

**2017
Winter
Conference**
Jan. 28 – Feb. 1
Las Vegas, NV



**AHR
Expo**
Jan. 30 – Feb. 1
Las Vegas, NV



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Sunday, January 29

Sunday, January 29, 8:00 AM - 9:00 AM

Conference Paper Session 1

Advancements in Ground Source Heat Pump Design

Track: HVAC&R Systems and Equipment



Chair: Rachel Romero, P.E., NREL, Golden, CO

Ground source heat pump (GSHP) designs have been used to reduce energy consumption and CO₂ emissions throughout the world. This session explores issues that may arise in installation that could limit their effectiveness. The session includes a case study where simulation and observed energy savings differed and the lessons learned. The session also explores the potential to increase the effectiveness of GSHPs by using the built environment already around us. For example, are underground railways in urban environments an untapped heat resource?

1. The Potential for Integration of Ground Energy from Underground Railway Tunnels (LV-17-C001)

Akos Revesz, London South Bank University, London, United Kingdom

2. Analysis of Heat Source Water Supply Network Between Two Buildings Utilizing Ground Heat and Exhaust Heat (LV-17-C002)

Eikichi Ono, M.D.¹, Katsuhiko Miura, Ph.D., Member¹, Naoyoshi Ichikawa¹, Tomohiro Teranishi¹, Taro Ohno¹ and Takeshi Wada¹, (1)Kajima Technical Research Institute, Tokyo, Japan

3. Metering Measurement Challenges and Monitoring of a Large Scale Ground Source Heat Pump System (LV-17-C003)

Metkel Yebiyio¹, Graeme Maidment, Ph.D., P.E.¹, Paurine Alex, Ph.D.¹ and Tony Day, Ph.D.², (1)London South Bank University, London, United Kingdom, (2)International Energy Research Centre, Cork, United Kingdom

8:00 AM - 9:00 AM

Seminar 1

Updating Scientific Evidence about the Effects of Low Humidity on People

Track: *Commercial and Industrial IAQ*



Sponsor: 5.11 Humidifying Equipment, 2.1 Physiology and Human Environment, TC 5.7, TC 9.6, SGPC 10, SSPC 62.1

Chair: Raul Simonetti, Carel Industries SpA, Brugine, Italy

Humidity is often associated to negative concepts like mold and sicknesses related to high levels of moisture in indoor environments and this invariably leads to talks and solutions for reducing it tout court. But, is it really correct to reduce it with no minimum limit? This session sheds some light on the need of a minimum level of humidity for health, well-being and productivity.

1. RP-1630, "Update the Scientific Evidence for Specifying Lower Limit Relative Humidity Levels for Comfort, Health and IEQ in Occupied Spaces"

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

2. 40 Is the New 20, Balanced Air-Hydration for Health!

Stephanie Taylor, M.D., Healthcare Acquired Infections Organization, Boston, MA

3. Limiting Criteria for Human Exposure to Low Humidity

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

8:00 AM - 9:00 AM

Forum 1

10 Minute Opportunities for Industrial Refrigeration Efficiency Improvement

Track: *Energy Efficient Industrial Buildings*

Sponsor: 10.8 Refrigeration Load Calculations, 10.1 Custom Engineered Refrigeration Systems

Chair: Daniel Dettmers, IRC U.W. Madison, Madison, WI

Section 10 presents a lightning round of multiple 10 minute presentations to help you reduce the energy consumption of your refrigeration system. Presentations will include: Dealing with Infiltration, Raising your Suction Pressure, Proper Application of Demand Shifting, VFD's on Evaporators, Doing Defrost Right! To add to the excitement, each speaker is limited to 5 slides and 10 minutes of time before the grim reaper slices them from the stage. Listen to them talk and watch them sweat as the clock ticks down. At the end, the crowd will decide who has the winning presentation.

8:00 AM - 9:00 AM

Workshop 1

ASHRAE's New Duct Size Calculator Tool: Where It Came From and How to Use It

Track: *HVAC&R Systems and Equipment*



Sponsor: , Residential Buildings Committee

Chair: Iain Walker, Ph.D., Lawrence Berkeley National Laboratory, Berkeley, CA

ASHRAE has recently developed a new duct calculator tool that uses the results of ASHRAE Research to provide ASHRAE members with better ways to size/design duct systems - particularly for flexible ducts. This workshop briefly discusses the research behind the new tool and provide demonstrations and examples of how to use it.

1. Research Background for ASHRAE's New Duct Calculator Tool

Charles Culp, Ph.D., Fellow ASHRAE, Texas A&M University, College Station, TX

2. Demonstration of ASHRAE's New Duct Design Tool

Chris Van Rite, M&M Manufacturing Co, Fort Worth, TX

8:00 AM - 9:00 AM

Workshop 2

Optimization of Direct AC Systems with Low GWP Refrigerants

Track: Fundamentals and Applications

Sponsor: Refrigeration Committee

Chair: Martin Dieryckx, Daikin Europe NV, oostende, Belgium

In view of the requirement to reduce the climate impact of refrigerants, several refrigerants are proposed for use in direct expansion air-conditioning systems. There are test programs such as AREP and PRAHA to evaluate some of the solutions. The results of these tests do not always give the straight answer that we expect. How should we read these results and what parameters are most important to decide the refrigerant for the specific application. This workshop has the target to give a better insight how the next generation refrigerant can be decided for direct expansion AC equipment.

1. Study on Properties of Low GWP Refrigerants

Osami Kataoka, Member, Daikin Industries, Ltd., Osaka, Japan

2. Analysis of Test Results on Low GWP Refrigerants

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

8:00 AM - 9:00 AM

Workshop 3

Sitting Around Collecting Dust: Evaluating Industrial Dust Collector Performance

Track: Commercial and Industrial IAQ



Sponsor: 5.4 Industrial Process Air Cleaning (Air Pollution Control)

Chair: Geoff Crosby, Lydall, Rochester, NH

ASHRAE Standard 199 was published in June 2016 to evaluate the performance of industrial pulse-cleaned dust collectors. This workshop reviews Standard 199, the research that led to this methodology, and explore actual performance data. This method of test applies to bag, cartridge, or envelope industrial dust collectors that recondition the filter media by using pulses of compressed air to discharge the dust cake from the filter media. Attendees will learn how the test evaluates dust collector performance in terms of energy consumption and particulate emissions.

1. Standard 199: Ashes to Ashes, Dust to Dust?

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

2. Dusting Off Some Research: From RP-1284 to Standard 199 Test Results

Bob Burkhead, Blue Heaven Technologies, Louisville, KY

8:00 AM - 9:00 AM

Workshop 4

What Is Renewable Energy?

Track: *Fundamentals and Applications*



Sponsor: 2.8 Building Environmental Impacts and Sustainability

Chair: Kevin Brown, The Linc Group, Atlanta, GA

This workshop attempts to define renewable energy from several different perspectives (government, industry, society). Additionally, it reviews real world examples of what qualifies for renewable energy credits according to different jurisdictions around the world.

1. PV Systems Cannot Be Attached to the Grid and Other Renewable Energy Myths

Paul A. Torcellini, Ph.D., Member, National Renewable Energy Laboratory, Golden, CO

2. The Role of Biomass in a Renewable Energy Future

Zia Haq, U.S. Department of Energy, Washington, DC

8:00 AM - 9:00 AM

Workshop 5

What Should Be in a New Applications Handbook Chapter Covering Semi-Conductor and Nano-Technology Facilities

Track: *Fundamentals and Applications*



Sponsor: 9.2 Industrial Air Conditioning, 9.11 Clean Spaces

Chair: Michael Connor, P.E., Connor Engineering Solutions, Alpharetta, GA

Currently the ASHRAE Handbook, Applications volume contains chapters that affect the design of components of semi-conductor and nano-technology facilities. There is no chapter currently that pulls all of it together. What is lacking in the other chapters that can be addressed in a high level chapter discussing these facilities?

1. Safety Aspects of Semi-Conductor Facilities

Deep Ghosh, Member, Southern Co., Atlanta, GA

2. Beyond Supply and Exhaust: What Else Should We be Concerned with in Semi-Conductor Facilities?

Michael Connor, P.E., Member, Connor Engineering Solutions, Alpharetta, GA

Sunday, January 29, 9:45 AM - 10:45 AM

Conference Paper Session 2

Modern Optimization Techniques for Hydronic Systems in Data Centers

Track: *Mission Critical Design and Operation*



Chair: *Adrian Wallace, Johnson Controls, Milwaukee, WI*

This session discusses several case studies and applications investigating energy consumption and savings techniques for data centers. While addressing the environmental impact of data centers and how to reduce their carbon footprint, the session considers the life cycle approach to data center operation and further the conversation by considering various types of cooling systems available, their configurations and the layout of the space being served in order to most effectively and efficiently maintain that mission critical space.

1. Energy and Water Environmental Trade-Offs of Data Center Cooling Technologies (LV-17-C004)

Sophia Flucker, CEng¹, Beth Whitehead, Ph.D.¹, Robert Tozer, Ph.D., Member¹ and Deborah Andrews, Ph.D.², (1)Operational Intelligence Ltd., Kingston upon Thames, United Kingdom, (2)London South Bank University, London, United Kingdom

2. Thermosyphon Cooler Hybrid System for Water Savings in an Energy-Efficient HPC Data Center: Modeling and Installation (LV-17-C005)

Thomas Carter, P.E., Member¹, David Sickinger, Associate Member², Zan Liu, Ph.D., Associate Member¹, Kevin Regimbal² and David Martinez³, (1)Johnson Controls, Waynesboro, PA, (2)National Renewable Energy Laboratory, Golden, CO, (3)Sandia National Laboratory, Albuquerque, NM

3. Case Study: Using Simulation Techniques to Optimize Migrations in an Existing Mission Critical Data Center (LV-17-C006)

Christian Pastrana, P.E., Member, Citigroup, New York, NY

9:45 AM - 10:45 AM

Seminar 2

ASHRAE Conference Crash Course

Track: *Fundamentals and Applications*



Sponsor: **YEA, CEC**

Chair: *Stephanie Kunkel, JMT, Sparks, MD*

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 you 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

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

2. Make the Most of Your Conference Experience

Frank Rivera, P.E., Mechanical Heating Supply, Bronx, NY

9:45 AM - 10:45 AM

Seminar 3

Hydronic Water Flow Measurement

Track: *Fundamentals and Applications*



Chair: Mark Hegberg, Hegberg & Associates, Chicago, IL

This session covers the fundamentals surrounding water flow measurement in hydronic systems. Why, how, what. Hydronic systems (chilled water, heating hot water, or condenser water) are effectively a HVAC transmission. Pumps, pipes and valves make-up the envelop and their effectiveness can be measured by the volume flow rate of water in the pipe. We measure flow rate through pressure drop - such as valves, orifices, venturis, equipment losses; by pump curve; and with throughput measurement equipment such as ultrasonic and magnetic meters. The merits and practicalities of each are covered here.

1. Hydronic Water Flow Measurement: Part 1

Hooman Daneshmand, P.E., Member, Valve Engineer, Dallas, TX

2. Submetering By Using Pumps

Niels Bidstrup, Ph.D., Member, Grundfos Management A/S, Bjerringbro, Denmark, Bjerringbro, Denmark

9:45 AM - 10:45 AM

Seminar 4

Indoor Air Quality and Desiccants

Track: *Commercial and Industrial IAQ*



Sponsor: 8.12 Desiccant Dehumidification Equipment and Components

Chair: Norm Maxwell, P.E., Environmental Air Quality, Great Neck, NY

This seminar discusses the use of desiccant dehumidification systems in yielding better indoor air quality. This session also includes information on the significant energy savings to be gained with the provided systems. The three speakers give insight and data to demonstrate the advantages. They discuss the health and IAQ benefits that will occur with these systems and the energy savings aspects. The presentations also provide descriptions of field installed tests for energy and IAQ performance.

1. Indoor Air Quality and Liquid Desiccant Dehumidification

Patrick Leach, Member, Alfa Laval Kathabar, Buffalo, NY

2. Field Operation of a Liquid-Desiccant DX Air Conditioner for High Latent Applications

Andrew Lowenstein, Ph.D., Member, AIL Research, Hopewell, NJ

3. Field Test Results of an Air Conditioner with Liquid Desiccant Heat Exchangers

Eric Kozubal, Member, National Renewable Energy Laboratory, Golden, CO

9:45 AM - 10:45 AM

Seminar 5

Blue Is the New Green: What Is the Water-Energy Nexus?

Track: Water-Energy Nexus



Chair: Nicole Olaes, Randall Lamb Associates, Inc., La Mesa, CA

In the U.S. water and energy are inescapably linked – both at large scale national and state electrical and water distribution systems, and at building scale systems that trade off on site electrical and water usage. These relationships are sometimes complex, but this seminar aims to deliver a basic understanding of the key issues at play with our current infrastructure and industry practices

1. Thirst for Power: Energy, Water and Human Survival

Michael Webber, Ph.D., Member, University of Texas, Austin, TX

2. Bringing It Home: Overview of the Building Scale Water Energy Nexus

Calina Ferraro, P.E., Associate Member, Randall Lamb Associates, Inc., La Mesa, CA

9:45 AM - 10:45 AM

Seminar 6

Recent Action in Evaporative Cooling

Track: Water-Energy Nexus



Sponsor: 5.7 Evaporative Cooling

Chair: Mark Modera, Ph.D., P.E., University of California, Davis, Davis, CA

Evaporative cooling and the integration of water evaporation into vapor-compression air conditioning are key components of the water energy nexus. This seminar summarizes a body of current work that includes a direct analysis of the water consumption versus energy savings, a recent ASHRAE standard on evaporative pre-coolers for rooftop packaged equipment, numerous field studies of hybrid vapor-compression/evaporative-cooling equipment, and case studies of designs where the inclusion of indirect evaporative cooling reduced on-site water use.

1. Does Evaporative Cooling Make Sense in an Arid Climate?

Nasim Tajmand, Ph.D., Associate Member, UC Davis, Davis, CA

2. Proposed ASHRAE Standard 212: Testing the Performance of Evaporative Pre-Coolers

Jay Madden, P.E., Associate Member, Southern California Edison, Rosemead, CA

3. Performance of Indirect Evaporative and Hybrid Cooling Equipment: Findings from Laboratory and Field Testing

Jonathan Woolley, Member, UC Berkeley Center for the Built Environment, Berkeley, CA

4. R-718 to the Rescue

James Falconer, Member, Affiliated Engineers, San Francisco, CA

9:45 AM - 10:45 AM

Seminar 7

Designing for the Future –Planning Today’s Buildings for Tomorrow’s Policies

Track: Effects of Climate Change on HVAC&R



Sponsor: 1.4 Control Theory and Application

Chair: Joseph Kilcoyne, P.E., SC Engineers, Inc., San Diego, CA

Organizations are choosing to commit to an increasing number of climate and sustainability goals and policies. How can we plan new facilities and modernizations to meet the unknown needs of the future? See how two organizations are meeting this challenge. The first speaks to the lessons learned from a recently completed \$1B “hospital of the future”. The second speaker addresses how her private University campus’ new Climate Action Plan has challenged her design teams to help reduce greenhouse gas emissions. See how both facilities are leveraging their BAS systems to validate their ongoing performance against policy goals.

1. The Hospital of the Future: Building with Flexibility in Mind

Daniel Farrow, Palomar Health, San Diego, CA

2. Planning for Climate Change Policies at the University of San Diego

Melissa Plaskonos, University of San Diego, San Diego, CA

Sunday, January 29, 11:00 AM - 12:30 PM

Conference Paper Session 3

Health Care Design for IAQ Focusing on Pathogen Minimization

Track: Mission Critical Design and Operation



Chair: Daniel Pettway, Hobbs & Associates, Norfolk, VA

The spread of contaminants and pathogens in hospitals results in poor IAQ and hospital acquired infections (HAI). This session discusses the airflow distribution in operating rooms and the use of UVGI to reduce bio-film on coil surfaces for improved IAQ and contaminate removal. The session also evaluates a laminar flow newborn incubator's temperature and velocity profiles compared to a conventional incubator. Lastly this session compares international air quality standards and proposes alternate ventilation rates for various healthcare spaces.

1. Restoring Acceptable HVAC Performance with Ultra Violet Germicidal Irradiation Coil Treatment (LV-17-C007)

Timothy Leach¹ and **Graham Taylor, P.E.**², (1)Steril-Aire, Burbank, CA, (2)Steril-Aire, Inc., Burbank, CA

2. Analysis of Airflow Distribution and Contaminant Flow Path in a Hospital Operating Room (LV-17-C008)

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

3. Proposed Outdoor Air Ventilation Rationale for Health Care Facilities (LV-17-C009)

Travis R. English, P.E., Member¹, **Maya Salabasheva, P.E., Member**¹, **Heather Platt**², **Abdel Darwich, P.E., HFDP, Member**³ and **Erica Stewart, Member**⁴, (1)Kaiser Permanente, Oakland, CA, (2)Seneca Construction Management, (3)Guttman & Blaevoet, Sacramento, CA, (4)Kaiser Permanente National EH&S, Pasadena, CA

4. Comprehensive Design of a Laminar Flow Newborn Incubator (LV-17-C010)

M. Zeki Yilmazoglu, Ph.D.¹ and **Atilla Biyikoglu, Ph.D., Member**¹, (1)Gazi University, Ankara, Turkey

11:00 AM - 12:30 PM

Conference Paper Session 4

Improving Energy Exchange in HVAC&R

Track: *Fundamentals and Applications*



Chair: *Xiufeng Pang, Lawrence Berkeley National Laboratory, Berkeley, CA*

Potential applications of heat recovery to increase energy efficiency is a practical and viable approach to energy conservation. This session includes papers describing several methods of using heat recovery for increased energy efficiency. Different system and building types are examined along with theoretical, modeling and case evaluations for effectiveness.

1. Environmental Parameters for Decontamination Room in Sterile Processing Department in U.S. Hospitals (LV-17-C011)

Maya Salabasheva, P.E., Member¹, Travis R. English, P.E., Member¹ and Erica Stewart, Member², (1)Kaiser Permanente, Oakland, CA, (2)Kaiser Permanente National EH&S, Pasadena, CA

2. Sensitivity of Energy and Exergy Performances of Heating and Cooling Systems to Auxiliary Components (LV-17-C012)

Ongun B. Kazanci, Student Member¹, Masanori Shukuya, Ph.D.² and Bjarne W. Olesen, Ph.D., Fellow ASHRAE³, (1)Technical University of Denmark, Kongens Lyngby, Denmark, (2)Tokyo City University, Tokyo, Japan, (3)Technical University of Denmark, Kgs. Lyngby, Denmark

3. Heat Recovery from Industrial Flue Gases with Varied Humidity Ratios Using Liquid Desiccant Technology (LV-17-C013)

Zhenying Wang¹, Zhen Li¹ and Xiaoyue Zhang¹, (1)Tsinghua university, Beijing, China

4. Metropolitan Integrated Cooling and Heating (LV-17-C014)

Graeme Maidment, Ph.D., P.E.¹, Nicholas Boot-Handford², Joseph Grice³ and Gareth F. Davies, Ph.D.¹, (1)London South Bank University, London, United Kingdom, (2)Transport for London, London, United Kingdom, (3)Islington Council, London, United Kingdom

5. Women in the Refrigeration Industry (LV-17-C015)

Didier Coulomb¹, Ina Colombo, Ph.D.² and Michael Kauffeld², (1)International Institute of Refrigeration, Paris, France, (2)London South Bank University, London, United Kingdom

11:00 AM - 12:30 PM

Seminar 8

Blue Is the New Green: The Water-Energy "Next Is"?

