High-Quality, Authoritative, and Credible Technical Training

“ASHRAE training has far exceeded my expectations. It provides a great overview of engineering concepts and fundamentals, systems design, commonly used HVAC equipment, control, codes, and much more. The content is provided in a very interactive manner, where you have the opportunity to ask questions and discuss different industry practices. I highly recommend ASHRAE training to anyone and everyone.”

Caroline M. (Sales Engineer)  Austin, TX

“This training has broadening my knowledge on HVAC&R design and applications. I have better understanding of the use of fundamentals and psychrometric in design, operation, maintenance, and applications.”

Ogunsuyi R. - Lagos, Nigeria

“This training was great and really has accelerated my understanding of HVAC design principles. The instructors are able to pull from their extensive experience and knowledge to give tips and examples that are useful and relevant. Great experience overall!”

Ariel F. (Toronto, ON)
The ASHRAE Learning Institute (ALI) offers a variety of full-day professional development seminars and half-day short courses to help you stay in the forefront of HVAC&R technology. ALI offers authoritative technical instructor-led training presented at

- ASHRAE Annual and Winter Conferences
- ASHRAE online course series
- ASHRAE Chapters (upon request)
- Companies (upon request)
- Other industry meetings/conferences

ASHRAE is an approved Continuing Education provider for the American Institute of Architects (AIA) and a U.S. Green Building Council (USGBC) Education Partner. Continuing Education hours earned from ASHRAE courses and seminars may be applied toward renewal of state-licensed professionals and maintenance of LEED® professional credentials.

Please check with your specific state authority for more information about continuing education requirements.

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Visit www.ashrae.org/certification to learn more about these seven programs:

- Building Commissioning Professional (BCxP)
- Building Energy Assessment Professional (BEAP)
- Building Energy Modeling Professional (BEMP)
- Certified HVAC Designer (CHD)
- High-Performance Building Design Professional (HBDP)
- Healthcare Facility Design Professional (HFDP)
- Operations and Performance Management Professional (OPMP)

www.ashrae.org/certification
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**Environmental Quality**

| Avoiding IAQ Problems | Half-Day Course | 3 | New/Transitioning and Intermediate |
| Humidity Control I: Design Tips and Traps | Half-Day Course | 3 | Intermediate and Experienced |
| Humidity Control II: Real World Problems and Solutions | Half-Day Course | 3 | Intermediate and Experienced |
| Humidity Control I and II: Tips for HVAC Design and Practical Solutions to Existing Problems | Full-Day Seminar | 6 | Intermediate and Experienced |
| Introduction to Ultraviolet Germicidal Irradiation (UVGI) Systems | Half-Day Course | 3 | Intermediate and Experienced |
| Optimizing Indoor Environment: Increasing Building Value | Full-Day Course | 3 | Intermediate and Experienced |

**HVAC&R Applications**

<p>| Air-to-Air Energy Recovery Fundamentals | Half-Day Course | 3 | Intermediate |
| Air-to-Air Heat Recovery Fundamentals and Applications (MENA) | Full-Day Course | 6 | New/Transitioning |
| Design of Affordable and Efficient Ground-Source Heat Pump Systems | Half-Day Course | 3 | Intermediate and Experienced |
| Designing and Operating High-Performing Healthcare HVAC Systems | Half-Day Course | 3 | Intermediate and Experienced |
| Designing HVAC Systems to Control Noise and Vibration | Full-Day Course | 6 | Intermediate |
| Designing Tall, Supertall, and Megatall Building Systems | Half-Day Course | 3 | Intermediate and Experienced |
| Effective Presentation for Positive Results | Half-Day Course | 3 | New/Transitioning |
| Integrated Building Design | Full-Day Seminar | 6 | Intermediate and Experienced |
| Introduction to BACnet® | Half-Day Course | 3 | New/Transitioning |
| Laboratory Design: The Basics and Beyond | Half-Day Course | 3 | Intermediate and Experienced |
| Laboratory Exhaust Stacks: Safe and Energy-Efficient Design | Half-Day Course | 3 | Intermediate and Experienced |
| Latest in High-Performance Dedicated Outdoor Air Systems (DOAS) | Half-Day Course | 3 | Intermediate and Experienced |
| New ASHRAE-Classified Refrigerants to Meet Society's Changing Needs | Half-Day Course | 3 | New/Transitioning and Intermediate |
| New Developments in Lower GWP Refrigerants (MENA) | Full-Day Seminar | 6 | Intermediate and Experienced |
| Solar PV and Thermal Systems Analysis and Design | Half-Day Course | 3 | New/Transitioning and Intermediate |</p>
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Visit [www.ashrae.org/education](http://www.ashrae.org/education) for more details and to register.

Seminars/Courses subject to change without notice.
COMMISSIONING

ASHRAE Guideline 0: The Commissioning Process
This course is ideal for building owners, facility managers, design engineers, building designers, architects, equipment manufacturers, and others interested in the commissioning process as defined by ASHRAE Guideline 0. The course focuses on commissioning objectives, activities, and deliverables. This is an entry-level course that will provide an understanding of the ASHRAE commissioning process for new construction. The course may be complimented by attending a more advanced course (such as ASHRAE's full-day HVAC and/or enclosure commissioning course).

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

Commissioning Process and Standard 202-2013
Much confusion and misinterpretation exists today about the commissioning process. To alleviate this situation, this introductory-level course describes the fundamentals of the code-language process of the ASHRAE Standard 202-2013, Commissioning Process for Buildings and Systems. The course focuses on the ASHRAE commissioning process intent, deliverables and activities. Standard 202 was written as a code-intended document that presents minimum acceptable characteristics for the practice of commissioning. This course complements ASHRAE’s Guideline 0-2013 course, which describes the characteristics and expectations of an ideal commissioning process. The course is suitable for building owners, facilities managers, design engineers, building designers, architects, and equipment manufacturers.

