measurement Protocols for Measuring and Benchmarking Commercial Building

Performance; Seminar 54: Standard 100-2015 Overview and the Potential of Its High-Performance Existing Building Metrics

TC 7.6 Federal Buildings (25/25)

Saturday (6/25) 9:00 am – 3:00 pm 127 (1)

TC 7.6 Federal Buildings (25/25)

Sunday (6/26) 9:00 am – 12:00 pm Landmark 3 (CL)

TC 7.6 Project Monitoring Committee for 1702-RP (8/0)

Sunday (6/26) 11:30 am – 1:00 pm 127 (1)

TC 7.6 Research (10/15)

Sunday (6/26) 1:00 pm – 2:00 pm Landmark 3 (CL)

TC 7.6 Commercial Building Energy Audit (10/15)

Sunday (6/26) 2:00 pm – 3:00 pm Landmark 3 (CL)

TC 7.6 Handbook (10/15)

Sunday (6/26) 3:00 pm – 4:00 pm Landmark 3 (CL)

TC 7.6 Monitoring and Energy Performance (10/30)

Monday (6/27) 2:15 pm – 4:15 pm 127 (1)

TC 7.6 Energy Management (10/15)

Monday (6/27) 4:15 pm – 5:15 pm 127 (1)

TC 7.6 Standards (10/15)

Monday (6/27) 5:15 pm – 6:15 pm 127 (1)

TC 7.6 Executive and Programs (10/15)

Monday (6/27) 6:15 pm – 7:00 pm 127 (1)

TC 7.7 Testing & Balancing (20/30)

Monday (6/27) 2:15 pm - 4:15 pm 221 (2)

TC 7.7 Handbook/Programs (15/10)

Saturday (6/25) 1:00 pm – 3:00 pm 120 (1)

TC 7.8 Owning & Operating Costs (20/5)

Monday (6/27) 2:15 pm - 4:15 pm 120 (1)

TC 7.8 Handbook, Program, Research (6/4)

Sunday (6/26) 3:00 pm – 5:00 pm Benton (M)

TC 7.9 Building Commissioning (40/20) Screen/Electric

Sunday (6/26) 3:00 pm – 5:00 pm 232 (2)

TC 7.9 Handbook, Research, Program (24/6) Electric

Saturday (6/25) 8:00 am – 12:00 pm 241 (2)

TC 8.1 Positive Displacement Compressors (12/14)**Tuesday (6/28) 3:30 pm – 6:00 pm 265 (2)***Sponsoring: Seminar 13: Advancements in Compressor Design, Testing and Performance Modeling for New Efficiency Standards and Alternative Refrigerants***TC 8.2 Centrifugal Machines (20/8)****Monday (6/27) 2:15 pm – 4:15 pm Lucas (21)***Sponsoring: Seminar 10: Performance Monitoring and Systems Testing Per ASHRAE Standards 184, 30, and the 41 Series; Seminar 31: Centrifugal Chiller Design: Back to Basics***TC 8.2 Programs, Research and Handbook (12/4) Screen**

Sunday (6/26) 5:00 pm – 7:00 pm Lucas (21)

TC 8.3 Absorption and Heat Operated Machines (20/10)**Monday (6/27) 3:30 pm – 6:00 pm 123 (1)***Sponsoring: Seminar 5: Innovative Absorption System Applications for Both Heating and Cooling***TC 8.3 Research/Handbook (7/20)**

Monday (6/27) 2:15 pm – 3:30 pm 123 (1)

TC 8.4 Refrigerant to Air Heat Transfer Equipment (20/10)**Screen/Electric****Tuesday (6/28) 3:30 pm – 6:00 pm 241 (2)****TC 8.4 Research/Standards/Handbook (30/20) Screen**

Monday (6/27) 6:30 pm – 9:30 pm Landmark 4 (CL)

TC 8.5 Liquid to Refrigerant Heat Exchangers (47/18) Screen**Monday (6/27) 4:15 pm – 6:30 pm 224 (2)****TC 8.5/1.3 Research Subcommittee (30/20)**

Sunday (6/26) 3:00 pm – 9:00 pm 224 (2)

TC 8.6 Cooling Towers and Evaporative Condensers (20/5)**Monday (6/27) 2:15 pm – 4:15 pm Parkview (M)****TC 8.6 Handbook/Program/Research (10/4)**

Monday (6/27) 9:00 am – 10:00 am Parkview (M)

TC 8.7 Variable Refrigerant Flow (20/30)**Monday (6/27) 4:15 pm – 6:30 pm 225 (2)***Sponsoring: Seminar 51: Passive Buildings and VRF: How Low Can You Go?***TC 8.8 Refrigerant System Controls & Accessories (10/10)****Screen/Electric****Tuesday (6/28) 1:00 pm – 3:30 pm 241 (2)****TC 8.8 Research, Program, Handbook (5/5)**

Sunday (6/26) 6:30 pm – 7:30 am 280 (2)

TC 8.9 Residential Refrigerators and Food Freezers (6/10)**Monday (6/27) 2:15 pm – 4:15 pm 225 (2)****TC 8.10 Mechanical Dehumidifiers & Heat Pipes (16/10)****Tuesday (6/28) 3:30 pm – 6:00 pm 267 (2)****TC 8.10 Program/Handbook/Research/Standards (16/10)**

Tuesday (6/28) 1:00 pm – 3:30 pm 267 (2)

TC 8.11 Unitary and Room Air Conditioners and Heat Pumps (20/30)**Monday (6/27) 4:15 pm – 6:30 pm 221 (2)****TC 8.11 Handbook, Program, Research (14/15)**

Sunday (6/26) 3:00 pm – 5:00 pm 223 (2)

TC 8.12 Desiccant Dehumidification Equipment and Components (15/15)**Monday (6/27) 2:15 pm – 4:15 pm 274 (2)****TC 9.1 Large Building Air-Conditioning Systems (23/20)****Tuesday (6/28) 1:00 pm – 3:30 pm 229 (2)***Sponsoring: Seminar 49: Bringing a New Look and Energy to a Federal Building in Houston***TC 9.1 Programs/Research/Handbook (13/5) Screen**

Tuesday (6/28) 12:00 pm – 1:00 pm 229 (2)

TC 9.2 Industrial Air Conditioning (25/10) Screen/Electric**Tuesday (6/28) 1:00 pm – 3:30 pm 232 (2)****TC 9.2 Industrial Air Conditioning Programs/Research/Handbook (8/2)**

Sunday (6/26) 4:00 pm – 6:00 pm 242 (2)

TC 9.2 Nuclear Subcommittee (8/4)

Monday (6/27) 2:15 pm – 4:15 pm 242 (2)

TC 9.3 Transportation Air Conditioning (14/20) Screen/Electric**Monday (6/27) 2:15 pm – 3:00 pm Aubert (M)****TC 9.3 Automobile Subcommittee (6/0)**

Sunday (6/26) 5:00 pm – 7:00 pm Shaw (M)

TC 9.3 Research Subcommittee (14/20)

