



2022 WINTER CONFERENCE
AND AHR EXPO

2022 ASHRAE Winter Conference – Preliminary Program

January 30 – February 2, 2022

Last Updated: 10/20/2021

Sunday, January 30

Sunday, January 30, 8:00 AM - 9:00 AM

Paper Session 1

Effect of Occupant Behavior and Occupancy Schedules on Buildings Energy Use and Consumption

Track: Buildings at 360°

Most current heating and cooling load estimation methods use simple approach to evaluate zone occupancy density which leads to an over estimation of the HVAC load and the need to use bigger equipment with a higher carbon footprint or to underestimate the load, which results in a lower comfort sensation. This session highlights the direct effect of occupancy rate coupled with occupants' schedules. The session also explores the interaction between the occupant's behavior and energy efficiency in buildings.

1. A Practical Method to Account for Different Possible Occupant Behaviors during Design Phase

Debby Veillette, Student Member, Jean Rouleau, Ph.D., P.E., Member and Louis Gosselin, Ph.D., P.E., Member, Université Laval, Quebec City, QC, Canada

2. How Household Characteristics Affect District Occupancy Schedules? A Case Study Using Canadian Time Use Survey Data

Mohamed Osman¹ and Mohamed Ouf, Associate Member², (1)Concordia University, Montréal, QC, Canada, (2)Concordia University, Montreal, QC, Canada

3. Developing an Automated Workflow for Non-Residential Building Retrofit as a Function of Usage and Occupancy Behavior

Mostafa M. Saad, Sanam Dabirian, Kartikay Sharma and Ursula Eicker, Concordia University, Montreal, QC, Canada

8:00 AM - 9:00 AM

Seminar 1 (Basic)

Codes and Design Standards for Motors and Motor Control Technology

Track: HVAC&R Systems and Equipment

Sponsor: 1.11 Electric Motors and Motor Control, 2.7 Seismic and Wind Resistant Design, TC 1.9 Electric Systems

Chair: Nicolas S. Rosner, P.E., Member, Eaton, City of Industry, CA

Today's global supply shortage, labor and transportation challenges have increased popularity of UL508A solutions. OSHA, NEC, UL, IBC, ASCE7 and OSHPD have set crucial standards for electrical panel design, motor and motor control basics, safety, as well as short circuit current rating standards. The purpose of this session is to understand these governing codes and how to apply them when designing motor control technology. Leading industry experts in the electrical and mechanical segment provide a general overview of control panel regulations as well as motor shake testing. Participants will be able to identify, differentiate and properly apply motor and motor control recommendations.

1. UL 508A Industrial Control Panels and Code Requirements of NFPA70/79/70E

John Ross, Eaton, Cleveland, OH

2. Seismic Certification of Motors

John Giuliano, P.E., Member, Vibration Mountings & Controls, Bloomingdale, NJ

8:00 AM - 9:00 AM

Seminar 2 (Basic)

Designing Control Systems for Net-Zero Energy Buildings

Track: Energy System Integration

Sponsor: 1.4 Control Theory and Application

Chair: Paul Ehrlich, P.E., Member, Building Intelligence Group, Portland, OR

Net zero energy buildings provide great potential to deliver an efficient building with on-site renewables. Properly designed and controlled these projects can also provide improved resilience and even become "carbon negative." This seminar focuses on design and control optimization of net-zero buildings. A new process for HVAC and controls design called "co-design" is introduced that uses energy models to concurrently make system design and control decisions resulting in balancing of energy use, generation and storage.

1. Co-Design of HVAC Systems and Controls for Energy-Flexible Buildings

Veronica Adetola, Ph.D., Member, Pacific Northwest National Laboratory, Richland, WA

8:00 AM - 9:00 AM

Seminar 3 (Intermediate)

How to Talk to Your Clients and Friends about Climate Change, Climate Zones and Codes

Track: Buildings at 360°

Sponsor: 4.2 Climatic Information, 2.5 Global Climate Change

Chair: Parag Rastogi, Ph.D., Member, arbnco Ltd., Glasgow, United Kingdom

Weather data is a critical input to building design and analysis. The design conditions and weather data published in Ch. 14 (Climatic Information) of the Handbook – Fundamentals, Std. 169, and IWEC files are the core of weather data published by ASHRAE for building design and analysis. The content of the chapter and standard has changed in recent updates and will continue to evolve to better serve the needs of ASHRAE members. This seminar discusses important aspects of this exercise, including the past, present and future of climate zoning, IWEC files and design conditions.

1. How the Sausage Is Made: Past, Present and Future Adventures in Determining Climate Zones

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

2. Climate Change Is Here: Historical Trends in Design Conditions

Michael Roth, Ph.D., Member, Klimaat Consulting & Innovation Inc, Guelph, ON, Canada

3. The ASHRAE IWEC2 Files Are Decades Old: Are They Still Useful in a Changing Climate?

Yu Joe Huang, BEMP, Fellow ASHRAE, White Box Technologies, Moraga, CA

8:00 AM - 9:00 AM

Seminar 4 (Intermediate)

Opportunities and Barriers for Self-Powered and Integrated HVAC

Track: Energy System Integration

Sponsor: 6.10 Fuels and Combustion

Chair: Aleksandr Fridlyand, Ph.D., Member, Gas Technology Institute, Des Plaines, IL

Integration between fuel-fired and electric heating and air conditioning systems is an established approach for minimizing the environmental impact of these end uses while providing superior comfort and lower operating costs. By further coupling these systems with power-generating equipment and grid-interaction, the overall integrated energy systems also gain superior resilience and grid flexibility. This seminar presents an overview of opportunities for and specific implementations of integrated and self-powered heating, cooling and water heating systems.

1. Gas-Electric Self-Powered, Hybrid and Grid-Interactive Energy Systems

Tim Kingston, Associate Member, Gas Technology Institute, Des Plaines, IL

2. Power Generation Cycle Options for Self-Powered Furnace

Ahmad Abu-Heiba, Associate Member, Oak Ridge National Laboratory, Oak Ridge, TN

3. Thermionic Converters for Self-Powered Residential Heating

Vikas Patnaik, Ph.D., Associate Member, Modern Electron, Bothell, WA

8:00 AM - 9:00 AM

Forum 1

Will High ACH Reduce the Spread of Airborne Contaminants

Track: Environmental Health and IEQ in the International Arena

Sponsor: MTG.ACR, 1852

Chair: Roland Charneux, P.Eng., Fellow ASHRAE, Pageau Morel et Associés Inc., Montreal, QC, Canada

It is generally believed that increasing the air change rate will automatically reduce the airborne contaminants in a room. More than the air change rate (ACR), would the effectiveness of ventilation play a more important role than ACR? Does the location of supply and return grille make a significant difference? This is an interactive brainstorming session and active participation of the audience is required.

Sunday, January 30, 9:45 AM - 10:45 AM

Paper Session 2

Indoor Environmental Quality Challenges in Public Places: Study Results from a College, School and Transit Buses

Track: Environmental Health and IEQ in the International Arena:

This session covers three studies looking at indoor environmental quality challenges at three public places. The first paper presents the results and conclusions to inform the university for the design of new buildings, retrofitting old buildings and determining ventilation strategies for older buildings that are not slated for retrofitting. The second paper is an approach to estimate occupant density, outdoor air ventilation rates and supply airflow rates through the school by analyzing the decay, steady-state and accumulation periods of CO₂ measured in return air. The third papers reviews criteria for evaluating the fit of an air-cleaning solution for transit bus applications.

1. Indoor Conditions in Higher Education: A Survey of College Students on the California Central Coast

Jennifer Mott, Ph.D., Associate Member, Khanhthy Le, Tarnvir Dhaliwal and Karina Nguyen, California Polytechnic State University, San Luis Obispo, CA

2. Indoor Air Quality Considerations for Transit Buses

Christos Polyzois, Ph.D., Member, Trane Technologies, Bloomington, MN

3. Determining Airflows and VOC Source Strengths for an Occupied School

Brett Stinson, Student Member, Aurélie Laguerre and Elliott Gall, Ph.D., Portland State University, Portland, OR

9:45 AM - 10:45 AM

Paper Session 3

Saving Energy and Water by Modelling

Track: Fundamentals and Applications

Energy and water are two of the most important resources we need to use wisely. The papers in this session describe how a HVAC system can be designed to minimize the input energy and how the associated operative costs can be estimated. The session investigates how water used by data centers can be estimated and measured to identify the best cooling solution that delivers required heat gain mitigation while minimizing water draw.

1. Building Energy Modeling Case Study of Retrofit of a University Laboratory Building

Kevin Anderson, Ph.D., P.E., Member, Raymond Yip, P.E., Member, Gabriel Navarro, Khoa Tran, Nicholas Hills, Aaron Aguirre, Yun-Do Jang and Yew Wong, California State Polytechnic University at Pomona, Pomona, CA

2. Characterizing Data Center Cooling System Water Stress in the United States

Li Chen and Aaron Wemhoff, Ph.D., Associate Member, Villanova University, Villanova, PA

3. A Numerical Investigation of the Gap Effect on the Condensation Heat Transfer in Vertical Mini-Channels with Various Wettability Conditions

Hyo Je Son¹, Jae Sung Yang, M.D.¹, Man Yeong Ha, Ph.D.¹, Hanchoon Lee, Ph.D.², Seungmo Jung² and June Kee Min, Ph.D.¹, (1)Pusan National University, Busan, Korea, Republic of (South), (2)LG Electronics, Seoul, Korea, Republic of (South)

9:45 AM - 10:45 AM

Seminar 5 (Intermediate)

Critical Ventilation in Critical Facilities: Demand Control Ventilation

Track: HVAC for Industrial and Commercial Purposes - Challenges and Opportunities

Sponsor: 9.10 Laboratory Systems

Chair: Christine Reinders-Caron, Member, Iowa State University, Omaha, IA

People working in critical facilities, such as laboratories, depend on proper design and operation of the building systems to provide safe and controlled workspaces to support their scientific endeavors. It is critical to get the laboratory airflow control systems right. Air is the primary carrier of heat, moisture, contaminants and airborne hazards in and around laboratory buildings. As a result, occupant safety is the main driver of laboratory ventilation system design and operation. In this presentation, attendees learn more about innovations in demand-controlled ventilation.

1. How the Demand for Ventilation Drives Safety and Energy Efficiency in Labs and Critical Workspaces

Tom Smith, Member, 3Flow, Cary, NC

2. A Low-Cost Demand-Control Ventilation Protocol for Critical Facilities

Amanda Kirkeby, Associate Member, National Renewable Energy Laboratory, Golden, CO

3. Cost-Benefit Approach to Design and Operation of Laboratory Demand Control Ventilation Systems

Paul Fuson, Phoenix Controls, Acton, MA

9:45 AM - 10:45 AM

Seminar 6 (Intermediate)

High Performance Design for Mega Airport Terminals

Track: Buildings at 360°

Sponsor: 9.8 Large Building Air-Conditioning Systems, 2.10 Resilience and Security

Chair: Anthony York, P.E., Member, Syska Hennessy Group, New York, NY

New state-of-the-art mega airport terminals are large multi-use facilities that not only serve as transportation hubs for travelers, but they have become iconic buildings that command latest technologies in achieving LEED and other sustainability and resilience goals. These buildings require careful engineering integration with architectural design as well as functional program requirements specific to the owners and stakeholders of each airport. This seminar presents unique challenges and innovative solutions in the HVAC design associated with high performance design for airport terminals.

1. Challenges in Design of Modern Airport Terminals

Sergiu Pelau, P.E., Member, Syska Hennessy Group, New York, NY

2. Sustainability and Resilient Design in Airport Environment

Kris Baker, P.E., Syska Hennessy Group, New York, NY

9:45 AM - 10:45 AM

Seminar 7 (Basic)

Introduction of Building Decarbonization

Track: Building Decarbonization

Sponsor: Task Force on Building Decarbonization

Chair: Doug Cochrane, P.E., Member, Carrier, Toronto, ON, Canada

This session will explain building decarbonization and the define what is associated with the process.