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

Commissioning Process in New and Existing Buildings
This introductory seminar focuses on how the building commissioning process can be applied cost-effectively to new construction and to existing facilities, with a strong emphasis on existing facilities applications. Learn the fundamentals of the commissioning process through each step of a new construction project, from predesign to occupancy and operations. The seminar will also discuss how the application of the commissioning process in existing facilities differs from new construction. Benefits of commissioning and how the process can improve the built environment, reduce environmental impacts through responsible resource utilization, improve the quality of design and construction, and raise the professional reputation of the entire commissioning team will be covered. Take away compelling information and case studies that demonstrate the value of investing in the commissioning process.

Instructor: Richard Casault, P.E., Member ASHRAE

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

Instructors: Fiona Aldous, Member ASHRAE; David Altenhofen, AIA; Jay Enck, Member ASHRAE, HBDP, CPMP, BEAP, LEED® AP; and Rob Kistler, AIA, Member ASHRAE

ENERGY EFFICIENCY

Advanced Designs for Net Zero Buildings
This advanced course is for professional engineers and architects who want to expand their practice to include the design, construction, and operation of zero energy (net zero) buildings. The first principle of zero energy design is to make the building as energy efficient as possible. On-site renewable energy systems will then be added to achieve these efficiency goals. If adequate on-site zero energy is not feasible, then options for off-site renewable energy should be explored. The test for zero energy is at the energy meter, so proper commissioning and operator training are critical to success. The zero energy principles outlined above will be presented with case studies and examples showing how other design professionals have met the zero energy goal.

Instructors: Peter Simmonds, Ph.D., Fellow ASHRAE; and Charles Eley, P.E., AIA, CEM, Member ASHRAE, BEMP, LEED® AP

Advanced High-Performance Building Design
Based on ASHRAE Standards 90.1 and 189.1, this course explores the integrated process applications essential for delivering a High-Performance Green Building. Covering all phases of a building life, from concept to design, construction, operation and removal, and using specific case studies, the course will help the student integrate their expertise into the green building delivery process and go beyond the minimum requirements of these standards. Course content is suitable for architects and engineers. This course should motivate qualified attendees to register for the ASHRAE High-Performance Design Professional Certification.

Instructor: Jeff Ross-Bain, P.E., Member ASHRAE, BEMP, LEED® AP

Basics of Combined Heat and Power
Combined heat and power (CHP) is an efficient, clean, and reliable approach to generating power and energy from a single fuel source. CHP is one of the most efficient ways to burn fuel since little energy is lost as waste heat. This course focuses on the fuel savings, emissions reduction, and decentralization of energy and power supply. The basic CHP terms and definitions, rating parameters, and energy conversion systems are discussed. The focus of this course is to understand thermal design for CHP systems and the types of technology that exists.

Instructor: Lucas B. Hyman, P.E., Member ASHRAE, LEED® AP

Basics of High-Performance Building Design
This course focuses on the basic application of relevant ASHRAE resources, such as ASHRAE Standards 90.1, 55, 62.1, 189.1, and the ASHRAE GreenGuide, to achieve high-performance building design. The course explains the differences in purpose and requirements between these various standards and provides recommendations on selection of what requirements to adopt into a building project, assuming it is not under the jurisdiction of ASHRAE Standard 189.1 but the design team still wanted to achieve a reasonable degree of high performance building design. Course content should be suitable for architects and engineers.

Instructor: Tom Lawrence, Ph.D., P.E., Member ASHRAE, LEED® AP
Building Demand Response and the Coming Smart Grid
This course presents applications of new technologies and design concepts that are leading the way to how buildings and their systems will interact with a coming smart electrical grid. The primary focus is on demand response measures and programs, although smart buildings and their new system concepts are also included. Finally, the course summarizes the future driving trends toward high-performance buildings across the globe.

Instructor: Tom Lawrence, Ph.D., P.E., Member ASHRAE, LEED®, AP

Cogeneration from the Basics through Operation
This combined heat and power (CHP) survey course provides a broad overview of cogeneration systems from concepts, to improving operational performance and efficiencies. The course includes a detailed discussion of different prime movers, appropriate applications, and the use of thermal equipment. Conducting a CHP feasibility study, the engineering design process (including basic CHP system design), required permitting efforts, and construction efforts are also covered.

Instructor: Lucas B. Hyman, P.E., Member ASHRAE, LEED®, AP

Combined Heat and Power: Creating Efficiency through Design and Operations
The successful implementation and operation of a cogeneration plant is the focus of this course. The course progresses from design through construction and operations and concludes with three case studies. The design section includes key issues that affect equipment sizes and selections, as well as the effects of those selections on plant performance and heat recovery. The construction section provides an overview of the key steps in a project’s construction phase that differ from more typical central plant or general construction projects. The operations section shows the methods that should be implemented to prolong equipment life and promote operational efficiency. Each case study provides background information for the campus and the corresponding results of the combined heat and power plant installation.

Instructor: Lucas B. Hyman, P.E., Member ASHRAE, LEED®, AP

Commercial Building Energy Audits
This seminar provides guidance on how to perform commercial building energy audits. Best practices and other information relevant for building owners, managers, and government entities are covered. The seminar includes a summary of materials essential for performing ASHRAE Level 1, 2, and 3 audits, time-saving tips for every auditor, how to hire an auditor, what to ask for in a comprehensive audit report, and how to build a successful energy efficiency retrofit team.

Instructor: Jim Kelsey, P.E., Member ASHRAE, BEAP, LEED®, AP

Commercial Building Energy Audits (MENA)
This course covers the information needed to perform commercial building energy audits. Best practices and other information relevant for building owners, managers, and government entities will be discussed. The seminar includes a summary of materials essential for performing Level 1, 2, and 3 audits, time-saving tips for every auditor, how to hire an auditor, what to ask for in a comprehensive audit report, and how to build a successful energy efficiency retrofit team. This course has been customized for the Middle East by instructors well versed in the concerns for professionals in the region.