Monday (6/27) 3:00 pm – 4:00 pm Aubert (M)

TC 9.3 Handbook Subcommittee (14/20)

Monday (6/27) 4:00 pm – 4:45 pm Aubert (M)

TC 9.3 Aviation Subcommittee (6/0)

Monday (6/27) 4:45 pm – 6:00 pm Flora (21)

TC 9.3 Ship Subcommittee (6/0)

Monday (6/27) 4:45 pm – 6:00 pm Lucas (21)

TC 9.3 Rail Subcommittee (14/20)

Monday (6/27) 4:45 pm – 6:00 pm Aubert (M)

TC 9.3 Transportation Air Conditioning

Monday (6/27) 6:00 pm – 6:30 pm Aubert (M)

TC 9.4 Justice Facilities (20/5)**Sunday (6/26) 8:00 am – 10:00 am 130 (1)****TC 9.6 Health Care Facilities (18/60) Screen****Sunday (6/26) 5:00 pm – 7:00 pm 131 (1)****TC 9.6 Healthcare Water (18/60) Screen**

Sunday (6/26) 9:00 am – 10:00 am 131 (1)

TC 9.6 Infectious Diseases (18/60) Screen

Sunday (6/26) 10:00 am – 12:00 pm 131 (1)

TC 9.6 Research (18/60) Screen

Sunday (6/26) 1:00 pm – 2:00 pm 131 (1)

TC 9.6 Handbook (18/60) Screen

Sunday (6/26) 2:00 pm – 3:00 pm 131 (1)

TC 9.6 Healthcare Energy (18/60) Screen

Sunday (6/26) 3:00 pm – 4:00 pm 131 (1)

TC 9.6 Program (18/60) Screen

Sunday (6/26) 4:00 pm – 5:00 pm 131 (1)

TC 9.7 Educational Facilities (13/10)**Sunday (6/26) 1:00 pm – 3:00 pm 280 (2)***Sponsoring: Seminar 7: U.S. EPA Guidance for Protecting Indoor Air Quality during School Building Upgrades***TC 9.8 Large Building Air-Conditioning Applications (20/10)****Monday (6/27) 2:15 pm – 4:15 pm 266 (2)***Sponsoring: Seminar 42: Heat and Cooling with Woody Biomass for Sustainable and Resilient Buildings and Communities***TC 9.8 Handbook/Research/Program (12/6) Electric**

Monday (6/27) 9:00 am – 12:00 pm 266 (2)

TC 9.9 Mission Critical Facilities, Data Centers, Technology Spaces and Electronic Equipment (25/75) Screen/**Monday (6/27) 2:15 pm – 6:30 pm 275 (2)***Sponsoring: Seminar 58: Improved Modeling Characteristics of a Data Center without Compromising Physics or Breaking The Bank***TC 9.9 Programs, Handbook and Research (15/60)**

Sunday (6/26) 5:00 pm – 7:00 pm 225 (2)

TC 9.10 Laboratory Systems (20/10) Screen/Electric**Tuesday (6/28) 3:30 pm – 6:00 pm 127 (1)****TC 9.10 Standards (20/20) Screen/ Electric**

Sunday (6/26) 3:00 pm – 3:45 pm 127 (1)

TC 9.10 Research (20/20)

Sunday (6/26) 3:45 pm – 4:30 pm 127 (1)

TC 9.10 Program (20/20)

Sunday (6/26) 4:30 pm – 5:15 pm 127 (1)

TC 9.10 Lab Classifications (20/20)

Sunday (6/26) 5:15 pm – 7:00 pm 127 (1)

TC 9.10 Labs Energy Efficiency (20/20) Screen

Tuesday (6/28) 1:30 pm – 2:30 pm 127 (1)

TC 9.10 Handbook (20/20) Screen
Tuesday (6/28) 2:30 pm – 3:30 pm 127 (1)

TC 9.11 Clean Spaces (30/45) Screen

Monday (6/27) 2:15 pm – 4:00 pm 228 (2)

Sponsoring: Seminar 35: Air Change Rates: Philosophy and Practice

TC 9.11 Research (12/6) Screen/Electric

Monday (6/27) 4:00 pm – 4:30 pm 228 (2)

TC 9.11 Energy Efficiency (12/6) Screen/Electric

Monday (6/27) 4:30 pm – 5:00 pm 228 (2)

TC 9.11 Handbook (12/6) Screen/Electric

Monday (6/27) 5:00 pm – 12:05 am 228 (2)

TC 9.11 Design Guide (12/6) Screen/Electric

Monday (6/27) 5:15 pm – 5:30 pm 228 (2)

TC 9.12 Tall Buildings (12/8)

Tuesday (6/28) 3:30 pm – 6:00 pm 121 (1)

Sponsoring: Seminar 4: Energy Use Index (EUI): Breakdown of Energy Components of Tall, Supertall and Megatall Buildings Both Domestic and International

TC 10.1 Custom Engineered Refrig Systems (30/10)

Monday (6/27) 2:15 pm – 4:15 pm 224 (2)

Sponsoring: Seminar 14: Ammonia and CO2: Advances in Application

TC 10.2 Automatic Ice Making Plants/Skating Rinks (12/3) Screen/Electric

Monday (6/27) 4:30 pm – 6:30 pm 242 (2)

TC 10.2 Research, Handbook, Programs (6/2)

Monday (6/27) 8:00 am – 10:00 am 231 (2)

TC 10.3 Refrigerant Piping, Controls and Accessories (20/10) Screen

Tuesday (6/28) 1:00 pm – 3:30 pm 242 (2)

TC 10.3 RP-1569 PMS (8/2) Screen/Electric

Tuesday (6/28) 8:00 am – 10:00 am 240 (2)

TC 10.5 Refrigeration Distrib and Storage Facilities (15/10)

Tuesday (6/28) 3:30 pm – 6:00 pm 125 (1)

TC 10.6 Transport Refrigeration (8/10)

Monday (6/27) 4:45 pm – 7:00 pm Laclede (20)

Sponsoring: Seminar 45: Planes, Trailers and Ships: Advances in Transport Refrigeration System Technologies

TC 10.6 Handbook (10/0)

Monday (6/27) 2:15 pm – 4:15 pm Laclede (20)

TC 10.7 Commercial Food and Beverage Cooling Display and Storage (24/30)

Monday (6/27) 2:15 pm – 4:15 pm 223 (2)

Sponsoring: Seminar 33: Innovation in a Commercial Refrigeration System with Natural Refrigerants and Low GWP Synthetic Refrigerants

TC 10.7 Program (20/20)

Sunday (6/26) 5:15 pm – 6:00 pm 120 (1)

TC 10.7 Research (20/20)

Sunday (6/26) 6:00 pm – 6:45 pm 120 (1)

TC 10.7 Handbook (20/20)

Sunday (6/26) 6:45 pm – 7:30 pm 120 (1)

TC 10.8 Refrigeration Load Calculations (10/10)