1. Building Decarbonization Part A

Don Brandt, Member, ASHRAE Design ESSENTIALS Instructor, Atlanta, GA

2. Building Decarbonization Part B

Ginger Scoggins, P.E., Member, Engineered Designs, Cary, NC

9:45 AM - 10:45 AM

Seminar 8 (Intermediate)

The Solar Panel: Enabling Renewable's Integration with Thermal Energy Storage Systems

Track: Energy System Integration

Sponsor: 6.9 Thermal Storage

Chair: Jason Woods, Ph.D., Associate Member, National Renewable Energy Laboratory, Golden, CO

Integrating variable renewable electricity on the grid requires system flexibility. This flexibility can come from several building end-uses, but it should not impact occupant comfort, safety or product quality. This is possible by using thermal energy storage, which enables load flexibility of HVAC&R loads while still delivering the cooling or heating when needed. This session presents three thermal storage applications that reduce utility costs for building owners while also providing the flexibility that the grid needs for higher renewable penetration. The presenters describe how controls are critical to facilitate renewable electricity generation, and, in one application, electric vehicle charging.

1. Optimization of Photovoltaic Self-Consumption with Residential Electric Water Heaters

Celeste Fieberg, Student Member, National Renewable Energy Laboratory, Golden, CO

2. Enabling Grid Penetration of Renewables with Residential Cool Thermal Energy Storage

Amy Van Asselt, Ph.D., Associate Member, Lafayette College, Easton, PA

3. Synergies between Building-Sited Batteries and Thermal Energy Storage

Jason Woods, Ph.D., Associate Member, National Renewable Energy Laboratory, Golden, CO

Sunday, January 30, 11:00 AM - 12:30 PM

Paper Session 4

How to Achieve the Desired Comfort Level in Extreme Weather Conditions

Track: Buildings at 360°

Extreme weather conditions "too hot or too cold" represent a challenge when dealing with desired comfort level. Approaches to achieve the desired comfort level are presented during this session. Approaches include the use of an electric heat pump water heater that can efficiently replace the traditional electric water heater, passive building strategies that can be integrated in modern building designs, manipulating the electric load by using "grid-interactive efficient buildings", changing the set point and novel DC-powered picogrid coupled with on-site renewable energy generation, such as solar and wind power to drive real-time electrical management decisions.

1. Preliminary Investigation of Active Demand Flexibility Control at Ahus Using Energy Feedback Control

Zufen Wang, University of Miami, Miami, FL

2. Potential Energy Savings By Switching Residential Electric Water Heaters to Electric Heat Pumps Water Heaters in Saudi Arabia

Ayman Youssef, P.E., Member and Ghadah Alamer, Saudi Aramco, Dhahran, Saudi Arabia

3. Detailed Analysis of the Loads Impact of Passive Architectural Elements in Hot-Dry Climates

Ahmed Mezaïen, Student Member and Juan-Carlos Baltazar, Ph.D., P.E., BEMP, Member, Texas A&M University, College Station, TX

4. Design and Implementation of a DC-Powered Local Weather Station Picogrid for Optimal Energy Management in a Residential Building

Jonathan Ore, Ph.D., Student Member¹, Aaron Farha, Student Member¹, Davide Ziviani, Ph.D., Member² and Eckhard Groll, Dr.Eng., Fellow ASHRAE², (1)Purdue University, United States of America, West Lafayette, IN, (2)Purdue University, West Lafayette, IN

11:00 AM - 12:30 PM

Paper Session 5

Simulation, Integration and Optimization of Decentralized Energy into District Systems

Track: Energy System Integration

Global decarbonization and net-zero targets require improved research for the simulation, integration and optimization of renewable energy usage. The papers in this session describe energy fluctuations of decentralized solar thermal collectors connected district heating to solve overheating, stagnation and energy losses of independent systems; investigate the maximization of waste heat recovery by modelling the coupling of thermal energy storage with a district-scale heat pump, based upon time-of-use electricity prices and recovering waste heat from the London Underground; provide a simulation with first order investigation of co-generation and tri-generation systems and their integration with renewable energy and storage systems; and simulate use testing of hybrid and grid-interactive integrated energy systems to balance energy grid supply and demand while exploiting multiple energy resources.

1. Integrating Waste Heat Recovery from Railway Tunnels into Flexible Heat Networks

Henrique Lagoeiro, Akos Revesz, Ph.D., Affiliate, Gareth Davies, Ph.D. and Graeme Maidment, Ph.D., P.E., London South Bank University, London, United Kingdom

2. Strategic Integration of Renewable Energy, Energy Storage, and Heat Pump with CHP Devices to Reduce Carbon Dioxide Emissions and Operation Cost: Case Study Using an Analysis and Design Software

Yasin Naman¹, Gregory J. Kowalski, Ph.D.² and Mansour Zenouzi, Ph.D., P.E., Member³, (1)Departamento de Energias Fundación, Universidad de America, Bogota, Colombia, (2)Dept. of Mechanical and Industrial Eng., Emeritus, Boston, MA, (3)School of Engineering, Wentworth Institute of Technology, Boston, MA

3. Demonstration and Analysis of Hybrid and Grid-Interactive Integrated Energy Systems Approaches
Tim Kingston, Associate Member, Alejandro Baez-Guada and Alex Fridlyand, Ph.D., Associate Member, Gas Technology Institute, Des Plaines, IL

11:00 AM - 12:30 PM

Seminar 9 (Basic)

Accelerating Change in Building Design and Operation for a Resilient Future

Track: Buildings at 360°

Sponsor: 7.1 Integrated Building Design, CIBSE ASHRAE Liaison Committee

Chair: Tim Dwyer, CEng, Fellow ASHRAE, UCL Institute for Environmental Design and Engineering (IEDE), London, United Kingdom

This seminar illustrates how readily adoptable and accessible changes to the status quo of systems design and operation can deliver buildings that are healthier, more productive and more resilient, potentially providing a route towards a decarbonized and net-zero energy future. This includes applying digitally integrated tools; employing available techniques to 'decarbonize' built environments towards net-zero energy; revolutionary changes in the design of lighting for 21st century buildings rather than being constrained by legacy paradigms; and how a strategic, automated approach to the operation of buildings can optimize energy efficiency, minimize GHG emissions and maximize occupant comfort.

1. Integrating Modern Methods for Sustainable Built Environments

Kevin Mitchell, CEng, Member, Mott MacDonald, London, United Kingdom

2. Sustainable Lighting for Health and Wellbeing in a Modern, and Swiftly Changing, World

Kevin Kelly, CEng, Technological University Dublin, Dublin, Ireland

3. Improving Building Performance with Intelligent Optimization

David Green, P.E., Member, Integral Group, Edmonton, AB, Canada

4. Achieving Zero Energy

Tom Phoenix, P.E., BEMP and BEAP, Presidential Fellow Life Member, CPL (Clark Patterson Lee), Greensboro, NC

11:00 AM - 12:30 PM

Seminar 10 (Intermediate)

Building-Integrated Indoor Air Quality Sensors

Track: Environmental Health and IEQ in the International Arena

Sponsor: 7.5 Smart Building Systems, 6.10 Fuels and Combustion

Chair: Zachary Siefker, Student Member, Purdue University, West Lafayette, IN

Current efforts in building science include the development of low-cost, low-power and high reliability sensing systems, capable of accurately quantifying indoor air quality (IAQ) metrics. Such information is of high value for model development, building energy management and improving occupant health and comfort. However, the widespread use of building-integrated IAQ sensors has yet to be fully realized. This seminar reviews recent developments in building-integrated IAQ sensing systems. Novel sensing technologies, best practice evaluation protocols used to assess the accuracy and reliability of IAQ sensors and end-use IAQ sensing applications are reviewed.

1. Development and Evaluation of Low-Cost IAQ Sensors

Zachary Siefker, Student Member, Purdue University, West Lafayette, IN

2. Developing CO2 Sensor System Reliability Evaluation Methods for Commercial Building Applications

Kristen Cetin, Ph.D., P.E., Member, Michigan State University, East Lansing, MI

3. An Application of Kitchen Indoor Air Quality Sensors in Phius+ and Energy STAR Multifamily Units

Rich Swierczynna, Member, Gas Technology Institute, Des Plaines, IL

11:00 AM - 12:30 PM

Seminar 11 (Basic)

Introduction to Research Knowledge and Building Standards Working Groups

Track: Building Decarbonization

Sponsor: Task Force for Building Decarbonization

Chair: George Pantelidis, Member, ZEB SA, ATHENS, Greece

Introduction to the Research Knowledge and Building Standards Working Groups of the Task Force on Building Decarbonization.

1. Research/Knowledge Hub for Building Decarbonization

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

- 2. Building Performance Standard: The Pathway to Decarbonize the Existing Building Stock-Part I**
Liu Bing, P.E., Fellow ASHRAE, Pacific Northwest National Laboratory, RICHLAND, WA
- 3. Building Performance Standard: The Pathway to Decarbonize the Existing Building Stock-Part II**
Harry Bergmann, U.S. Department of Energy, Washington, DC

11:00 AM - 12:30 PM
Seminar 12 (Advanced)

Renewables and the Smart Grid

Track: Energy System Integration

Sponsor: 7.5 Smart Building Systems, 6.7 Solar Energy Utilization, 7.6 Building Energy Performance and 2.8 Building Environmental Impacts and Sustainability

Chair: Christie Kjellman, Member, Kliewer & Associates, Aliso Viejo, CA

Renewable energy resources are nearly 20% of the U.S. generation mix, growing rapidly through advanced technology and state policy changes. Matching these accelerations in the energy markets are the emerging developments at the distribution level, also known as the “Smart Grid”. While electric customers are now both consuming and generating electricity, the Smart Grid and buildings will both need to dynamically respond to manage resources, loads and reliability. This session presents a variety of approaches used to optimize and integrate renewables and the Smart Grid.

1. Microgrid Applications

Mehdi Ganji, Ph.D., Willdan, San Francisco, CA

2. Field Demonstration of Optimal Control for Campus Cooling Plant for Renewable Energy Integration and Decarbonization

Donghun Kim, Ph.D., Member, Lawrence Berkeley National Laboratory, Berkeley, CA

3. Integration of Renewables and the Smart Grid

Randall Higa, P.E., Member, Southern California Edison, Rosemead, CA

4. Decentralized Renewable Energy System and CO2 Expected Reductions by 2050

Samer Zawaydeh, Ph.D., Al Hussein Technical University, Amman, Jordan

Sunday, January 30, 1:30 PM - 3:00 PM
Paper Session 6

Energy Codes, Standards and Emission Trading Scheme (ETS) to Achieve NetZero in 2050

Track: Buildings at 360°

This session presents the efforts and major findings toward achieving the NetZero carbon emission goal in 2050. The session casts a light on what has been achieved and reviews future planning. Several aspects are evaluated from having a better understanding of the impact of implementing energy codes, updating energy standards and integrating new approaches that can reduce the GHG emissions to mitigate the global warming and anthropogenic impact on the environment. The well-being and comfort of humans are the ultimate priority which cannot be achieved unless joint efforts are combined.

1. Integrative Economic Analysis of Office Building HVAC Systems Incorporating the Emission Trading Scheme (ETS)

Hyeonsoo Kim, Ph.D., Student Member and Lars Junghans, Ph.D., Associate Member, University of Michigan, Ann Arbor, MI

2. Planning for Net Zero By 2050, What HVAC System Interventions Will Today’s Code Minimum Commercial Buildings Require?

Patrick Pease, P.E., Member, Libu Babu, Jayati Chhabra and Zahra Zolfaghari, cove.tool, Atlanta, GA

3. Expanding the Role of Energy Codes to Meet Generational Shifts

Jim Edelson, Member, Alexi Miller, P.E., Member, Kim Cheslak and Mark Lyles, New Buildings Institute, Portland, OR

4. Impact and Value of ASHRAE’s Standards and Technology (RP-1848) (T)

Liping Liu, Ph.D., Associate Member, Lawrence Tech University, Southfield, MI

1:30 PM - 3:00 PM
Paper Session 7

Recent Advancement in Heat Pump and Heating Systems

Track: HVAC&R Systems and Equipment

This session focuses on improving the HVAC system efficiency, achieving energy and cost savings and reducing GHG emissions by simulating or developing new heat pump and heating systems. The papers in this session estimate combined HVAC system annual efficiency, investigates operating costs & GHG emissions using virtual test home (VTH) method, which helps engineers select efficient systems; explains thermal energy storage integrated heat pump systems to meet the residential building's thermal

demand while reshaping its electricity load profile; and describes modeling results of a novel EHP water heating application and uses VTH test methods and modeling for assessing as-installed performance of HVAC and water heating systems.