Instructor: Hassan Younes, Member ASHRAE, BEAP, BEMP, HBDP, CPMP, HFDP, OPMP

Designing High-Performance Healthcare HVAC (MENA)
This course provides a discussion of fundamentals of system design for healthcare facilities, design considerations, basic methodology of HVAC design, psychrometrics, energy, and sustainability goals of high-performance healthcare facilities. In addition, this course will cover definitions of the key elements of high-performance in healthcare, control sequences and set points, and energy conservation strategies and relationships to temperature/relative humidity requirements.

Instructor: Hesham Safwat, Ph.D., Member ASHRAE

Designing Toward Net Zero Energy Commercial Buildings
The course provides application knowledge of the design and operating principles for energy-efficient buildings and available technologies and systems to achieve net zero energy building design. Building design strategies; review of current policy and regulation, energy, environmental and economic assessment of building’s performance; energy efficiency in HVAC, lighting and appliances; and on-site renewable energy sources are topics covered.

Instructors: Dunstan Macauley, P.E., Member ASHRAE, HBDP, LEED®, AP; and Frank Mills, C.Eng., Member ASHRAE

District Cooling and Heating Systems: Central Plants
Design principles for an efficient, reliable district cooling/heating plant that serves multi-building facilities are described and demonstrated. The course addresses each component of equipment and the relationship with other equipment within the plant. Types of equipment and the choices available within a type, such as chillers, will be reviewed and the criteria for selection will be a part of the course. Included is a short discussion of special applications such as thermal storage, combined heat and power, and deep lake water cooling.

Instructor: William Bahnfleth, Ph.D., P.E., Presidential/Fellow Member ASHRAE

Effective Energy Management in New and Existing Buildings
Buildings use 40% of U.S. energy, of which one-third can be cost effectively saved by using energy management—an orderly process in which managers use resources at their disposal to accomplish clear, energy-saving objectives. Sustained energy management is the quickest, cheapest, cleanest way to expand our world’s energy supplies and reduce greenhouse gas emissions. This seminar weaves together energy management principles of the ASHRAE Handbook—HVAC Applications, ENERGY STAR® guidelines, and the new ASHRAE/IES Standard 100-2018, Energy Efficiency in Existing Buildings. Practical experiences of successful energy managers are presented. Numerous case studies are discussed, including a hospital, high-rise building, bank, and convention center. Together, these successful examples demonstrate how to take advantage of the ENERGY STAR® Portfolio Manager for documented performance tracking and national recognition as an ENERGY STAR.

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

Effective Energy Management in New and Existing Buildings (MENA)
This course offers techniques for the adoption of energy optimization and the introduction of specialized energy-saving systems in the Middle East. The training weaves together energy management principles found in ASHRAE Handbook—HVAC Applications, U.S. ENERGY STAR® guidelines, and ASHRAE/IES Standard 100-2018, Energy Efficiency in Existing Buildings, a standard used internationally to guide organizations in reducing overall energy costs by providing procedures and programs essential for energy efficiency, maintenance, management, and monitoring.

Instructor: Hassan Younes, Member ASHRAE, BEAP, BEMP, HBDP, CPMP, HFDP, OPMP
The course provides numerous how-to solutions from successful energy managers who achieved a reduction in energy consumption by implementing sustainable energy technologies. These solutions demonstrate how to take advantage of the ENERGY STAR® Portfolio Manager for documented performance tracking and recognition as an ENERGY STAR in a hospital, high-rise building, bank, and a convention center. Among other course features are interactive exercises that uses data loggers to collect data during the course to demonstrate real-time logging of CO₂, light, temperature, and relative humidity in the classroom, as well as the best ways to use data-logging instruments.

Instructors: Samir Traboulsi, Ph.D., P.Eng., Fellow Life Member ASHRAE; and Hassan Younes, Member ASHRAE, BEAP, BEMP, HBDP, CPMP, HFDP, OPMP

Energy Efficiency in Data Centers
There are plenty of opportunities to save energy in data centers. Data centers are using an increasing amount of the total energy used by commercial facilities. However, these increases have a downside in that they have caused a significant increase in the power required and the heat dissipated by the computing equipment, such that it is becoming very difficult to power and cool these systems in data centers or telecommunications rooms. This course examines the best practices for data center energy efficiency by focusing on thermal guidelines for data processing, datacom facility energy efficiency, and actual high density data centers in operation today. You will gain an understanding of equipment environment specifications while learning methods for measuring performance and developing means to evaluate effectiveness of data center cooling. You will also receive instructions on the use of the U.S. DOE’s DCPro web-based energy modeling tools for data centers.

Instructors: Don Beaty, P.E., Fellow ASHRAE; Jack Glass, P.E., Member ASHRAE; and Roger Schmidt, Ph.D., P.E., Member ASHRAE

Energy Management Best Practices
Buildings use 40% of U.S. energy, of which one-third can be cost-effectively saved. To achieve this goal, building professionals can utilize energy management—an orderly process in which managers use resources at their disposal to accomplish clear, energy-saving objectives. This course weaves together energy management principles of the ASHRAE Handbook—HVAC Applications, ENERGY STAR® guidelines, and ASHRAE/IES Standard 100-2015, Energy Efficiency in Existing Buildings. The practical experiences of successful energy managers are presented. Numerous case studies are discussed including a hospital, high-rise building, bank, and convention center. Together, these successful examples demonstrate how to take advantage of the ENERGY STAR Portfolio Manager for documented performance tracking and national recognition as an ENERGY STAR.