Track: *Water-Energy Nexus*



Chair: *Calina Ferraro, P.E., Randall Lamb Associates, Inc., La Mesa, CA*

With the increasing discussion of the water energy nexus, the industry is responding with innovative technologies to improve onsite water and energy use. This seminar highlights new technology being developed to optimize performance as well as proven technology that is gaining new traction as greater attention is focused on this area.

1. Air Cooled vs Water Cooled Chillers

Fred Betz, Ph.D., Member, Affiliated Engineers, Inc., Madison, WI

2. Direct and Indirect Evaporative Cooling Technologies

Ransom Hamrick, P.E., Member, Randall Lamb Associates, Inc., La Mesa, CA

3. Aiming for Net Zero: Onsite Water Treatment Systems

Charles Upshaw, Student Member, University of Texas at Austin, Austin, TX

4. Water Re-Use Options and Opportunities

William J. Worthen Jr., AIA, Urban Fabrick, San Francisco, CA

11:00 AM - 12:30 PM

Seminar 9

Fire Safety Operations in Commercial Kitchens

Track: Building Operation and Performance



Sponsor: 5.10 Kitchen Ventilation, 5.6 Control of Fire and Smoke

Chair: Mark Skierkiewicz, P.E., UL, LLC, Northbrook, IL

This session discusses increased risk of fires in commercial kitchens employing solid fuel cooking, resulting deposits of highly combustible creosote deposits in exhaust systems. Case studies will show how solid fuel cooking fires challenge conventional in-hood fire suppression systems and increase the need for strict adherence to code and standards requirements, requirements for clearance to combustible construction, and the need for increased frequency and aggressiveness of duct cleaning. These points will be illustrated by real world examples of fires, fire system performance, issues with code requirements for clearances, and how defined maintenance programs and proper inspections can reduce fire hazards.

1. The Increasing Fire Risk from Solid Fuel Cooking

Doug Horton, D.J. Horton and Associates, Batavia, IL

2. Kitchen Exhaust Duct Fire Safety: Concerns and Solutions

Michael Morgan, Associate Member, Captive Aire Systems, Inc., Allentown, PA

3. Inspection and Maintenance Operations for Kitchen Exhaust Fire Safety

Bernard Basel, Member, Besal Services, Inc, Atlanta, GA

11:00 AM - 12:30 PM

Seminar 10

Performance of Chilled Water Pipe Insulation Systems in Humid Environments: Problems, Solutions, ASHRAE Research and the Use of Hygrothermal Analyses

Track: Fundamentals and Applications



Sponsor: 1.8 Mechanical Systems Insulation

Chair: Manfred Kehrler, P.Eng., JustSmartSolutions LLC, Oak Ridge, TN

CHW pipe insulation systems sometimes fail due to long-term moisture accumulation, particularly in unconditioned spaces in humid environments. The first speaker will describe a case study of several school buildings which suffered from severe mold growth and was successfully remediated. A second speaker will describe a case study of a building that experienced extensive CHW pipe insulation failures and was successfully remediated. A third speaker will summarize the findings of laboratory tests on insulated cold pipes in ASHRAE RP-1646. Finally, a fourth speaker will address the results of computerized hygrothermal analyses simulating four different CHW pipe insulation systems.

1. Controlling Mold Growth on Chilled Water Pipe Insulation

Ed Light, Member, Building Dynamics, LLC, Ashton, MD

2. Air Conditioned Football Stadium and Convention Center Chilled Water Pipe Insulation Assemblies Failure and Remediation with New Developed Insulation Systems

Willis J. "Bill" Brayman, Brayman Insulation Consultants, Sterrett, AL

3. Recent ASHRAE Research on Thermal Conductivity of Pipe Insulation Systems Working at Below-Ambient Temperature and in Wet Condensing Conditions with Moisture Ingress

Lorenzo Cremaschi, Ph.D., Member, Auburn University, Auburn, AL

4. Hygrothermal Analyses of Four Different Chilled Water Pipe Insulation Systems in a Hot and Humid Climate

Gordon Hart, P.E., Member¹ and Christian Bludau, Dr.Ing.², (1)Artek Engineering, LLC, Shrewsbury, MA, (2)Fraunhofer Institute for Building Physics, Valley, Germany

11:00 AM - 12:30 PM

Seminar 11

The Current State-of-the-Art for an Automated Pathway from BIM Building Models Direct to HVAC Heating/Cooling Load Calculations

Track: *Fundamentals and Applications*



Sponsor: 4.1 Load Calculation Data and Procedures, 1.5 - Computer Applications

Chair: Reinhard Seidl, Taylor Engineering, Alameda, CA

Building information modeling (BIM) is a software-based method to enhance the efficiency of integrated building design including HVAC load calculations. This seminar looks at several different methods of performing HVAC load calculations on the ASHRAE Headquarters building. One method involves performing HVAC load calculations inside the BIM authoring software tool. Another method involves exporting the building information to a standard schema and importing that same information into another vendor's HVAC load calculation tool. This seminar examines the advantages and disadvantages along with the struggles of using these tools to perform comprehensive load calculations.

1. Defining the Baseline for BIM Loads Comparison

Steve Bruning, P.E., Fellow ASHRAE, Newcomb & Boyd, Atlanta, GA

2. Heating and Cooling Load Calculations from BIM Using Autodesk Insight 360

Krishnan Gowri, Ph.D., Member, Autodesk, Bothell, WA

3. Performing Load Calculations in Aecosim Energy Simulator Using a gbXML File Exported from Revit

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

4. The Process of Using gbXML to Export the ASHRAE HQ Revit Model to Trace to Perform HVAC Load Calculations

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

11:00 AM - 12:30 PM

Seminar 12

Variable Speed Drives and Chillers - Back to Basics

Track: *HVAC&R Systems and Equipment*



Sponsor: 8.2 Centrifugal Machines, 1.11 Electric Motors and Motor Control, 1.11, 8.1

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

Variable speed drives are increasingly being applied to chillers with both positive displacement compressors and centrifugal compressors. In addition, advancements in variable speed drive technology are continually enabling enhancements in chiller component design and control. From enabling compressors to be designed for optimum speed to eliminating traditional capacity control mechanisms such as inlet guide vanes to hybrid systems with drives on some compression elements, variable speed drives are revolutionizing chiller designs.

1. Variable Speed Drive Basics

Terry Davies, Danfoss, Jacksonville, FL

2. Variable Speed Screw Chiller Basics

Robert Feduik, Carrier, Syracuse, NY

3. Variable Speed Centrifugal Chiller Basics

Jeb Schreiber, JCI, York, PA

11:00 AM - 12:30 PM

Seminar 13

Yes, It Is Your Fault: How Faults Affect Your System's Performance and How to Model the Faults' Effects in Advance

Track: Building Operation and Performance



Sponsor: 8.11 Unitary and Room Air Conditioners and Heat Pumps, 7.3 Operation and Maintenance Management, TC 7.5 Smart Building Systems

Chair: David P. Yuill, Ph.D., P.E., University of Nebraska, Omaha, NE

Faults happen. They can occur in unitary air-conditioning equipment and cause it to perform below its expected, rated or designed value, leaving owners/operators disappointed. Examples of faults include coil fouling, loss of refrigerant charge, excessive duct flow resistance, economizer faults, etc. This seminar shows results of recent groundbreaking research projects focusing on the effects of faults on unitary equipment, and presents new methods for modeling the effects of those faults. Attendees of the seminar will be prepared to account for these effects when designing, planning maintenance, or predicting building energy performance.

1. Effect of Heat Pump Commissioning Faults on Annual Energy Use

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

2. Modeling the Effect of Vapor Compression Cycle Faults Using Gray-Box Models

Alireza Behfar, Student Member, University of Nebraska-Lincoln, Omaha, NE

3. Effect of Economizer Faults on Expected Whole-Building Energy Savings

Brianna Brass, Associate Member, Davis Design, Lincoln, NE

4. Generalized Models of Fault Effects on Air Conditioners in Heating and Cooling Mode

Mehdi Mehrabi, Student Member, University of Nebraska, Omaha, NE

Sunday, January 29, 1:00 PM - 2:00 PM

Forum SSPC

What Challenges Do You Face in Using the IAQ Procedure?

Track: Commercial and Industrial IAQ

Sponsor: SSPC 62.1

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

OPEN SESSION: No badge required; no PDHs awarded; presented during the SSPC's meeting. ASHRAE Standard 62 has contained an Indoor Air Quality procedure since the 1980s. This procedure is not widely used. Some practitioners have used the procedure in special designs in special classes of buildings. In addressing energy concerns and special environmental conditions this risk-based approach should be more widely used. Input from practitioners who have used the procedure and those who have decided not to use the procedure are needed by the committee that is revising Standard 62.1 to improve your ASHRAE Standard.

1:00 PM - 2:00 PM

Forum TC

Should ASHRAE Develop a Net Zero Energy Building Standard?

Track: Building Operation and Performance

Sponsor: 2.8 Building Environmental Impacts and Sustainability

Chair: Dunstan Macauley, P.E., WSP, Arlington, VA

OPEN SESSION: No badge required; no PDHs awarded; presented during the TC's meeting. If an entity requires a Net Zero Energy Building (NZEBS), how do you design and verify it? ASHRAE and other organizations currently provide or are developing guidance on constructing NZEBs; however, there are currently no consensus standards for designing or certifying the achievement of Net Zero. Does the industry need a NZEB Standard, and what building type(s) should the standard encompass? Should it be a design standard and/or performance verification standard? Can this be accomplished within the context of an existing ASHRAE Standard Project Committee?

Sunday, January 29, 1:30 PM - 3:00 PM

Conference Paper Session 5

Designing Energy Efficient Buildings Can Save Money and Provide Better Comfort

Track: Building Operation and Performance



Chair: Fadi Alsaleem, University of Nebraska, Omaha, NE

This session addresses issues in energy efficiency in design through building operation, involving conversations ranging from energy conservation relating to older units, insulation or controls. Likewise, specific building types and locations such as hospitality, religious, or green buildings and tropical climates, are discussed for their unique energy demands.

1. Thermal Insulation System for Energy Efficient and Green Buildings (LV-17-C016)

Krishna Kumar Mitra, Fellow ASHRAE¹ and **Ashish Rakheja, P.E., Member²**, (1)Lloyd Insulations (India) Limited, New Delhi, India, (2)AEON Integrated Building Design Consultants LLP, Noida, India

2. Experimental Investigation of Potential Energy Savings and Payback Ratio in Renewing Old Split-Type Air Conditioners (LV-17-C017)

Abdullah Alabdulkarem, Ph.D., Member¹, **Zeyad Almutairi, Ph.D.¹**, **Turki Al-Qahtani²**, **Majed AlShahrani²** and **Khaled AlAwaad²**, (1)King Saud University, Riyadh, Saudi Arabia, (2)Saudi Standard, Metrology and Quality Organization (SASO), Riyadh, Saudi Arabia

3. Development of a Hardware-in-the-Loop Framework with Modelica for Energy Efficient Buildings (LV-17-C018)

Zheng O'Neill, Ph.D., P.E., Member¹ and **Aaron Henry, Student Member¹**, (1)University of Alabama, Tuscaloosa, AL

4. Energy Saving with Comfort Guarantee in Hospitality Buildings (LV-17-C019)

Kyung Jae Kim, Ph.D.¹, **Hye-Jung Cho, Ph.D.¹**, **Kwanwoo Song, M.D.²**, **Gunhyuk Park, P.Eng.¹**, **Dae-eun Yi, M.D.¹**, **Jungil Seo, P.Eng.²**, **Sangsun Choi, M.D.¹**, **HyunSuk Min, M.D.¹**, **Ki Uhn Ahn³** and **Cheol-Soo PARK, Ph.D.³**, (1)Samsung Electronics, Seoul, South Korea, (2)Samsung Electronics, Suwon, South Korea, (3)SungKyunKwan University, Suwon, Korea, Republic of

5. Best Practices and Lessons Learned in Churches: How Energy Use and Efficiency in Religious Facilities Compares to Other Types of Commercial Buildings (LV-17-C020)

Trevor Terrill¹ and **Bryan Rasmussen¹**, (1)Texas A&M University, College Station, TX

1:30 PM - 3:00 PM

Conference Paper Session 6

Energy Efficient Design for Buildings with an Industrial Focus

Track: *Energy Efficient Industrial Buildings*



Chair: *David Yashar, NIST, Gaithersburg, MD*

Saving energy in our home or office comes easy to most of us. But what about when designers are faced with saving energy in food processing plants, factories, or even refineries – facilities where health and safety regulations play a crucial role? This session looks at three such cases of applying energy efficiency measures while maintaining a safe workplace environment. It also explores a new approach to thermal comfort studies in the indoor environment.

1. Performance Assessment of Fanger's PMV in a UK Residential Building in Heating Season (LV-17-C021)

Mahroo Eftekhari, Ph.D., Member¹, Faisal Durrani, Ph.D.², Safwan Samsuddin² and Yoshitaka Uno, CEng³, (1)Loughborough University, Loughborough, United Kingdom, (2)School of Civil & Building Engineering, Loughborough university, Loughborough, United Kingdom, (3)Mitsubishi Electric R&D Centre Europe BV, Livingston, United Kingdom

2. Integrating Energy Efficiency Performance in Processes for the Dairy Industry (LV-17-C022)

Oliver Koenigseder, Associate Member, K2E Koenigseder Energy Engineering, Krefeld, Germany

3. An Application of Energy Conservation Measures to a Middle-Sized Factory Using Energy Management System (LV-17-C023)

Tomohiro Konda¹, Chosei Kaseda¹, Kyoshiro Oto², Nobuyuki Minami³ and Koji Maeda³, (1)Azbil Corporation, Fujisawa, Japan, (2)Azbil Corporation, Hiroshima, Japan, (3)Azbil Kimmon Wakayama Co., Ltd., Gobo, Japan

4. Energy Efficiency in Buildings Inside Oil Refineries (LV-17-C024)

Abdel Darwich, P.E., HFDP, Member, Guttman & Blaevoet, Sacramento, CA

1:30 PM - 3:00 PM

Seminar 14

Data Driven Energy Auditing, Measurement and Verification

Track: *Building Operation and Performance*



Sponsor: 7.5 Smart Building Systems, 7.6 Building Energy Performance, TC 7.6

Chair: *Xin Hu, Ph.D., P.E., PG&E Company, San Francisco, CA*

This seminar provides an overview of several building energy software programs for commercial buildings (including offices, schools, and data centers) in both the U.S. and China. These programs were developed to collect energy data, provide enhanced visualization, perform energy analytics, benchmark and identify savings opportunities, quantify savings impacts, and support an ongoing commissioning process in actual facilities. Several real-world project examples are provided to illustrate how these tools will be used and what benefits they bring to the industry.

1. Using Analytics Platforms to Continuously Evaluate Buildings and Drive Persistent Savings

Ryan Hoest, P.E., BEAP, Member, EcoVox, Inc, San Luis Obispo, CA

2. A Smart Data Center Energy Expert System for Automatic Measurement, Energy Audit and Energy Efficiency Improvement

Wenli Yu, BEAP¹ and Liangcai Tan, Ph.D., P.E., BEAP and HBDP, Member², (1)Archimedes Controls Corp, Palo Alto, CA, (2)HDR Architecture Inc, San Francisco, CA

3. Using Advanced Energy Management System for Automatic Energy Audit in China

Hui Li, Ph.D., P.E., BEAP, Member, Shenzhen Secom Tech. Ltd, China, Shenzhen, China

1:30 PM - 3:00 PM

Seminar 15

Do the Users Follow the Model?

Track: *Building Operation and Performance*



Sponsor: 9.10 Laboratory Systems

Chair: Guy Perreault, P.Eng., Evap-Tech MTC inc., Québec, QC, Canada

This session presents case studies to provide guidance for developing energy models for laboratory buildings. The presenters demonstrate real life examples of energy savings using demand based ventilation and the implementation of wind responsive VAV exhaust systems in laboratories. Finally, it addresses why the actual energy consumption of laboratories may differ from the original model.

1. Modelling, Measuring and Evaluating Laboratory Energy Efficiency Performance

Gordon Sharp, Member, Aircuity Inc, Newton, MA

2. Wind Response Exhaust Fan Control Case Study

Brad Cochran, P.E., Member, C P P Inc, Fort Collins, CO

3. Energy Model vs. Actual Performance Case Study

Kelley Cramm, P.E., Member, Henderson Engineers, Overland Park, KS

1:30 PM - 3:00 PM

Seminar 16

Heat Exchanger Corrosion: Fundamentals to Application

Track: *HVAC&R Systems and Equipment*



Sponsor: 8.4 Air-to-Refrigerant Heat Transfer Equipment

Chair: Chad Bowers, Ph.D., Ingersoll Rand, Clarksville, TN

This session provides a thorough overview and in-depth analysis of the air side corrosion behavior on air-to-refrigerant heat exchangers. This includes fundamental design side considerations for both round tube and microchannel tubes, as well as applied lessons from ongoing research.

1. Corrosion Mechanisms in All Aluminum Microchannel and Round Tube Plate Fin Heat Exchangers

Seifollah Nasrazadani, University of North Texas, Denton, TX

2. Multifunctional Nanostructured Water Repellent and Anti-Corrosion Coatings

Panos Dastkos, Oak Ridge National Laboratory, Oak Ridge, TN

3. Aluminum Round Tube Applications and Corrosion Resistance Mechanisms

Vikas Somani, Brazeway, Adrian, MI

4. Fundamental Alloying, Processing and Field Application Considerations for Aluminum HVAC&R Heat Exchangers

David Ellerbrock, Sapa, Rockledge, FL

1:30 PM - 3:00 PM

Seminar 17

Energy Management: A Crucial Component of Operations and Maintenance

Track: *Building Operation and Performance*



Sponsor: 7.3 Operation and Maintenance Management

Chair: *John Constantinide, Alpha MRC Architects Engineers, Merritt Island, FL*

In the overall facility operations and maintenance (O&M) picture, energy management plays an integral role in proper facility management. This role is increasingly valued with a push in the public and private sectors for reduced energy consumption, leading to reduced facility costs and, in the case of equipment replacement, reduced payback periods. Effective energy management in O&M requires calculated and focused strategies with a proper investment of time, funding, and personnel. These strategies and their energy-saving impacts will be discussed by seminar speakers who have worked in institutional settings, providing perspectives from the United States and in an international setting.