1. Combined Cold-Climate Air-Source Heat Pump and Heat Pump Water Heater System Performance in Multiple Climate Zones

Alejandro Baez Guada, Member¹ and Tim Kingston, Associate Member², (1)Gas Technology Institute, Chicago, IL, (2)Gas Technology Institute, Des Plaines, IL

2. Ejector Heat Pump for Water Heating

Ahmad Abuheiba, Member¹, Kashif Nawaz, Ph.D., Member¹, Hongbin Ma, Ph.D.² and Pengtao Wang², (1)Oak Ridge National Laboratory, Oak Ridge, TN, (2)Missouri University, Columbia, MO

3. A Novel Approach to Determining As-Installed Space and Water Heating Equipment Performance and Quantifying Potential Energy and Cost Savings in Buildings

Alejandro Baez Guada, Member¹ and Tim Kingston, Associate Member², (1)Gas Technology Institute, Chicago, IL, (2)Gas Technology Institute, Des Plaines, IL

4. The Drop-in Performance of Low-GWP Zeotropic Mixtures in an R410A Water-Source Heat Pump (T)

Saad Saleem, Student Member, Oklahoma State University (OSU), Stillwater, OK

1:30 PM - 3:00 PM

Seminar 13 (Intermediate)

Expansion Devices 101: What Options Are There and Which One to Choose?

Track: HVAC&R Systems and Equipment

Sponsor: 8.8 Refrigerant System Controls and Accessories

Chair: Christian Bach, Ph.D., Associate Member, Oklahoma State University, Stillwater, OK

Expansion devices are a ubiquitous but often overlooked device common to all vapor compression systems. They are selected based on the size of the system, the application type, as well as the refrigerant. Smaller scale applications typically use fixed devices, but with increases in size and the addition of variable speed compressors, means to actively control the refrigerant flowrate are implemented. Large scale and high-pressure applications use ejectors to further improve the system's energy efficiency. This seminar provides an overview of the different devices function, their design and their application range in a compact format.

1. Thermostatic Expansion Valves: Basics and Application

Everardo Cano, Associate Member, Sporlan Division of Parker Hannifin, Washington, MO

2. Fixed Area Expansion Devices: Basics and Application

William V. (Vance) Payne, National Institute of Standards and Technology, Gaithersburg, MD

3. Operation of Electronic Expansion Valves and Their Use for Efficient HVAC System Operation

Kirk Stifle, P.E., Member, Fujikoki America, Dallas, TX

4. Two-Phase Refrigerant Ejector: An Expansion Device Capable of Recovering Work

Stefan Elbel, Ph.D., Member, University of Illinois at Urbana-Champaign, Urbana, IL

1:30 PM - 3:00 PM

Workshop 1 (Basic)

Role Models: How to Inspire the Next Generation of Engineers

Track: HVAC&R Systems and Equipment

Chair: Catarina Marques, Ph.D., London South Bank University, London, United Kingdom

Refrigeration employs 15 million people worldwide and the need for RACHP professionals is increasing due to a growing demand for cooling. Role models are paramount to highlight the career opportunities in RACHP and a diverse workforce benefits the industry. Companies with inclusive business cultures see a 59% increase in innovation and 37% better assessment of consumer demand. With climate change as a major challenge to tackle, promoting diversity, equality and inclusion (DEI) has never been more important or timely. This workshop explores benefits of DEI in the refrigeration industry, showing how role models can inspire the next generation of engineers.

1. Benefits of Diversity, Equality and Inclusion in the Refrigeration Industry

Andres Sepúlveda, Member, Commtech and Fagerhult, Madrid, Spain

2. Role Models Influence of Young People Career Decisions: Case Studies

Ina Colombo, Ph.D., International Institute of Refrigeration, Paris, France

1:30 PM - 3:30 PM

Seminar 14 (Basic)

Smart Thermostats, Energy Savings and Cooling Equipment Cycling

Track: HVAC&R Systems and Equipment

Sponsor: 6.3 Central Forced Air Heating and Cooling Systems, 8.11 Unitary and Room Air Conditioners and Heat Pumps

Chair: Lawrence Brand, Member, Frontier Energy, Oakland, CA

Smart thermostats are used extensively with residential air conditioners to save energy. Of the four types of thermostats, three are considered smart. Do smart thermostats control residential cooling equipment in a way not considered by ASHRAE standard 240? What is the field experience with these devices and how much energy do they save? In this seminar the speakers address how smart thermostats control split system air conditioners, how the ASHRAE 240 standard uses thermostat cycling parameters and how utility programs determine energy savings and incentives.

1. How Smart Thermostats Determine Cycling and Save Energy

Michael Sinclair, Ecobee, Toronto, ON, Canada

2. Warm Climate Utility Incentives and Energy Savings for Smart Thermostats

John Lallier, CenterPoint Energy, Houston, TX

3. How ASHRAE Standard 240 Uses Thermostat Cycling

Christopher Stone, Member, Air-Conditioning, Heating and Refrigeration Institute, Arlington, VA

Sunday, January 30, 3:15 PM - 4:45 PM

Seminar 15 (Basic)

Update on the Progress of the Task Force on Building Decarbonization

Track: Building Decarbonization

Sponsor: Task Force on Building Decarbonization

Chair: Donald Brandt, Life Member, Trane Company - Retired, Phoenix, AZ

This session provides a progress update on the work of the Task Force on Building Decarbonization.

1. Progress of the Task Force on Building Decarbonization

Don Colliver, Presidential Fellow Life Member, University of Kentucky, Lexington, KY

Monday, January 31

Monday, January 31, 8:00 AM - 9:30 AM

Paper Session 8

Performance Evaluation of Latest HVAC Systems

Track: HVAC&R Systems and Equipment

This session reviews different approaches to hybrid heating with TDHPs in multifamily buildings, analyzes the seasonal performance and relative cost savings of GHP VRF systems paired with dedicated outdoor air system and highlights outstanding issues with the advanced fuel-fired technologies testing standard (ANSI Z21.40.4/CGA-2.94). A comparison of steady-state and load-based approaches performed for seasonal performance estimation of a heat pump in heating mode is also reviewed.

1. Hybrid Heating and Hot Water in Multifamily Buildings: Demonstration and Analysis of Integrated Boilers and Thermally-Driven Heat Pumps

Paul Glanville, P.E., Member¹, Michael Mensinger Jr.¹, Matt Blaylock, Associate Member², Tao Li, Associate Member³ and Ryan Hardesty, Associate Member³, (1)GTI, Chicago, IL, (2)SMTI, Johnson City, TN, (3)Weil McLain, Burr Ridge, IL

2. Gas Engine Heat Pump VRF Modeling Comparison Study with Cold Climate Electric VRF and VAV System

Ramanathan Dharmarajan, Associate Member, Aleksandr Fridlyand, Ph.D., Member and Patricia Rowley, Associate Member, Gas Technology Institute, Des Plaines, IL

3. A Review and an Evaluation of the Updated Method of Test for Rating Fuel-Fired Heat Pumps in HVAC

Aleksandr Fridlyand, Ph.D., Member, Paul Glanville, P.E., Associate Member and Navin Kumar, Ph.D., Gas Technology Institute, Des Plaines, IL

4. Comparison of Residential Heat Pump Heating Seasonal Performance Based on Load-Based and Steady-State Testing Methodologies

Parveen Dhillon, Student Member, Travis Horton, Ph.D., Member and James Braun, Ph.D., Fellow ASHRAE, Purdue University, West Lafayette, IN

8:00 AM - 9:30 AM

Paper Session 9

Two Sides of a Coin: Addressing AC Energy Costs

Track: Energy System Integration

Urbanization and rising living standards are increasing the demand for AC, already accounting for a third of global energy. The papers in this session address the increase from two different perspectives. The presenters investigate efficient uses of energy by prototyping a thermoelectric envelope to harvest waste heat into electricity and advancing the modeling of rotary thermal wheels for better optimization. Case studies of natural gas emergency power supply systems (EPSS) with demand-side management operation comparing the economic benefits to both conventional diesel and natural gas emergency-only EPS is reviewed. A comparison of a gas-fired furnace system with cooling and a combined heat and power system in a residential case study is also reviewed during the session.

1. Comparing Combined Heat and Power with Conventional Forced Air/Grid in Residential Buildings

Danielle Caron, Student Member and Ryan Milcarek, Ph.D., Member, Arizona State University, Tempe, AZ

2. Natural Gas Generators for Standby Power and Demand-Side Management for More Cost-Effective Energy Resilience

Patricia Rowley, Alex Lovallo and Jason Stein, GTI, Des Plaines, IL

8:00 AM - 9:30 AM

Seminar 16 (Intermediate)

Electric Grid to Building Interface and Decarbonization through Sequestration

Track: Building Decarbonization

Sponsor: Task Force on Building Decarbonization

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

When a building is operational, it has a choice of both how to manage its electricity usage and where to obtain that electricity. The electricity can be site generated, obtained from on-site energy storage and obtained from the electric grid. In order to advance reductions in carbon, the building needs to have the ability to make both a carbon and a value judgement in these decisions. The amount of carbon in a central electric grid changes on a minute-by-minute basis, as does the cost to provide that electricity. How does decarbonization through sequestration work in building design?

1. How Do Buildings Play a Role in Decarbonizing the Grid and How Does the Grid Talk Back?

Katherine Hammack, USGBC, Washington DC, DC

2. Decarbonization through Sequestration

Lance Davis, Member, US General Services Administration, Washington, DC

8:00 AM - 9:30 AM

Seminar 17 (Intermediate)

Energy System Integration a.k.a. Combined Heat and Power

Track: Energy System Integration

Sponsor: 1.10 Cogeneration Systems

Chair: Blake Ellis, P.E., Fellow ASHRAE, Burns & McDonnell, Overland Park, KS

Combined Heat and Power (CHP) defines energy system integration, as the waste heat of power generation is recycled for building thermal needs. While some are focused on electrification of all building loads, CHP can provide a practical pathway towards decarbonization through energy system integration and provides the most efficient use of fuel, whether fossil, bio, hydrogen or other. This session explores how CHP supports the development of the renewable energy grid, compares electrification to CHP and provides a glimpse of the future with non-carbon CHP that provides dispatchable energy which is vital to a stable grid.

1. Energy System Integration with Loads and the Grid through CHP

Gearoid Foley, Member, Integrated CHP Systems Corp., Princeton, NJ

2. ESI Vs. ESI

Praveen Cheekatamarla, Oak Ridge National Laboratory, Oak Ridge, TN

3. Energy Systems Integration with H2 CHP

Richard Sweetser, Life Member, Exergy Partners Corp., Herndon, VA

8:00 AM - 9:30 AM

Seminar 18 (Intermediate)

Lubricants for New Low GWP Refrigerant Candidates

Track: Refrigerants and Refrigeration

Sponsor: 3.4 Lubrication

Chair: Greg Smith, Ph.D., Associate Member, Honeywell International, Buffalo, NY

The HVAC/R industry continues to develop new refrigerants to meet low global warming potential regulations, and this can lead to challenges for lubrication. The presentations in this session provide insight into how refrigerant and lubricant chemical stability, miscibility and physical performance metrics are evaluated and applied to determine if new lubricants are required when refrigerants change, and if so, how new lubricants are developed to meet the needs of the industry.

1. Lubricants for Low GWP Refrigerants: From Concept to Compressor Operation

Joseph Karnaz, Member, Shrieve Chemical Products, Inc, The Woodlands, TX

2. Performance Review of Lubricants for Automotive Air Conditioning

Bridgett Rakestraw, Ph.D., Associate Member, CPI Fluid Engineering, Midland, MI

3. Investigation of Lubricant Effects on Low GWP Refrigerant Performance

Ramesh Navaratnam, Patech Fine Chemicals Co. Ltd., Dublin, OH

4. Lubricants for New Low GWP Refrigerant Candidates

Joseph Karnaz, Member, Shrieve Chemical Products, Inc, The Woodlands, TX

Monday, January 31, 9:45 AM - 10:45 AM

Paper Session 10

Improving Operational and Energy Efficiency of Building Heating and Cooling

Track: HVAC for Industrial and Commercial Purposes - Challenges and Opportunities

This session reviews a multi-sourced, data-driven energy management toolkit that combines anomaly detection and diagnostics, load disaggregation, and occupancy and occupant complaint analytics to identify inappropriate control sequences and hard faults in HVAC systems that lead to poor building energy performance, and in turn focuses fault correction efforts on specific components or systems. The session also discusses factors and strategies to improve the economics, energy and water savings available by utilizing thermal storage in commercial and industrial facilities.