Sunday (6/26) 3:00 pm – 5:00 pm Shaw (M)

Task Groups (TG), Technical Resource Groups (TRG), and Multidisciplinary Task Groups (MTG)

TG1.Optimization (10/5)

Sunday (6/26) 1:00 pm – 3:00 pm Lafayette (M)

TG2 HVAC Security (20/6)

Tuesday (6/28) 9:00 am – 12:00 pm 229 (2)

TRG4.IAQP – Indoor Air Quality Procedure (12/20) Screen/Electric

Sunday (6/26) 10:30 am – 12:00 pm 126 (1)

MTG Chairs' Section Breakfast (11/4)

Sunday (6/26) 6:30 am – 8:00 am Lucas (21)

MTG Hot Climate Design Guide (20/0)

Sunday (6/26) 8:00 am – 9:00 am 125 (1)

MTG Occupant Behavior in Buildings (20/30) Screen

Monday (6/27) 8:00 am – 10:00 am Majestic C (CP2)

MTG Building Information Modeling (20/0)

Monday (6/27) 10:15 am – 12:00 pm

MTG Energy Targets (10/10) Screen/Electric

Tuesday (6/28) 12:00 pm – 3:00 pm Lindell (CL)

Sponsoring: Seminar 2: Results of RP-1651 Development of Maximum Technically Achievable Energy Targets for Ultra-Low Energy Use Commercial Buildings

MTG Cold Climate Design Guide (20/0)

Wednesday (6/29) 9:00 am – 11:00 am Hawthorne (21)

MTG Low GWP Refrigerants (17/25)

Wednesday (6/29) 10:00 am – 12:00 pm Landmark 5 (CL)

Standard Project Committees (SPC) and Standing Standard Project Committee (SSPC)

PC Chairs Training Breakfast (100/0) Screen

Sunday (6/26) 7:00 am – 9:00 am Majestic A (CP2)

SSPC 15 Safety Standard for Refrigeration Systems 2L

Working Group (14/30) Screen

Saturday (6/25) 1:00 pm – 4:00 pm Landmark 1 (CL)

SSPC 15 Safety Standard for Refrigeration Systems Rewrite (14/30) Screen

Sunday (6/26) 10:00 am – 12:00 pm Landmark 1 (CL)

SSPC 15 Safety Standard for Refrigeration Systems (14/30) Screen

Sunday (6/26) 1:00 pm – 5:00 pm Landmark 1 (CL)

SSPC 15 Subcommittee 15.2 Safety Standard for Refrigeration Systems in Residential Applications (12/12) Screen/Electric

Tuesday (6/28) 8:00 am – 12:00 pm Landmark 1 (CL)

SPC 20 MOT/Rating Remote Mechanical-Draft Air-Cooled Refrigerant Condensers (6/2) Screen/Electric

Sunday (6/26) 12:00 pm – 2:00 pm 241 (2)

SPC 23 MOT for Rating Positive Displacement Refrigerant Compressors and Condensing Units that Operate at Subcritical Pressures of the Refrigerant (13/5) Screen/Electric

Monday (6/27) 2:15 pm – 6:15 pm Benton (M)

SPC 25 MOT/Forced Convection and Natural Convection Air Coolers for Refrigeration (6/6)

Monday (6/27) 7:30 pm – 10:30 pm Lafayette (M)

SPC 26 Mechanical Refrigeration & Air-Conditioning Installation Aboard Ship (6/2) Screen/ Electric

Tuesday (6/28) 1:00 pm – 5:00 pm 200 (2)

SPC 28 MOT Flow Capacity of Refrigerant Capillary Tubes (5/5) Electric

Sunday (6/26) 5:00 pm – 7:00 pm Lafayette (M)

SPC 30 MOT Liquid Chillers (7/10) Screen

Monday (6/27) 8:00 am – 11:00 am Flora (21)

SPC 32.2 MOT for Rating Pre-Mix and Post-Mix Beverage Dispensing Equipment (6/2) Screen

Tuesday (6/28) 8:30 am – 11:30 am Pershing (CL)

SSPC 34 Designation and Safety Classification of Refrigerants (15/45) Screen/ Electric

Monday (6/27) 6:30 pm – 10:00 pm Landmark 5 (CL)

SSPC 34 Designation and Nomenclature Subcommittee (8/40) Screen/Electric

Saturday (6/25) 7:00 am – 10:00 am Landmark 5 (CL)

SSPC 34 Flammability Subcommittee (18/40) Screen/Electric

Saturday (6/25) 10:00 am – 3:00 pm Landmark 5 (CL)

SSPC 34 Toxicity Subcommittee (10/30) Screen/Electric

Sunday (6/26) 6:30 pm – 10:00 pm Landmark 5 (CL)

SPC 37 MOT for Rating Electrically Driven Unitary Air-Conditioners and Heat Pump Equipment (7/15) Screen/ Electric

Wednesday (6/29) 8:00 am – 12:00 pm Pershing (CL)

SSPC 41 Standard Methods for Measurement (15/10) Electric

Sunday (6/26) 1:00 pm – 4:00 pm s';242 (2)

41.1 Subcommittee, Standard Methods for Temperature Measurement (10/5) Screen/Electric

Tuesday (6/28) 10:00 am – 12:00 pm 242 (2)

41.9 Subcommittee, Standard Methods for Refrigerant Mass Flow Measurement Using Calorimeters (10/5) Screen/Electric

Monday (6/27) 8:00 am – 12:00 pm 280 (2)

41.10 Subcommittee, Standard Methods for Refrigerant Mass Flow Measurement Using Flowmeters (10/5) Screen/Electric

Tuesday (6/28) 8:00 am – 10:00 am 242 (2)

SSPC 52.2 Method of Testing General Ventilation Air Cleaning Devices for Removal Efficiency by Particle Size (16/45) Screen/Electric

Saturday (6/25) 8:00 am – 12:00 pm Landmark 4 (CL)

SSPC 55 Thermal Env. Cond. for Human Occupancy (20/5) Screen/Electric

Saturday (6/25) 8:00 am – 3:00 pm 230 (2)

SSPC 55 Thermal Env. Cond. for Human Occupancy (20/5) Screen/Electric

Sunday (6/26) 9:00 am – 12:00 pm 230 (2)

SSPC 62.1 Ventilation for Acceptable Indoor Air Quality (30/30) Screen/Electric

Saturday (6/25) 8:00 am – 12:00 pm Landmark 6 (CL)

SSPC 62.1 Ventilation for Acceptable Indoor Air Quality (30/30) Screen/Electric

Sunday (6/26) 1:00 pm – 7:00 pm Landmark 6 (CL)

SSPC 62.1 IAQ Guideline Subcommittee (15/15) Screen/Electric

Friday (6/24) 8:00 am – 12:00 pm Landmark 3 (CL)

SSPC 62.1 Administration Subcommittee (15/15) Screen/Electric

Friday (6/24) 1:00 pm – 3:00 pm Landmark 4 (CL)

Saturday (6/25) 1:00 pm – 3:00 pm Landmark 4 (CL)