1. The OMMP Annual Program and the Impact on Energy Conservation

Terrence Rollins, RHC Global Energy Solutions, Corpus Christi, TX

2. Energy Management in Operations and Maintenance

David Norvell, P.E., Member, University of Central Florida, Orlando, FL

3. Energy and Resources Conservation through O&M

Mohammad Baig, Member, President of ASHRAE NPC, Islamabad, Pakistan

1:30 PM - 3:00 PM

Seminar 18

Thermally Driven Devices Are Heating Up: Emerging International Field Studies and Standards for Residential Fuel-Fired Sorption Heat Pumps

Track: *HVAC&R Systems and Equipment*



Sponsor: 8.3 Absorption and Heat Operated Machines

Chair: *Kyle Gluesenkamp, Ph.D., Oak Ridge National Laboratory, Oak Ridge, TN*

As current natural gas heating units approach their efficiency limits, what will be next? Sorption systems (including absorption and adsorption) can provide gas heating efficiencies well above 100% by extracting heat from the ambient. They are rapidly expanding into water and space heating systems, especially in Europe. The IEA Annex 43 has the goal to widen use of fuel driven heat pumps, and in this seminar, member countries report on recent field studies and development of international rating standards that can help sorption technologies accelerate their rapid expansion into residential and commercial space and water heating markets.

1. Practical Experience of Field Testing Residential and Light Commercial Gas Absorption Heat Pumps

Axel Albers, Dr.Ing., Bosch Thermotechnik GmbH, Wernau, Germany

2. Field Testing of Residential Gas Absorption Storage Water Heaters

Paul Glanville, P.E., Associate Member, Gas Technology Institute, Des Plaines, IL

3. Existing and Emerging International Standards for Evaluation of Fuel-Fired Sorption Heat Pumps

Ivan Malenkovic, Dr.Ing., Fraunhofer Institute for Solar Energy Systems, Freiburg, Germany

4. Multi-Laboratory Round-Robin Testing of Commercialized Sorption Heat Pumps for Residential Space Heating

Patrizia Melograno, Ph.D., Politecnico di Milano, Milan, Italy

Sunday, January 29, 3:00 PM - 6:00 PM

Seminar TC

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

Track: Building Operation and Performance

Sponsor: 7.3 Operation and Maintenance Management

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

OPEN SESSION: No badge required; no PDHs awarded; presented during the TC's meeting. Successful engineers require many communication skills. This seminar workshop focuses on the value and importance of good writing skills for both experienced engineers and YEA, the requirement as engineers to communicate technical ideas and data, and how to achieve improved writing. Sample writings will be used to demonstrate writing techniques.

Sunday, January 29, 3:15 PM - 4:45 PM

Seminar 19

Walking the Walk: Delivering a Truly High Performance Building

Track: Building Operation and Performance



Sponsor: 7.3 Operation and Maintenance Management, 7.9 Building Commissioning, 7.6 Building Energy Performance

Chair: Alyse Falconer, P.E., Interface Engineering, San Francisco, CA

The lifecycle of a new construction project can last several years. Initial goals are set by the team with high aspirations but are often deviated from as the process continues. Tracking and monitoring the project's energy goals through design deliverables, energy analysis and commissioning reports is crucial for adhering to objectives. However, what happens when unforeseen issues occur? Does the team achieve the owner's aspirations? This presentation reviews achieving client goals while working through obstacles, from design inception through occupied building. Working together as a high performance team, performance goals can be achieved and confirmed through post-occupancy measurement and verification.

1. Architect and Engineer: An Evolving Relationship Required for Synergy within Sustainable Design

Evan Jacob, AIA, Pfau Long Architecture, San Francisco, CA

2. HVAC Design Options: Navigating Owners and Architects through HVAC Systems to Provide Client Specific Solutions

Alyse Falconer, P.E., Member, Interface Engineering, San Francisco, CA

3. Commissioning: Why Designers, Owners and Operators Should Care

Michael Flemming, P.E., Associate Member, Interface Engineering, San Francisco, CA

4. Integrating Energy Analysis into Design: How to Ensure Predicted Energy Utilization Index Values Are Achieved

Anna Brannon, P.E., BEMP, Integral Group, San Francisco, CA

Monday, January 30

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

Conference Paper Session 7

Advances in Building Simulation Tools

Track: Fundamentals and Applications



Chair: Christopher R. Laughman, Ph.D., Mitsubishi Electric Research Laboratories, Waltham, MA

Interest in the use of predictive energy modeling tools as guides to support decision making continues to grow. This session discusses in detail advances in calculation methodology, improved procedures for standardizing model input data and the use of templates for rapidly constructing complex models for energy use predictions. In addition, the session proposes innovative solutions to addressing the performance gap between expected and realized energy performance.

1. General-Purpose Building Energy Simulation Program BEST (LV-17-C025)

•Saitoh S. Endo et al. in Japan (LV-17-C025)

Iwao Hasegawa, Associate Member¹, Shuzo Murakami, Ph.D., Fellow ASHRAE², Hisaya Ishino, Ph.D., Member³, Fumio Nohara¹, Hiroshi Ninomiya, Member¹ and Reika Iida¹, (1)Nikken Sekkei, Tokyo, Japan, (2)Institute for Building Environment and Energy Conservation, Tokyo, Japan, (3)Tokyo Metropolitan University, Tokyo, Japan

2. Development of Equipment Characteristics Databases of BEST Program (LV-17-C026)

Kohichi Shinagawa¹, Shuzo Murakami, Ph.D., Fellow ASHRAE², Hisaya Ishino, Ph.D., Member³, Takashi Yanai¹ and Yukihiro Kawazu, Ph.D.¹, (1)NIHON SEKKEI, INC., Tokyo, Japan, (2)Institute for Building Environment and Energy Conservation, Tokyo, Japan, (3)Tokyo Metropolitan University, Tokyo, Japan

3. Features and Capabilities of Integrated Building Energy Simulation Program Newly Developed in Japan, BEST (LV-17-C027)

Hisaya Ishino, Ph.D., Member¹, Shuzo Murakami, Ph.D., Fellow ASHRAE², Kimiko Kohri, Ph.D., Member³, Isao Makimura⁴ and Fumio Nohara⁵, (1)Tokyo Metropolitan University, Tokyo, Japan, (2)Institute for Building Environment and Energy Conservation, Tokyo, Japan, (3)Utsunomiya University, Utsunomiya, Japan, (4)Naguwashi E&TP Laboratory, Kawagoe, Japan, (5)Nikken Sekkei, Tokyo, Japan

4. Simulation Method of HVAC Systems Using Self-Adjusting Templates in the BEST (Building Energy Simulation Tool) (LV-17-C028)

Hiroshi Ninomiya, Member¹, Shuzo Murakami, Ph.D., Fellow ASHRAE², Hisaya Ishino, Ph.D., Member³, Tatsuo Nagai⁴, Fumio Nohara¹ and Iwao Hasegawa, Associate Member¹, (1)Nikken Sekkei, Tokyo, Japan, (2)Institute for Building Environment and Energy Conservation, Tokyo, Japan, (3)Tokyo Metropolitan University, Tokyo, Japan, (4)Tokyo University of Science, Tokyo, Japan

5. Real Time Data Monitoring to Get Operations on Track (LV-17-C029)

Celeste Cizik, P.E., Member¹ and Matt Cooper, P.E., Associate Member¹, (1)Group14 Engineering, Inc., Denver, CO

8:00 AM - 9:30 AM

Conference Paper Session 8

Designing Hydronic Systems Using Energy and Water Conservation Practices

Track: HVAC&R Systems and Equipment



Chair: Bill Murphy, University of Kentucky, Lexington, KY

This session provides three real-world studies: energy efficient heat exchanger design in a natatorium, effect of architectural screens on energy consumption for a cooling tower, and potential water and energy savings associated with reusing ablation water to run mosque air-conditioning systems. Another study explains how recent market influences, advances in centrifugal compressor technology, and new refrigerant choices have coincided to make centrifugal compressors a viable application for air cooled packaged chillers. Also included is a study exploring the ever-changing dynamic of air-cooled versus water-cooled systems, along with the major growth of renewable power generation in grid energy mix.

1. Centrifugal Compressors in Air-Cooled Package Chillers: Coincidence of Market Forces and Technology (LV-17-C030)

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

2. A HEAT Pipe Indirect/Direct Evaporative Cooling/Humidification Design for Natatorium IAQ and Energy Savings, Too (LV-17-C031)

Mike Scofield, P.E., Fellow Life Member¹ and Jeff Stein, P.E., Member², (1)Conservation Mechanical Systems, Sebastopol, CA, (2)Taylor Engineering, LLC, Alameda, CA

3. Sustainability, Energy and Water: Air-Cooled Versus Water-Cooled Heat Rejection (LV-17-C032)

Omar Hawit, P.E., Member¹, Coral Pais¹ and Trevor Jaffe, P.E., Member¹, (1)Westlake Reed Leskosky, Washington, DC

4. Energy Cost of Architectural Screens Around a Cooling Tower (LV-17-C033)

Omer A. Qureshi, Student Member¹ and P.R. Armstrong, Ph.D., Member¹, (1)Masdar Institute of Science and Technology, Abu Dhabi, United Arab Emirates

5. Reuse of Ablution Water for Mosque Air Conditioning Using Indirect/Direct Evaporative Cooling Technology in Saudi Arabia (LV-17-C034)

Kostas Vatopoulos¹, Ayman Youssef, P.E., Member¹ and Adel Hamid, Member¹, (1)Saudi Aramco, Dhahran, Saudi Arabia

8:00 AM - 9:30 AM

Conference Paper Session 9

Optimizing Energy and Water Efficiency in Buildings

Track: Water-Energy Nexus



Chair: Jaya Mukhopadhyay, Ph.D., Montana State University, Bozeman, MT

Given that commercial buildings are the largest consumers of water and energy, studying their systems for potential savings is prudent in contemporary designs. This session covers three building systems (commercial dish washing, green walls and cooling towers) and presents research findings for their associated water and energy savings.

1. Performance Based Outcomes: A Case Study on the Stone 34 Project (LV-17-C035)

Michael Frank, P.E., Associate Member, McKinstry Company, Seattle, WA

2. Results from 20 Field Monitoring Projects on Rack and Flight Conveyor Dishwashers in Commercial Kitchens (LV-17-C036)

Rodney Davis¹, Amin Delagah, Associate Member¹, Michael Slater¹ and Angelo Karas¹, (1)Fisher Nickel Inc., San Ramon, CA

4. The Effects of the Green Walls on Building Energy Use and Rainwater Management (LV-17-C038)

Shaojie Yuan, Student Member¹ and Donghyun Rim, Ph.D., Associate Member¹, (1)Pennsylvania State University, University Park, PA

8:00 AM - 9:30 AM

Seminar 20

Fresh Insights on Building Automation: A Seminar by the YEA Group

Track: Building Operation and Performance



Sponsor: 1.4 Control Theory and Application, 7.5 Smart Building Systems, YEA

Chair: Joseph Kilcoyne, P.E., SC Engineers, Inc., San Diego, CA

With a focus on emerging trends in building automation systems, three Young Engineers in ASHRAE members will highlight where they see the control industry heading. According to many experts, smart, interconnected building technologies are the next major step in the evolution of buildings. With the increase of the prevalence of the “Internet of Things” and the falling costs of sensors and wireless technology, the smart building technology and implementation market has a huge potential. Topics covered include predictive energy modeling for energy dashboards, functional control testing through injection and stimulation, and connected commissioning methods.

1. Emerging Smart Building Automation Technologies and Barriers to Implementation

Chris Perry, Member, American Council for an Energy Efficient Economy, Washington, DC

2. Customizing Energy Dashboard Performance Goals Using Predictive Modeling, Historical Data Analysis and Energy-Conservative Logic

Alex Scambos, Member, Randall Lamb Associates, Inc., La Mesa, CA

3. Successful Functional Testing Methods for Building Automation Systems

Israa Ajam, Member, Sebesta, Arlington, VA

8:00 AM - 9:30 AM

Seminar 21

Low Energy LED Lighting Heat Gain Distribution in Buildings (ASHRAE RP-1681)

Track: Fundamentals and Applications



Sponsor: 4.1 Load Calculation Data and Procedures

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

The components of lighting heat gains are a significant contributor to space cooling load in buildings. These components include the fraction of convective and radiative heat gains, as well as the fraction of conditioned space and plenum space heat gains. Relevant data for the LED lighting heat gain is sparse. As the LED technology and application are rapidly growing, the need to identify LED lighting heat gain becomes highly demanded. This seminar summarizes the findings of ASHRAE RP-1681, in which 14 commercially available LED lighting luminaries’ heat gain distributions were determined through systematically designed experiments.

1. Approach, Test Setup and LED Luminaire Selection for Testing LED Lighting Heat Gain Distribution

Ran Liu, Ph.D., Member, China Building Design Consultants, Beijing, China

2. Test Results of LED Lighting Heat Gain Distribution and Comparison to Conventional Lighting

Xiaohui Zhou, Ph.D., P.E., Member, Iowa Energy Center, Ankeny, IA

3. Field Application of LED Lighting Heat Gain Distribution Data

Steven Bruning, P.E., Fellow ASHRAE, Newcomb & Boyd, Atlanta, GA

8:00 AM - 9:30 AM

Seminar 22

The Past Present and Future of Combined Heat and Power Systems in Mission Critical Facilities

Track: Mission Critical Design and Operation



Sponsor: 1.10 Cogeneration Systems, 6.2 District Energy

Chair: James Freihaut, Ph.D., Pennsylvania State University, University Park, PA

This session describes combined heat and power as a robust, efficient, economical and clean solution for critical infrastructure, microgrids and resiliency.

1. U.S. Department of Energy CHP for Resiliency Accelerator Progress Report

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

2. Combined Heat and Power: A Robust, Efficient, Economical and Clean Solution for Critical Infrastructure, Microgrids and Resiliency

Burce Hedman, Dr.Ing., Entropy LLC, Alexandria, VA

3. Resilient CHP Design for Mission Critical Facilities while Minimizing the Impact on Energy and Water Usage

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

8:00 AM - 9:30 AM

Seminar 23

The Road to Zero Energy Buildings Goes Through Energy Indices: What's Fair and How Do We Get There?

Track: Building Operation and Performance



Sponsor: 2.8 Building Environmental Impacts and Sustainability, 7.6 Building Energy Performance

Chair: Michael Deru, Ph.D., National Renewable Energy Laboratory, Golden, CO

Measuring progress toward achieving net zero energy buildings can be difficult. Performance metrics such as energy use index and energy rating index will provide misleading information if they are insensitive to the impact of parameters such as size, process loads, and occupant behavior. This seminar highlights challenges facing popular performance metrics targeted toward net zero buildings. Options for addressing some of these challenges will be described, including lessons learned from an extensive evaluation of airport terminals, and technical approaches such as O&M Index and Index Adjustment Factors to address disparities in ratings caused by geometry and operating assumptions.

1. An O&M Index Can Help Address EUI Limitations

David Goldstein, Natural Resources Defense Council, San Francisco, CA

2. Developing EUI Adjustment Factors for Benchmarking Airport Terminal Buildings

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

3. ERI Adjustments for Standard 90.2 and Other Residential Applications

Philip Fairey, Member, Florida Solar Energy Center, Cocoa, FL

8:00 AM - 9:30 AM

Seminar 24

When Buildings Get Wet....What Does That Mean?

Track: *Fundamentals and Applications*



Sponsor: 1.12 Moisture Management in Buildings

Chair: *Lan Chi Nguyen Weekes, P.Eng., InAIR Environmental Ltd, Ottawa, ON, Canada*

This session's theme is moisture, humidity, dampness and what are the differences between them all? The session focuses on the fundamental concepts of moisture management in buildings, discusses common moisture problems and fixes and attempts to describe dampness as it applies to real world situations.

1. New Fundamentals Chapter: Moisture and Buildings - What about Vapor Sources?

Hugo Hens, Ph.D., Fellow ASHRAE, University of Leuven (KU Leuven), Leuven, Belgium

2. New Chapter 62 of Applications Volume: Moisture Management from the School of Hard Knocks

Lew Harriman, Member IAQA, Mason-Grant Consulting, Portsmouth, NH

3. New ASHRAE Guidance for Moisture Management in Buildings

Carl Grimes, HHS, CIEC, Hayward Healthy Home, Monterey, CA

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

Conference Paper Session 10

Climate and Its Effect on HVAC System Performance

Track: *Effects of Climate Change on HVAC&R*



Chair: *Jessica Mangler, P.E., Affiliated Engineers, Inc., Seattle, WA*

This session identifies the need to design an HVAC system around a variable climate. The first study focuses on the transient thermal comfort and sensation reported by subjects over a 20-minute time frame. The second study investigates the effect climate variability would have on Salt Lake County's future energy demand and air quality impacts, and identifies potential changes communities can incorporate to lower energy demand and improve air quality. The final study explores the interrelationship between climate, enclosure, and micro cogeneration heat to power ratio with the goal of developing and designing enclosure and micro cogeneration systems that are more adaptive to climate changes.

1. Energy Demands for Commercial Buildings with Climate Variability and Associated Air Quality Impacts (LV-17-C039)

Carlo Bianchi, Student Member¹, Amanda D. Smith, Ph.D., Associate Member¹, Richard Didier, Student Member¹, Daniel Mendoza, Ph.D.¹ and Tho Dinh "Thomas" Tran¹, (1)University of Utah, Salt Lake City, UT

2. Measured Thermal Comfort and Sensation in Highly Transient Environments (LV-17-C040)

Erin Eckels¹, Steven Eckels, Ph.D., Member¹, Meredith Schlabach, Student Member¹ and Michael Young, Ph.D.¹, (1)Kansas State University, Manhattan, KS

3. Predicting Micro Cogeneration and Envelope Performance in Future Climates (LV-17-C041)

Ryan Milcarek, Student Member¹, Jeongmin Ahn, Ph.D.¹, Jianshun Zhang, Ph.D., Fellow ASHRAE¹, Shaun Turner¹ and Rui Zhang¹, (1)Syracuse University, Syracuse, NY

9:45 AM - 10:45 AM

Conference Paper Session 11

Impact of VOCs and Organics on Ventilation System Design

Track: Commercial and Industrial IAQ



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

Volatile organic compounds (VOCs) can have a serious impact on the IAQ within occupied spaces. This session addresses the use of oxidation as a means of VOC control and removal, and what impact such devices could have on the building ventilation system. One paper also addresses the potential of building occupants as a source of VOCs within the space they occupy.

1. Can Using Active UV-C Technology Reduce the Amount of Bacteria and/or Fungus in the Air and Improve Indoor Air Quality? (LV-17-C042)

Linda D. Lee, Ph.D., Member, American Green Technology, South Bend, IN

3. Effects of Air Flow Rates on VOC Removal Performances of Oxidation-Based Air Cleaning Technologies (LV-17-C044)

Chang-Seo Lee, Ph.D., Associate Member¹, Fariborz Haghighat, Ph.D., P.E., Fellow ASHRAE¹ and Ali Bahloul, Ph.D.²,

(1)Concordia University, Montreal, QC, Canada, (2)IRSST, Montreal, QC, Canada

9:45 AM - 10:45 AM

Seminar 25

Wire-to-Air Fan Power Performance and Energy Consumption

Track: HVAC&R Systems and Equipment



Sponsor: 5.1 Fans, 5.9 Enclosed Vehicular Facilities

Chair: Asesh Raychaudhuri, P.E., U S Dept of Veterans Affairs, Washington, DC

Estimating wire-to-air fan power performance and energy consumption requires inclusion of a number of variables and few other consideration. Power performance varies depending on whether the fan is an independent equipment or connected to other accessories. This seminar focuses on describing and explaining the steps and a standardized method to follow.