1. A Framework for a Multi-Sourced, Data-Driven Building Energy Management Toolkit

Andre Markus, Student Member, Brodie Hobson, Student Member, Burak Gunay, Ph.D., Associate Member and Scott Bucking, Ph.D., Associate Member, Carleton University, Ottawa, ON, Canada

2. Reducing Cost of Chilled Water Thermal Storage Systems to Encourage Adoption of Energy Efficient Thermal Plants

Jacob Miller, Member, M2 Thermal Solutions LLC, Somerville, MA

9:45 AM - 10:45 AM

Paper Session 11

Research Advancements in Air Side Equipments and Components

Track: HVAC&R Systems and Equipment

This session covers how backward centrifugal fans performance is impacted by suction chamber intrusions and the proximity of the housing wall to the fan discharge by using CFD analysis. The level of insulation required to prevent condensation on the duct surface from the air surrounding the duct by developing a coupled heat transfer model is also evaluated. The final paper presented in this session explains the field studies to test the ASHRAE Guideline 36 duct static resetting algorithm, measures its performance under various conditions in fully instrumented VAV systems located in the HVAC lab at the University of Cincinnati, and proposes improvements to the guideline.

1. Studying the Effects of Suction Chamber Intrusions and Housing Proximity on Backward Centrifugal Fan Performance Utilizing Computational Fluid Dynamics

Adam Michalson, Montana State University, Bozeman, MT

2. Analysis of Condensation on Ducts of Various Insulation Levels Using Coupled Heat-Mass Model with Building Simulation Data for California Climate Zones.

Antash Najib, Ph.D., Member¹, Mark Modera, Ph.D., P.E., Fellow ASHRAE² and Frederick Meyers², (1)Pakistan Navy Engineering College (NUST), Karachi, Pakistan, (2)University of California, Davis, CA

3. Field and Simulation Testing and Improvement of Ashrae Guideline 36 Duct Static Pressure Resetting Algorithm

Nabil Nassif, Ph.D., P.E., Member, University of Cincinnati, Cincinnati, OH

9:45 AM - 10:45 AM
Seminar 19 (Basic)

ASHRAE Conference Crash Course

Track: Fundamentals and Applications

Sponsor: YEA Committee

Chair: Madison Schultz, P.E., Member, OK BeCo, Oklahoma City, OK

First time at an ASHRAE Conference? Been coming for years, but still confused? What is a TC? What is a Standing Committee? Who can attend what? What is the AHR Expo? And why is all this happening at once? This crash course provides all attendees with an introduction to all the ASHRAE Conference activities, explains how you can get involved, and allows you to ask questions to experienced attendees.

1. The Ins and Outs of ASHRAE

Elise Kiland, P.E., Critchfield Mechanical, Inc, San Jose, CA

2. Make the Most of Your Conference Experience

Chris Krieps, P.E., Salas O'Brien, Chicago, IL

9:45 AM - 10:45 AM
Seminar 20 (Intermediate)

HVAC Design, Control and Operation of Hospitals After COVID-19 Fiasco

Track: Environmental Health and IEQ in the International Arena

Sponsor: 1.4 Control Theory and Application, 9.6 Healthcare Facilities , TC-1.5, TC-7.3, TC-7.5, TC-2.8

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

COVID-19 came from nowhere; worldwide and without exception, our hospitals were not ready. Healthcare planners didn't expect it and HVAC Engineers had not designed for it. So, what happens now? Obviously there are not adequate numbers of isolation rooms and research indicates that the ventilation methods of the past are inadequate to support the infection control and indoor air quality requirements of the future. This seminar presents the latest technology and findings for the proper design, control and operation of hospitals to comply with today's requirements. Air change per hour, filtration, and building automation are among the topics of discussion.

1. The Hospital of the Future: Designing for Energy Efficiency and Infection Control

Timothy Jacoby, Scripps Health, San Diego, CA

2. Designing Flexible and Adaptable HVAC Systems

Renshaw Edward, P.E., Kaiser Permanente, La Mesa, CA

9:45 AM - 10:45 AM
Forum 2

Diversity, Equity, Inclusion and ASHRAE: Does It Really Matter?

Track: Fundamentals and Applications

Sponsor: Board of Directors DEI Advisory Subcommittee

Chair: Adrienne Thomle, Retired, Reno, NV

In 2020, ASHRAE established a Proactive Diversity Task Group to recommend programs and initiatives seeking to eliminate all forms of discrimination and social injustice and proactively drive diversity through all levels within ASHRAE. Some members ask "why?" As an engineering society, shouldn't ASHRAE be focusing its efforts and that of its volunteers on research and education? What role, if any, should ASHRAE play in diversity in the AEC community and social justice? Is there really a problem that needs to be solved? We want to hear from you: the members. This forum intends to tackle these questions head on.

9:45 AM - 10:45 AM
Workshop 2 (Intermediate)

Benefits and Cost Justification of Cloud-Based Building Energy Analytics

Track: HVAC for Industrial and Commercial Purposes - Challenges and Opportunities

Chair: Bert Phillips, UNIES Ltd., Winnipeg, MB, Canada

NYSERDA's real time energy management program incentivized over 600 cloud-based energy analytics deployments in New York state, in commercial and multifamily buildings with systems from over 40 providers. This presentation delivers a cross-cutting of cost-benefits analysis of energy analytics platforms spanning various construction vintages, mechanical systems,

building end-uses, occupancy patterns and technology providers. The installed costs range from fractions of a dollar to over ten dollars per square foot. Regardless, benefits almost always justified total costs while improving the health and comfort of the building environments.

1. Benefits and Cost Justification of Cloud-Based Building Energy Analytics

Pavan Kumar Ryali, NYSERDA, New York, NY

Monday, January 31, 11:00 AM - 12:00 PM

Paper Session 12

Modelling Materials and Devices to Use Them at Best

Track: HVAC&R Systems and Equipment

Knowing the properties of materials and devices is an essential prerequisite for exploiting their characteristics at both the design and deployment phase. The papers in this session cover this important topic spanning from wall assemblies, to HVAC mixing boxes, and, finally, to phase change materials (PCMs)

1. Development of a U-factor Calculation Procedure for Cold-Formed Steel C-shape Clear Wall Assemblies (T)

Merle McBride, Ph.D., P.E., Life Member, Consulting Engineer, Granville, OH

2. The Use of CFD to Understand Mixing, Controls, and Dampers in Air Handling Units (T)

Donald Willoughby, ASHRAE, Atlanta, GA

3. A Novel Process for Selecting a PCM For a Building Energy Retrofit (T)

Neda Askari Tari, Arizona State University, Tempe, AZ

11:00 AM - 12:00 PM

Paper Session 13

Simulations and Control Algorithms for Reducing Energy Consumption

Track: Buildings at 360°

The variability of climatic conditions, and occupancy patterns and behavior constitute a challenge when designing building systems and assemblies (e.g., HVAC, services, etc.), or when doing existing building commissioning (EBCx). Modelling and simulations can help address this challenging variability. The papers in this session span across a pre- & post-EBCx comparison, natural ventilation modelling to save energy, configuration and control for dual VAV systems.

1. The Impact of Existing Building Commissioning on Electric Peak Demand (T)

Ahmed Morsy, Student Member, Texas A&M University, College Station, TX

2. Assessing the Impacts of Natural Ventilation on Building Energy Use: A Case Study of a Mid-rise Residential Building in Chicago, IL (T)

Insung Kang, Illinois Institute of Technology, Chicago, IL

3. New Configuration and Control for Dual VAV Systems to Achieve Better Building Energy Efficiency (T)

Nabil Nassif, University of Cincinnati, Cincinnati, OH

11:00 AM - 12:00 PM

Seminar 21 (Intermediate)

Does it Matter Where your Weather Data Comes From?

Track: Buildings at 360°

Sponsor: 4.2 Climatic Information, 2.5 Global Climate Change

Chair: Parag Rastogi, Ph.D., Member, arbnco ltd, Glasgow, United Kingdom

Weather is a critical input to building design and analysis. Novel weather data sources like global climate models, hyperlocal modelling and crowd-sourced weather data currently coexist with outdated “weather files” from conventional airport stations. This session discusses neglected but important questions about weather data, such as whether common data sources are physically and meteorologically consistent and accurate, or whether the use of “nearby” files is justified. The speakers share their experience with creating weather files from raw data, new technologies changing data quality and availability, and whether users should be concerned about where their file comes from.

1. The Promise and Perils of Modelled and Satellite Derived Data

Paul W. Stackhouse Jr., Ph.D., SSAI/NASA Langley Research Center, Hampton, VA

2. Adventures in Wrangling Weather Data for Building Design and Analysis

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

3. How the Choice of Weather Data Affects a Robust Controller

John Allison, Ph.D., Member, arbnco Ltd., Glasgow, United Kingdom

11:00 AM - 12:00 PM

Seminar 22 (Intermediate)

Infection Control in Commercial Spaces

Track: Environmental Health and IEQ in the International Arena

Sponsor: 4.10 Indoor Environmental Modeling

Chair: Himanshu Sharma, Ph.D., Pacific Northwest National Laboratory, Richland, WA

Understanding the dynamics of infectious aerosol spread in indoor environment is critical for occupant safety. The COVID-19 pandemic has further highlighted the significance of the research in this area. While many studies have considered contaminant transport in a small indoor environment, limited studies have given attention to understand the spread in commercial and large spaces such as conference rooms, warehouses, etc. This seminar session presents the opportunity for building science practitioners, engineers and researchers to understand the intricacies of contaminant transport modeling in commercial spaces. It also provides details on the state-of-the-art simulation methods and approaches for simulating aerosol transport.

1. Evaluation of Mitigation Strategy for Aerosol Disease Transmission in a Conference Room

Wangda Zuo, Ph.D., Member, University of Colorado, Boulder, CO

2. The Micro (Individual) and Macro (Population) Aspects of Assessing Infection Control in Commercial Spaces

Duncan Phillips, Ph.D., P.E., Member, Rowan Williams Davies & Irwin, Guelph, ON, Canada

11:00 AM - 12:00 PM

Seminar 23 (Advanced)

Integrated Smart Heating and Cooling Systems

Track: Energy System Integration

Sponsor: 6.8 Geothermal Heat Pump and Energy Recovery Applications

Chair: Graeme Maidment, Ph.D., P.E., London South Bank University, London, United Kingdom

Heating and cooling can be controlled individually or can form part of a smart heating and cooling network. By integrating into a low temperature heat networks, it's possible to deliver further carbon savings, since heat can be shared between heating and cooling applications and captured from secondary sources. The principles of integrated smart heating and cooling energy systems are well described, lessons learned may not because their deployment is relatively new. This seminar brings together knowledge and understanding of these smart networks by presenting and discussing examples with different levels of complexity and application.

1. The Need for Smart Local Energy Systems

Graeme Maidment, Technical Energy Lead, UK Government, London, United Kingdom

2. Green Smart Community Integrated Energy Systems

Akos Revesz, Ph.D., Affiliate, London South Bank University, London, United Kingdom

3. Low Temperature Heat Networks in Sweden

Helen Carlström, E.On, Malmo, Sweden

4. Feeding R&D Back into Government Policy

Dr. Joel Hamilton, Technical Energy Lead, UK Government, London, United Kingdom

11:00 AM - 12:00 PM

Seminar 24 (Intermediate)

The Future of Controls: Transition from Algorithmic to Predictive Control

Track: HVAC&R Systems and Equipment

Sponsor: 1.4 Control Theory and Application

Chair: Paul Ehrlich, P.E., Member, Building Intelligence Group, Portland, OR

Grid interactive energy efficient buildings will require control systems that are able to balance out the needs to provide for a safe, comfortable and efficient building environment while at the same time coordinating the operation of the building with the needs of the grid. The use of new technology including model predictive control (MPC) can provide solutions that are able to both control and estimate future needs using data and simplified building models. This session looks at the pros and cons of these new approaches and discuss potential research needs and direction for industry.

1. Moving to MPC: What, Why and How

Draguna Vrabie, Ph.D., Member, Pacific Northwest National Laboratory, Richland, WA

2. Practical Applications Using MPC

Troy Harvey, Passive Logic, Salt Lake City, UT

Monday, January 31, 2:15 PM - 3:45 PM

Seminar 25 (Intermediate)

Seismic Certification of Equipment

Track: Fundamentals and Applications

Sponsor: 2.7 Seismic and Wind Resistant Design

Chair: Matthew Hooti, P.E., Member, ISOTECH Industries Inc, Woodbridge, ON, Canada

Join this session to gain a clear understanding of the requirements, benefits and ease of going through the process of certifying equipment to the ASCE7. Presenters in this session provide greater understanding of code requirements for seismic certification of equipment. When is it required, where is it required and what are acceptable methods and standards?