SSPC 62.1 Research and Education Subcommittee (15/15) Screen/Electric

Friday (6/24) 1:00 pm – 3:00 pm Landmark 3 (CL)

Saturday (6/25) 1:00 pm – 3:00 pm Landmark 3 (CL)

SSPC 62.1 Buildings, Systems and Equipment (15/15) Screen/Electric

Friday (6/24) 3:00 pm – 5:00 pm Landmark 4 (CL)

Saturday (6/25) 1:00 pm – 3:00 pm Landmark 6 (CL)

SSPC 62.1 Ventilation Subcommittee (15/15) Screen/Electric

Friday (6/24) 3:00 pm – 5:00 pm Landmark 3 (CL)

Saturday (6/25) 1:00 pm – 3:00 pm Landmark 2 (CL)

SSPC 62.2 Ventilation and Acceptable IAQ in Residential Buildings (30/15) Screen/Electric

Friday (6/24) 9:00 am – 2:30 pm Landmark 5 (CL)

SSPC 62.2 Ventilation and Acceptable IAQ in Residential Buildings (30/15) Screen/Electric

Saturday (6/25) 8:00 am – 3:00 pm 125 (1)

SSPC 62.2 Envelope Subcommittee (20/2) Screen

Friday (6/24) 2:30 pm – 5:00 pm Landmark 7 (CL)

SSPC 62.2 IAQ Subcommittee (12/20) Screen

Friday (6/24) 2:30 pm – 5:00 pm Landmark 6 (CL)

SSPC 62.2 System Subcommittee (12/2) Screen

Friday (6/24) 2:30 pm – 5:00 pm Landmark 5 (CL)

SPC 63.1 Method of Testing Liquid-Line Refrigerant Driers (5/6)

Sunday (6/26) 6:00 pm – 8:00 pm 122 (1)

SPC 63.2 Method of Testing Liquid-Line Filter Drier Filtration Capability (10/5)

Sunday (6/26) 2:00 pm – 3:00 pm 122 (1)

SPC 64 Methods of Lab Testing Remote Mechanical Draft Evaporative Refrigerant Condensers (6/2)

Monday (6/27) 10:00 am – 11:00 am Parkview (M)

SPC 70 MOT/for Rating the Performance of Air Outlets and Air Inlets (9/20) Electric

Monday (6/27) 8:00 am – 12:00 pm 122

SSPC 72 Standard 72-2014, Method of Testing Open and Closed Commercial Refrigerators and Freezers (15/12)

Sunday (6/26) 1:00 pm – 5:00 pm 220 (2)

SPC 78 Method of Testing Flow Capacity of Suction Line Filters and Filter-Driers (6/6)

Sunday (6/26) 3:00 pm – 4:00 pm 122 (1)

SPC 84 Method of Testing Air-to-Air Heat/Energy Exchangers (12/0) Screen/Electric

Monday (6/27) 4:15 pm – 6:30 pm 267 (2)

SSPC 90.1 Energy Eff. Design of New Bldg. (50/60) Screen/ Electric

Saturday (6/25) 8:00 am – 12:00 pm 274 (2)

SSPC 90.1 Energy Eff. Design of New Bldg. (50/60) Screen/ Electric

Sunday (6/26) 9:00 am – 12:00 pm 274 (2)

SSPC 90.1 Energy Eff. Design of New Bldg. (50/60) Screen/ Electric

Monday (6/27) 8:00 am – 12:00 pm 274 (2)

SSPC 90.1 Envelope Subcommittee (15/30) Screen/Electric

Friday (6/24) 9:00 am – 10:00 pm Embassy/Laurel A (4)

Saturday (6/25) 1:00 pm – 8:00 pm 275 (2)

Sunday (6/26) 1:00 pm – 8:00 pm 275 (2)

SSPC 90.1 Lighting Subcommittee (12/10) Screen/Electric

Friday (6/24) 9:00 am – 10:00 pm Embassy/Mercantile S (4)

Saturday (6/25) 1:00 pm – 7:00 pm 266 (2)

Sunday (6/26) 1:00 pm – 8:00 pm 266 (2)

SSPC 90.1 Mechanical Subcommittee (25/25) Screen/Electric

Friday (6/24) 9:00 am – 10:00 pm Embassy/Laurel B (4)

Saturday (6/25) 1:00 pm – 7:00 pm 274 (2)

Sunday (6/26) 1:00 pm – 8:00 pm 274 (2)

SSPC 90.1 ECB Subcommittee (12/18) Screen/Electric

Friday (6/24) 3:00 pm – 8:00 pm Embassy/Mercantile N (4)

Saturday (6/25) 1:00 pm – 5:00 pm 265 (2)

Sunday (6/26) 1:00 pm – 4:00 pm 265 (2)

SSPC 90.1 Envelope Subcommittee Working Group (15/30) Screen/ Electric

Friday (6/24) 4:00 pm – 6:00 pm Embassy/Laurel C (4)

Saturday (6/25) 4:00 pm – 6:00 pm 276 (2)

SSPC 90.1 Format & Compliance Subcommittee (6/6) Electric
Friday (6/24) 5:00 pm – 10:00 pm Embassy/Boardroom (4)
Saturday (6/25) 1:00 pm – 5:00 pm 280 (2)
Sunday (6/26) 4:00 pm – 7:00 pm 265 (2)

SSPC 90.2 Energy Eff. Design of New Low Rise Res. Bldg. (26/20) Screen/Electric

Monday (6/27) 2:15 pm – 6:15 pm Hawthorne (21)

SSPC 90.2 Energy Eff. Design of New Low Rise Res. Bldg. (26/20) Screen/Electric

Tuesday (6/28) 1:00 pm – 5:00 pm Hawthorne (21)

SSPC 90.2 Envelope (11/15) Screen/Electric

Monday (6/27) 6:30 pm – 9:15 pm Hawthorne (21)

Tuesday (6/28) 8:00 am – 12:00 pm Hawthorne (21)

SSPC 90.2 Lighting (4/4) Screen/Electric

Monday (6/27) 6:30 pm – 9:15 pm Flora (21)

Tuesday (6/28) 8:00 am – 12:00 pm Flora (21)

SSPC 90.2 Mechanical (6/6) Screen/Electric

Monday (6/27) 6:30 pm – 9:15 pm Shaw (M)

Tuesday (6/28) 8:00 am – 12:00 pm Shaw (M)

SPC 90.4 Energy Standard for Data Centers and Telecommunications Buildings (17/20) Screen/Electric

Saturday (6/25) 9:00 am – 1:00 pm 265 (2)

SPC 90.4 Energy Standard for Data Centers and Telecommunications Buildings (17/20) Screen/Electric

Monday (6/27) 7:30 am – 11:30 am 265 (2)

SPC 94.2 MOT/Thermal Storage Devices with Electrical Input and Thermal Output based on Thermal Performance (5/3)

Monday (6/27) 8:00 am – 11:00 am 126 (1)