1. Standardizing Fan System Energy Calculation

Michael Brendel, Ph.D., Member¹ and Helmuth Glatt, P.E.¹, (1)Lau Industries, Dayton, OH

2. Measurement of Fan Component Efficiency

Tim Mathson, Member, Greenheck Fan Corporation, Schofield, WI

9:45 AM - 10:45 AM

Seminar 26

Small Stuff, Big Problems: Origins and Exposures to Nanoparticles

Track: Fundamentals and Applications



Sponsor: , EHC

Chair: Lan Chi Nguyen Weekes, P.Eng., InAIR Environmental Ltd, Ottawa, ON, Canada

Nanomaterials development and application are viewed as an emerging discipline but is that new? Concerns have been raised about exposure to nanomaterials as it presents a unique set of exposure pathways with potentially new benefits and risks. This seminar explores the sources of nanomaterials indoors, their impact on indoor air quality and their associated risks.

1. Airborne Nanoparticles in Residential Environments

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

2. Exposure Pathways for Nanomaterials from the Indoor Environment

Patricia Fritz, Member, New York State Department of Health, Albany, NY

9:45 AM - 10:45 AM

Seminar 27

Specifying IoT, Cyber Security and Advanced BAS Sequences and Applications: The Future of Guideline 13

Track: HVAC&R Systems and Equipment



Sponsor: 1.4 Control Theory and Application, 1.5 Computer Applications

Chair: Kristopher L Kinney, KECG, Durham, NC

Building automation systems are evolving and specifications need to adapt for advances in fault diagnostics, advanced control sequences, smart grid, and methods how to secure them. This session presents the panel's views on how specifying engineers can improve, secure and enhance new and existing control systems. It highlights efforts of ASHRAE Guideline 13 to stay relevant, include specification language and guidance and provide future specifiers background needed to set the roles and responsibilities without being an expert in those advanced fields. This should be an informative discussion ending with questions to tie it together.

1. Advanced Control Sequences

Mark Hydeman, P.E., Fellow ASHRAE, Consultant, San Francisco, CA

2. Fault Detection and Diagnostics

Grant Wichenko, P.Eng., Member, Appin Associates, Winnipeg, MB, Canada

4. Cyber Security

Ron Bernstein, Member, RBCG, LLC, Encinitas, CA

9:45 AM - 10:45 AM

Seminar 28

When Good Valve Sizing Goes Bad

Track: Fundamentals and Applications



Sponsor: 6.1 Hydronic and Steam Equipment and Systems, 1.4 Control Theory and Application

Chair: Robert C. Walker, Belimo Aircontrols Usa, Danbury, CT

This seminar presents an overview of hydronic control valve sizing with special emphasis on sizing issues which can affect the performance of the control valves. Actual examples of incorrect valve sizing will be shown with an explanation of the problems caused and the solutions required to correct the problems.

1. Basics of Hydronic Control Valve Sizing

Tricia Bruenn, Member, Belimo Aircontrols USA, Danbury, CT

2. Hydronic Valve Sizing: Behind the Curtain

James Del Monaco, P.E., Member, P2S Engineering, Long Beach, CA

9:45 AM - 10:45 AM

Seminar 29

Zero Net-Energy Buildings: Modeled Predictions and Outcomes

Track: *Building Operation and Performance*



Chair: *Charles Eley, P.E., Eley Consulting, San Francisco, CA*

ASHRAE and many other societies and governmental organizations have adopted the Architecture 2030 challenge which calls for new buildings to be zero net-energy (ZNE) by the year 2030. This seminar addresses the technical feasibility of meeting this challenge based on recent analysis, including ASHRAE research on the maximum technical potential for achieving low energy buildings (RP-1651), and the on-site renewable energy production potential for typical climates. Data from measured energy performance (utility bills) of recently constructed ZNE buildings will then be compared to the theoretical targets, and the areas of agreement as well as the gaps will be explored.

1. ZNE Feasibility and Issues By Building Type and Climate

Charles Eley, P.E., BEMP, Member, Eley Consulting, San Francisco, CA

2. Comparing Outcomes to Modeling Results

Mark Frankel, AIA, Affiliate, New Buildings Institute, White Salmon, WA

9:45 AM - 10:45 AM

Workshop 6

Food Cold Chain for Developing Countries

Track: *Fundamentals and Applications*



Sponsor: Refrigeration Committee

Chair: *Didier J. Coulomb, Dr.Ing., IIR, Paris, France*

Developing countries have lower refrigeration capacities than developed countries and thus more post-harvest losses. International organizations and private companies need to invest in these countries.

1. International Policy to Build a Sustainable Cold Chain in Developing Countries

Didier J. Coulomb, Dr.Ing., Member, IIR, Paris, France

2. Refrigeration Industries Projects in Developing Countries

Jon Shaw, CEng, Member, Carrier, Washington, DC

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

Panel

Fifty Shades of Hydronic Balancing: The His, Hers and Theirs of Flow Control

Chair: Hailey Mick, IMI Flow Design, Dallas, TX

In a world where options for balancing seems to be limitless and completely based on personal preference, we offer you the opportunity to hear from industry experts who advocate on behalf of manual balancing valves, automatic balancing valves and pressure independent control valves. While undoubtedly not as exciting as the 2016 US Presidential debates we have recently endured, in this forum we will learn the good, the bad, and the ugly of each device, the appropriate application for use, and the differences between them all allowing us to make a more informed decision on what to use in future projects.

Panelist 1

Mike Trantham, IMI Flow Design, Dallas, TX

Panelist 2

Calina Ferraro, P.E., Associate Member, Randall Lamb Associates, Inc., La Mesa, CA

Panelist 3

Steven Babin, Emerson Swan, Inc., Randolph, MA

11:00 AM - 12:00 PM

Conference Paper Session 12

IAQ in the Airline Industry

Track: Commercial and Industrial IAQ



Chair: Luke Leung, P.E., Skidmore Owings & Merrill, Chicago, IL

For both passengers and crew members, the quality of air that is circulated within commercial airliners is of particular concern. ASHRAE Standard 161, Air Quality Within Commercial Aircraft, deals with this issue, amongst many others. This session presents papers addressing the difficulties in measuring contaminants in the air in aircraft cabins, and what contaminants need to be measured. One paper also explores the exposure of airline personnel to contaminants both in the air and on the ground.

1. Measurement and Exposure of Airline Staff to Tri-Cresyl Phosphates from Engine Oil (LV-17-C045)

Hans de Ree¹, Huub Agterberg¹, John Havermans², Jan Bos² and Marc Houtzager², (1)KLM Royal Dutch Airlines, Schiphol, Netherlands, (2)TNO, Utrecht, Netherlands

2. The Nature of Particulates in Aircraft Bleed Air Resulting from Oil Contamination (LV-17-C046)

Byron Jones, Ph.D., P.E., Fellow ASHRAE¹, Shahin Nayyeri Amiri, Ph.D.¹, Jake Roth² and Mohammad Hosni, Ph.D., Fellow ASHRAE¹, (1)Kansas State University, Manhattan, KS, (2)Black & Veatch, Overland Park, KS

3. Experimental Determination of the Characteristics of Lubricating Oil Contamination in Bleed Air (LV-17-C047)

David Space, Member¹, Kurt Matthews¹, John Takacs¹, Peter Umino¹, Anil Salgar¹, Jake Roth², Shahin Nayyeri Amiri, Ph.D.³ and Byron Jones, Ph.D., P.E., Fellow ASHRAE³, (1)Boeing, Everett, WA, (2)Black & Veatch, Overland Park, KS, (3)Kansas State University, Manhattan, KS

11:00 AM - 12:00 PM

Conference Paper Session 13

Solar Effectiveness from Roofs to Cooling Panels

Track: HVAC&R Systems and Equipment



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

This session examines performance aspects of three rather different radiation sensitive components/systems used on building envelopes. The first presentation looks at energy saving/thermal comfort trade-offs when different control strategies are used for a system that couples nocturnal radiative cooling panels with phase change ceiling panels in Denmark. The second compares the performance of transparent and opaque building integrated photoVoltaic/thermal collectors in two different locations in Canada. The last paper presents comprehensive measurements of roof solar reflectivity made on 30 different buildings in each of three different cities around the U.S. to get a better understanding of the field performance of high solar reflectivity roofing materials.

1. Field Measurements of Solar Reflectivity for In-Service Single Ply Roof Membranes (LV-17-C048)

Mathew Dupuis, Ph.D., P.E., SRI, Middleton, WI

2. Parametric Analysis of the Control System of Solar Panels for Nocturnal Radiative Cooling Coupled with PCM Ceiling Panels (LV-17-C049)

Eleftherios Bourdakis, Student Member¹, Ongun B. Kazanci, Student Member¹, Thibault Q. Péan¹ and Bjarne W. Olesen, Ph.D., Fellow ASHRAE¹, (1)Technical University of Denmark, Kongens Lyngby, Denmark

3. Comparative Performance Evaluation of Transparent and Opaque BIPV/T Collectors: Roof and Façade Integration (LV-17-C050)

Raghad Kamel, Ph.D., Member¹, Alan S. Fung, P.Eng., Member¹, Navid Ekrami, Student Member¹ and Kaammran Raahemifar¹, (1)Ryerson University, Toronto, ON, Canada

11:00 AM - 12:00 PM

Seminar 30

Electronic Project and Document Management: An Introduction and ASHRAE's System

Track: Fundamentals and Applications



Sponsor: 1.7 Business, Management & General Legal Education, Electronic Communications Committee

Chair: James Arnold, P.E., Haslett Heating and Cooling, COLUMBUS, OH

Electronic project management systems and collaborative editing tools are collaborative programs for business and design professionals. These systems can include document management and retention, project scheduling and communication. The communications can include proposals, budgets, submittals, information requests, timelines, submittals and more. With any new system, training and standardizing procedures for efficiency and sustained usage are important. Additionally, this session covers the ASHRAE selected project management system Basecamp. Including the goals of using Basecamp, where ASHRAE is currently, and what the challenges were. Lastly, a demonstration of the ASHRAE Authoring Portal, a collaborative editing tool is shown, including sample projects.

1. Basecamp Fundamentals

Cynthia Callaway, P2S Engineering Inc, Long Beach, CA

2. ASHRAE Authoring Portal

Mark Owen, Member, ASHRAE, Atlanta, GA

11:00 AM - 12:00 PM

Seminar 31

Ref Cooling Water-Saturation Indices: Understanding the Water Balance When Designing and Operating a HVAC System

Track: *Water-Energy Nexus* 

Sponsor: 3.6 Water Treatment

Chair: Dan B. Weimar, Chem-Aqua, Inc, Irving, TX

Specifying the water usage ratio for HVAC equipment is an increasing goal in high performance building designs. This session introduces the concept of saturation indices for heat transfer systems, and demonstrate the tools available for predicting water consumption, water treatment control limits and chemical treatment directives. We will further delve into how the indices can be utilized to develop a successful water treatment program which balance water consumption and equipment life. This seminar provides the engineer, owner and operator with the tools and understanding necessary, for an efficient HVAC system, regardless of local makeup water quality.

1. Should Your Water be Used As Delivered? Softened? Blended Back? RO? or What? If Blended Back, How Much?

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

2. How Water Treatment Programs Utilize Saturation Indices to Reduce Water Consumption and Protect System Equipment: A Case Study

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

11:00 AM - 12:00 PM

Seminar 32

What Fire and Safety Engineers Have Learned Since the MGM Grand Fire in Las Vegas and What Are Present Day Fire and Life Safety Codes and Applications

Track: *Fundamentals and Applications* 

Sponsor: 9.12 Tall Buildings

Chair: Peter Simmonds, Ph.D., Buildings and Systems Analytics, Marina Del Rey, CA

The MGM Grand Fire in 1980 created a new thought process and applications on how fire and life safety systems in buildings are addressed. This session provides a description of the 1980 fire and lessons learned as well as an overview of present day fire and life safety codes, especially applications for tall, supertall and Mega-tall buildings.

1. The MGM Grand Fire and What Was Learned

John Klote, P.E., Fellow ASHRAE, John Klote Fire and Smoke Consulting, Leesburg, VA

2. What Are the Latest Fire and Life Safety Codes and Regulations for Buildings, Especially Tall, Supertall and Mega-tall Buildings?

Matt Davy, P.E., Member, Buildings and Systems Analytics, Marina Del Rey, CA

11:00 AM - 12:00 PM

Forum 2

Identifying a Minimum List of Contaminants of Concern for Utilizing the IAQ Procedure of Standard 62.1

Track: Commercial and Industrial IAQ

Sponsor: TRG4 Indoor Air Quality Procedure Development, SSPC 62.1 (IAQP Subcommittee)

Chair: Dean Tompkins, Ph.D., Dean Tompkins Group LLC, Madison, WI

The IAQ Procedure of ASHRAE Standard 62.1 (Ventilation for Acceptable Indoor Air) is being substantially improved. The TRG4.IAQP (Indoor Air Quality Procedure Development) is developing (for the very first time) a minimum list of Contaminants of Concern (CoC) for use with the IAQP of Standard 62.1. Any gas-phase air cleaning manufacturer/product/ seeking to utilize the IAQ Procedure must establish a (gas-phase) filter efficiency (Ef) when challenged against each contaminant in this minimum list of CoC and in accordance with ASHRAE Standard 145.2. This forum provides attendees the opportunity to discuss/debate/ (a) the minimum number CoC and (b) each specific CoC.

11:00 AM - 12:00 PM

Workshop 7

Key Impacts of ASHRAE Standards on Waterside Construction and Design

Track: Building Operation and Performance



Sponsor: 7.2 HVAC&R Construction & Design Build Technologies

Chair: James Robert Fields, ASHRAE, Greensboro, NC

ASHRAE standards have become building codes throughout North America. Contractors and design build engineers are expected to apply standards to construction projects. In the real world of HVAC hydronic system construction, we find a lack of understanding of basic sections. This workshop takes a common sense approach to specific sections of Standard 90.1 and others that have a direct impact on HVAC installation and design. Then approach this from a real world perspective, explaining why they are needed from an energy and health standpoint. This workshop is about understanding a few important sections and why ASHRAE has included them.

1. Key Impacts of ASHRAE Standards on Waterside Construction and Design

Chris Edmonson, Member, ASHRAE, Greensboro, NC

2. Impact of ASHRAE Standards on Piping Systems

James Fields, Member, Superior Mechanical Services, Inc, Greensboro, NC

Monday, January 30, 2:15 PM - 3:45 PM

Poster 1

Poster Session

Track: HVAC&R Systems and Equipment

Presentation of ASHRAE Technical Papers by Poster. ASHRAE Conference Badge Required.

1. Accounting for Non-Quadratic Behavior of AHU Systems in Determination of Air Flow Rate (LV-17-001)

Mikhail Nudelman¹, Ed Kernerman² and Nicholas Muscolino¹, (1)Aero Building Solutions, Franklin Park, IL, (2)Novosibirsk State Architecture and Construction University, Novosibirsk, Russian Federation

2. Analysis of Refrigeration and HVAC Impacts on Supermarket Energy Performance (RP-1467) (LV-17-002)

Michael Brandemuehl¹ and Penelope Cole, Member², (1)University of Colorado, Boulder, CO, (2)MKK Consulting Engineers, Inc., Greenwood Village, CO

3. BIM-Enabled Operations and Maintenance Work Processes (RP-1609) (LV-17-003)

Robert Hitchcock, Ph.D., Member¹, John Butterfield², Elizabeth Ford-Wilkins² and Francisco Forns-Samso³, (1)Hitchcock Consulting, Kelsey, CA, (2)Hallam ICS, South Burlington, VT, (3)Granlund Oy, Helsinki, Finland

4. Comparison of Approaches to Deep Energy Retrofit of Buildings with Low and High Internal Loads and Ventilation Requirements (LV-17-004)

Michael Case, Ph.D., Associate Member¹, Alexander M. Zhivov, Ph.D., Member¹, Donald Fisher, P.Eng., Life Member² and Richard Liesen, Ph.D.³, (1)US Army Corps of Engineers, Champaign, IL, (2)Fisher Consultants, Danville, CA, (3)US Army Corps of Engineers, Newark, OH

5. Deep Energy Retrofit of Presidio Army Barracks (LV-17-005)

Jay Tulley¹, Alexander M. Zhivov, Ph.D., Member², Brian Clark³, Matt Jungclaus, Affiliate⁴, Cara Carmichael⁴, Chris McClurg⁴, Margaret Simmons⁵, Randall Smidt⁶, Kinga Hydras, Member⁷, Sharon Conger⁷, Fred Winter⁷, John Shonder⁸ and Cyrus Nasser⁹, (1)U.S. Army Garrison, Monterey, CA, (2)US Army Corps of Engineers, Champaign, IL, (3)Engineer Research and Development Center, Construction Engineering Research Laboratory, Champaign, IL, (4)Rocky Mountain Institute, Boulder, CO, (5)U.S. Army Engineering & Support Center, Huntsville, AL, (6)HQ Department of the U.S. Army, Washington D.C., (7)U.S. General Services Administration, Washington, DC, (8)U.S. Department of Energy Sustainability, Washington D.C., (9)US Department of Energy, Washington, DC

6. Deep Energy Retrofits in Federal Buildings: The Value, Funding Models and Best Practices (LV-17-006)

Matthew Jungclaus¹, Margaret Simmons², Randall Smidt³, Cara Carmichael¹, Chris McClurg¹, Alexander M. Zhivov, Ph.D., Member⁴, Kinga Porst⁵ and John Shonder⁶, (1)Rocky Mountain Institute, Boulder, CO, (2)U.S. Army Engineering & Support Center, Huntsville, AL, (3)HQ Department of the U.S. Army, Washington D.C., (4)US Army Corps of Engineers, Champaign, IL, (5)Federal High Performance Green Buildings, Washington D.C., (6)U.S. Department of Energy Sustainability, Washington D.C.