1. Code Requirements: When/Where

Robert Simmons, P.E., Member, Petra Seismic Design, Houston, TX

2. Equipment Manufacturing Experience

Mark VanderKooy, P.E., Member, Greenheck, Wisconsin, WI

3. How: Certification Requirements

John Giuliano, P.E., Member, The VMC Group, Bloomingdale, NJ

Tuesday, February 1

Tuesday, February 1, 8:00 AM - 9:30 AM

Panel 1 (Intermediate)

In Real Time: Charting the Pathway for Existing Buildings to get to Carbon Neutrality

Track: Buildings at 360°

Sponsor: 2.8 Building Environmental Impacts and Sustainability

Chair: Paul Torcellini, Ph.D., P.E., Fellow ASHRAE, National Renewable Energy Laboratory, Golden, CO

Many corporate entities have set goals to be carbon neutral by a specific date, often within the next 20 years. This shift will take a concerted effort by these owners to make substantial changes to their buildings. But who makes the plan? Design firms are being asked more and more to provide planning and strategies to shift carbon consumption within the business cases for owners. This interactive panel in real-time will debate and create an action plan to bring a building to carbon neutrality. The audience will have a change to brainstorm, comment and help drive the action plan development.

1. Creating an Effective Action Plan #1

Stet Sanborn, AIA, Member, Smith Group, San Francisco, CA

2. Creating an Effective Action Plan #2

Kent Peterson, P.E., Presidential Fellow ASHRAE, P2S, Inc., Long Beach, CA

3. Creating an Effective Action Plan #3

John Hickey, P.E., Jacobs, Seattle, WA

4. Creating an Effective Action Plan #4

Kiersten Washle, Associate Member, CMTA, Boston, MA

8:00 AM - 9:30 AM

Paper Session 14

Characterizing Device Performances by Field Tests and Measurements

Track: HVAC&R Systems and Equipment

The quest for increasing the energy efficiency of equipment and buildings, both at individual and at district level, requires the estimation/assumption of device characteristics and the assessment of what the real performance is. This session deals with measuring the performances of the following devices by experiment or by real-time measurement in the field including adsorption-based desiccant material, AC for a data center, hybrid boiler array and residential AC systems.

1. Real-Time Search for Optimum Operation Parameters of Air Conditioning System in the Data Center By Using Regression Prediction and Deep Reinforcement Learning on CFD Analysis Data

Hiroki Tsukamoto¹, Yuki Sogawa¹, Kazuhiro Matsuda¹, Morito Matsuoka¹, Keisuke Otani² and Kazunari Momose², (1)Osaka University, Osaka, Japan, (2)Advanced Knowledge Laboratory Inc., Tokyo, Japan

2. Demonstration of Hybrid Boiler Arrays to Improve Heating Season Efficiency, Provide Redundancy, and Minimize Capital Investment

Kris Jorgensen, Ph.D., Associate Member, Douglas Kosar, Member, Alex Lavollo and Patricia Rowley, Associate Member, GTI, Des Plaines, IL

3. Experimental Characterization of Adsorption Isotherm of Solid Desiccant Materials for Use in Air Dehumidification Devices

Tomas Venegas, BEMP, Associate Member¹, Ming Qu, Ph.D., Associate Member¹ and Kashif Nawaz, Ph.D., Member², (1)Purdue University, West Lafayette, IN, (2)Oak Ridge National Laboratory, Oak Ridge, TN

4. Repeatability Assessment of Load-Based Testing Methodology for Residential Air Conditioning Equipment

Parveen Dhillon, Student Member, Dohyeon Kim, Travis Horton, Ph.D., Member and James Braun, Ph.D., Fellow ASHRAE, Purdue University, West Lafayette, IN

8:00 AM - 9:30 AM

Paper Session 15

Light and Shade

Track: Buildings at 360°

Controlling the lighting in a room has consequence on the indoor environmental quality. This session investigates the use of lights and shades by proposing an intelligent control of a venetian blind that automatically adjusts the solar irradiation reaching the room by tilting the slat angle; it also proposes a study about adjusting the internal light by using a fully-integrated lighting control system which dynamically controls the fixture dimming level; finally, co-modeling the shading devices and the fenestrations using energy and irradiation simulation software which can predict the optimal settings, is presented.

1. More Light, Less Energy: Validating Fully-Integrated LED Controls for DoD Interior Lighting Applications

Bryan Urban, Fraunhofer USA, Boston, MA

2. Co-Simulation and Validation of Automated Shading Devices Using Energyplus and Radiance to Optimize Building Energy Use

Soham Vanage, Student Member, Michigan State University, East Lansing, MI

8:00 AM - 9:30 AM

Seminar 26 (Intermediate)

Advanced Heat Exchanger Simulation and Optimization Tools for HVAC Applications

Track: HVAC&R Systems and Equipment

Sponsor: 1.13 Optimization

Chair: Khaled Saleh, Ph.D., P.E., Member, Goodman Manufacturing, Daikin Group, Houston, TX

In this session, there will be three presentations by National Institute of Standards and Technology, University of Maryland and Oak Ridge National Lab to introduce the state-of-the-art simulation and optimization tools for air-cooled heat exchangers for HVAC Application. All the tools can be used for designing and optimizing the heat exchangers for the current refrigerants and low GWP refrigerants. Practical examples from industry are presented along with the description of the optimization algorithms used in simulation and optimization tools.

1. Optimization of Heat Exchangers Using Steady State Simulation Tools Coupled with CFD and Multiobjective Genetic Algorithms

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

2. Evap-Cond Simulation Tool with Optimization Refrigerant Circuitry

Piotr Domanski, Ph.D., Fellow ASHRAE, National Institute of Standards and Technology, Gaithersburg, MD

3. Optimization and Lccp Evaluation of a Residential Heat Pump Using 5-Mm Tubes and Refrigerants with GWP <150

Zhenning Li, Ph.D., Associate Member, Oak Ridge National Laboratory, Oak Ridge, TN

8:00 AM - 9:30 AM

Seminar 27 (Advanced)

Impact of Workplace Furnishing System and Air Distribution on Infectious Diseases

Track: Environmental Health and IEQ in the International Arena

Chair: Julia Murphy, SOM, New York City, NY

Will the workplace layout be changed after pandemics? While there are Wells Riley tools to understand overall risk in offices, the layout of furnishing systems interaction with people and air flow are less understood. In this seminar, a conceptual framework of diseases spread in the workplace is provided. A furnishing system provider will identify different conventional and possible post pandemic furnishing set ups to understand the risk of infection with air flow interaction impacts. Both Wells Riley and computational fluid dynamics tools will be used to evaluate the risk.

1. Framework of Infectious Disease Spread in the Workplace

L. Bourouiba, Ph.D., MIT, Cambridge, MA

2. The Effect of Workplace Furnishing Layouts on Air Flow and Disease Transmission

Sharon Tracy, Ph.D., Steelcase, Grand Rapids, MI

3. ASHRAE ETF Office Guide: Consideration of Air Flow and Furnishing Systems

Luke Leung, P.E., BEMP, Member, Skidmore, Owings, & Merrill LPP, Chicago, IL

4. Utilizing CFD to Study Different Post Pandemic Workplace Layouts

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

8:00 AM - 9:30 AM

Seminar 28 (Intermediate)

Understanding and Applying Gas-Fired Low Intensity Infrared Radiant Heat Systems in Industrial Facilities.

Track: HVAC for Industrial and Commercial Purposes - Challenges and Opportunities

Sponsor: 6.5 Radiant Heating and Cooling

Chair: Devin Abellon, P.E., Member, Uponor, Centennial, CO

This session is a continuation of information on gas-fired low intensity infrared heat presented at the virtual summer meeting in June. This session strives to present an overall awareness of the benefits of gas-fired low intensity infrared heat when applied to industrial and commercial buildings. Practitioners must understand that its physical properties differ from air based heat systems. The presentations exemplify the basic physical properties of infrared heating, energy efficiency and its high level of comfort when applied correctly. Presenters will cover basic theory and applications in distribution and industrial facilities.

1. Intermediate Understanding of Infrared Radiant Heating

Kevin Mahoney, Specified Air, Comstock Park, MI

2. Gas-Fired Infrared Heat for Distribution and Fulfillment Centers

Donald E. Larsson, Member, Specified Air Solutions, Buffalo, NY

3. Gas Fired Infrared Heating from a Consulting Engineer's Perspective

Gregory Topp, P.E., Roger D Fields Associates, Columbus, OH

4. Gas Fired Infrared Heating from an Owner's Perspective

Firyal Kassim, Federal Express Ground, Moon Township, PA

Tuesday, February 1, 9:45 AM - 10:45 AM

Paper Session 16

How the Use of Smart "Self-Learning" Controls Can Enhance the Building Efficiency

Track: Buildings at 360°

In the last decade the use of controls that can predict occupancy inside buildings or interacts with the rate of occupancy has evolved tremendously in the vision to have more energy efficient buildings and enhance comfort. However, controls can fail and send the wrong message to the equipment. The need of new control approaches is crucial to make buildings smarter by measuring not only the direct presence of occupants, but also to predict the historical occupancy density based on factors such as dynamic schedules, environmental records and people behavior. This session presents different approaches toward smarter controls.

1. A Data-Driven Method to Test and Fine-Tune Occupant-Centric Building Controls Prior to Implementation

Hamidreza Karimian¹ and Mohamed Ouf, Associate Member², (1)Concordia university, Montreal, QC, Canada, (2)Concordia University, Montreal, QC, Canada

2. Towards Post-Pandemic City Management: Prediction of Occupancy Profiles of Commercial Buildings in New York City

Aya Doma, Student Member¹, Ahmed Zaalouk¹, Hamidreza Karimian², Mohamed Osman³, Mazdak Nik-Bakht⁴ and Mohamed Ouf, Associate Member⁴, (1)Concordia University, Montréal, QC, Canada, (2)Concordia university, Montreal, QC, Canada, (3)Concordia University, Montréal, QC, Canada, (4)Concordia University, Montreal, QC, Canada

3. Experimental Design and Analysis of Reliability Evaluation of Off-the-Shelf Occupancy Sensor System in Residential Buildings

Yiyi Chu, Debrudra Mitra and Kristen Cetin, Ph.D., P.E., Member, Michigan State University, East Lansing, MI

9:45 AM - 10:45 AM

Paper Session 17

Water-Energy Nexus Both in Central and District Systems

Track: HVAC&R Systems and Equipment

This session discusses the water-energy nexus. Water, not only energy, is one of the most importance resources that needs preserving. The concept of energy saving can be expanded to water saving, and to resource saving. Water and energy usage are strictly related in systems that focus on saving the energy while minimizing water. They range from central systems to district systems, that need to consider the variability of climatic conditions to deliver the required heating and cooling. The concept of saving energy, water, etc., however, cannot be disentangled from that of resilience, because systems are required to recover their duties after a disruption.

1. Waterside Economizer Control in ASHRAE RP-1711 (T)

Steven Taylor, ASHRAE, Atlanta, GA

2. Installation Energy and Water Resilience Planning (T)

William James Wolfe, US Army Corps of Engineers, Champaign, IL

3. Energy Modeling Development and Calibration for a Mini-District Energy Loop Assessment Comprised of a Set of Campus Buildings (T)

Joshua Hays, Montana State University, Bozeman, MT

9:45 AM - 10:45 AM

Seminar 29 (Intermediate)

Cutting-Edge Japanese Technologies: 2021 SHASE Annual Award Winners for Buildings in Special Environments

Track: HVAC&R Systems and Equipment

Chair: Ryozo Ooka, Ph.D., Member, University of Tokyo Institute of Industrial Science, Tokyo, Japan

Two buildings in special environments having earned the 2021 SHASE award are presented. Environmental control under special circumstances requires an innovative air-conditioning system. Methods for energy-saving and comfortable indoor environment control are discussed. One example is a data center in a cold region, where an indirect outdoor air-cooling system, capable of preventing costlier maintenance involving dust removal while controlling humidity, is newly developed as an energy-saving HVAC method. Another example, in areas potentially at risk from sea salt damage, involves adopting a water-cooled VRV system with a medium-temperature buffer tank simultaneously for more flexible operations.