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

Energy Modeling Best Practices and Applications (co-sponsored with IBPSA)
This seminar covers the fundamentals of building energy modeling and explains how to use modeling to guide design decisions, with an emphasis on HVAC. Integrating modeling into the design process from the programming stage through post-occupancy and measurements and verification will be discussed. The seminar explains modeling principles and provides modeling tips related to the building envelope, plug loads, lighting systems, and HVAC systems. Concluding with guidance on model calibration and the use of energy models for measurement and verification, this seminar also includes case studies and links to valuable modeling resources.

Instructors: Drury Cawley, Ph.D., AIA, Fellow ASHRAE, BEMP; Joseph Deringer, AIA, Life Member ASHRAE, LEED® AP; James Dirkes, P.E., Member ASHRAE, BEMP, LEED® AP; David Eldridge, P.E., Member ASHRAE, BEMP, BEAP, HBDP, LEED® AP; Erik Kolderup, P.E., Member ASHRAE, BEMP, LEED® AP; Annie Marston, Ph.D., Member ASHRAE, BEMP, LEED® AP; Sam Mason, P.E., Member ASHRAE, BEMP, LEED® AP, and McHenry Wallace, P.E., Member ASHRAE, LEED® AP

Evaluation Methods for High-Performance Green Buildings
Building performance design guidelines and evaluation metrics include LEED®, Portfolio Manager®, Green Globes, ISO 50001, IPMVP, and ASHRAE standards and guidelines, including ASHRAE Standards 90.1 and 189.1. Each serves a specific purpose; some are focused on a single aspect, others view performance in a holistic sense. Selecting a guide or metric depends on design goals and target audience. This course introduces various guidelines and their applicability to high-performance buildings. It then discusses establishing design goals, the need for verification, performance evaluation methods, implementing specific methods, and identifying corrective actions as needed. Demonstrations of relevant tools such as Portfolio Manager and Target Finder will be conducted.

Instructor: Mark Stetz, P.E., Member ASHRAE, BEAP

High-Performance Building Design: Applications and Future Trends
This course presents applications of new technologies and design concepts to achieve the goal of high-performance buildings, including zero energy or nearly zero energy buildings. The course discusses exactly what a high-performance building is from the perspective of various stakeholders. High performance is more than just energy efficiency, and this course addresses issues and methods for providing high performance in areas beyond energy efficiency, such as indoor environmental quality. The course describes future possibilities for high-performance buildings across the globe and quickly summarizes how ASHRAE standards (existing and those in development) address these topics.

Instructor: Tom Lawrence, Ph.D., P.E., Member ASHRAE, LEED® AP
How Smart, Efficient, Sustainable Systems Lead to Improved Resilience
This course provides a descriptive summary of the concept of resilience in the built environment and how sustainability, efficiency, and smart technology can help improve resilience. The concept of resilience in the context of the built environment applies to both manmade (e.g., terrorism) and natural (e.g., weather) events as they influence the infrastructure and systems that our society is built around. In this respect, we can define resilience as the capacity of the built environment (such as buildings, transportation, and energy and water distribution systems), as well as the communities and individuals within, to survive, adapt, and grow when subject to chronic stress or acute shocks. The course concludes by looking at future trends and technologies that will soon (or may reasonably in the near future) enter the market and of which the attendee should be aware.

Instructors: Tom Lawrence, Ph.D., P.E., Member ASHRAE, LEED®; and Drury Crawley, Ph.D., AIA, Fellow ASHRAE, BEMP

IT Equipment Design Evolution and Data Center Design Operation Optimization
IT manufacturers are continually responding to customer demands. Depending on the market sector, the demands call for IT equipment that is lower cost, more energy efficient, provides more storage, and provides more computing capabilities. This results in continued, significant changes in hardware, including the hardware operating conditions. This course describes the changing IT equipment and its impact on data center operating conditions. The course also shares important insight resulting from the hard work in these areas by ASHRAE Technical Committee 9.9, Mission Critical Facilities, Data Centers, Technology Spaces, and Electronic Equipment.

Instructors: Don Beatty, P.E., Fellow ASHRAE; Roger Schmidt, Ph.D., P.E., Member ASHRAE; and Jack Glass, P.E., Member ASHRAE

Operations and Maintenance of High-Performance Buildings
A high-performance building “consistently delivers a highly productive environment without wasting resources,” according to ASHRAE Guideline 32, Sustainable High-Performance Operations and Maintenance. Operating and maintaining high-performance buildings often requires different actions than for a typical commercial or institutional building. The course includes an interactive group project to reinforce concepts such as how to identify and define energy and maintenance management metrics and how to make the business case for changes to an existing building and its systems.

Instructor: Laurie Gilmer, P.E., Member ASHRAE, LEED® AP

Thermal Energy Storage Systems for Air Conditioning
Building air-conditioning systems are the single greatest contributor to aggregate peak electrical demand. As a technology, thermal energy storage enables shifting a significant proportion of a facility’s demand for electricity from daytime to nighttime periods. Furthermore, thermal energy storage enables flexibility in the demand for electricity by building air-conditioning systems—principally operating during time periods where renewable energy is plentiful and idling during time periods where renewable energy is sparse or unavailable. Through this course, participants will come to understand how thermal energy storage can enable greater use of renewable energy generation and learn whether an existing or new facility may benefit from the application of a thermal energy storage system.

Instructor: Doug Reindl, Ph.D., P.E., Fellow ASHRAE

Avoiding IAQ Problems
Based on ASHRAE’s Indoor Air Quality Guide: Best Practices for Design, Construction, and Commissioning, this course provides a systematic overview of the key objectives that must be met to achieve good indoor air quality. A review of the most common causes of IAQ problems in buildings, as well as the process management strategies that owners and design teams can use during design, construction, and turnover to help avoid IAQ problems are discussed. The course discusses the state-of-the-art strategies to prevent IAQ problems related to moisture and mold in building assemblies, outdoor contaminants, moisture and dirt in air handling systems, material emissions, outdoor air monitoring and control, and more. Case studies and examples are provided to help make the IAQ Guide easy to use for the next project.