7. Determination of Heat Transfer Coefficient between Heated Floor and Space Using the Principles of ANSI/ASHRAE Standard 138 Test Chamber (LV-17-007)

M. Fatih Evren¹, Abuzer Ozsunar², Atilla Biyikoglu, Ph.D., Member² and Birol Kilkis, Ph.D., Fellow ASHRAE³, (1)Hezarfen Energy Co., Istanbul, Turkey, (2)Gazi University, Ankara, Turkey, (3)Baskent University, Ankara, Turkey

8. Determination of Solar Heat Gain Coefficient for Semi-Transparent Photovoltaic Windows: An Experimental Methodology (LV-17-008)

Konstantinos Kapsis, Student Member¹ and Andreas K. Athienitis, Ph.D., P.E., Member¹, (1)Concordia University - BCEE, Montreal, QC, Canada

9. Development of Heat Transfer Model for Ceiling Radiant Cooling Panel through Combined Experimental and Simulation Study (LV-17-009)

Yasin Khan, P.E.¹, Jyotirmay Mathur, Dr.Eng., Member¹, **Mahabir Bhandari, Ph.D., Member**², Vivek Kumar¹ and Prateek Srivastava¹, (1)Malaviya National Institute of Technology, Jaipur, India, (2)Oak Ridge National Laboratory, Oak Ridge, TN

10. Diurnal and Seasonal Experimental Performance of a Liquid Desiccant Solar Regenerator (LV-17-010)

Gezahegn Habtamu Tafesse¹, S.C. Mullick² and Sanjeev Jain, Ph.D., Member³, (1)IIT Delhi, New Delhi, India, (2)Indian Institute of Technology Delhi, New Delhi, India, (3)Indian Institute of Technology Delhi, Hauz Khas, New Delhi 110016, New Delhi, India

11. Effect of Supply Air Temperature on Air Distribution in a Room with Radiant Heating and Mechanical Ventilation (LV-17-011)

Xiaozhou Wu¹, Lei Fang², Bjarne W. Olesen, Ph.D., Fellow ASHRAE², Jianing Zhao³ and Fenghao Wang¹, (1)Xi'an Jiaotong University, China, (2)Technical University of Denmark, Lyngby, Denmark, (3)Harbin Institute of Technology, Heilongjiang, China

12. Energy Analysis of a LEED Silver Certified Dining Hall on an Academic Campus: A Revisit Three Years after Its Initial Certification (LV-17-012)

Michael M. Ohadi, Ph.D., Fellow ASHRAE¹, Stefan Bangerth, Student Member¹ and Chauncey Jenkins¹, (1)University of Maryland, College Park, MD

13. Energy Solution for Laboratory Facilities (LV-17-013)

Lawrence R. Meisenzahl, Vortex Hoods, LLC, New Castle, DE

14. Evaluation of Alternative Refrigerants for Mini-Split Air Conditioners (LV-17-014)

Som Shrestha, Ph.D., BEMP, Member¹ and Omar Abdelaziz, Ph.D., Member¹, (1)Oak Ridge National Laboratory, Oak Ridge, TN

15. Experimental Comparison of Energy Optimal Coordinated Control Strategies for Heat Pump Systems (LV-17-015)

Chao Wang, Student Member¹, Bryan Rasmussen¹ and Kyaw Wynn², (1)Texas A&M University, College Station, TX, (2)Emerson Climate Technologies, Sidney, OH

16. Experimental Measurement of Frosting Limits in Cross-Flow Air-to-Air Energy Exchangers (LV-17-016)

Mohammad Rafati Nasr, Student Member¹ and Carey Simonson, Ph.D., P.E., Member¹, (1)University of Saskatchewan, Saskatoon, SK, Canada

17. Implementation of Advanced DER EPC Business Models in Dormitories in Mannheim/Germany (LV-17-017)

Ruediger Lohse, P.Eng., Leiter Contracting, Karlsruhe, Baden-Württembe, Germany

18. Infiltration and Heating Load Analysis of an Apartment with Respect to Window Type, Window Location and Lock Operation (LV-17-018)

Young Il Kim¹, Jong Jun Park¹ and Kwang-Seop Chung¹, (1)Seoul National University of Science and Technology, Seoul, Korea, Republic of

19. In-Situ Fan Curve Calibration for Virtual Airflow Sensor Implementation in VAV Systems (LV-17-019)

Li Song, Ph.D., P.E.¹, Alejandro Rivas Prieto, Student Member¹, Wesley M. Thomas¹ and Gang Wang, Ph.D., P.E.², (1)University of Oklahoma, Norman, OK, (2)University of Miami, Coral Gables, FL

20. Measurement and Verification of Efficiency Upgrades in Chilled Water Systems (LV-17-020)

Abdul Qayyum Mohammed¹, Mohamed Tatari¹, Shawn Brown, Ph.D.¹ and John Seryak¹, (1)Go Sustainable Energy LLC, Columbus, OH

22. Optimization Under Economic Uncertainty: Effect of Solar Variability on Energy and Economic Indicators (LV-17-021)

Scott Bucking, Ph.D., Member, Carleton University, Ottawa, ON, Canada

23. Portable Small Scale Multi Nozzle Volumetric Flow Meter with Exit Pressure Control (LV-17-022)

Young Il Kim¹, Sang Taek Oh¹ and Kwang-Seop Chung¹, (1)Seoul National University of Science and Technology, Seoul, Korea, Republic of

24. Potential of U-Shaped Heat Pipe Heat Exchanger in Tropical Climates for Low Sensible Heat Ratio (LV-17-023)

Amit Sharma, Ph.D.¹, **Sanjeev Jain, Ph.D.**², S C Kaushik, Ph.D.³ and Amit Kakkar⁴, (1)Deenbandhu Chhotu Ram University of Science and Technology, Murthal, Sonapat, Haryana-131039, India, Sonipat, India, (2)Indian Institute of Technology, New Delhi, India, (3)Indian Institute of Technology Delhi, Hauz Khas, New Delhi-110016, India, New Delhi, India, (4)Rajasthan Public Works Department, Jaipur, Rajasthan, India, Jaipur, India

25. Reducing the Need for Electrical Storage by Coupling Solar PVs and Precooling in Three Residential Building Types in the Phoenix Climate (LV-17-024)

Reza Arababadi, Student Member¹ and Kristen Parrish, Ph.D.¹, (1)Arizona State University, Tempe, AZ

26. Sequencing Control of Parallel Pumps in Variable Flow Systems Using Wire-to-Water Efficiency (LV-17-025)

Gang Wang, Ph.D., P.E.¹ and Xuejing Zheng², (1)University of Miami, Coral Gables, FL, (2)Tianjin University, Tianjin, China

28. Wireless Heating Management System and Tenant Usage Behavior in Bulk-Metered Apartment Buildings: A Case Study (LV-17-026)

Zixiao Shi¹, William O'Brien, Ph.D.¹, Daniel Dicaire² and Yitian Hu¹, (1)Carleton University, Ottawa, ON, Canada, (2)Ottawa Community Housing Corporation, Ottawa, ON, Canada

Tuesday, January 31

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

Conference Paper Session 14

Optimizing Energy and Ventilation in Residential Applications

Track: HVAC&R Systems and Equipment



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

This session examines multiple issues related to residential energy efficiency using laboratory results and modeling studies. Air conditioners are typically evaluated using SEER ratings based on performance measurements made across a very limited range of conditions. Measurements made across a much wider range of conditions are presented to help understand how variable capacity systems perform. Another paper discusses the impact of different mechanical ventilation systems used in multi-family buildings on building aesthetics, capital cost, annual energy cost, systems and equipment maintenance, and green construction rating impact. A method using singular value decomposition is introduced to reduce the computation time needed to carry out comprehensive energy optimization studies for residential buildings is introduced and used to perform case studies on a building in six different U.S. locations. Another study looks at the impact of various retrofits and air conditioner upgrades in Saudi Arabia. The final presentation finds differences of as much as +/- 50% in the annual electricity and gas use for the same house calculated by four widely used energy modeling programs and explores reasons for these differences.

1. Building Impacts of Code Compliant Ventilation in Multi-Family Dwellings (LV-17-C051)

Jesse Fisher, P.E., Member, WB Engineers + Consultants, Washington, DC

2. Life Cycle Cost Optimization of Residential Buildings (LV-17-C052)

Yeonjin Bae, Student Member¹ and Travis Horton, Ph.D., Member¹, (1)Purdue University, West Lafayette, IN

3. Investigation of Potential Energy Savings in Retrofitting a Residential Building at Riyadh's Weather Conditions (LV-17-C053)

Mohamad Alrished¹ and Abdullah Alabdulkarem, Ph.D., Member², (1)Center for Complex Engineering Systems at King Abdulaziz City for Science and Technology, Riyadh, Saudi Arabia, (2)King Saud University, Riyadh, Saudi Arabia

4. Real-World Assessment of Three Residential Variable Capacity Air Conditioners of Varying SEER (LV-17-C054)

Walter E. Hunt, Member¹, Sean Gouw, P.E., Associate Member² and Jerine Ahmed², (1)Electric Power Research Institute, Knoxville, TN, (2)Southern California Edison, Irwindale, CA

5. Comparison of Building Energy Simulation Models for Residential Homes (LV-17-C055)

Henry Liu, Associate Member¹ and A. S. (Ed) Cheng, Ph.D., P.E., Member¹, (1)San Francisco State University, San Francisco, CA

8:00 AM - 9:30 AM

Conference Paper Session 15

Ventilation Systems and Their Impact on IAQ and Energy

Track: Commercial and Industrial IAQ



Chair: Van Baxter, Oak Ridge National Laboratory, Oak Ridge, TN

HVAC engineers often face conflicting system design goals of maximizing IAQ while minimizing energy usage. This session addresses this complex topic by presenting several different approaches for 'walking the line'. New information on the measured performance of flexible duct systems is shared, and both clever design and novel control strategies for both active and passive ventilation systems are discussed.

1. Whole-Building Fault Detection: A Scalable Approach Using Spectral Methods (LV-17-C056)

Michael Georgescu, Ph.D., Member¹, Sophie Loire¹, Don Kasper¹ and Igor Mezic, Ph.D.², (1)Ecorithm, Inc., Santa Barbara, CA, (2)University of California, Santa Barbara, Santa Barbara, CA

2. Indoor Air Quality of Naturally Ventilated Buildings in a Roadside Environment (LV-17-C057)

Zheming Tong, Ph.D., Student Member, Harvard University, Cambridge, MA

3. Ductless Car Park Ventilation: Global Trends and Design Practices (LV-17-C058)

Troy Goldschmidt, Member, Greenheck, Schofield, WI

4. Lessons Learned of Applying Indoor Air Quality Procedure in Commercial Buildings (LV-17-C059)

Marwa Zaatari, Ph.D., Member, enVerid Systems, Boston, MA

5. Experimental Measurement of the Hydrodynamics and Thermal Behavior of Airflow in a "Flex-Duct" Air Distribution System (LV-17-C060)

Samad Gharehdaghi, Student Member¹ and Samir Moujaes, Ph.D., P.E., Member¹, (1)University of Nevada - Las Vegas, Las Vegas, NV

8:00 AM - 9:30 AM

Seminar 33

Considerations in Hydronic Heating System Design and Performance

Track: HVAC&R Systems and Equipment



Chair: Jennifer E. Leach, P.E., Harsco Industrial Patterson-Kelley, East Stroudsburg, PA

To familiarize the audience on the critical considerations involved in successful design and performance of hydronic heating systems, specifically incorporating condensing boiler technology, and the effects of proper vs. improper venting and the necessity of water treatment in multi-metal systems.

1. Considerations in Hydronic Heating Systems Design

Lucas Wonnell, Harsco Industrial Patterson-Kelley, East Stroudsburg, PA

2. "Green" Water Treatment in a Multi-Metal System

Dave Ritz, TGWT, Longueuil, QC, Canada

3. Special Gas Venting Systems Proper System Design for Category IV Appliances

Michael L. Mommsen, Schebler Chimney Systems, Bettendorf, IA

8:00 AM - 9:30 AM

Seminar 34

Delivering Real Buildings That Meet High Performance Design Ambition

Track: *Building Operation and Performance*



Sponsor: , 2.8 Building Environmental Impacts and Sustainability, CIBSE ASHRAE Liaison Committee

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

When buildings are designed the predicted energy performance is often over optimistic and, in many cases, owners and occupants suffer from excessive operational costs with unsustainable buildings. This seminar considers how this performance gap can be practically removed by applying methods that more properly understand the reality of the operating building; the sensible application of data rich building modelling software for lifelong performance and future refurbishment; by unravelling end-user expectation to inform the design and construction of a world-beating basketball arena and, finally, by connecting design with performance. Real projects are used to illustrate the explanations.

1. Towards Robust Building Design: A Systematic Approach to Mitigate Design Risk

Bruno Lee, Ph.D., Associate Member, Concordia University, Montreal, QC, Canada

2. The Role of Building Information Modelling Data for Design and Post Design Purposes

Brian J. Dargan, CEng, Member, BuroHappold Engineering, Los Angeles, CA

3. Reinventing the Professional Sports Arena

Alastair MacGregor, CEng, AECOM, Los Angeles, CA

4. Design and Assessment Procedures to Produce Well-Performing Buildings

John W. Field, CEng, Member, Native-Hue Energy Management, London, United Kingdom

8:00 AM - 9:30 AM

Seminar 35

Energy Efficiency Assessment in Industrial Facilities: Case Studies and Lessons

Track: *Energy Efficient Industrial Buildings*



Sponsor: 7.5 Smart Building Systems

Chair: Zheng O'Neill, Ph.D., P.E., The University of Alabama, Tuscaloosa, AL

The U.S. DOE sponsors 24 industrial assessment centers (IAC). These centers conduct energy audit for small and medium-sized manufacturers to identify site-specific opportunities to improve productivity, reduce waste and save energy through immediate changes in manufacturing processes and equipment and energy systems. This seminar covers an overview of IACs and a typical industrial energy efficiency assessment process. Results of data-mining the recommendations made in over 17,000 assessments will be presented. The basic elements of an industrial control system will be discussed with examples of energy efficiency projects. This seminar also covers a framework for achieving energy and material sustainability.

1. Identification and Trends of Most Frequent Savings Opportunities Found and Implemented in Energy Audits of Manufacturing Facilities

Donald Colliver, Ph.D., P.E., Presidential Member, University of Kentucky, Lexington, AL

2. Leveraging Control Systems for Energy Savings in Industrial Facilities

Bryan Rasmussen, Ph.D., P.E., Member, Texas A&M University, College Station, TX

3. A Guide to Environmentally Sustainable Manufacturing

J. Kelly Kissock, Ph.D., P.E., Member, University of Dayton, Dayton, OH

8:00 AM - 9:30 AM

Seminar 36

Modeling and Control of the Personal Micro-Environment

Track: *Building Operation and Performance*



Sponsor: 4.10 Indoor Environmental Modeling

Chair: *H. Ezzat Khalifa, Ph.D., Syracuse University, Syracuse, NY*

Significant HVAC energy savings and improvement in IEQ can be achieved if the micro environment around the occupant is controlled rather than the whole room, zone or building. This is enabled by localized personal environmental control systems (PECS). To design and optimize such systems, a detailed understanding of the interactions between PECS and the occupant's micro environment is necessary. These interactions influence the comfort, IEQ and energy savings achievable by PECS. The seminar presents advances in the modeling and control of the personal micro-environment, and to illustrate how these can influence the design of PECS.

1. Personal Environment Conditioning with Minimum Exergy Loss

Shinsuke Kato, Dr.Eng., Fellow ASHRAE, University of Tokyo Institute of Industrial Science, Tokyo, Japan

2. Delivering Efficient Local Cooling/Heating Using a Micro Environmental Control System (μ X)

Meng Kong, Student Member, Syracuse University, Syracuse, NY

3. Control of the Personal Micro-Environment

Arsen Melikov, Ph.D., Fellow ASHRAE, Technical University of Denmark, Kongens Lyngby, Denmark

4. The Role of Thermal Plume in Person-to-Person Contaminant Cross-Transmission

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

8:00 AM - 9:30 AM

Seminar 37

HVAC Maintenance: Using Field Test Data to Benchmark and Improve System Performance

Track: *Building Operation and Performance*



Sponsor: 7.3 Operation and Maintenance Management

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

The typical HVAC system operates 40% below specified capacity and efficiency once it is installed in a building. During routine maintenance visits, changes in the performance of an HVAC system can be diagnosed in less than seven minutes by recording and comparing seven simple airside field measurements. This test method compares benchmarked data to pinpoint the causes of deterioration in system airflow, economizer performance and duct system functionality and enables detection and surgical correction of the uncovered and often invisible system defects.

1. Performance Perspective

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

2. Utilities Perspective

Mel Johnson, DEO Consulting, Los Angeles, CA

3. Engineering Perspective

Ben Lipscomb, P.E., Associate Member, NCI, Sheffield Lake, OH

8:00 AM - 9:30 AM

Seminar 38

The Impact of Uncertainty and Validation Quality on CFD Results

Track: Fundamentals and Applications



Sponsor: 4.10 Indoor Environmental Modeling

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

CFD is a powerful and efficient tool that provides scientific analysis and images to enhance the design. It is a practical and cost effective method to investigate different design alternatives especially in large industrial and commercial buildings. However, the CFD results should meet some level of accuracy to be used in design process. Some factors like the type of the CFD model, boundary condition set up, mesh dependency, and convergence criteria affect the uncertainty and accuracy. The speakers go through several different industrial applications to show the work flow and importance of uncertainty and validation quality in HVAC industry.

1. Uncertainty Qualification and Validation of a CFD Simulation of Surface Condensation

Duncan Phyfe, Alden Research Laboratory, Alden, MA

2. CFD Modeling Accuracy: Comparative Study of Airflow Around a Thermal Manikin

John Zhai, Ph.D., Member, University of Colorado, Boulder, CO

3. Impact of Grid on CFD Prediction for Industry Applications

Ran Duan, Beijing Tsinghua Tongheng Urban Planning & Design Institute, Beijing, China

Tuesday, January 31, 9:45 AM - 11:00 AM

Seminar 39

Low-GWP Alternative Refrigerants and Their Applications: Part 1

Track: Fundamentals and Applications

Sponsor: , Journal Policy Committee with Co-sponsors TC 1.3, TC 3.1, and TC 8.4

Chair: J. Steven Brown, Ph.D., P.E., The Catholic University of America, Washington, DC

The seminar addresses low-GWP alternative refrigerants and their applications. As regulations and legislation become increasingly more widespread and restrictive, the HVAC&R industry will need to identify viable alternatives for existing refrigerant solutions. This environmentally-driven change is different than past ones since additional constraints are being placed on refrigerants in essence reducing the number of viable single-component solutions. The seminar highlights five papers appearing in ASHRAE's Science and Technology for the Built Environment November 2016 edition (one dedicated specifically to low-GWP refrigerants.) The presentations focus on low-GWP halocarbon refrigerants containing unsaturated carbon bonds during boiling heat transfer and in system applications.

1. Oil Retention of Lower GWP Refrigerants and Lubricant Mixtures and Its Effect on Heat Transfer and Pressure Drop in Microchannel Type Air Conditioning Evaporators

Lorenzo Cremaschi, Ph.D., Member, Auburn University, Auburn, AL

2. Miscibility of POE and PVE Oils with Low-GWP Refrigerant R-1234ze(E)

Man-Hoe Kim, Ph.D., Member, Kyungpook National University, Buk-gu, Daegu, South Korea

9:45 AM - 11:00 AM

Seminar 40

Addressing Information Incompatibilities in Building Performance Monitoring

Track: *Building Operation and Performance*



Sponsor: 7.3 Operation and Maintenance Management, 1.5 Computer Applications

Chair: Michael Bobker, CUNY Institute for Urban Systems, New York, NY

This session examines challenges in coordinating data extracted from building automation systems with predictions from building energy models. With BEM increasingly informing design decisions, comparison to post-construction performance at the system level becomes key to troubleshooting and tuning. Discrepancies often first noted in whole-building energy use must be traced back to system level sources. Such comparison between BAS and BEM data is hindered by inconsistencies in data organization, naming, grouping and parameters. This issue is examined as a use-case for ASHRAE Guideline 20-2010, Documenting HVAC&R Work Processes and Data Exchange Requirements.