1. Indirect Outdoor Air-Cooling System for Data Centers in Cold Regions

Kenzo Maeda, Kajima Corporation, Tokyo, Japan

2. Methods for Using Air-Conditioning and Renewable Energy in Training Facilities in Coastal Areas

Jun Yoshida, Takenaka Corporation, Osaka, Japan

9:45 AM - 10:45 AM

Seminar 30 (Intermediate)

High Performance Lab Design for Mixed Use Research Building

Track: Buildings at 360°

Sponsor: 9.10 Laboratory Systems

Chair: Eric Fontaine, Member, vanZelm Engineers, Farmington, CT

The Center for Engineering and Computer Science is a high-performance mixed-use building, including research labs, teaching labs, classrooms, a parking garage and a large atrium. The building employs numerous energy conservation measures including: high performance lighting, heat recovery of laboratory exhaust, cascading ventilation, chilled beams, radiant heating, cooling panels and floor, air quality sensing and hood sash sensing equipment. Predicted site energy use is 76.1 kBtu/sf/yr, which is 55% less than baseline, and 79% less than the AIA 2030 benchmark.

1. High Performance Lab Design for Mixed Use Research Building

Eric Fontaine, Member¹ and Samir Srouji, AIA², (1)vanZelm Engineers, Farmington, CT, (2)HGA Architects, Boston, MA

9:45 AM - 10:45 AM

Forum 3

Should Have Seen That Coming! Climate Impacts on Cleanrooms, Labs, Hospitals and other Critical Environment Operations.

Track: HVAC for Industrial and Commercial Purposes - Challenges and Opportunities

Sponsor: 9.11 Clean Spaces, 1823, TC 1.7; TC 9.02; TC 9.09; TC 9.10

Chair: Mitchell Swann, P.E., Resolution Management Consultants, Marlton, NJ

Blistering heat waves, droughts, monsoon-esque floods, massive power outages and municipal water system shutdowns – all of these stablemates of the apocalypse have come to visit in recent years. Are massive forest fires really a ‘surprise’ out west anymore? Swings in climatic conditions have gotten more extreme and more widely dispersed across the globe. These extremes can wreak havoc on operations with critical environmental control needs or high resource demands. This forum looks at the role and limits of design in dealing with these infrequent but impactful events on design and operating decisions and on business interruption insurance policies.

9:45 AM - 10:45 AM

Workshop 3 (Basic)

Best Practices of the Mentor-Mentee Relationship

Track: Fundamentals and Applications

Sponsor: YEA Committee, College of Fellows

Chair: Shona O'Dea, Member, DLR Group, Chicago, IL

Mentoring can be a powerful resource for personal and professional growth, not only for mentees, but for mentors as well. Are you working through a challenging new project or moving into a new role? ASHRAE members at any stage of their career will benefit from this interactive workshop. Mentorship does not just happen; it's important to be intentional about finding and nurturing relationships, both with those that fill experience gaps, but also with peers to achieve your highest potential. It's the goal of this workshop to organically connect members to develop their skills, knowledge and confidence to enhance attendees' growth.

1. Best Practices of the Mentor-Mentee Relationship

Ralph Kison, Member, Growth Through Learning Inc., Vancouver, BC, Canada

AHR Expo Sessions: Las Vegas Convention Center

Tuesday, February 1, 11:00 AM - 12:30 PM

AHR Expo Session 1 (Intermediate)

The Industry Transition to A2L Refrigerants: Where Are We and Where Are We Headed?

Track: Refrigerants and Refrigeration

Sponsor: 7.3 Operation and Maintenance Management

Chair: Matthew Mullen, P.E., Member, EMCOR Services New England Mechanical, South Windsor, CT

U.S. Regulations are requiring the industry to transition to low Global Warming Potential (GWP) refrigerants as early as 2025 due to the recently passed American Innovation and Manufacturing Act. Many proposed lower GWP refrigerants are classified as slightly flammable ASHRAE Class 2L refrigerants which will require changes in how our industry works. This seminar explains the regulatory landscape, some of the key industry research done by AHRI and ASHRAE, changes in critical industry standards (including ASHRAE 15), changes in service practices and codes that will be necessary for the transition to the lower GWP ASHRAE class 2L refrigerants.

1. U.S. and Worldwide Regulatory Drivers for Transitioning to Low GWP Refrigerants

Helen Walter-Terrinoni, Air Conditioning, Heating and Refrigeration Institute, Arlington, VA

2. Understanding the Risks: Research Results on A2L Refrigerant Safety

Dick Lord, Carrier, Monteagle, TN

3. The Standard and Code Impacts of A2L Refrigerants

Mary Koban, Air Conditioning, Heating and Refrigeration Institute, Arlington, VA

4. Servicing Equipment with A2L Refrigerants: What Technicians Will Need Know

Jason Obrzut, ESCO Group, Mt. Prospect, IL

1:00 PM - 2:30 PM

AHR Expo Session 2 (Advanced)

Thermal and Hydraulic Performance of Low GWP Refrigerants under Flow Condensation and Evaporation

Track: Refrigerants and Refrigeration

Room:

Sponsor: 1.3 Heat Transfer and Fluid Flow, 8.5 Liquid-to-Refrigerant Heat Exchangers , Co-Sponsor: MTG.LowGWP

Chair: Pratik Deokar, Ph.D., Member, Rheem Manufacturing Company, Lewisville, TX

The emerging attention to conventional HFC refrigerants' environmental impact and their subsequent phasing out has led to the evaluation of heat transfer and pressure drop performance of alternative low-GWP refrigerants. This seminar highlights flow condensation and spray evaporation performance of several low-GWP refrigerants, both pure and HFC/HFO mixtures, in minichannel tubes, internally enhanced microfin tubes and externally enhanced tubes. The tested refrigerants were R-32, R-1234yf, R-1234ze(E), R-454C, R-450A, and R-513A, whose results were experimentally compared with R134a and R410A, and with existing correlations. This session benefits refrigerant selection and design of microchannel, fin-and-tube and shell-and-tube type of heat exchangers.

1. Condensation of R32 inside Microfin and Smooth ID 4 Mm Tubes: A Direct Experimental Comparison

Simone Mancin, Ph.D., University of Padova, Padua, TN, Italy

2. Condensation of Low Global Warming Potential Non-Azeotropic Mixture R454C in Horizontal Microfin Tubes

Brian Fronk, Ph.D., Member, Oregon State University, Corvallis, OR

3. Condensation Heat Transfer Performance of R513A and R450A in Minichannel Square Tubes

Melanie Derby, Ph.D., Member, Kansas State University, Manhattan, KS

4. Spray Evaporation on an Enhanced Surface Tube Bundle with Low GWP Refrigerant HFO-1234ze(E)

Joshua Rothe, Student Member, Auburn University, Auburn, AL

Tuesday, February 1, 2:45 PM - 3:45 PM

AHR Expo Session 3 (Basic)

Decarbonization as it Applies to Appliance & Equipment Standards

Track: Buildings at 360°

Chair: William McQuade, P.E., Member, Air Conditioning, Heating and Refrigeration Institute, Arlington, VA

This session presents an overview of current and upcoming standards and how they can be used for building decarbonization.

1. Appliance & Equipment Standards for Building Decarbonization

William McQuade, P.E., Member, Air Conditioning, Heating and Refrigeration Institute, Arlington, VA

Tuesday, February 1, 4:00 PM - 5:30 PM

AHR Expo Session 4 (Basic)

System Stability and Contaminant Control with Lower GWP Refrigerants

Track: Refrigerants and Refrigeration

Sponsor: 3.2 Refrigerant System Chemistry

Chair: Rashid Zakeri, Member, Circle Proscro, Inc., Bloomington, IN

Changes to lower global warming potential (GWP) refrigerants require investigation of these candidates with other components found within a refrigeration and air conditioning system. Studies are typically initiated under controlled laboratory testing for stability and compatibility with various lubricants, chemicals, metals and other materials of construction. This seminar presents industry efforts to screen various lower GWP refrigerant candidates through collaborative research and individual company studies. Several refrigerant and lubricant interactions are discussed along with studies on the acceptable stability and compatibility of system additives and components.

1. An Update on Low GWP Refrigerant Material Compatibility and Lubricant Research

Xudong Wang, Ph.D., Member, Air-Conditioning, Heating and Refrigeration Technology Institute, Arlington, VA

2. Filter-Drier for Contaminant Control in Air Conditioning Application of R466A

Debasis Banerjee, Parker Hannifin Corporation, Washington, MO

3. AHRTI9016 - Insights with R-32, R-1234yf, and Their Blends

Elyse Sorenson, Associate Member, Trane Technologies, La Crosse, WI

4. Compatibility of Odorants with Refrigerant/Lubricant Systems

Ngoc Dung (Rosine) Rohatgi, Ph.D., Member¹, Eric Forsell¹, Scott Ayers¹ and Marc Scancarello, P.E., Member², (1)Spauschus Associates Inc., Bethlehem, GA, (2)Emerson Climate Technologies, Inc., Sidney, OH

11:00 AM - 12:30 PM

Paper Session 18

Addressing IEQ Challenges Through CFD Simulations, Air Cleaning Technologies and Advanced Particle Removal Technology

Track: Environmental Health and IEQ in the International Arena

The SARS-CoV-2 pandemic has created new IEQ challenges. The papers in this session present CFD analysis to determine the efficacy of UVGI systems and provide valuable insights to practicing and design engineers related to the design and operation of UVGI systems; evaluation of various IAQ technologies such as filters, ultraviolet germicidal irradiation, bipolar ionization, photocatalytic oxidation and dry hydrogen peroxide generators; a new form of electrostatic filtration consisting of porous collecting electrodes to collect and hold a large capacity of different particles regardless of their nature of physical properties.

1. Computational Fluid Dynamics (CFD) Analysis of Ultraviolet Germicidal (UV-C) to Control the Probability of Infection Due to Transmission of Airborne Pathogens

Kishor Khankari, Ph.D., Fellow ASHRAE¹ and William Bahnfleth, Ph.D., P.E., Presidential Fellow ASHRAE², (1)AnSight LLC, Ann Arbor, MI, (2)Penn State, University Park, PA

2. Comparative Testing and Evaluation of Air-Cleaning Technologies

Christos Polyzois, Ph.D., Member, Trane Technologies, Bloomington, MN

3. Advanced Particle Removal Technology (APART) as an Efficient Tool for Addressing Emerging Global Air Quality and Safety Challenges

Igor Krichtafovitch, Ph.D.¹, Larry Rothenberg, J.D.², Alan Viosca¹ and Norm Long, Member¹, (1)AgentiAir, rockville, MD, (2)Agentis Air LLC, Rockville, MD

11:00 AM - 12:30 PM

Paper Session 19

Dehumidification: Materials, Devices, Energy Issues and Water Recovery

Track: Fundamentals and Applications

The water content of air is its humidity. Dehumidification consists in the reduction of the air's water content, and it may occur spontaneously or be forced on purpose. In the latter case, the condense that builds up affects the heat transfer properties of the device causing dehumidification, not to mention its energy consumption. Authors in this session present the negative effects of frost formation on evaporators and how they can be tackled by superhydrophilic or superhydrophobic coatings. The session investigates the gap effect in mini-channel heat exchangers with condensation and analyzes the energy associated to some dehumidification technologies cannabis indoor operations.

1. Investigation of Influence of Superhydrophilic and Superhydrophobic Coated Aluminum Surfaces on Frost Formation

Emma Nyholm Humire¹, Mikael Järn, Ph.D.² and Erik Björk, Ph.D.¹, (1)Royal Institute of Technology (KTH), Stockholm, Sweden, (2)RISE Research Institutes of Sweden, Stockholm, Sweden

2. Novel Use of Fertilizer as a Liquid Desiccant for Greenhouse Dehumidification and Water Recovery

Jonathan Maisonneuve, Ph.D., Associate Member, Oakland University, Rochester, MI

3. Comparative Energy Analysis of Dehumidification Technologies for Indoor Cannabis Operations

Josh Spalding, Associate Member, Quest, Los Angeles, CA

11:00 AM - 12:30 PM

Seminar 31 (Intermediate)

High Efficiency Variable Speed Pumping Systems and Integration Challenges with Chiller Plant Design

Track: Buildings at 360°

Sponsor: 8.2 Centrifugal Machines, 6.1 Hydronic and Steam Equipment and Systems, TC 8.1, TC 2.8

Chair: Trent Hunt, Member, Mechanical Products NSW, Salt Lake City, UT

This session overviews variable speed chilled water pumping systems with a technical understanding of how a chiller fits into primary-secondary, variable primary and distributed-variable primary systems. The purpose of this seminar is to present the technical points of each type of pumping system in terms of function and operation while providing an understanding of how a water chiller responds functionally to a variable fluid flow through its evaporator. Presenters provide pointers and suggestions in the form of lessons learned regarding the control and operation of each of these systems.