Instructor: Hoy Bohanon, P.E., Member ASHRAE, BEAP, LEED® AP

IAQ Best Practices for Design, Construction, and Commissioning
What are the critical parts of a project that can jeopardize indoor air quality (IAQ) in your next building or building project? Knowing the key components of IAQ will help you to manage, organize, direct, design, or commission your next project. In addition to identifying key issues, this course will point out what parts of the project process are especially vulnerable to risk. There are also decisions made in the project process related to building envelope, building HVAC, and building operations and maintenance that affect the long term health of the building and its occupants. Knowledge conveyed is based upon ASHRAE’s Indoor Air Quality Guide.

Instructor: Hoy Bohanon, P.E., Member ASHRAE, BEAP, LEED® AP

Humidity Control I: Design Tips and Traps
In commercial buildings, excess humidity and moisture promotes mold, mildew, and uncomfortable conditions for occupants. This course, based on ASHRAE’s Humidity Control Design Guide for Commercial and Institutional Buildings and on the ASHRAE Guide for Buildings in Hot & Humid Climates, helps the designer achieve true control of humidity, rather than just its moderation. The course covers how to understand and easily estimate the major humidity loads that must govern the design of the system and decisions about equipment size and configuration. Attendees will learn what equipment is used for this purpose, how it works, and how to apply it quickly, economically, and reliably.

Instructors: Lew Harriman, Fellow ASHRAE; and Mark Nunnely, P.E., Member ASHRAE, BEMP, LEED® AP

Humidity Control II: Real-World Problems and Solutions
Based on ASHRAE’s best-selling Humidity Control Design Guide for Commercial and Institutional Buildings, this course includes an in-depth discussion of moisture load calculations and how humidity control can be added to HVAC designs for seven different types of commercial buildings. The course also covers the effects of different humidity levels on thermal comfort, corrosion, mold growth, and airborne microorganisms—information that helps the owner and designer define the optimal humidity control level for each application.

Instructors: Lew Harriman, Fellow ASHRAE; and Mark Nunnely, P.E., Member ASHRAE, BEMP, LEED® AP
Humidity Control I and II: Tips for HVAC Design and Practical Solutions to Existing Problems

Sooner or later, every HVAC designer and facility manager comes up against a problem created by moisture and/or excessive humidity in their buildings. This six-hour seminar consists of two, three-hour modules. Humidity Control I explains how humidity problems can be easily avoided in new designs by simple and effective humidity specifications and use of dedicated outdoor air systems that keep ventilation air dry. Humidity Control II describes classic problems and solutions for existing buildings when there may be little or no budget for different equipment or controls.

**Instructors:** Lew Harriman, Fellow ASHRAE; and Mark Nunnelly, PE., Member ASHRAE, BEMP, LEED® AP

Introduction to Ultraviolet Germicidal Irradiation (UVGI) Systems

A comprehensive introduction to how ultraviolet germicidal irradiation (UVGI) can be used in conjunction with HVAC systems to improve indoor environmental quality (IEQ) and reduce airborne disease transmission is the focus of the course. The course surveys the history and development of UVGI from its beginnings in the 19th century to the present, describes the fundamentals of the germicidal action of UVGI and characteristics of UVGI sources, common system types and their applications, the economics of UVGI, and practical considerations including material degradation, maintenance and safety. Case studies are used to illustrate typical applications.

**Instructor:** William Bahnfleth, Ph.D., PE., Presidential/Fellow, Member ASHRAE

Optimizing Indoor Environment: Increasing Building Value

Increase building value by meeting owner and occupant requirements. Buildings are provided to house and accommodate people individually or in groups. These structures can either help or hinder peoples’ productivity and enjoyment of the indoor environment. Indoor environmental quality (IEQ) is highly correlated to building occupants’ performance and satisfaction. ASHRAE sets the standards for minimum IEQ. ASHRAE also provides resources for understanding how to go beyond the minimum in improving IEQ conditions in buildings. Another factor in building productivity is cost. ASHRAE provides multiple resources for managing utilities costs in commercial buildings. The newest and most sophisticated tool for buildings is Building EQ. This course focuses on implementing ASHRAE guidance for improvement with background information to provide understanding of the various interrelated components that affect IEQ. Implementing the processes provided will set a direction for continuous improvement of building productivity, thus increasing value in tomorrow’s built environment.

**Instructor:** Hoy Bohanon, PE., Member ASHRAE, BEAP, LEED® AP

**HVAC&R APPLICATIONS**

Air-to-Air Energy Recovery Applications: Best Practices

Air-to-air energy recovery provides one of the most cost-effective and efficient ways to recycle waste energy and create superior indoor environments. This course will review real-world examples of where and how air-to-air energy recovery technologies are integrated into some of the most common, commercially available systems. Particular configurations that are most commonly used in high performance buildings and how they can best be used to meet stretch goals for IEQ, energy efficiency, and thermal comfort will be examined with respect to established performance metrics, peak performance results, and annual energy savings. A variety of different dedicated outdoor air systems, neutral air systems, and enhanced dehumidification strategies (with single and multiple heat exchangers) will be examined in detail. The advantages and important considerations for using air-to-air energy recovery in a variety of different applications will be covered. Best practices for mechanical design, exchanger selection, and control strategies will be discussed throughout.