1. Real-Time Energy Simulation for Whole Building Performance Monitoring

Zheng O'Neill, Ph.D., P.E., Member, University of Alabama, Dept of Mechanical Engineering, Tuscaloosa, AL

2. BEM-BAS Data Exchange

Robert Hitchcock, Ph.D., Member, Hitchcock Consulting, Kelsey, CA

3. BIM-Based Energy Model Calibration for Evaluating Building Retrofit Opportunities

Krishnan Gowri, Ph.D., Member, Autodesk, Bothell, WA

9:45 AM - 11:00 AM

Seminar 41

Saving Water (and Energy) with Solid Geothermal Design and Operation

Track: *Water-Energy Nexus*



Sponsor: 6.8 Geothermal Heat Pump and Energy Recovery Applications

Chair: Cary Smith, Sound Geothermal Corp., Sandy, UT

Geothermal heat pump systems have long been known as a leading system choice for energy performance. But in many regions of the world, geothermal is also the best choice for saving water, as it avoids significant operation and water usage from cooling towers used in those regions. Hybrid systems are also sometimes operated with both geothermal loops and cooling towers; these can be operated optimally to save both energy and water.

1. The Energy-Water Highway: Getting the Least Use from Evaporative Devices

Cary Smith, Member, Sound Geothermal Corp., Sandy, UT

2. Water Wizards and Water Wasters: Geothermal Exchange Replaces Cooling Towers

Jay Egg, Egg Geothermal, Kissimmee, FL

3. Managing Water in Las Vegas: Keeping the Cats Clean and Cool

Jerry Zupancic, Cashman Equipment, Henderson, NV

9:45 AM - 11:00 AM

Seminar 42

Power and Cooling Considerations for Back of Rack Ecosystems within the Data Center

Track: *Mission Critical Design and Operation*



Sponsor: 9.9 Mission Critical Facilities, Data Centers, Technology Spaces and Electronic Equipment

Chair: Nick Gangemi, Northern Air Systems, Rochester, NY

IT equipment power and cooling trends continue to push the limits in the industry, primarily due to packaging density, high performance computing, and mass scale out deployment. The challenges associated with supporting these increasing trends is further exacerbated with the additional pain points of deploying the associated ‘Back of Rack Ecosystems’, i.e. power and networking solutions. This seminar presents the existing challenges in deploying rack level infrastructure solutions, and the associated best practices and considerations that must be implemented.

1. Rack Level Power Solutions and Its Associated Challenges and Deployment Best Practices

Jon Fitch, Ph.D., Dell Inc, Round Rock, TX

2. Top of Rack Networking Solutions and Its Associated Challenges and Deployment Best Practices

Dave Moss, Dell Inc., Round Rock, TX

3. IT Equipment Exhaust-Side Deployment Challenges and Considerations

Dustin Demetriou, Ph.D., IBM, Poughkeepsie, NY

9:45 AM - 11:00 AM

Seminar 43

Urban-Scale Energy Modeling, Part 3

Track: *Building Operation and Performance*



Sponsor: 1.5 Computer Applications, TC4.7 - Energy Calculations

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

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

1. A Data and Computing Platform for City and District Scale Building Energy Efficiency

Tianzhen Hong, Ph.D., Member, Lawrence Berkeley National Laboratory, Berkeley, CA

2. Urban Energy

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

3. District and City Scale Modeling Using Openstudio

Nicholas Long, Member, National Renewable Energy Laboratory, Golden, CO

9:45 AM - 11:00 AM

Seminar 44

Toward a 21st Century Standard for Natural Ventilation: Review of Existing and Presentation of New Research

Track: Commercial and Industrial IAQ



Sponsor: 4.3 Ventilation Requirements and Infiltration, SSPC 62.1

Chair: Jordan Clark, Ph.D., CPP Wind Engineering and Air Quality Consultants, Fort Collins, CO

Natural ventilation offers the promise of more energy efficient, healthier, and more productive commercial buildings. However, most designers and code compliance officials are in agreement that the current prescriptions for natural ventilation contained in ASHRAE Standard 62.1 are inadequate. This session presents some of the work being done by the members of the Natural Ventilation Working Group under SSPC 62.1 in order to open up discussion on potential standard changes to the greater ASHRAE community and present original research done by the group's members.

1. What Climatic Conditions and Building Parameters Identify a Commercial Building as a Good Candidate for Natural Ventilation?

Alejandra Menchaca¹ and Travis English, P.E., Member², (1)Payette, Boston, MA, (2)Kaiser Permanente, Anaheim, CA

3. Review of Indoor Air Quality Considerations for Naturally Ventilated Commercial Buildings

Elliott Gall, Ph.D., Portland State University, Portland, OR

2. Using Facade Pressures to Predict Wind-Driven Natural Ventilation Rates

Jordan Clark, Ph.D., Associate Member, Lawrence Berkeley National Laboratory, Berkeley, CA

4. Natural Ventilation Design Incorporating Moisture and Air Velocity Control

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

9:45 AM - 11:00 AM

Seminar 45

Using the IAQ Procedure from ASHRAE Standard 62.1 as an Alternate Compliance Path on LEED Projects: Reports from the Field

Track: Commercial and Industrial IAQ



Sponsor: 2.3 Gaseous Air Contaminants and Gas Contaminant Removal Equipment, SSPC 62.1

Chair: Christopher O. Muller, Purafil, Inc., Doraville, GA

For many years those seeking LEED certification were required to use the Ventilation Rate Procedure from ASHRAE Standard 62.1 to determine the minimum outdoor air intake flow for mechanical ventilation systems. The IAQ Procedure (IAQP) could not be used even when it could be demonstrated that IAQ would be improved along with reductions in HVAC capital costs and ongoing energy costs. This has changed due to the development of an alternate compliance path for LEED certification that allows the use of the IAQP under a pilot credit. Case studies demonstrating successful application of this pilot credit are presented.

1. A Case Study in a High-Performance Office Building By Applying and Comparing LEED IAQ Procedure Pilot Credit to the Conventional Ventilation Procedure

Marwa Zaatari, Ph.D., Member, enVerid Systems, Boston, MA

2. Successful Application of the LEED IAQ Procedure Pilot Credit in a Retail Chain Store

Scott Williams, P.E., Williams Building System Engineering, PC, Golden Valley, MN

3. Prestigious College-Preparatory School Achieves Sustainability Goals and LEED Certification Using the IAQ Procedure from Standard 62.1

Christopher O. Muller, Member, Purafil, Inc., Doraville, GA

9:45 AM - 11:00 AM

Seminar 46

What Do We Know About Energy Use in Agriculture Facilities

Track: Energy Efficient Industrial Buildings



Sponsor: 2.2 Plant and Animal Environment

Chair: Carol A. Donovan, Alares LLC, Quincy, MA

This session highlights the energy use data available and describe what assumptions are used in interpreting the available information. It provides a perspective on the portion of agricultural energy used for the operation of agricultural facilities and particularly what mechanized systems in these facilities are major energy users. The session also demonstrates what information is still needed to effectively evaluate energy use in facilities with building envelopes.

1. What Do We Know about Energy Use in Agricultural Buildings

Morgan Hayes, Member, University of Kentucky, Lexington, KY

2. Energy Use in Livestock Production Facility Systems

Joe Zulovich, Member, University of Missouri, Columbia, MO

3. Energy Use in Indoor Plant Production Facilities

Nadia Sabeh, Ph.D., P.E., Member, Guttman & Blaevoet, Sacramento, CA

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

Seminar 48

Did It Really Work?: Theory vs. Practice in Residential HVAC

Track: Building Operation and Performance



Sponsor: , Residential Building Committee

Chair: R. Christopher Mathis, Mathis Consulting Company, Asheville, NC

The late, great Yogi Berra once said: "In theory, there's no difference between theory and practice. But in practice... there is." The speakers at this seminar agree with Yogi. Using measured data from both dry and humid climates, they show how actual energy and thermal comfort in real-world houses differs from expectations. But beyond the problems, the speakers also show data from specific designs and installation practices that have helped contractors meet and exceed customer expectations with simple, low-cost, reliable equipment instead of whiz-bang, expensive stuff that too often fails to deliver comfort and low energy performance.

1. How Dry I'm Not: Measured Humidity Loads vs. Measured Dehumidification By Heat Pumps in Occupied Houses

Lewis G. Harriman III, Fellow ASHRAE, Mason-Grant Consulting, Portsmouth, NH

2. What Works and What Does Not: Measured Residential HVAC Performance and Comfort in Dry Climates

Rick Chitwood, Chitwood Energy Management, Mt. Shasta, CA

1:00 PM - 2:30 PM

Seminar 49

ASHRAE's Residential Initiative: Why We Care

Track: Building Operation and Performance



Sponsor: , Residential Building Committee

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

Although ASHRAE historically has not focused on residential HVAC energy use, the residential sector consumes at least as much energy as the commercial sector, and approximately one-fifth of all primary energy in the United States. Three Presidential Fellows will present on ASHRAE's recent endeavors into the residential sector. The session covers how the Residential Ad Hoc Committee became the newly established Residential Building Committee, what purpose the RBC serves, and the importance of residential design in ASHRAE standards, including Standard 100, 62.2, 55, and ICC/ASHRAE Standard 700. They also summarize ASHRAE's residential market advocacy efforts with government agencies.

1. Getting Our House in Order

William Bahnfleth, Ph.D., P.E., Presidential Fellow ASHRAE, Pennsylvania State University, University Park, PA

2. ASHRAE Standards in the Residential Sector

Gordon V. R. Holness, P.E., Fellow Life Member, Consulting Engineer, West Palm Beach, FL

3. ASHRAE's Advocacy in the Residential Market

Thomas H. Phoenix, P.E., Member, Moser Mayer Phoenix Associates, Greensboro, NC

Tuesday, January 31, 2:45 PM - 3:45 PM

Seminar 50

Flex Ducts, Hard Ducts and No Ducts: Migration Patterns for Duct Hunters (or not) in the Land of Thermal Comfort

Track: Building Operation and Performance



Sponsor: 6.5 Radiant Heating and Cooling, 6.1 Hydronic and Steam Equipment and Systems, Residential Building Committee

Chair: Constantinos A. Balaras, Ph.D., Institute for Environmental Research & Sustainable Development, NOA, Athens, Greece

In the land of comfort, educated home owners are changing their thermal expectations from HVAC systems, and contractors are on the front line hunting for the best solutions. Regardless of ducts or pipes, the "migration" of heat takes a basic understanding of what works and what doesn't. It is not easy to figure out the right design for the application, especially as homes get more efficient. Low-cost ducted systems may not always work right or be the best fit. This seminar looks at best practices for distributing heat in residential air and hydronic systems, including ducted and radiant design options.

1. Flex Duct Doesn't Mean You Can Flex the Rules

Chris VanRite, Member, M&M Manufacturing, Fort Worth, TX

2. Hard Ducts Are Not so Hard

Allison Bailes, Ph.D., Member, Energy Vanguard LLC, Decatur, GA

3. What Ducts? Who Needs Ducts?

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

Tuesday, January 31, 4:00 PM - 5:00 PM

Seminar 51

International Experience and Contractors Perspectives on Residential Aspects that Need to be Considered on Every Job

Track: *Building Operation and Performance*



Sponsor: , Residential Building Committee

Chair: Lewis G. Harriman III, Mason-Grant Consulting, Portsmouth, NH

It has long been recognized that design and installation faults have an impact on HVAC system capacity and efficiency. However, the magnitude and consequences of these fault impacts was unknown. This seminar provides insights from a recently concluded four-year investigation that quantifies the consequences of failing to observe the design and installation elements contained within the industry's HVAC Quality Installation Specifications. It also highlights steps taken in Europe that are relevant to the North American market to reduce residential energy consumption, including deep retrofit strategies and incremental options with large market uptake for overall large impact.

1. Quantifying Performance and Efficiency Losses Due to Improper HVAC Quality Installation

Glenn Hourahan, P.E., Member, ACCA, Arlington, VA

2. European Deep Energy Retrofit Strategies Applied to North American Homes

P. Marc LaFrance, Member, U.S. Department of Energy, Washington, DC

Tuesday, January 31, 11:15 AM - 12:45 PM

Conference Paper Session 16

Building Operation and Performance with Sustainability in Mind

Track: *Building Operation and Performance*



Chair: Wade Conlan, P.E., exp US Services Inc, Maitland, FL

Much research has been done to investigate the overall performance of buildings that were designed for sustainability. This session covers the expectations of design versus the reality of their implementation as well as research on the effectiveness of sensors and building envelopes. One presentation also covers the relationship between renewable resources and the utility grid. A varied array of sustainable building design issues will be covered.

1. The Social Dynamics of a Project (LV-17-C061)

David Yancosky, Member, P2S Engineering, Long Beach, CA

2. A Comparison of Stochastic and Deterministic Optimization Algorithms on the Virtual In-Situ Sensor Calibration in Building Systems (LV-17-C062)

Sungmin Yoon, Student Member¹ and Yuebin Yu, Ph.D., Associate Member¹, (1)University of Nebraska-Lincoln, Omaha, NE

3. Risk of Condensation Analysis of Common Concrete Balcony Configurations (LV-17-C063)

Farhad Hemmati, Student Member¹, Ali Vaseghi, Student Member¹ and Fitsum Tariku¹, (1)British Columbia Institute of Technology (BCIT), Burnaby, BC, Canada

4. Duck – The Volcano is Coming! (LV-17-C064)

Alexi Miller, P.E., Associate Member¹ and Jim Edelson, Member¹, (1)New Buildings Institute, Portland, OR

5. Infrared Thermography For Building Envelope Analysis (LV-17-C065)

David M. Underwood, Member¹ and Dahtzen Chu, Member², (1)U.S. Army Corps of Engineers, Champaign, IL, (2)Construction Engineering Research Laboratory (CERL), Champaign, IL

11:15 AM - 12:45 PM

Seminar 52

College of Fellows Debate: Codes and Standards Help. Alternatively, Do They Inhibit Excellence?

Track: Mission Critical Design and Operation

Sponsor: 1.7 Business, Management & General Legal Education, College of Fellows

Chair: Larry Spielvogel, P.E., Consulting Engineer, Bala Cynwyd, PA

A great amount of time and effort is put into the writing of standards. Rigorous procedures ensure the correctness and consensus of those standards. There are tensions among customers, clients, government, researchers, politicians, designers, manufacturers, researchers, installers, commissioning agents, financial controllers and litigators. Low energy, reliability, sustainability, and familiarity are set against costs of manufacture, construction, operation, and general productivity. Does a slavish following of standards prevent or inhibit innovation. Does lazy design result?

Team A Speaker 1

Don Beaty, P.E., Fellow ASHRAE, DLB Associates, Eatontown, NJ

Team A Speaker 2

Dennis Knight, P.E., BEMP, Fellow ASHRAE, Whole Building Systems, LLC, Charleston, SC

Team A Speaker 3

John W. Field, CEng, Member, Native-Hue Energy Management, London, United Kingdom

Team B Speaker 1

Steven T. Taylor, P.E., Fellow ASHRAE, Taylor Engineering, LLC, Alameda, CA

Team B Speaker 2

David J. Branson, P.E., Fellow ASHRAE, Compliance Services Group, Inc., Lubbock, TX

Team B Speaker 3

Richard Rooley, FEng, OPMP, Presidential Fellow ASHRAE, Project Management Partnership, Stoke Poges, United Kingdom

11:15 AM - 12:45 PM

Seminar 53

Commissioning a Central Chilled Water Plant

Track: HVAC&R Systems and Equipment



Sponsor: 6.1 Hydronic and Steam Equipment and Systems, 7.9 Building Commissioning

Chair: Thomas E. Cappellin, P.E., Cappellin Consulting Services, Springfield, IL

Preparing equipment and assemblies for final check-out verification, start-up procedure and proper operation requires a coordinated activity of testing, adjusting, measurement and documentation that will ensure a successful result. This session describes how the commissioning process would be applied to achieve a successful chilled water plant operation needed to comply with the owner's project requirement and the design documents.

1. Commissioning Chilled Water and Condenser Water Pumps

David Cohen, P.E., Member, Grumman/Butkus Associates, Evanston, IL

2. Commissioning a Cooling Tower

Stephen Wiggins, Member, Newcomb & Boyd, Atlanta, GA

3. Commissioning a Water-Cooled Chiller

Stephen Wiggins, Member, Newcomb & Boyd, Atlanta, GA

11:15 AM - 12:45 PM

Seminar 54

Cutting-Edge Japanese Technologies SHASE Annual Award for HVAC System and Equipment in 2016

Track: HVAC&R Systems and Equipment



Chair: Shinsuke Kato, Dr.Eng., University of Tokyo Institute of Industrial Science, Tokyo, Japan

This session introduces three different types of buildings. One is a suburb-type Zero-Energy office building, which introduces PV, biomass generation, lithium batteries, a wood-pellet boiler etc. Another is a medium-sized office building, housing an efficient data center and an experimental R&D facility, where cost-effective ITC technology applications are effectively designed and installed. The third is a dormitory for an oil and petroleum company. A gas-fired cogeneration system is also installed to power an electricity, hot water supply, road heating and bath room dryer system. This equipment is well designed around the BCP (business continuity planning) concept.

1. Symbiosis with Nature and the Achievement of Japan's First ZEB

Naofumi Imaida, Shimizu Corporation, Tokyo, Japan

2. Implementation of Environment-Friendly Office Building with High-Efficiency Data Center

Yosuke Mino, P.E., NTT FACILITIES, INC., Tokyo, Japan

3. Corresponding to BCP and Environment Consideration Method for Company's Dormitory

Takeshi Kimura, Obayashi Corporation, Tokyo, Japan

11:15 AM - 12:45 PM

Seminar 55

Urban-Scale Energy Modeling, Part 4

Track: Building Operation and Performance



Sponsor: 1.5 Computer Applications, TC4.7 - Energy Calculations

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

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

1. Urban Microclimate for Building Energy Models

Melissa Allen, Ph.D., Oak Ridge National Laboratory, Oak Ridge, TN

2. Urban-Scale Building Energy Modeling: Why Working at Scale Matters

Michael Bobker, Member, CUNY Institute for Urban Systems, New York, NY

3. Application of Building Energy Modeling for Utility Analytics

Haider Khan, ICF International, Toronto, ON, Canada

4. Virtual UBEM: Visualizing, Analyzing and Reporting

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

11:15 AM - 12:45 PM

Seminar 56

Low-GWP Alternative Refrigerants and Their Applications, Part 2

Track: Fundamentals and Applications

Sponsor: 1.1 Thermodynamics and Psychrometrics, Journal Policy Committee with Co-sponsors TC 1.3, TC 3.1, and TC 8.4

Chair: J. Steven Brown, Ph.D., P.E., The Catholic University of America, Washington, DC

The seminar addresses low-GWP alternative refrigerants and their applications. As regulations and legislation become increasingly more widespread and restrictive, the HVAC&R industry will need to identify viable alternatives for existing refrigerant solutions. This environmentally-driven change is different than past ones since additional constraints are being placed on refrigerants in essence reducing the number of viable single-component solutions. The seminar highlights five papers appearing in ASHRAE's Science and Technology for the Built Environment November 2016 edition (one dedicated specifically to low-GWP refrigerants.) The presentations focus on low-GWP halocarbon refrigerants containing unsaturated carbon bonds during boiling heat transfer and in system applications.