SPC 97 Sealed Glass Tube Method to Test the Chemical Stability of Materials for Use Within Refrigerant Systems (9/6) Screen/Electric

Tuesday (6/28) 9:30 am – 11:00 am 127 (1)

SPC 99 Refrigerant Oil Description (9/6) Screen/Electric

Tuesday (6/28) 8:00 am – 9:30 am 127 (1)

SSPC 100 Energy Efficiency in Existing Buildings (20/10) Screen/Electric

Tuesday (6/28) 8:00 am – 12:00 pm 232 (2)

SSPC 100 Operation and Maintenance (WG3) (5/5) Screen

Sunday (6/26) 8:00 am – 10:00 am 280 (2)

SSPC 100 Alternative to EUI (WG5) (16/10) Screen

Sunday (6/26) 12:00 pm – 2:00 pm 232 (2)

SSPC 100 International Target Table and Climate Zones (WG4) (4/5) Screen

Sunday (6/26) 4:00 pm – 6:00 pm 280 (2)

SSPC 100 Site/Source and Boundary (WG2) (20/10) Screen

Monday (6/27) 6:30 pm – 8:30 pm Landmark 7 (CL)

SPC 110P MOT Performance of Laboratory Fume Hoods (20/20)

Tuesday (6/28) 1:00 pm – 1:30 pm 127 (1)

SPC 111 Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation and Air-Conditioning Systems (12) (7/5) Screen/Electric

Tuesday (6/28) 8:00 am – 12:00 pm 264 (2)

SPC 113 Preliminary/Informational Committee Meeting (1/20)

Tuesday (6/28) 3:30 pm – 4:30 pm 124 (1)

SPC 118.1 Method of Testing for Rating Commercial Gas, Electric and Oil Service Water (16/20) Screen/Electric

Sunday (6/26) 9:00 am – 11:00 am 241 (2)

SPC 118.2 Method of Testing for Rating Residential Water Heaters (15/15)

Tuesday (6/28) 1:00 pm – 5:00 pm 126 (1)

SPC 124 MOT/Rating Combinations Space-Heating and Water Heating Appliances (16/12) Screen/Electric

Tuesday (6/28) 9:00 am – 12:00 pm Majestic G (CP2)

SPC 127 MOT/for Rating Computer and Data Processing Room Unitary Air Conditioners (12/8) Screen

Tuesday (6/28) 8:00 am – 12:00 pm 200 (2)

SPC 128 Method of Rating Portable Air Conditioners (10/0)

Tuesday (6/28) 11:00 am – 12:00 pm 131 (1)

SPC 130 MOT/for Rating Ducted Air Terminal Units (15/20)

Sunday (6/26) 2:00 pm – 6:00 pm 230 (2)

SSPC 135 BACnet (40/15) Electric

Saturday (6/25) 8:00 am – 3:30 pm Majestic G (CP2)

SSPC 135 BACnet (40/15) Electric

Monday (6/27) 8:00 am – 12:00 pm Majestic G (CP2)

SSPC 135 BACnet Working Groups (20/5) Electric

Thursday (6/23) 8:30 am – 4:30 pm Aubert (M)

SSPC 135 BACnet Working Groups (20/5) Electric

Friday (6/24) 8:00 am – 5:00 pm Hawthorne (21)

Sunday (6/26) 8:00 am – 5:00 pm Hawthorne (21)

SSPC 135 BACnet Working Groups (20/5) Electric

Friday (6/24) 8:00 am – 5:00 pm Parkview (M)

Sunday (6/26) 8:00 am – 5:00 pm Parkview (M)

SSPC 140 Standard MOT for Evaluation of Bldg. Energy Analysis Computer Program (16/10) Screen

Monday (6/27) 2:15 pm – 6:15 pm 121 (1)

SSPC 145 Test Method for Assessing the Performance of Gas Phase Air Cleaning Equipment (10/10) Screen/Electric

Sunday (6/26) 12:00 pm – 3:00 pm 231 (2)

SPC 146 Method of Testing and Rating Pool Heaters (7/6)

Tuesday (6/28) 8:00 am – 12:00 pm 276 (2)

SSPC 147 Reducing the Release of Halogenated Refrigerants from Refrigerating and Air-Conditioning Equipment (10/10) Screen/Electric

Monday (6/27) 6:30 pm – 9:30 pm Lindell (CL)

SSPC 154 Ventilation for Commercial Cooking Operations (15/10) Screen

Sunday (6/26) 8:00 am – 12:00 pm 121 (1)

SPC 155P Method of Testing for Rating Commercial Space Heating Boiler Systems (10/8) Screen/Electric

Sunday (6/26) 1:00 pm – 5:00 pm 200 (2)

SPC 158.1 MOT Capacity of Refrigerant Solenoid Valves (5/5) Electric

Sunday (6/26) 5:00 pm – 7:00 pm Lafayette (M)

SPC 158.2 MOT Capacity of Refrigerant Pressure Regulators (5/5) Electric

Sunday (6/26) 5:00 pm – 7:00 pm Lafayette (M)

SSPC 160 Criteria for Moisture Control Design Analysis (20/5) Screen/Electric

Tuesday (6/28) 8:00 am – 12:00 pm 121 (1)

SPC 164 MOT for Humidifiers (7/5) Screen/Electric

Monday (6/27) 9:00 am – 12:00 pm Lucas (21)

SSPC 169 Climatic Data for Building Design Standards (10/5) Screen/Electric

Monday (6/27) 10:00 am – 12:00 pm 231 (2)

SSPC 170 Ventilation of Healthcare Facilities (25/25) Screen

Monday (6/27) 4:00 pm – 6:00 pm Majestic B (CP2)

SSPC 170 Ventilation of Healthcare Facilities (25/25) Screen

Tuesday (6/28) 8:00 am – 1:00 pm Majestic B (CP2)

SSPC 170 Ventilation of Health Care Facilities, Natural Ventilation Work Group (15/25) Screen
Monday (6/27) 2:00 pm – 4:00 pm Majestic B (CP2)

SPC 171 Method of Testing & Rating Seismic Restraint Devices for HVAC & R Equipment (17/15)

Tuesday (6/28) 8:00 am – 12:00 pm 122 (1)

SPC 172P Methods of Testing the Particulate Formation Temperature of Refrigeration Grade Oils (10/0)

Tuesday (6/28) 8:00 am – 12:00 pm 125 (1)

SPC 174P Method of Test for Rating Desiccant Based Dehumidification Equipment (6/3)

Monday (6/27) 10:00 am – 12:00 pm Shaw (M)

SPC 180 Standard Method of Inspection and Maintenance of HVAC Systems (20/10) Screen Electric

Friday (6/24) 2:00 pm – 6:00 pm 274 (2)

SPC 182 MOT Absorption Water-Chilling and Water-Heating Packages (5/5)

Monday (6/27) 11:00 am – 12:00 pm Lafayette (M)

SPC 184P: Method of Test for Field Performance of Liquid Chilling Systems (11/6) Electric