1. Key Chiller Selection Criteria in a Variable Flow Pumping System

Rick Heiden, Member, Trane - Ingersoll Rand, La Crosse

2. Pumps That Know the Flow in Chilled Water Pumping Systems

David Lee, P.Eng., Member, Armstrong Fluid Technology, Toronto, ON, Canada

3. Lessons Learned in Control and Operation of Primary-Secondary and Distributed Pumping Chilled Water Systems.

Chris Miller, P.E., Member, P2S, Inc., Long Beach, CA

4. Key Design Considerations for the Implementation of Variable Primary Chilled Water Pumping Systems

Brandon Gill, P.E., Member, Taylor Engineering, Alameda, CA

11:00 AM - 12:30 PM

Seminar 32 (Intermediate)

Novel Heat Exchangers Enabled by Shape Optimization and Additive Manufacturing

Track: HVAC&R Systems and Equipment

Sponsor: 8.5 Liquid-to-Refrigerant Heat Exchangers, 1.3 Heat Transfer and Fluid Flow , TC 1.13

Chair: Kashif Nawaz, Ph.D., ORNL, Oak Ridge, TN

Heat exchangers are fundamental components of HVAC&R systems, and thus significant research efforts have focused on improving the performance of these components. In recent years, advancements in computational tools and optimization algorithms alongside advancements in additive manufacturing have expanded the horizon to improve the conventional HX design to include concepts such as topology optimization. This seminar provides an overview of the fundamentals of shape and topology optimization, modeling methods and their effect on the performance of heat exchangers.

1. Shape and Topology Optimized Heat Exchangers: Challenges and Opportunities

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

2. Heat Transfer Enhancement of Single-Phase Internal Flows Enabled by Shape Optimization and Additive Manufacturing

William King, Ph.D., University of Illinois at Urbana-Champaign, Champaign, IL

3. Topology Optimization of Fluid-Fluid Heat Exchange Systems

Kentaro Yaji, Ph.D., Osaka University, Osaka, Japan

Tuesday, February 1, 1:00 PM - 1:30 PM

Panel 2 (Basic)

Building Automation, Cybersecurity, Artificial Intelligence, BACnet/SC and Optimizing Controls Sequences: A Panel Discussion for YEA

Track: Fundamentals and Applications

Sponsor: 1.4 Control Theory and Application

Room: TC 1.4 Meeting

Chair: Michelle Shadpour, Member, SC Engineers, Inc., San Diego, CA

TC 1.4 is playing a critical role in the development of building automation, cybersecurity, artificial intelligence, BACnet/SC and optimizing control sequences. Join this session to learn how each subcommittee has contributed to the discussion on many of these topics. Moderated by the technical committee's YEA subcommittee chair, the panelists will include past committee and subcommittee chairs that are pioneers in these arenas.

Tuesday, February 1, 3:15 PM - 4:45 PM

Seminar 33 (Intermediate)

Level Up Your Flower Game: Hydronic Design for Cannabis Grow Facilities

Track: HVAC for Industrial and Commercial Purposes - Challenges and Opportunities

Sponsor: 6.1 Hydronic and Steam Equipment and Systems

Chair: David Lee, P.Eng., Member, Armstrong Fluid Technology, Toronto, ON, Canada

Cannabis cultivation has a major dependency on its HVAC systems towards accurately controlling the indoor climate to be able to produce healthy crops at a high yield; and using hydronic systems is one of the most effective approaches to cultivation. This

seminar explores the best-in-class practices on indoor climate requirements, hydronic pumping and parallel pumping strategies for reduced energy consumption, as well as psychrometric analysis of grow rooms.

1. Indoor Climate Forecasting

Adam Zebrowski, PID Controls, Toronto, ON, Canada

2. Hydronic Pumping for Cannabis Grow Facilities

Tony Furst, Armstrong Fluid Technology, North Tonawanda, NY

3. Psychrometric Analysis for Cannabis Cultivation

Devin Lake, P.Eng., Greer Galloway Consulting Engineers, Kingston, ON, Canada

Wednesday, February 2

Wednesday, February 2, 8:00 AM - 9:30 AM

Paper Session 20

Innovation in Closed Cavity Façade, Double Skin Façade and Drying Air Cavity

Track: Buildings at 360°

This session investigates different approaches to reduce the HVAC loads by studying the use of new methods when designing the facades of a building. Studies have shown that the cooling load can be reduced by more than 20% if an efficient façade is used to protect a building from weather conditions, such as the closed cavity façade with different geometrical shapes, by introducing a double skin façade which integrates a PV device that can reduce the heat gain and produce energy at the same time, or by choosing the optimum shape of a vinyl siding cladding which affects the efficacy of drying air and hence the HVAC load.

1. Challenges and Opportunities of Using Closed Cavity Façade (CCF) for Improving Energy Efficiency and Indoor Environmental Quality (IEQ) in Office Buildings in US Climates

Michalis Michael, Associate Member, University of Cambridge UK, Cambridge, United Kingdom

2. Double Skin Façade Integrating SEMI-Transparent Photovoltaics: A Case Study for Different Climates

Zisis Ioannidis, Student Member, Concordia University, Montreal, QC, Canada

3. Potential Drying of Air Cavity Behind Vinyl Siding for Building Envelopes (T)

Yanmei Xie, North Dakota State University, Fargo, ND

8:00 AM - 9:30 AM

Paper Session 21

Refining ASHRAE COVID Guidelines and Standard 100

Track: HVAC&R Systems and Equipment

ASHRAE Epidemic Task Force committee has responded quickly to the COVID-19 pandemic and released its guidelines for the safety of the public. This session explores results of building readiness assessments conducted for more than 100 commercial office buildings across the United States and recommends action where additional risk mitigation measures are warranted. The session also discusses ASHRAE Standard 100 and derives localized Standard 100 EUI targets for 11 cities across 7 climate zones using local benchmarking data collected through annual building energy benchmarking ordinances. It suggests new ideas that may be worth implementing when a region adopts Standard 100.

1. From Guidance to Implementation: Applying Ashrae Epidemic Task Force Building Readiness Strategies in 100+ Commercial Office Buildings

Meghan McNulty, P.E., Member, Jamie Kono, P.E., Affiliate and Barry Abramson, P.E., BEAP, Member, Servidyne, LLC, Atlanta, GA

2. Ashrae Standard 100 Energy Targets Using Local Benchmarking Data

Jamie Kono, P.E., Affiliate¹ and Noriaki Kono², (1)Servidyne, LLC, Atlanta, GA, (2)Independent Researcher, Atlanta, GA

8:00 AM - 9:30 AM

Seminar 34 (Intermediate)

Advanced Pumping Designs for Hydronic Systems

Track: HVAC&R Systems and Equipment

Sponsor: 6.1 Hydronic and Steam Equipment and Systems

Chair: David Lee, P.Eng., Member, Armstrong Fluid Technology, Toronto, ON, Canada



With the advancement of technologies and availability of pumps with built-in intelligence, PMS motors with high efficiency and control logic, a new way of hydronic pumping design is possible. A major concern in earlier times has been on resilience of pumps when introducing more technology. With the intelligent pump, resilience is not an issue with validated long lifetime expectancy. Distributing secondary pumps and controlling primary pumps to balance primary flow with secondary flow has been mentioned and described for decades but with the intelligent pumps there is viable solution on efficient chilled water pumping.

1. Theory and Concepts Behind

Agisilaos Tsouvalas, Grundfos Holding A/S, Midtjylland, ON, Denmark

2. A Case Story from Singapore: Ngee Ann Polytechnic

Sam Lam, CEng, Member, Ngee Ann Polytechnic, Singapore, Singapore

3. A Digital Twin Approach: What Energy Modelling Can Provide Us

Ben L. Davis, P.E., Van Boerum & Frank Associates, Salt Lake City, UT

8:00 AM - 9:30 AM

Seminar 35 (Intermediate)

Energy Modeling and Performance Assessment of Fuel Switching Retrofit Strategies with Air-to-Water Heat Pump Central Plant Systems

Track: Buildings at 360°

Sponsor: 1.5 Computer Applications, 7.1 Integrated Building Design

Chair: Krishnan Gowri, Ph.D., Fellow ASHRAE, Intertek, TACOMA, WA

This seminar presents strategies and a case study of energy modeling to evaluate the energy performance of air-to-water heat pump central plant systems replacing conventional chiller-boiler plant systems. A fuel-switch retrofit model of a large hotel prototype used for ASHRAE 90.1 development is created by replacing the baseline plant system with an air-to-water heat pump system. An energy management control algorithm is developed to supplement heat pump operation with a natural gas boiler for optimal performance. Energy simulation results show that energy savings greater than 20% and up to 50% emissions reduction can be realized with this fuel switch strategy.

1. An Energy Modeling Case Study of Air-to-Water Heat Pump Fuel-Switch Retrofit Central Plant Systems

Krishnan Gowri, Ph.D., Fellow ASHRAE, Intertek, TACOMA, WA

2. Air-to-Water Heat Pump Application Techniques for Fuel-Switching Retrofit

Chris DesRocches, P.Eng., Mitsubishi Electric Sales Canada Inc., Toronto, ON, Canada

8:00 AM - 9:30 AM

Seminar 36 (Basic)

How to Select and Size HVAC Fans for Optimum Acoustical Performance

Track: Fundamentals and Applications

Sponsor: 2.6 Sound and Vibration, 5.1 Fans

Chair: Jerry Lilly, P.E., Member, 5266 NW Village Park Drive, Issaquah, WA

This seminar provides basic information on how fans are measured for sound, why different fan types generate different sound levels and why two fans with the same sound level, but different fan design can sound totally different and yield very different sound levels in remote locations. Guidance is provided to best select the appropriate fan type and size for a given application. Finally, case studies are presented illustrating real situations where a poor fan selection has resulted or could have resulted in a noise problem that was difficult and/or expensive to resolve.

1. Basics of Fan Noise and Application Considerations.

Rad Ganesh, Ph.D., Twin City Fan & Blower, Minneapolis, MN

2. Fan Noise in Air Handling Systems

Paul Bauch, Member, Johnson Controls, York, PA

3. 20-20 Foresight: Choosing the Right Fan for the Job

Jerry Lilly, P.E., Member, 5266 NW Village Park Drive, Issaquah, WA

8:00 AM - 9:30 AM

Seminar 37 (Intermediate)

Reduced Order Modeling for HVAC&R Systems and their Components

Track: HVAC&R Systems and Equipment

Sponsor: 8.1 Positive Displacement Compressors, 8.2 Centrifugal Machines

Chair: Alex Schmig, Member, Trane, La Crosse, WI

This seminar focuses on methods and advantages of simplifying physical analytical models to reduced order models that can be implemented and adapted for use in system models or for standalone analysis. Presenters focus on differing approaches to reduce modeling complexity and decrease computational intensity. Topics explore modulation and extrapolation of reduced order compressor models, uncertainty propagation, adaptability to new low-GWP refrigerants, simulated cycle modeling and validation of reduced order models.

1. Application of Data-Driven Models for Positive Displacement Compressor Mapping

Davide Ziviani, Ph.D., Member, Purdue University, West Lafayette, IN

2. Semi-Empirical Compressor Model Evaluation Considering Modulation and Extrapolation Performance

Kalen Gabel, Student Member, Center for Integrated Building Systems, Oklahoma State University, Stillwater, OK

3. Reduced-Order Modeling and Fast Simulation of Transient Vapor Compression Cycles

Jiacheng Ma, Student Member, Purdue University, West Lafayette, IN

Wednesday, February 2, 9:45 AM - 10:45 AM

Panel 3 (Basic)

AIM Act Impact on Commercial Refrigeration and Technology Opportunities

Track: HVAC for Industrial and Commercial Purposes - Challenges and Opportunities

Chair: David Reitz, Matelex/Climalife, Paris and New Haven, CT USA., France

This panel will explore the impact/opportunity of the AIM Act on commercial refrigeration through a discussion with a broad panel including a senior policy analyst, IoT technology company and refrigerant design install company. The purpose of this session is to increase the awareness of the AIM Act, provide latest details on how the act will be enforced/supported and to provide examples/discussions on opportunities. The 2020, AIM Act requires the EPA to develop a system to aggressively phase down the consumption of HFCs. The Act relies on four central mechanisms data collection, allowance trading, sector-specific technology transitions, and refrigerant management practices.