1. Insights into the Next Generation HVAC&R Refrigerant Future

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

2. Model Validations for Low-GWP Refrigerants in Mini-Split Air-Conditioning Units

Omar Abdelaziz, Ph.D., Member¹ and **Bo Shen, Ph.D., Member¹**, (1)Oak Ridge National Laboratory, Oak Ridge, TN

3. Experimental Evaluation and Field Trial of Low GWP R404A Replacements for Commercial Refrigeration

Ankit Sethi, Associate Member¹ and **Michael Petersen, Associate Member²**, (1)Honeywell International, Buffalo, NY, (2)Creative Thermal Solutions, Inc., Urbana, IL

4. Horizontal Convective Boiling of R448A, R449A and R452B within a Micro-Fin Tube

Mark A. Kedzierski, Ph.D., Member, National Institute of Standards and Technology, Gaithersburg, MD

11:15 AM - 12:45 PM

Seminar 57

Occupant Behavior Driven Building Operation and Maintenance

Track: Building Operation and Performance



Sponsor: MTG.OBB Occupant Behavior in Buildings, 7.5 Smart Building Systems

Chair: Bing Dong, University of Texas at San Antonio, San Antonio, TX

Building energy consumption is a systematic procedure influenced by not only engineering technologies, but also cultural concept, occupant behavior and others. People spend more than 90% of time in buildings and as a result occupant behavior becomes a leading factor that affects building energy consumption. Occupant behavior driven building operation is one critical way to reduce energy consumption in buildings. This seminar aims to highlight current state-of-art research on occupant behavior driven building operation by LBNL, Department of Energy, the University of Texas at San Antonio and Delos Living LLC. This seminar is part of IEA EBC Annex 66 activities.

1. An Introduction of ASHRAE Multidisciplinary Task Group on Occupant Behavior in Buildings

Tianzhen Hong, Ph.D., Member, Lawrence Berkeley National Laboratory, Berkeley, CA

2. Development and Commercialization of Occupant-Centered Building Control Schemes: An Energy Policy Perspective

Marina Sofos, U.S. Department of Energy, Washington, DC

3. Behavior Driven Transactive Energy for Residential Buildings

Amin Mirakhorli, UTSA, San Antonio, TX

4. Occupant Preferences on Indoor Environmental Conditions in an Open Office

Jie Zhao, Delos LLC, New York, NY

11:15 AM - 12:45 PM

Seminar 58

Sewage Water Heat Pump Systems: Recovering Heat, Cold and Water

Track: *Water-Energy Nexus* 

Sponsor: 6.8 Geothermal Heat Pump and Energy Recovery Applications

Chair: Jeffrey Spitler, Ph.D., P.E., Oklahoma State University, Stillwater, OK

Sewage water represents an enormous, yet largely untapped resource, that could be used as a heat source and sink for heat pumps providing heating, cooling and hot water to buildings. This seminar presents recent research, development and a project case study of a sewage water heat pump system at the Denver Museum of Nature and Science. This system also processes sewage water on site for non-potable uses.

1. Waste Water Heat Recovery with Heat Pumps: Possibilities and Experiences

Jörgen Wallin, Ph.D., KTH (Royal Institute of Technology), Stockholm, Sweden

2. Recycling Water and Energy at the Denver Museum of Nature and Science, Part 1: System Design

Trey Austin, P.E., Member, Geo-Energy Services, Littleton, CO

3. Recycling Water and Energy at the Denver Museum of Nature and Science, Part 2: System Performance

Piljae Im, Ph.D., Member, Oak Ridge National Laboratory, Oak Ridge, TN

Tuesday, January 31, 1:00 PM - 1:30 PM

Seminar TC

Want a Cutting Edge Career? Be in Controls! An Open Session for YEA Members.

Track: *Fundamentals and Applications*

Sponsor: 1.4 Control Theory and Application

Chair: Chad Moore, P.E., Engineering Resource Group, Jackson, MS

OPEN SESSION: No badge required; no PDHs awarded; presented during the TC's meeting. In this seminar, two speakers share their career path experiences in Building Automation Systems (BAS). The seminar focuses on the different careers within the BAS industry. Chariti Young, Member, Automated Logic Corp. presents, "A Cutting Edge Career in Building Automation Systems". Jason Beu, The RMH Group, Inc., presents, "Path to a Career in Controls".

Tuesday, January 31, 1:30 PM - 3:00 PM

Seminar 59

Recent Research in Data Center Cooling

Track: *Mission Critical Design and Operation*



Sponsor: 4.10 Indoor Environmental Modeling, 9.9 Mission Critical Facilities, Data Centers, Technology Spaces and Electronic Equipment

Chair: Nick Gangemi, Northern Air Systems, Rochester, NY

Recent research in data center cooling is changing our thinking about designing and operating facilities for maximum efficiency and thermal performance and keeping pace with recent infrastructure changes such as air containment and a move to modular systems. This seminar re-considers PUE and energy efficiency, introduces a counterintuitive approach to containment, reveals recent work in designing for uniform tile airflow and discusses the thermal design implications of new modular systems.

1. Does Designing and Operating an Efficient Data Center Guarantee Performance?

Mark Seymour, CEnv, Member, Future Facilities Ltd, London, United Kingdom

2. Computer Room Air-Handler Bypass: A Novel Approach for Reducing the Cooling Infrastructure Power Consumption in Air-Cooled Data Centers

H. Ezzat Khalifa, Ph.D., Fellow ASHRAE, Syracuse University, Syracuse, NY

3. Evaluation of Strategies for Uniform Airflow through Perforated Tiles in Data Centers

Cheng-Xian (Charlie) Lin, Ph.D., Member, Florida International University, Miami, FL

4. Thermal Design of Modular Mission Critical Systems

James VanGilder, P.E., Member, Schneider Electric, Andover, MA

Tuesday, January 31, 3:15 PM - 4:45 PM

Seminar 60

Blue Is the New Green: ASHRAE Takes the Plunge into Water Use

Track: *Water-Energy Nexus*



Sponsor: , Standard 191, Standard 188

Chair: Calina Ferraro, P.E., Randall Lamb Associates, Inc., La Mesa, CA

ASHRAE's previous scope is expanding beyond ventilation, heating, cooling and energy. As designs become more integrated, ASHRAE members are seeking standards and guidance related to water use in the build environment, particularly water efficiency and the impacts of water on energy and health. This session introduces ASHRAE standards addressing water in the built environment, particularly Standards 191, 188 and 189.1.

1.00. Standard 189.1: Standard for Design of High-Performance Green Buildings

Thomas Pape, Alliance for Water Efficiency, Chicago, IL

2.00. Standard 188: Legionellosis: Risk Management for Building Water Systems

Thomas Watson, P.E., Presidential Fellow ASHRAE, Daikin Applied, Staunton, VA

3.00. Standard 191: Standard for the Efficient Use of Water in Building, Site and Mechanical Systems

Fred Betz, Ph.D., Member, Affiliated Engineers, Inc., Madison, WI

Wednesday, February 1

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

Conference Paper Session 17

Building Cooling and Heating System Design

Track: HVAC&R Systems and Equipment



Chair: David Shipley, P.Eng., ICF Marbek, Ottawa, ON, Canada

There are many factors to be considered when determining which is the best HVAC system for any given application. The papers in this session discuss a number of those factors ranging from hydronic heating emitters, to thermally activated building systems, to variable refrigerant flows, to energy recovery.

1. Experimental Study on Heating Emitters in an Environmental Chamber (LV-17-C066)

Duan Wu, Ph.D., Member, Mitsubishi Electric R&D Center Europe-UK, Livingston, United Kingdom

2. Full and Part Load Performance Evaluation of Variable Refrigerant Flow System Using an Occupancy Simulated Research Building (LV-17-C067)

Piljae Im, Ph.D., Member¹, Mini Malhotra, Associate Member² and Jeffrey Munk, Member¹, (1)Oak Ridge National Laboratory, Oak Ridge, TN, (2)Oak Ridge National Laboratory, Roane County, TN

3. Development of Water-Based Hybrid VRF System for Buildings (LV-17-C068)

Naofumi Takenaka¹, Shinichi Wakamoto¹, Yuji Motomura² and Koji Yamashita, Ph.D.³, (1)Mitsubishi Electric, Amagasaki City, Japan, (2)Mitsubishi Electric, Wakayama City, Japan, (3)Mitsubishi Electric, Tokyo, Japan

4. Influence of Acoustic Ceiling Units on the Cooling Performance of Thermally Activated Building Systems (LV-17-C069)

Luis Marcos Domínguez Lacarte¹, Bjarne W. Olesen, Ph.D., Fellow ASHRAE², Ongun B. Kazanci, Student Member³, Pierre Chigot⁴ and Nils Rage¹, (1)Technical University of Denmark, Copenhagen, Denmark, (2)International Centre for Indoor Environment and Energy, Technical University of Denmark, Lyngby, Denmark, (3)Technical University of Denmark, Kongens Lyngby, Denmark, (4)Saint-Gobain Ecophon, Hyllinge, Sweden

5. Modeling and Simulation of Membrane-Based Dehumidification and Energy Recovery Process

Zhiming Gao, Ph.D.¹, Omar Abdelaziz, Ph.D., Member¹ and Ming Qu, Ph.D.², (1)Oak Ridge National Laboratory, Oak Ridge, TN, (2)Purdue University, West Lafayette, IN

8:00 AM - 9:30 AM

Seminar 61

Developments in Building Benchmarking and Energy Performance Data: A Program Manager's Perspective

Track: Building Operation and Performance



Sponsor: 7.6 Building Energy Performance

Chair: Amanda Webb, The Pennsylvania State University, University Park, PA

Building energy performance data are essential to benchmarking and target setting. While the Commercial Buildings Energy Consumption Survey (CBECS) is the principal resource for this data across the U.S, recent disclosure laws in several cities and states have produced an additional wealth of data. This seminar examines these data sources from the perspective of several programs that collect and analyze them, and explores the challenges and opportunities for their use. Presenters provide program updates and lessons learned from the U.S. Energy Information Administration's CBECS, U.S. Environmental Protection Agency's ENERGY STAR, and disclosure and benchmarking initiatives in several U.S. cities.

1. CBECS: Highlights from 2012, Looking Ahead to 2017

Joelle Michaels, U.S. Energy Information Administration, Washington, DC

2. EPA's Energy STAR Portfolio Manager: A Consistent Framework to Assess and Learn from Local Data

Leslie Cook, U.S. Environmental Protection Agency, Washington, DC, DC

3. Using City and State Benchmarking Policies to Improve Energy Efficiency

Jayson Antonoff, Institute for Market Transformation, Washington, DC

8:00 AM - 9:30 AM

Seminar 62

Highlights of RP-1404: Measurement, Modeling, Analysis and Reporting Protocols for Short-term M&V of Whole Building Energy Performance

Track: Building Operation and Performance



Sponsor: 4.7 Energy Calculations

Chair: Ralph Muehleisen, Ph.D., P.E., Argonne National Laboratory, Lemont, IL

Data collection for measurement and verification for whole building energy performance usually requires one full year of measurement data. ASHRAE RP 1404 developed analysis methodologies for determining reduced time periods for monitoring that would satisfy accuracy levels required for annual energy performance verification. This session highlights the undertaken research, discussing the background of short-term monitoring for long-term prediction, the developed methodology, along with the results and analysis.

1. An Hourly Hybrid Multivariate Change Point Inverse Model Using Short-Term Monitored Data for Annual Prediction of Building Energy Performance: Background and Methodology

Bass Abushakra, Ph.D., Member, Datadigm, LLC, Wauwatosa, WI

2. An Hourly Hybrid Multivariate Change Point Inverse Model Using Short-Term Monitored Data for Annual Prediction of Building Energy Performance: Results and Analysis

Mitch Paulus, P.E., Student Member, Texas A&M University, College Station, TX

3. Predicting Building Energy Use Using Short-Term Monitoring and Daily Time Scales: The DBTA and the HIM-D Methods

T. Agami Reddy, Ph.D., P.E., Fellow ASHRAE, Arizona State University, Tempe, AZ

8:00 AM - 9:30 AM

Seminar 63

Inverse Design: A Fast Way to Achieve Your Goal in IAQ

Track: Commercial and Industrial IAQ



Sponsor: 4.10 Indoor Environmental Modeling

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

Designing an indoor environment with good indoor air quality is often a practice of guess-and-correction which is a lengthy process. This seminar introduces how to achieve the desired IAQ for various indoor environment through various inverse designs. Speakers discuss the concept and methodology of inverse design for IAQ. Then the usage of inverse design is demonstrated through applications for offices and aircraft cabins.

1. Inverse Design of Enclosed Environment By Adjoint Method

Qingyan Chen, Ph.D., Fellow ASHRAE, Purdue University, West Lafayette, IN

2. Inverse Modeling for Optimization of Indoor Air Quality

John Zhai, Ph.D., Member, University of Colorado, Boulder, CO

3. Inverse Design of Cabin Air-Supply Parameters By CFD-Based Proper Orthogonal Decomposition

Tengfei Zhang, Dalian University of Technology, Dalian, China

8:00 AM - 9:30 AM

Seminar 64

Research Update on Activities Toward the Safe Use of Low GWP Flammable Refrigerants

Track: Effects of Climate Change on HVAC&R

Sponsor: MTG.LowGWP Lower Global Warming Potential Alternative Refrigerants, 3.1 Refrigerants and Secondary Coolants, SSPC-15, and Refrigeration Committee

Chair: Thomas Watson, P.E., Daikin Applied, Staunton, VA

AHRI, ASHRAE, and the U.S. Department of Energy (DOE) are collaborating to fund vital research that will establish a more robust fact base about the properties and the use of flammable refrigerants. This \$5.8 million research program is coordinated by the AHRTI Flammable Refrigerants Committee. This session provides the Society with a summary and status update on these key research projects. The audience can learn the industry's challenge and efforts towards implementing flammable refrigerants. Open dialogue during the discussion phase will help provide valuable feedback to research teams.

1. AHRTI Research Projects on Flammable Refrigerants

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

2. ASHRAE Research Projects on Flammable Refrigerants

Kenneth Schultz, Ph.D., Ingersoll Rand, La Crosse, WI

3. ORNL Research Effort on Charge Limits for Various Types of Equipment Employing Flammable Refrigerants

Omar Abdelaziz, Ph.D., Member, Oak Ridge National Laboratory, Oak Ridge, TN

4. NIST Effort on Modeling Tools for Flammability Ranking of Low-GWP Refrigerant Blends

Gregory Linteris, Ph.D., National Institute of Standards and Technology, Gaithersburg, MD

8:00 AM - 9:30 AM

Seminar 65

Impacts of Technology and Energy Markets to the Performance of Absorption Economics

Track: HVAC&R Systems and Equipment



Sponsor: 8.3 Absorption and Heat Operated Machines

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

Absorption chillers and heat pumps have gained significant popularity in recent years due to advances in technology and improvements in efficiency and versatility. This session covers a taste of current research in absorption technology, a real world application integrated with renewable energy and a study of overall life cycle economic analysis of absorption systems based on current energy utility rates.

1. Hybrid Membrane-Based Ionic Liquid Absorption Cycle for Water Heating, Dehumidification and Cooling

Saeed Moghaddam, Ph.D.¹, Devesh Chugh, Associate Member¹, Kyle Gluesenkamp, Ph.D., Member² and Omar Abdelaziz, Ph.D., Member², (1)University of Florida, Nanoengineered Energy Systems (NES) Laboratories, Gainesville, FL, (2)Oak Ridge National Laboratory, Oak Ridge, TN

2. Solar Thermal HEAT Pump/Chiller Debut

Donald C. Erickson, Associate Member¹ and **Ellen Makar²**, (1)Energy Concepts Company LLC, Annapolis, MD, (2)Energy Concepts Co., Annapolis, MD

3. Absorption Systems' Economics

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

8:00 AM - 9:30 AM

Seminar 66

The Best of “Engineer’s Notebook”

Track: Fundamentals and Applications



Sponsor: 9.1 Large Building Air-Conditioning Systems, 4.3 Ventilation Requirements and Infiltration

Chair: John Kuempel, P.E., DeBra-Kuempel, Cincinnati, OH

The “Engineer’s Notebook” series in ASHRAE Journal was established in its current form in 2013 with four authors contributing monthly articles on a rotating basis. All four authors are ASHRAE Fellows and senior consulting engineers with more than 100 years of collective practical experience, and the concept of the recurring column is to share with peers what they have learned (sometimes the hard way) and experienced in the course of their careers, along with helpful design tips and tools. In this Seminar, each of the four has chosen their favorite column to date and has adapted it for presentation.

1. VAV Box Duct Design

Steven T. Taylor, P.E., Fellow ASHRAE, Taylor Engineering, LLC, Alameda, CA

2. Reverse Return Reexamined

Stephen W. Duda, P.E., BEAP, HBDP and HFDP, Fellow ASHRAE, Ross & Baruzzini, Inc., St. Louis, MO

3. Waterside Economizers and Standard 90.1

Daniel Nall, P.E., BEMP and HBDP, Fellow Life Member, Syska Hennessy Group, New York, NY

4. Improving Central Chilled Water System Performance

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

8:00 AM - 9:30 AM

Seminar 67

The Future of Water and Energy Efficiency in Commercial Foodservice

Track: *Water-Energy Nexus*



Sponsor: 5.10 Kitchen Ventilation, 6.6 Service Water Heating Systems

Chair: Andre Saldivar, Southern California Edison, Ontario, CA

Restaurants are among the buildings with the highest energy and water consumption. But utilities, representing 2% to 6% of the operating cost, are a low priority within the design process due to the lack of “hard” data. The challenge for the designer is to identify efficient technologies that deliver consistent savings that “payback” the incremental cost. Fortunately, energy and water efficiency generally translates to increased performance. The less energy wasted the more available for cooking product! Energy and water efficiency is one of the most practical ways to imbed “green” into the design of a commercial foodservice facility.

1. Emerging Technologies and the Water-Energy Nexus in the Commercial Kitchens

David Zabrowski, FisherNickel Inc, San Ramon, CA

2. Commercial Ice Machines: Case Studies in Energy/Water Savings Combined with Load Shifting

Don Fisher, P.Eng., Life Member, Food Service Technology Center, San Ramon, CA

3. Optimizing the Design of the Water Heating System in a Full-Service Restaurant: A Retrofit Case Study

Amin Delagah, Associate Member, Fisher Nickel Inc., San Ramon, CA

4. Restaurant Sustainability: Impact on Energy and Water Reduction

Cherish Samuels, Associate Member, McDonald's USA, Oak Brook, IL

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

Conference Paper Session 18

Modeling for Smoke Management Systems

Track: *Fundamentals and Applications*



Sponsor: 05.06 Control of Fire and Smoke

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

All three conference papers in this session focus on verifying modeling information with hands-on experimentation to validate the modeled results. In the first paper, differential pressures from shaft to building were measured in 15 different buildings. Comparing the experimental results to the modeled results, found that in most cases, hand-calculations underestimate differential pressures. In the second paper, experimentation with smoke movement through a high-rise shaft was undertaken and found that previous modeling methods did not match the experimentation results; so a new and improved method was proposed. In the third paper, a building fire was simulated and data on smoke movement in the shaft was captured. When compared to available modeling software, the experimental results were significantly different. More information about this research and their interesting results are up next.