Tuesday (6/28) 8:00 am – 12:00 pm 266 (2)

SSPC 185 Methods of Test to Inactivate Microorganisms in HVAC Systems with UV-C Lights (6/6)

Saturday (6/25) 10:00 am – 12:00 pm 200 (2)

SPC 188 Legionellosis: Risk Management for Building Water Systems (22/30) Screen/Electric

Tuesday (6/28) 8:00 am – 12:00 pm 231 (2)

Tuesday (6/28) 3:45 pm – 5:45 pm 231 (2)

Wednesday (6/29) 8:00 am – 12:00 pm Landmark 4 (CL)

SSPC 189.1 ASHRAE/USGBC/IES Standard for the Design of High-Performance Green Buildings except Low-Rise Residential Buildings (45/50) Screen/Electric

Tuesday (6/28) 8:00 am – 10:00 am 276 (2)

Wednesday (6/29) 8:00 am – 12:00 pm 220 (2)

SSPC 189.1 Working Group 6 (Water Use) (20/20) Screen/Electric
Tuesday (6/28) 10:00 am – 1:00 pm 275 (2)

SSPC 189.1 Working Group 7 (Energy Efficiency) (30/30) Screen/Electric
Tuesday (6/28) 10:00 am – 1:00 pm 276 (2)

SSPC 189.1 Working Group 5 (Site Sustainability) (20/20) Screen/Electric
Tuesday (6/28) 1:00 pm – 4:00 pm 274 (2)

SSPC 189.1 Working Group 9 (Materials and Resources) (20/20) Screen/Electric
Tuesday (6/28) 1:00 pm – 4:00 pm 276 (2)

SSPC 189.1 Working Group 7.5 (30/30) Screen/Electric
Tuesday (6/28) 1:30 pm – 4:30 pm 275 (2)

SSPC 189.1 Working Group 10 (20/20) Screen/ Electric
Tuesday (6/28) 4:00 pm – 7:00 pm 276 (2)

SSPC 189.1 Working Group 8 (IEQ) (30/30) Screen/Electric
Tuesday (6/28) 4:00 pm – 7:00 pm 274 (2)

SPC 189.3P Design, Construction and Operation of Sustainable High Performance Health Care Facilities (14/10) Screen

Monday (6/27) 8:00 am – 12:00 pm 264 (2)

SPC 191 Standard for Efficient Water Use in Buildings (8/3) Screen/Electric

Monday (6/27) 8:00 am – 12:00 pm 125 (1)

SPC 194 MOT/Direct-Expansion Ground Source Heat Pumps (5/8)

Sunday (6/26) 1:00 pm – 3:00 pm Lucas (21)

SPC 196P MOT/ Measuring Refrigerant Leak Rates (8/8) Screen
Sunday (6/26) 6:00 pm – 10:00 pm Lindell (CL)

SPC 199P Method of Testing the Performance of Industrial Pulse Cleaned Dust Collectors (10/10)

Sunday (6/26) 8:00 am – 12:00 pm 132 (1)

SPC 200 MOT/Chilled Beams (20/20) Screen

Monday (6/27)8:00 am – 12:00 pm Majestic Ballroom B (CP2)

SSPC 202 Commissioning Process for Buildings and Systems (15/15) Screen/Electric

Monday (6/27) 8:00 am – 12:00 pm 242 (2)

SSPC 202 Subcommittee: GLD 0-2013 The Commissioning Process (8/10) Screen/Electric

Saturday (6/25) 8:00 am – 10:00 am 121 (1)

SSPC 202 Subcommittee: GLD 1.1 The HVAC&R Technical Requirements for Commissioning Process (8/10) Screen/Electric

Saturday (6/25) 10:00 am – 12:00 pm 121 (1)

SSPC 202 Subcommittee Standard 202-2013 (14/10) Screen/ Electric

Saturday (6/25) 1:00 pm – 3:00 pm 121 (1)

SPC 204P MOT/Rating Micro Combined Heat and Power Devices (15/10)

Monday (6/27) 6:30 pm – 9:30 pm Lucas (21)

SPC 205 Standard Representation of Performance Simulation Data for HVAC&R and Other Facility Working Group (20/5) Screen/Electric

Sunday (6/26) 9:00 am – 12:00 pm 123 (1)

Tuesday (6/28) 8:00 am – 12:00 pm 123 (1)

SPC 207P Laboratory Method of Test of Fault Detection and Diagnostics Applied Commercial Air-Cooled Packaged Systems (20/30) Screen/ Electric

Monday (6/27) 8:00 am – 10:00 am 124 (1)

SPC 207 Airflow Working Group (15/0) Screen

Monday (6/27) 10:00 am – 12:00 pm 124 (1)

SPC 207 Economizer Working Group (10/0) Screen

Monday (6/27) 4:30 pm – 6:30 pm 124 (1)

SPC 207 Refrigerant Working Group (10/0) Screen

Monday (6/27) 6:30 pm – 8:30 pm 124 (1)

Balance Valve Capacity (10/5) Screen/Electric

Tuesday (6/28) 7:00 am – 9:00 am 274 (2)

SPC 209P Energy Simulation Aided Design (45/15) Screen/ Electric

Monday (6/27) 2:15 pm – 6:15 pm 232 (2)

SPC 209P Construction/Operations Subcommittee (10/5) Screen

Sunday (6/26) 6:00 pm – 10:00 pm Benton (M)

SPC 209P Design Development/Construction Documents Subcommittee (10/5) Screen

Sunday (6/26) 6:00 pm – 10:00 pm Aubert (M)

SPC 209P Predesign Subcommittee (10/5) Screen

Sunday (6/26) 6:00 pm – 10:00 pm Portland (M)

SPC 209P Conceptual Design/Schematic design (10/5) Screen

Monday (6/27) 8:00 am – 12:00 pm Portland (M)

SPC 209P Resources Subcommittee (10/5) Screen

Monday (6/27) 8:00 am – 12:00 pm Benton (M)

SPC 210 MOT/for Rating Commercial Walk-in Refrigerators and Freezers (5/30) Screen

Monday (6/27) 8:00 am – 12:00 pm 275 (2)

SPC 211 Commercial Building Energy Audits (18/20) Screen/ Electric

Monday (6/27) 8:00 am – 12:00 pm 123 (1)

SPC 212 MOT/for Determining Energy Performance and Water-Use Efficiency of Add-On Evaporative Pre-Coolers for Unitary Air Conditioning Equipment (7/5)

Tuesday (6/28) 8:00 am – 12:00 pm Lafayette (M)

SPC 213P Method of Calculating Moist Air Thermodynamics (6/4)

Tuesday (6/28) 8:00 am – 10:00 am Lindell (CL)

SPC 214P Standard for Measuring and Expressing Building Energy Performance in a Rating Program (14/10) Screen

Monday (6/27) 2:15 pm – 6:15 pm 125 (1)

SPC 215P Method of Test to Determine Leakage Airflows and Fractional Leakage of Operating Air-Handling Systems (15/10) Screen/ Electric