1. AIM Act Impact on Commercial Refrigeration and Technology Opportunities I

Brian Whitesell, Enviro Max, Indianapolis, IN

2. AIM Act Impact on Commercial Refrigeration and Technology Opportunities II

Elodie Delonca, Matelex/Climalife, Paris and New Haven, CT USA., France

9:45 AM - 10:45 AM

Paper Session 22

Implementing and Optimizing Smart Local Energy Systems

Track: Energy System Integration

Smart local energy systems (SLES) that integrate heat, power and mobility vectors are part of the UK strategy to reach net zero carbon by 2050. The papers in this session investigate the opportunities and challenges for implementing SLES in UK cities and towns through case studies and provide an overview of a systematic approach for the optimization of SLES using central London as a case study.

1. A Systematic Optimisation Approach of Smart Local Energy Systems in Cities

Akos Revesz, Ph.D., Affiliate¹, Phil Jones, CEng², Chris Dunham³, Catarina Marques, Ph.D.¹ and Graeme Maidment, Ph.D., P.E.¹, (1)London South Bank University, London, United Kingdom, (2)Building Energy Solutions; London South Bank University, London, philjones100@virginmedia.com, (3)Carbon Descent Projects, London, United Kingdom

2. Opportunities and Challenges for Implementing Smart Local Energy Systems in Cities and Towns, Demonstrated through Case Studies

Ana Catarina Marques, Ph.D.¹, Helen Turnell, Ph.D.¹, Phil Jones², Chris Dunham³, Kate Ashworth⁴, Mark Taylor⁵, Robert Clarke⁶, Matthew Fox⁷, Akos Revesz, Ph.D., Affiliate¹ and Graeme Maidment, Ph.D., P.E.¹, (1)London South Bank University, London, United Kingdom, (2)Building Low Carbon Solutions, London, United Kingdom, (3)Carbon Descent Projects, London, United Kingdom, (4)West Midlands Combined Authority, Birmingham, United Kingdom, (5)Sandwell Metropolitan Borough Council, Smethwick, United Kingdom, (6)Greenfield Nordic, Sheffield, United Kingdom, (7)Barnsley Metropolitan Borough Council, Barnsley, United Kingdom

9:45 AM - 10:45 AM

Seminar 38 (Intermediate)

Sensing Technologies for Smart Window Controls

Track: Energy System Integration

Sponsor: 4.5 Fenestration

Chair: Athanasios (Thanos) Tzempelikos, Ph.D., Member, Purdue University, West Lafayette, IN

In this session, new developments in sensing technologies for fenestration (window) systems controls, in order to reduce energy use, maintain occupant comfort and satisfy occupant preferences are presented. Low-cost programmable sensors and cameras can be used for efficient window control, integrated with other building systems. This seminar presents details on these technologies and integration demonstration.

1. Smart Programmable Cameras As Sensors for Window Controls

Athanasios (Thanos) Tzempelikos, Ph.D., Member, Purdue University, West Lafayette, IN

2. Shading Control for Visual Comfort: Sensors and Considerations

Iason Konstantzos, Ph.D., Member, University of Nebraska, West Lafayette, IN

3. Real-Time Glare Control Using Programmable Image Sensors

Michael Kim, Ph.D., Student Member, Purdue University, West Lafayette, IN

9:45 AM - 10:45 AM

Seminar 39 (Intermediate)

Transmission of Aerosols in Dental Treatment Rooms

Track: Environmental Health and IEQ in the International Arena

Sponsor: MTG.ACR, 9.10 Laboratory Systems , Co-sponsor: TC 9.6 Healthcare Facilities

Chair: Pratik Deokar, Ph.D., Member, Rheem Manufacturing Company, Lewisville, TX

Airflow patterns play an important role in determining the flow path of aerosol transmission. The spread and accumulation of aerosols in dental treatment rooms, including pathogens and other harmful byproducts, can depend on several design and operating parameters related to HVAC system. The seminar presents CFD studies that demonstrate the impact of airflow patterns on the spread of aerosols and resulting probability of infection. With experimental tests and CFD, it also discusses the evaluation of air management and role of local extract devices in mitigating the spread of aerosols and control of infection within the spaces of dental treatment rooms.

1. Airborne Contaminants at Dental Care Facilities.

Michael Wetzel, P.E., Member, Air Innovations, North Syracuse, NY

2. Aerosols in the Dental Treatment Environment.

David J Ahearn, Design Ergonomics, Inc., Little Compton, RI

3. CFD Analysis of Aerosol Transmission and Probability of Infection in a Dental Treatment Room

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

9:45 AM - 10:45 AM

Forum 4

The Future of Thermally Driven Heat Pumping and Cooling in the Age of Decarbonization

Track: Energy System Integration

Sponsor: 8.3 Absorption and Heat Operated Machines

Chair: Kyle R. Gluesenkamp, Kyle R., Ph.D., Member, Oak Ridge National Labs, Oak Ridge, TN

This forum covers a discussion on the future of heat operated heat pumps and cooling systems, and focuses on how these technologies can participate and be correctly evaluated on both efficiency and environmental terms in a low carbon future.

Wednesday, February 2, 11:00 AM - 12:30 PM

Paper Session 23

Effectiveness of Various Cleaning Methods and Kitchen Hoods

Track: Environmental Health and IEQ in the International Arena

This session analyzes the interaction of multiple air and surface cleaning methods and the efficacy of a solution, including numerous cleaning methods controlled by an algorithm informed by continuous air quality sensor data. The results indicate that cleaning method optimization in variable environments is achievable using relatively low-cost air quality sensors and simple control systems. Kitchen hood design, operator behavior, cooking processes, airflow rates, cooking location and ventilation configurations all contribute to the capture, containment and removal of the cooking emissions from the kitchen space. The IAQ levels in the kitchens of two 6-unit buildings, each built to different energy/construction specifications are also examined.

1. Optimization and Control of Layered Air and Surface Cleaning Methods Based on Air Quality Sensor Data

Scott Wenger, Member, Trane Technologies, Davidson, NC

2. Evaluating Residential Kitchen IAQ and Hood Performance

Rich Swierczynna, Member and M. Frank G. Johnson, Ph.D., Member, Gas Technology Institute, Des Plaines, IL

11:00 AM - 12:30 PM
Seminar 40 (Intermediate)

Climate Change Considerations in Energy Audits.

Track: Buildings at 360°

Sponsor: 2.5 Global Climate Change, 7.9 Building Commissioning, TC4.2

Chair: Elizabeth Tomlinson, P.E., Member, TKDA, St. Paul, MN

As climate change impacts our built environment today, ASHRAE members seek to improve design of tomorrow's buildings. Projections of energy consumption, conservation opportunities and return on investments calculations rely on averaged historic weather files, consistent energy rate increases and utility choices. This session unpacks energy modeling and analysis assumptions with a focus on climate change impacts.

1. Incorporating Project Climate Change Information into Building Design and Analysis

Parag Rastogi, Ph.D., Member, arbnco ltd, Glasgow, United Kingdom

2. Predictive Energy Modeling for a Changing Climate

Pierre Khalil, P.E., McKinstry, Minneapolis, MN

3. Corporate Considerations of Future Climate Change: ESG Scope I-III Calculations

Daniel Katzenberger, P.E., Member, Best Buy, Minneapolis, MN

11:00 AM - 12:30 PM
Seminar 41 (Advanced)

Design Challenges to the Electrification of Heating in Mid to Large Buildings

Track: Energy System Integration

Sponsor: 8.2 Centrifugal Machines, 2.8 Building Environmental Impacts and Sustainability

Chair: Raymond Good Jr., P.E., Member, Danfoss Turbocor Compressors, Inc., Tallahassee, FL

Electrification of heating is becoming an imperative based on a desire to reduce heating with fossil fuels and in some cases to meet codes and standards enacted to reduce greenhouse gas emissions. This seminar introduces some of the basic concepts and driving forces behind the current and developing trend of electrified heating. It also explores some of the technologies available and share specific design and control strategies that make the dream a reality.

1. Fundamentals and Technologies of Heating Electrification

Drew Turner, Danfoss, Baltimore, MD

2. Time Independent Energy Recovery: The Solution to Large Building Electrification

Brandon Gill, P.E., Member, Taylor Engineering, Alameda, CA

3. The Ins and Outs of Heat Recovery Chiller Sizing and Control

Chris Miller, P.E., Member, P2S, Inc., Long Beach, CA

11:00 AM - 12:30 PM
Seminar 42 (Intermediate)

Humidifiers for Health and Comfort: Installation and Use Considerations

Track: HVAC&R Systems and Equipment

Sponsor: 5.11 Humidifying Equipment, 5.7 Evaporative Cooling

Chair: Steven Slayzak, Associate Member, Seeley International, Denver, CO

The current pandemic has highlighted the importance of IEQ for the health and comfort of building occupants. Humidification is one of the fundamental air parameters that contributes to the reduction of transmission of airborne pathogens and when combined with increased air changes, helps contain the concentration of pathogens within acceptable limits. In addition, optimal humidity levels guaranty proper comfort and improved human health and immune response. This session explains how to install, retrofit, run and maintain humidification systems in various types of buildings (e.g., health-care facilities, museums, etc.) so that they can consistently contribute to IEQ.

1. Steam Humidification Systems: How to Get the Best Results

David Baird, Member, Dristeem Corporation, Eden Prairie, MN

2. Adiabatic Humidification Systems: How to Get the Best Results

Duncan Curd, Member, DriSteem, Eden Prairie, MN

3. Indirect-Direct Cooling: An Optimum Humidity Opportunity

Edgar Necochea, P.E., Seeley International Pty Ltd, Sacramento, CA

4. Clean and Under Control: Getting Humidifier Maintenance Right

Nicholas Lea, P.Eng., Member, Condair Ltd., Ottawa, ON, Canada

11:00 AM - 12:30 PM

Seminar 43 (Advanced)

Latest Developments in Low-GWP Refrigerants, Systems for Refrigeration and Related Regulations

Track: Refrigerants and Refrigeration

Sponsor: 10.7 Commercial Food and Beverage Refrigeration Equipment, 3.1 Refrigerants and Secondary Coolants , 8.1; 10.6, REF Committee

Chair: Vishaldeep Sharma, Member, Oak Ridge National Laboratory, Oak Ridge, TN

Flammable refrigerants are playing an increasing role in reducing the environmental impact of refrigeration and air-conditioning. However, their safe use requires new approaches in the design of the systems and equipment in compliance with the new and improved standards and safety regulations. This seminar presents the latest developments in the low-GWP refrigerants and systems for refrigeration, as well as the updated on the related regulations.

1. “Global View on the Implementation of Flammable Refrigerants in Refrigeration and Air-Conditioning”

Rajan Rajendran, Ph.D., Associate Member, Emerson Climate Technologies, Inc., Dayton, OH

2. Transition to Low Global Warming Potential Refrigerants in Light Commercial and Residential Air Conditioning

Helen Walter-Terrinoni, Air-Conditioning, Heating, and Refrigeration Institute, Arlington, VA

3. Updates on ASHRAE Standard 15

Tim Anderson, Ph.D., Hussmann, Bridgeton, MO

4. Update on UL Standards

Brian Rodgers, Underwriters Laboratories, Northbrook, IL

11:00 AM - 12:30 PM

Seminar 44 (Intermediate)

Upgrading Existing Building Control Systems for High Performance Operation

Track: Buildings at 360°

Sponsor: 1.4 Control Theory and Application, 7.6 Building Energy Performance , 2.8 Building Environmental Impacts and Sustainability

Chair: Gregory Cmar, Member, Interval Data Systems, Boston, MA

The Commonwealth of Kentucky evolved an approach to upgrading existing buildings that not only yields high performance (based upon Guideline 36 SOO) and better-quality delivery of automation but does so repeatedly across multiple manufacturers' BASs. Buildings are retrofit with far fewer operational deficiencies and operate consistent with design intent much earlier in warranty period. The seminar takes you through KY's program for better quality automation and the role of the owner, engineer, and verification of performance—and it started with G36.

1. Upgrading Building Control Systems for High Performance Operation across a Portfolio

Dick Mink, Commonwealth of Kentucky, Frankfort, KY

2. Designing, Specifying and Managing High Performance Controls Upgrades into a Centralized System

Casey Wilson, Member, CMTA, Inc., Louisville, KY

3. Verifying Control System Performance Using Data, a Digital Twin, and Easy to Understand Analytics

Kevin Fuller, Interval Data Systems, Boston, MA