1. Modeling of Stack Effect in High-Rise Buildings Under Winter Conditions: Evaluating the Validity of Field Observations (LV-17-C071)

Steven M. Stregge, P.E., Member¹ and Michael J. Ferreira, P.E.¹, (1)JENSEN HUGHES Inc., Baltimore, MD

2. Scale Modeling of Smoke Spread in High-Rise Shafts during Fires (LV-17-C072)

Liangzhu Wang, Ph.D., P.E., Member¹, Dahai Qi, Student Member¹ and Radu Zmeureanu, Ph.D., P.E., Member¹, (1)Concordia University, Montreal, QC, Canada

3. Comparison of COSMO Smoke Management Software and Experimental Measurements of Smoke Properties During a Structural Fire (LV-17-C073)

William Black, Ph.D., P.E., Member¹, Guanchao (Jeremy) Zhao² and Liangzhu Wang, Ph.D., P.E., Member², (1)Georgia Institute of Technology, Atlanta, GA, (2)Concordia University, Montreal, QC, Canada

9:45 AM - 10:45 AM

Conference Paper Session 19

Modern Heat Pump Applications

Track: HVAC&R Systems and Equipment



Chair: Yunho Hwang, Ph.D., University of Maryland, College Park, MD

This session explores new research on residential style heat pumps and their increased efficiency and performance. The first presentation discusses the research of multi-family houses supplied with water source heat pumps tied to a buried storage tank, which reduces compressor electricity and increases COP. The second presentation explores the increased efficiencies of heat pump units when a coating is applied to the coils to minimize defrost. The last presentation discusses recent studies from a gas heat pump's single-effect absorption cycle and its opportunities of energy savings.

1. Feasibility of Combined Water-Source Heat Pump with Thermal Energy Storage in Multi-Family Dwellings (LV-17-C074)

Mohammad Tehrani, M.D., Student Member¹ and Hessam Taherian, Ph.D., Member¹, (1)University of Alabama at Birmingham, Birmingham, AL

2. The Application of Icephobic Coatings to Air-Source Heat Pumps (LV-17-C075)

Cara Martin, BEMP, Associate Member¹, Song Li, Associate Member¹, Ron Domitrovic, Ph.D., Member², John Bush, P.E., Member² and Paul Oppenheim, Ph.D., P.E., Member³, (1)Optimized Thermal Systems, Inc., Beltsville, MD, (2)Electric Power Research Institute, Knoxville, TN, (3)University of Florida, Gainesville, FL

3. Development of a Low-Cost Gas Absorption Heat Pump (LV-17-C076)

Paul Glanville, P.E., Associate Member¹, Michael Garrabrant², Roger Stout² and Chris Keinath, Ph.D.², (1)Gas Technology Institute, Des Plaines, IL, (2)Stone Mountain Technologies, Inc., Erwin, TN

9:45 AM - 10:45 AM

Conference Paper Session 20

Ventilation System Modeling for Improved IAQ

Track: Mission Critical Design and Operation



Chair: Geoffrey C. Bares, P.E., CB&I, Plainfield, IL

Modeling can provide both designers and building owners/operators with multiple choices in determining how best to meet their energy and IAQ goals for any given type of building. This session provides examples of how modeling can be used to provide alternative HVAC design choices, as well as the level of accuracy required by the modeling to allow for reasonable choices to be made.

1. Air Dehumidification Using Desiccant Coated Oblique Fin Plate Frame Structure (LV-17-C077)

Mrinal Jagirdar, Ph.D.¹, Poh Seng Lee, Ph.D.¹ and Ghim Wei Ho, Ph.D.¹, (1)National University of Singapore, Singapore, Singapore

2. Zero-Equation Turbulence Models for Large Electrical and Electronics Enclosure Applications (LV-17-C078)

James VanGilder, P.E., Member¹, Pratik Dhoot², Zachary Pardey¹ and Christopher M. Healey, Ph.D.¹, (1)Schneider Electric, Andover, MA, (2)Northeastern University, Boston, MA

3. Numerical Evaluation of Thermal and Ventilation Performance of Passive Chilled Beams (LV-17-C079)

Wenyu Shan, Student Member, Penn State University, State College, PA

9:45 AM - 10:45 AM

Seminar 68

Thermal Comfort Prediction Tools and Outcomes for the Built Environment

Track: Fundamentals and Applications



Sponsor: 2.1 Physiology and Human Environment

Chair: John Elson, Ph.D., Kansas State University, Manhattan, KS

Achieving the necessary occupant satisfaction with the built environment is a major focus of engineers. The demand to increase energy efficiency requires more creative methods to maintain the essential thermal comfort needs of the occupants. Energy saving measures, such as natural ventilation and non-uniform environments created by windows, can make prediction of thermal comfort complicated for the designer. SSPC 55 has created tools to improve thermal comfort prediction and account for the effects of natural ventilation. This seminar explores the tools developed for the thermal comfort standard and the areas where natural ventilation applications can be improved.

1. Understanding Thermal Comfort and ASHRAE Standard 55: Free Online Analysis and Visualization Tools

David Heinzerling, Member, Taylor Engineering, Alameda, CA

2. How Comfortable Is Natural Ventilation

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

9:45 AM - 10:45 AM

Seminar 69

Design for IAQ Enhancement in Healthcare and Industrial Buildings using CFD

Track: Commercial and Industrial IAQ



Sponsor: 4.10 Indoor Environmental Modeling

Chair: Gang Tan, Ph.D., P.E., University of Wyoming, Laramie, WY

Health problems related to poor IAQ have appeared more frequently in recent years. Indoor pollutants may be generated indoors or can ingress from the outdoor environment. This seminar presents pollutant source control in a hospital by optimizing the air intake design to avoid helicopter exhaust fume entrainment, and local air quality controls through detailed ventilation design for two industrial facilities to meet the requirements of health and safety legislation. Due to complexity of the IAQ related problems, three-dimensional CFD simulations provide informative calculations and help to understand air flows and particulate concentrations during the design process.

1. Design Analysis of the Intakes Using CFD in Hospitals to Avoid Helicopter Exhaust Fume Entrainment and Improving IAQ

Reza Ghias, Ph.D., Member¹ and **Ramin Rezaei, Affiliate¹**, (1)Southland Industries, Dulles, VA

2. Design Considerations for Industrial Health and Sustainability in Large Aircraft Painting Facilities

James Bennett, Ph.D., Member, CDC/NIOSH, Cincinnati, OH

3. Using Displacement Ventilation for Airborne Particle Control in an Industrial Space

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

9:45 AM - 10:45 AM

Seminar 70

The New Laboratory Ventilation Design Guide, What's In It For Me

Track: *Fundamentals and Applications*



Sponsor: 9.10 Laboratory Systems

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

This session provides laboratory designers with up to date information on lab design.

1. ASHRAE's Laboratory Design Guide: What's in It for Me?

Henry Hays, Member, U.S. Department of Agriculture, Severn, MD

2. How the Design Guide Serves the Engineer

Jim Coogan, P.E., Member, Siemens Building Technology, Buffalo Grove, IL

9:45 AM - 10:45 AM

Seminar 71

What's New In HVAC Pumping Efficiency? A Look At 90.1-2016 Updates, EU Legislation and U.S. DOE Efficiency Legislation

Track: *Fundamentals and Applications*



Sponsor: 6.1 Hydronic and Steam Equipment and Systems

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

The drive towards high performance buildings has seen energy standards continue to increase their minimum efficiency targets to hydronic equipment. This session explores the recent changes to Standard 90.1-2016 on efficiency targets of hydronic pumps and the upcoming U.S. DOE pump efficiency legislation. A look at the European Union efficiency legislation around hydronic pumping equipment and how they compare to North American levels is presented.

1. New Standards from ASHRAE and U.S. DOE for Commercial HVAC and Plumbing Pumps

Brent Ross, P.Eng., Member, Armstrong Fluid Technology, Toronto, ON, Canada

2. Future Pump Performance Regulations in EU and USA

Niels Bidstrup, Ph.D., Member, Grundfos Management A/S, Bjerringbro, Denmark, Bjerringbro, Denmark

9:45 AM - 10:45 AM

Forum 3

Climate Change: The need for a Hot Climate Building Design Guide Manual

Track: *Fundamentals and Applications*

Sponsor: MTG.HCDG Hot Climate Design Guide

Chair: Melvin Glass, P.E., Emc Engineers, El Paso, TX

This forum is intended to solicit input regarding the content of the new Hot Climate Building Design Guide. The hot climate areas presently defined as 0A, 0B, 1A, 1B, 2A, and 2B zones. MTG HCDG Hot Climate Design Guide has been tasked with the generation of this guide for designing in hot climates. MTG HCDG has been tasked with identifying potential enhancements and would like to give the ASHRAE membership an opportunity to provide their comments to provide a well-designed, relevant, and energy efficient hot climate design guide manual.

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

Conference Paper Session 21

Optimizing Efficiency in Fin Heat Exchangers

Track: *Fundamentals and Applications*



Chair: *Steven Eckels, Ph.D., Kansas State University Institute For Environmental Research, Manhattan, KS*

Heat transfer efficiency through modern fin heat exchanger design and fenestration is described in this session. Increasing fin efficiency and reducing heat load through fenestration design are highlighted. New research in calculations are revealed and detailed modeling approaches to fin design are also highlighted.

1. Revised Indoor-Side Convection Coefficients for Complex Fenestration Systems with Roller Blinds (LV-17-C080)

John Wright, Ph.D., P.E., Member¹, Seyed Sepehr Mohaddes Foroushani, Student Member¹, Michael Collins, Ph.D., P.E., Member¹ and David Naylor, Ph.D., P.E.², (1)University of Waterloo, Waterloo, ON, Canada, (2)Ryerson University, Toronto, ON, Canada

2. Comparative Study of Optimized Small Diameter Tube-Fin Heat Exchangers vs. Traditional, Larger Diameter Tube-Fin Heat Exchanger Designs (LV-17-C081)

Dennis Nasuta, Associate Member¹, Shekhar Sarpotdar, Ph.D.¹ and Cara Martin, BEMP, Associate Member¹, (1)Optimized Thermal Systems, Inc., Beltsville, MD

3. Correlating Swirl Behavior in Low Reynolds Number Flows in Wavy-Fin Heat Exchanger (LV-17-C082)

Dantong Shi¹, Milind A. Jog, Ph.D.¹ and Raj M. Manglik, Ph.D., Member¹, (1)University of Cincinnati, Cincinnati, OH

4. Computational Study of Laminar Flow Heat Transfer Characteristics of Offset Strip Fin Channels (LV-17-C083)

Chittatosh Bhave¹, Srivatsan Madhavan¹, Raj M. Manglik, Ph.D., Member¹ and Milind A. Jog, Ph.D.¹, (1)University of Cincinnati, Cincinnati, OH

11:00 AM - 12:30 PM

Conference Paper Session 22

Refrigeration Systems and Low GWP Refrigerants

Track: *HVAC&R Systems and Equipment*

Chair: *Michelle Contri, P.E., Mid-Atlantic Mechanical, Millstone, NJ*

This session includes five papers on advances in refrigeration systems and low global warming potential refrigerants. The first paper introduces a new type of refrigerant pressure sensor, a chip capable of operating at the required temperature and pressure ranges and compatible with the fluids used in these systems. The second and third papers present promising test results on the performance characteristics and chemical stability of next generation refrigerants, as replacements for R123. The fourth paper presents the performance gains achievable in DX systems using controls that continuously adjust refrigerant charge. Finally, the fifth paper presents modeling results on the global warming impacts of four types of supermarket refrigeration systems..

1. Refrigerant-Compatible MEMS Pressure and Temperature Sensor Chip (LV-17-C084)

Tom Kwa, Ph.D., Associate Member, DunAn Sensing LLC, San Jose, CA

2. Assessment of Next Generation Refrigerant R514A as Replacement for R123 in Centrifugal Chillers (LV-17-C085)

Kenneth Schultz, Ph.D., Member¹ and Erica Gallant, Member², (1)Ingersoll Rand, La Crosse, WI, (2)Trane, La Crosse, WI

3. Chemical Stability Assessments of R-514A and R-1233zd(E) (LV-17-C086)

Julie Majurin, Associate Member¹, Elyse Sorenson, Associate Member¹, Daryl Steinke¹ and Morgan Herried¹, (1)Trane, Ingersoll Rand, La Crosse, WI

4. Continuous Tuning of Refrigerant Charge to Improve DX Equipment Performance (LV-17-C087)

Michael K. West, Ph.D., P.E., Member, Advantek Consulting Engineering, Melbourne, FL

5. Modeling of Total Equivalent Global Warming Impacts of Supermarket Refrigeration Systems (LV-17-C088)

Meredith Woy¹ and A. S. (Ed) Cheng, Ph.D., P.E., Member¹, (1)San Francisco State University, San Francisco, CA

11:00 AM - 12:30 PM

Seminar 72

Introducing the Guide for Sustainable Refrigerated Facilities and Refrigeration Systems (1634-RP)

Track: Energy Efficient Industrial Buildings



Sponsor: 10.5 Refrigerated Processing and Storage, 10.1 Custom Engineered Refrigeration Systems, Refrigeration Committee

Chair: Daniel Dettmers, IRC U.W. Madison, Madison, WI

Each refrigerated facility is unique. Due to this, design guidance and system level optimization is rare and difficult especially in the developing world. This ASHRAE research project, co-funded by UNEP and IAR, has developed a design guide to aid designers, contractors and operators of refrigerated facilities and industrial and commercial refrigeration systems along with the teachers, utilities and policy makers that assist them. This seminar previews the contents and use of this upcoming ASHRAE Special Publication.

1. Refrigeration Systems for Refrigerated Facilities: The Current Landscape

Douglas Reindl, Ph.D., P.E., Member, University of Wisconsin-Madison, Madison, WI

2. Overview of ASHRAE Design Guide for Refrigerated Facilities

Richard Love, Ph.D., Associate Member, Massey University, Palmerston, New Zealand

3. Applying the ASHRAE Design Guide for Refrigerated Facilities

Todd Jekel, Ph.D., P.E., Member, Industrial Refrigeration Consortium, Madison, WI

11:00 AM - 12:30 PM

Seminar 73

Low Energy Building Design Using Exergy Modeling

Track: Fundamentals and Applications



Sponsor: 7.4 Exergy Analysis for Sustainable Buildings (EXER)

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

Achieving low energy buildings requires optimal usage of energy in different forms, which can be predicted by exergy modeling. This seminar invites experts to introduce how to perform exergy modeling for evaluating different energy systems such as a PV system and a hybrid heating system. The experts will also elaborate the difference between energy modeling and exergy modeling to highlight the unique information obtained from exergy modeling.

1. A Simplified Exergy Methodology for Net-Zero Buildings Using Rational Exergy Management Model

Siir Kilkis, DSc, Member, The Scientific and Technological Research Council of Turkey, Ankara, Turkey

2. An Exergo-Parametric Study of Hybrid Heating Systems

M. Fatih Evren, Baskent University, Ankara, Turkey

3. Application of Exergy Principles in the Design and Analysis of Heating and Cooling Systems in Buildings

Ongun Berk Kazanci, Technical University of Denmark, Lyngby, Denmark

4. Energy and Exergy Analysis of Water and Air Cooled PVT Systems with Heat Pipe Technology

Birol Kilkis, Ph.D., Fellow ASHRAE, Baskent University, Ankara, Turkey

11:00 AM - 12:30 PM

Seminar 74

Pivotal Role of Forward Model and Data Driven Model in Existing Building Performance Enhancement

Track: *Building Operation and Performance*



Sponsor: 4.7 Energy Calculations

Chair: Alamelu Brooks, ICF International, Columbia, MD

This session addresses how the two modeling approaches i.e. Forward Model and Data Driven Model will be put in to practical use. Checking, sustaining and improving the performance of existing buildings are often ignored due to lack of information, system interactions and budget constraints. Energy models can be effectively used to address these issues.

1. Application of Calibrated BEM to the Residential Sector

Haider Khan, ICF International, Toronto, ON, Canada

2. Implications of Inverse and Forward Models to Study Energy Efficiency of Campus Buildings

Mohammad Heidarinejad, Ph.D., Associate Member, University of Maryland, College Park, MD

3. Data-Driven Approach for Predicting Building Energy Usage

Liping Wang, Ph.D., P.E., Member, University of Wyoming, Laramie, WY

4. Calibrated Forward Model vs. Measured Building Energy Use

Xiaohui Zhou, Ph.D., P.E., Member¹ and **Jason Steinbock**², (1)Iowa Energy Center, Ankeny, IA, (2)The Weidt Group, Minnetonka, MN

11:00 AM - 12:30 PM

Seminar 75

Connecting Water and Energy in Facility Management

Track: *Water-Energy Nexus*



Sponsor: 7.6 Building Energy Performance

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

Water and energy management are often separated when addressing resource conservation and system efficiencies. However, energy usage is closely linked to water usage in buildings and other applications in what is commonly known as the water-energy nexus. This seminar presents connections between water and energy management, demonstrating how conserving energy usage can reduce and control water consumption. Collected data will demonstrate that the connection between water and energy is more than a correlation. Case studies will highlight design approaches and operations procedures that strategically manage water and energy consumption as part of a facility resource management plan.

1. Water Usage Data in the Commercial Buildings Energy Consumption Survey

Katie Lewis, Office of Energy Consumption and Efficiency Statistics, U.S. Energy Information Administration, Washington, DC

2. Water Usage Patterns and Metrics in Commercial Buildings

Camilla Dunham¹ and **Jonah Schein**¹, (1)WaterSense, U.S. Environmental Protection Agency, Washington, DC

3. A Case Study of Water and Energy Conservation

David Sandberg, Noresco, Harleysville, PA

4. Air Conditioning Condensate Recovery and Reuse for Non-Potable Applications

Jennifer Isenbeck, P.E., CPMP, Member, University of Tampa, Tampa, FL

11:00 AM - 12:30 PM

Seminar 76

Standard 205 HVAC Energy Simulation Standard Representation in Practice

Track: Fundamentals and Applications



Chair: Elyse Malherek, The Weidt Group, Minnetonka, MN

ASHRAE Standard 205: Standard Representation of Performance Simulation Data for HVAC&R and Other Facility Equipment, an upcoming standard, has the potential to revolutionize energy modeling through streamlining of operational performance characteristics for typical HVAC component's including chillers, fans, and unitary DX equipment. This seminar explores the early experience of manufacturers, software developers and energy modelers using this standard.

1. Standard 205P: Overview and Structure

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

2. Chiller Performance Ratings: A Continual Evolution

Michael Zamalis, P.E., Daikin Applied, Staunton, VA

3. Transfer of HVAC Performance Data: The Software Side

Timothy P. McDowell, BEMP, Member, Thermal Energy System Specialists, LLC, Madison, WI

4. Impact of Standard 205 on the Energy Modeling Process

Elyse Malherek, The Weidt Group, Minnetonka, MN