Monday (6/27) 2:15 pm – 6:15 pm 241 (2)

SPC 216 MOT for Determining Application Data of Overhead Circulator Fans (11/5) Screen/Electric

Monday (6/27) 2:15 pm – 5:15 pm 125 (1)

SPC 217 Non-Emergency Ventilation in Enclosed Road, Rail and Mass Transit Facilities (12/5) Screen/Electric

Tuesday (6/28) 7:30 am – 12:00 pm Lucas (21)

SPC 218P – MOT for Lubricant and Refrigerant Miscibility Determination (9/4) Screen/Electric

Monday (6/27) 8:00 am – 10:00 am 200 (2)

SPC 219 Method of Testing the Ability of Liquid Line Filter Driers or Absorbents to Remove Organic and Inorganic Acid (5/2)

Monday (6/27) 10:00 am – 12:00 pm Laclede (20)

Guideline Project Committees (GPC) and (SGPC)

GPC 1.2P Technical Requirements for the Commissioning Process for Existing HVAC&R Systems and Assemblies (18/5) Screen

Friday (6/24) 8:00 am – 12:00 pm 266 (2)

GPC 1.3 Building Operation and Maintenance Training for the HVAC&R Commissioning Process (12/2) Electric

Tuesday (6/28) 1:00 pm – 5:00 pm Lafayette (M)

GPC 4-2008R Preparation of Operating and Maintenance Documentation for HVAC&R Systems (7/8)

Monday (6/27) 8:00 am – 12:00 pm Lindell (CL)

GPC 11 Field Testing of HVAC Controls Components (7/3) Screen/Electric

Saturday (6/25) 9:00 am – 12:00 pm Flora (21)

GPC 21 Guideline for the Ventilation and Thermal Management of Batteries for Stationary Applications (5/5)

Tuesday (6/28) 10:00 am – 11:00 am 131 (1)

GPC 22 Instrumentation for Monitoring Central Chilled Water Plants (5/3) Screen

Tuesday (6/28) 10:00 am – 12:00 pm 124 (1)

GPC 27P Measurement Procedures for Gaseous Contaminants in Indoor Environments (5/4)

Sunday (6/26) 3:00 pm – 5:00 pm Portland (M)

GPC 29 Guideline for Risk Management (6/0)

Sunday (6/26) 3:00 pm – 5:00 pm Lafayette (M)

GPC 32 Sustainable, High Performance Operations & Maintenance (5/6)

Saturday (6/25) 12:00 pm – 2:00 232 (2)

GPC 34P Energy Guideline for Historical Buildings and Structures (8/8)

Tuesday (6/28) 7:00 am – 9:00 am Laclede (20)

GPC 35 Method for Determining the Energy Consumption Caused By Air-Cleaning and Filtration Devices (10/40) Screen/ Electric

Monday (6/27) 8:00 am – 12:00 pm Majestic F (CP2)

GPC 36P High Performance Sequences of Operation for HVAC Systems (30/20) Screen/Electric

Monday (6/27) 8:00 am – 12:00 pm 232 (2)

GPC 37 Upper Room Ultraviolet Germicidal (UV-C) Devices to Control the Transmission of Airborne Pathogens (6/6)

Saturday (6/25) 1:00 pm – 3:00 pm 200 (2)

GPC 38P Guideline for Using Metal Pressure Vessels to Test Materials Used in Refrigeration Systems (6/6)

Monday (6/27) 4:15 pm – 6:15 pm Pershing (CL)

GPC 41 Design, Installation and Commissioning of Variable Refrigerant Flow Systems

Monday (6/27) 8:00 am – 12:00 pm Hawthorne (21)

SGPC 10 Interaction Affecting the Achievement of Acceptable Indoor Environments (8/4)

Sunday (6/26) 9:00 am – 12:00 pm 200 (2)

SGPC 13 Specifying Automation Systems (12/5) Screen/Electric

Saturday (6/25) 8:00 am – 12:00 pm 232 (2)

US TAG to ISO/TC 86 (20/10) Screen/Electric

Monday (6/27) 8:00 am – 10:00 am 230 (2)

US TAG to ISO/TC 142 Cleaning Equipment for Air and other Gases (20/25) Screen/Electric

Saturday (6/25) 2:30 pm – 3:15 pm 220 (2)

JWG ISO/TC 163/WG4 and ISO/TC 205 (18/11) Screen/ Electric

Tuesday (6/28) 2:30 pm – 3:00 pm 130 (1)

US TAG to ISO/TC 163 Thermal Performance and Energy in a Building Environment (18/11) Screen/Electric

Tuesday (6/28) 3:00 pm - 4:30 pm 130 (1)

US Tag to ISO/TC 205 (22/12) Screen/Electric

Tuesday (6/28) 1:00 pm - 2:30 pm 130 (1)

ISO 817 MA (23/11) Screen/Electric

Tuesday (6/28) 8:00 am - 12:00 pm 130 (1)

ISO 817 MA-Flammability (15/10) Screen/Electric

Monday (6/27) 8:00 am - 9:00 am 131 (1)

ISO 817 MA-Toxicity (15/10) Screen/Electric

Monday (6/27) 8:00 am - 10:00 am 130 (1)

ISO 817 MA - Design and Nomenclature (15/10) Screen/Electric

Monday (6/27) 9:00 am - 10:00 am 131 (1)

OTHER

USNC/IIR (20/20)

Tuesday (6/28) 2:00 pm - 4:00 pm Landmark 6 (CL)

USNT/IEA (20/10)

Tuesday (6/28) 4:00 pm - 6:00 pm Landmark 6 (CL)

IEA Annex 41 Cold Climate Heat Pumps (15/0)

Friday (6/24) 1:00 pm - 6:00 pm 266 (2)

gbXML (10/0)

Tuesday (6/28) 12:00 pm - 1:00 pm Laclede (20)

Thermal Envelope Conference (30/0)

Monday (6/27) 9:00 am – 12:00 pm Landmark 4 (CL)

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SPEAKERS' LIST

A

Abellon, Devin, *Seminar 21, 26 & 30*
Acosta, Marcelo, *Seminar 53*
Acuna, Jose, *Seminar 61*
Adamkiewicz, Gary, *Seminar 62*
Agarabi, Mina, *Seminar 1*
Allen, Melissa, *Seminar 56*
Ally, Moonis, *Conference Paper Session 19*
Altwies, Joy, *Conference Paper Session 2 & Workshop 8*
Alvares, Jose, *Seminar 53*
Aman, Julia, *Conference Paper Session 1*
Arababadi, Reza, *Technical Paper Session 7*
Athalye, Rahul A., *Conference Paper Session 17*
Aute, Vikrant, *Seminar 13 & 44*