**Instructor:** Paul Pieper, P.Eng., Member ASHRAE

Air-to-Air Energy Recovery Fundamentals

This course introduces recommendations in the latest ASHRAE and AHRI standards, codes, and guidelines with respect to air-to-air energy recovery technology to help determine where and when energy recovery is mandated and why. In addition, the course will also review a variety of important performance metrics to provide realistic measures to help evaluate these devices. Finally, the course will also provide a detailed overview of the most popular commercially available technologies on the market today and explore their construction, psychrometrics, thermodynamic theory of operation, and important operations and maintenance considerations for long life and consistent performance. The advantages of using different technologies and a variety of different applications along with practical advice and concrete examples will be provided throughout.

**Instructor:** Paul Pieper, P.Eng., Member ASHRAE

Air-to-Air Heat Recovery Fundamentals and Applications (MENA)

This course reviews real-world examples of where and how air-to-air energy recovery technologies are integrated into some of the most commonly used, commercially available systems. A variety of different dedicated outdoor air systems (DOAS), neutral air systems, and enhanced dehumidification strategies (with single and multiple heat exchangers) are examined in detail, along with the advantages and important considerations for using air-to-air energy recovery in many different applications. Best practices for mechanical design, exchanger selection, and control strategies will be discussed throughout. Participants should be interested in learning how to evaluate different DOAS setups incorporating air-to-air energy recovery and how to avoid common errors in equipment design while simultaneously evaluating these systems beyond just peak performance.

**Instructor:** Hassan Younes, Member ASHRAE, BEAP, BEMP, HBDP, CPMP, HDFP, OPMP

Design of Affordable and Efficient Ground-Source Heat Pump Systems

This course describes the best design practices of ground-source heat pump systems to achieve maximum customer benefit. The course examines the economic analysis of ground-source versus more traditional systems and what is necessary to design an effective and efficient ground-source system. The course covers energy analysis, equipment selection, drilling technologies, testing requirements, hydronic system design, and system controls. Participants will learn all that is necessary for the design and installation of a successful ground-source heat pump system.

**Instructor:** Steve P. Kavanaugh, Ph.D., Fellow ASHRAE

Designing and Operating High-Performing Healthcare HVAC Systems

This advanced course discusses the nuances of HVAC system design for healthcare facilities. The course details the relationship of infection control and HVAC design including application of...
ASHRAE/ASHE Standard 170-2017, *Ventilation of Health Care Facilities*. The course will go into detail on the interactions of the key elements of high performance in healthcare, infection control, comfort, reliability, safety, maintenance, energy and sustainability. Numerous energy conservation strategies will be considered in the context of achieving all the goals of a high-performing hospital. For example, the hardware and controls for setback of temperature and airflow and the relationship to temperature, relative humidity, air exchange, filtration, and pressurization requirements are discussed.

**Instructors:** Daniel Koenigshofer, PE, Member ASHRAE, HFDP; LEED® AP; and Donald Burroughs, PE, Member ASHRAE

### Healthcare Facilities: Best Practice for HVAC Design and Operation

Based on the ASHRAE book *HVAC Design Manual for Hospitals and Clinics*, this course introduces many unique and up-to-date healthcare design considerations and applications. The course covers Chapters 1-4, 6-11, and 13-16. Common medical terminology is introduced, and terminology differences between the medical and engineering fields are examined. Infection particles and their transport mechanisms are covered, followed by infection control methods. A major emphasis is placed on the necessary considerations for various diagnostic and treatment and support areas. The second half of the course focuses on air-distribution designs for surgical and patient rooms. Various control and energy efficiency techniques for cooling and heating plants are presented along with O&M and other commissioning topics. Smoke control and life safety best practices and application issues finish the course.

**Instructor:** Daniel Koenigshofer, PE, Member ASHRAE, HFDP

### Integrated Building Design

This seminar will provide a working knowledge of the integrated building design process, explaining the basic concepts involved and outlining the fundamental application of this approach. Course content will explain the advantages and benefits of integrated building design and how this process differs from conventional design practice. The program structure will identify the necessary sequencing and scope of activities that should be implemented to support development of collaborative solutions. In addition to design-related philosophy, course content will explore the critical elements of TEAM activity and management of collaborative teams. This seminar will benefit any person who has a role in the planning, design, construction, and operation of a built solution. Attendees will be able to strategically position themselves in the market place by understanding the value of project fundamentals and the importance of holistic interdependencies. Emphasis will be placed on transitioning traditional processes that aggregate isolated silos of knowledge into collaborative thought and shared outcome.

**Instructor:** Charles Gulledge, PE, Member ASHRAE, HBDP; LEED® AP; Lisa Rosenow, Member ASHRAE, LEED® AP; and Dennis Knight, PE, Fellow ASHRAE

### Introduction to BACnet®

This course helps students understand some of the elements required to successfully plan for BACnet® and some of the complex issues that must be addressed to achieve interoperability. Students learn that interoperability covers a wide range of possible options, and how to simplify interoperability by defining specific areas where interoperability is required. Also discussed are the basic components of any multi-vendor or multi-discipline BACnet® control system, how different systems can be merged together using BACnet®, and how BACnet® facilitates the integration of older systems with BACnet®-based systems. The course does not discuss specific manufacturers or alternatives to BACnet® or BACnet® specification writing.

**Instructor:** David Fisher, Member ASHRAE

### Laboratory Design: The Basics and Beyond

A comprehensive overview of HVAC design for laboratories is examined in this course. The course focuses on the essential elements of the design process that are unique to laboratory HVAC systems.

Visit [www.ashrae.org/education](http://www.ashrae.org/education) for more details and to register. Seminars/Courses subject to change without notice.
Topics include planning steps, determining exhaust/supply requirements, load calculation, pressure mapping, evaluating system options, layout of ducts and rooms, sizing primary air systems, designing exhaust stacks, sustainability in laboratories, and control strategies. Example problems and case studies will also be presented.