B

Bagge, Hans, *Conference Paper Session 17*
Bahnfleth, William, *Seminar 41*
Balaras, Constantinos, *Seminar 15 & 64*
Baltazar, Juan-Carlos, *Conference Paper Session 17*
Barnaby, Charles S., *Seminar 23*
Bay, Christopher, *Technical Paper Session 3*
Bean, Robert, *Seminar 26 & 30*
Beason, Kent, *Conference Paper Session 9*
Beaty, Don, *Seminar 41*
Beck, Terry, *Seminar 38*
Becker, Henry A., *Conference Paper Session 12 & 19*
Betz, Frederick, *Seminar 10*
Bhandari, Mahabir, *Conference Paper Session 4*
Blalock, Alonzo, *Seminar 49*
Blanton, Robert, *Seminar 10*
Bochat, Jim, *Seminar 24*
Bohanon, Hoy, *Seminar 29*
Boldt, Jeff, *Seminar 18*
Bortone, Vicente, *Conference Paper Session 10*
Bosworth, David, *Seminar 22 & 34*
Bourdakis, Eleftherios, *Conference Paper Session 4 & Seminar 21*
Boyce, Darryl, *Seminar 19*
Brandt, Don, *Seminar 2*
Briscoe, Casey, *Seminar 45*
Brooks, Alamelu, *Conference Paper Session 9 & Technical Paper Session 7*
Brown, Cillian, *Conference Paper Session 6*
Brown, Jason, *Seminar 56*
Brown, Kevin, *Workshop 8*
Brunner, Gregory, *Seminar 3*
Buford, Jasmine, *Conference Paper Session 3*

C

Carda, Ryan, *Seminar 61*
Carpenter, Joseph, *Conference Paper Session 3*
Cedillos, Dagoberto, *Conference Paper Session 12*
Cerra, Helen R., *Conference Paper Session 4 & 13*
Cetin, Kristen, *Seminar 37 & 52*
Chen, Yixing, *Conference Paper Session 13*
Chin, Joe, *Seminar 50*
Chmielewski, Donald, *Seminar 32*
Chong, Howard, *Seminar 52*
Chopko, Robert, *Seminar 45*
Claridge, David E., *Conference Paper Session 8 & 11*
Coenen, Anja, *Workshop 1*
Cohen, Jon, *Seminar 18 & Workshop 6*
Collins, Patrick, *Conference Paper Session 11*
Colombo, Ina, *Conference Paper Session 15*

Comstock, Steve, *Workshop 2*
Cooper, Michael, *Seminar 48*
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Crawley, Drury, *Seminar 2 & 63*
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Curlin, Chuck, *Seminar 50*

D

Dalpane, Pietro, *Conference Paper Session 9*
Davila, Carlos, *Seminar 39*
Davis, Aika, *Conference Paper Session 18*
Davis, Douglas A., *Seminar 5*
DeCaria, Domenic, *Seminar 17*
DeMarco, Christopher, *Seminar 11*
Denis, Derrick A., *Seminar 41*
Dieryckx, Martin, *Workshop 5*
Doppel, Paul, *Seminar 51*
DuChane, Greg, *Seminar 8*
Duffy, Pamela, *Seminar 40*

E

Eftekhari, Mahroo, *Seminar 16*
Elbel, Stefan, *Seminar 33*
Ellis, Robyn, *Seminar 27 & 57*
English, Travis R., *Conference Paper Session 14 & Seminar 35*
Escobar, Luis, *Seminar 23*
Eslami Nejad, Parham, *Technical Paper Session 6*

F

Fadl, Mohamed Sakr, *Technical Paper Session 8*
Falke, Rob, *Seminar 27 & 57*
Fallahi, Ali, *Technical Paper Session 8*
Felts, Margaret, *Conference Paper Session 15*
Ferrari, Sarah, *Seminar 7*
Fisher, Donald, *Seminar 8*
Fisher, Larry J., *Workshop 4*
France, Brandon, *Seminar 14*
Francisco, Paul W., *Seminar 36 & 62*
Fricke, Brian, *Seminar 55*
Friedman, Glenn, *Seminar 23*

G

Gagné-Boisvert, Laurent, *Conference Paper Session 9*
Gallaher, John, *Seminar 14*
Gangemi, Nick, *Seminar 58*
Gao, Kaimi, *Technical Paper Session 3*
Gayeski, Dr. Nicholas T., *Technical Paper Session 5*
Geoghegan, Patrick, *Seminar 5*
Gercek, Ersin, *Seminar 5*
Gervind, Pernilla, *Conference Paper Session 20*
Ghias, Reza, *Seminar 16*
Gladfelter, Seth, *Seminar 31*
Glazer, Jason, *Seminar 2*
Gluesenkamp, Kyle, *Conference Paper Session 19*
Goldstein, Eli, *Conference Paper Session 4*
Gouw, Sean, *Seminar 33*
Gray, Chris, *Seminar 9*
Guither, Blake, *Conference Paper Session 22*
Guzman, Sam, *Forum 1 & Seminar 12*

H

Haaland, Daniel, *Conference Paper Session 10*
Haberl, Jeff S., *Seminar 24*
Habte, Aron, *Seminar 63*
Hackel, Scott, *Seminar 61*
Hackner, Richard, *Seminar 11*
Haiad, Carlos, *Seminar 37*
Haider, Ali, *Technical Paper Session 3*

Hakkaki-Fard, Ali, *Technical Paper Session 2*
Halel, Danny, *Seminar 43*
Hall, Richard, *Seminar 10*
Ham, Sang-Woo, *Conference Paper Session 16*
Hasan, Ali M., *Technical Paper Session 1 & 4*
Hawit, Omar, *Seminar 21*
Hayter, Richard, *Seminar 28*
He, Shan, *Seminar 20*
Heiden, Rick, *Seminar 31*
Heinzerling, David, *Seminar 24*
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Henry, Michael C., *Seminar 15*
Heo, Yeonsook, *Seminar 39*
Hickman, Craig, *Seminar 38*
Holness, Gordon V. R., *Seminar 54*
Howard, III, Eli P., *Workshop 9*
Huang, Yu Joe, *Seminar 63*
Huizing, Ryan, *Seminar 6*
Hunn, Bruce, *Seminar 24*
Hutzel, William, *Seminar 47*
Hydras, Kinga, *Workshop 3*

I

Ibarra, Maribella, *Conference Paper Session 8*
Ince, Joshua, *Seminar 7*
Ingui, Michael, *Seminar 15*
Ishihara, Masaya, *Conference Paper Session 6*
Ivester, Gwenn, *Seminar 19*
Iwamatsu, Toshiya, *Conference Paper Session 2*

J

Jacobs, Dave, *Seminar 62*
Jaffe, Trevor, *Seminar 21*
Jalayerian, Mehdi, *Seminar 4*
Johansson, Dennis, *Conference Paper Session 17*
Johnson, Mel, *Seminar 27*
Johnson, Phillip, *Seminar 10*
Jones, Dennis, *Conference Paper Session 17*
Jones, Nathaniel, *Seminar 34*
Joshua, New, *Seminar 22*

K

Karakash, John, *Seminar 42*
Karg, Richard, *Seminar 36*
Karnaz, Joseph A., *Seminar 43*
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