**Instructor:** John Varley, PE, Member ASHRAE, HBDP, LEED® AP

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**New Developments in Lower GWP Refrigerants (MENA)**

This training provides a fast review of proposed refrigerants and how they can be used in different HVAC&R applications based on theoretical and empirical analyses. Challenges and opportunities associated with the different types of refrigerants are presented, including hydrofluoroolefins and natural refrigerants. Current and future refrigerant options suiting the region are covered, as well as related standards and codes of systems and substances.

**Instructor:** Omar Abdelaziz, Ph.D., Member ASHRAE

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**Understanding and Designing Chilled-Beam Systems**

This course is primarily designed for mechanical engineers with at least three years of experience in the design of commercial HVAC systems. Chilled-beam systems save on cooling and transport energy by decoupling most or all of the space sensible loads from the air-distribution system and removing them with water, a much more efficient heat transfer medium. Attendees will review HVAC fundamentals as they relate to chilled-beam system design. They will also understand the system benefit, be able to identify suitable applications, and learn how to design chilled-beam systems to optimize the energy and operational benefits. Properly identifying and controlling equipment and components that optimize design are also major components of this course.
Efficient design of a chilled-beam system requires some departure from practices and conventions used to design all-air VAV systems. As most North American HVAC designers have almost exclusively used VAV systems, they are often not aware of the energy benefits that can be derived by departure from some of these VAV-system rule-of-thumb design procedures. This course seeks to identify those areas where slight design modifications can greatly enhance the performance of the system. This course is intended to educate the attendees so that they can decide whether claims regarding the operation and costs of chilled-beam systems are justified.

Instructor: Ken Loudermilk, P.E., Member ASHRAE

Variable Refrigerant Flow Systems: Design and Applications

Variable refrigerant flow (VRF) systems are now being applied in many building types across North America. This course provides non-manufacturer-specific concepts of how to apply VRF systems to buildings. The course supplements the fundamental technology presented in the 2016 ASHRAE Handbook—HVAC Systems and Equipment, offering consulting engineers who already have a basic knowledge of VRF technology comprehensive system design and application guidance using building-specific scenarios. This course is geared towards mechanical engineers, design/build contractors, consulting engineers, HVAC system designers, and facility engineers.

Instructor: Jocelyn Léger, P.Eng., CEM, Member ASHRAE, LEED® AP

Variable Refrigerant Flow Systems: Design and Applications (MENA)

This course provides an overview of variable refrigerant flow (VRF) technology, including equipment and system types, heating/cooling operation, heat recovery, and the benefits of VRF systems. Also described is the VRF design process, including load profile analysis, unit sizing, ventilation air strategy, refrigerant piping design, and system monitoring/controls. Refrigerant safety considerations are explained, including a discussion of ASHRAE Standards 15 and 34. The course concludes with a focus on human comfort and sustainable design featuring example buildings, ventilation systems, and VRF system layouts.

Instructors: Samir Traboulsi, Ph.D., P.Eng., Fellow Life Member ASHRAE; and Hassan Younes, Member ASHRAE, BEAP, BEMP, HBDP, CPMP, HFDP, OPMP

Variable Refrigerant Flow Systems: Technology Introduction

This course provides an overview of variable refrigerant flow (VRF) technology including equipment and system types, heating/cooling operation, heat recovery and the benefits of VRF systems. Also described is the VRF design process, with a particular focus on load profile analysis, unit sizing, ventilation air strategy, refrigerant piping design, and system monitoring/controls. Refrigerant safety considerations are explained, and there is a discussion of ASHRAE Standards 15 and 34. The course concludes with a focus on human comfort and sustainable design featuring example buildings, ventilation systems, and VRF system layouts.

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

HVAC APPLICATIONS

Consulting Engineering Essentials

The typical entry-level consulting engineer spends a great deal of time on technical issues such as calculating, designing, or drawing, or perhaps being mentored in these issues. To advance, the engineer be more involved in the management of projects and engineering issues. To advance from design engineer to project manager to firm owner, an engineer should have training and experience in acquiring new projects (business development and marketing of engineering services), planning and management of those projects to be profitable, accounting associated with client billing, and even client management. If young engineers intend to start a consulting engineering firm, the knowledge of firm ownership and operation offered in this course is essential.

Instructor: Dennis Wessel, P.E., Fellow/Life Member ASHRAE, LEED® AP

HVAC Design: Level I—Essentials

When graduates from technology or engineering schools enter the workforce, they are often ill-equipped to deal with the challenges of their positions. This three-day training provides participants with training that accelerates their transformation into effective members of a design, construction or facilities maintenance team. Attendees will gain practical and immediately useful skills and knowledge to design and maintain HVAC systems.

Instructors: José Luís Alexandre, Ph.D., Member ASHRAE; Donald Brandt, Life Member ASHRAE, BEAP; Charlie Henck, P.E., Fellow/Life Member ASHRAE, CEM, LEED® AP; Julia Keen, Ph.D., P.E., Fellow ASHRAE, BEAP, HBDP; Joel Primeau, Eng., Member ASHRAE, HBDP, LEED® AP; Rafael Úrculo, Member ASHRAE; and Dennis Wessel, P.E., Fellow/Life Member ASHRAE, LEED® AP

HVAC Design: Level I—Essentials (MENA)

The ASHRAE Global Training Center for Building Excellence is organizing a three-day HVAC Design Essentials training to provide intensive, practical training for HVAC designers and others involved in the delivery of HVAC services in the MENA region. In three days, gain real-world practical design skills and knowledge that can be put to immediate use in designing and maintaining HVAC systems. Developed by industry-leading professionals selected by ASHRAE and customized for the Middle East, the training provides the fundamental and technical aspects of designing and maintaining HVAC systems.

Instructors: Walid Chakroun, Ph.D., P.E., Fellow ASHRAE; Hassan Younes, Member ASHRAE, BEAP, BEMP, HBDP, CPMP, HFDP, OPMP; and Samir Traboulsi, Ph.D., P.Eng., Fellow Life Member ASHRAE

HVAC Design: Level II—Applications

ASHRAE’s HVAC Design: Level II—Applications training provides participants with detailed instruction on HVAC system designs. The course is tailored for engineers with advanced experience in the HVAC design field or those who completed HVAC Design: Level I—Essentials. Developed by industry-leading professionals, the training provides advanced information that allows practicing engineers and designers an opportunity to expand their exposure to HVAC system design procedures. Attendees will improve their understanding of system options to save energy and improve indoor air quality.

Instructors: José Luís Alexandre, Ph.D., Member ASHRAE; Donald Brandt, Life Member ASHRAE, BEAP; Charlie Henck, P.E., Fellow/Life Member ASHRAE, CEM, LEED® AP; Julia Keen, Ph.D., P.E., Fellow ASHRAE, BEAP, HBDP; Joel Primeau, Eng., Member ASHRAE, HBDP, LEED® AP; Rafael Úrculo, Member ASHRAE; and Dennis Wessel, P.E., Fellow/Life Member ASHRAE, LEED® AP

Visit www.ashrae.org/education for more details and to register.

Seminars/Courses subject to change without notice.
Choosing the Right Energy Code for Your Project: IECC 2018 or ASHRAE 90.1-2016

ASHRAE/IES Standard 90.1-2016 has been determined by the Department of Energy (DOE) to cost-effectively save energy, triggering adoption of the standard in numerous states and federal departments. The International Energy Conservation Code (IECC) has been adopted by states as a part of the International Code Council suite of codes. The IECC allows ASHRAE/IES Standard 90.1 to be used as an alternate path to compliance for specified requirements of the IECC. Early in a project, a designer must determine whether to use the standard or the code to comply with all project disciplines. This seminar will provide the information needed to make the determination with full knowledge of the requirements that must be met. It will compare the requirements of the standard and the code and explain how to apply each. Participants will identify the effort and compromises required to show compliance with codes based on the project design.

Instructor: McHenry Wallace, P.E., Member ASHRAE, LEED® AP; and Joseph Deringer, AIA, Life Member ASHRAE, LEED® AP

Improving Existing Building Operation (MENA)

Instructor: Julia Keen, Ph.D., PE, Fellow ASHRAE, BEAP, HBDP

Improving Existing Building Operation (MENA) provides the fundamental and technical knowledge for the proper operation and maintenance of existing HVAC systems to maximize building performance. The training has been customized to take into account the special design requirements of the Middle East. This two-day seminar focuses on the importance of proper operation and maintenance of existing HVAC systems. The training also introduces different methods for evaluating potential improvements to a building and its systems in the MENA region. Developed by industry-leading professionals selected by ASHRAE and customized for the Middle East, the training provides techniques to effectively select and communicate with consulting engineers and energy consultants.

Instructors: Hassan Younes, Member ASHRAE, BEAP, BEMP, HBBD, CPMP, HFDP, OPMP; and Hesham Safwat, Ph.D., Member ASHRAE

STANDARDS AND GUIDELINES

Applications of Standard 62.1-2013: Multiple Spaces (Equations and Spreadsheets)

Instructor: Hoy Bohanon, PE, Member ASHRAE, BEAP, LEED® AP

Applications of Standard 62.1-2013 to multiple spaces can be challenging even for advanced HVAC practitioners. This advanced course covers the new Appendix A method and focuses on using the new spreadsheet from the 2013 user’s manual. The material includes both constant-volume and VAV applications and then examines certain cases where secondary recirculation applies. The course intent is to develop proficiency in using the spreadsheet tool for improving design solutions that will comply with the 2013 standard. A copy of the spreadsheet will be provided and attendees are strongly encouraged to bring their laptops to learn the spreadsheet's power and the effect on total outdoor air required when changing different design parameters.

ASHRAE 90.1 Code Compliance and Plan Review for Authorities Having Jurisdiction

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

ASHRAE 90.1 Code Compliance and Plan Review for Authorities Having Jurisdiction

This seminar provides guidance on how to specify and manage the compliance procedures conducted and recognize issues that surface under both design/bid/build and design/build project arrangements. The prescriptive compliance section focuses on reviewing ASHRAE forms and relevant ComCheck submissions and cross checking the information on standard design documents. The seminar explains the requirements of the standard and how the requirements are presented in the energy model input and output. Examples of several different energy simulation model platforms are given.

Complying with Standard 90.1-2013

Targeted at design professionals, code officials, and building owners, the various versions of ASHRAE/IES Standard 90.1 have been the benchmarks for commercial building energy codes in the United States and a key basis for standards in more than 15 countries around the world. The 2013 update of ASHRAE/IES Standard 90.1 is a major revision, containing more than 100 changes from the 2010 version.

Instructors: McHenry Wallace, P.E., Member ASHRAE, LEED® AP; and Joseph Deringer, AIA, Life Member ASHRAE, LEED® AP

Complying with Standard 90.1-2016

The 2016 update of ASHRAE/IES Standard 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings is a major revision, containing more than 125 changes from the 2013 version. This seminar is designed to give the participants a good understanding of how to comply with the requirements of ASHRAE/IES Standard 90.1-2016. This seminar is highly interactive and includes example buildings plus several in-class exercises (for building envelope, lighting, and HVAC) with problems that participants can solve individually or in teams. Files for the example buildings and in-class exercises will be available for download from ASHRAE. Participants are strongly encouraged to bring their laptops to the seminar for use with ComCheck software and other exercises.

Instructors: McHenry Wallace, P.E., Member ASHRAE, LEED® AP; and Joseph Deringer, AIA, Life Member ASHRAE, LEED® AP

Complying with Standard 90.1-2013: Envelope/Lighting

The 2013 update of ASHRAE/IES Standard 90.1 is a major revision, containing more than 100 changes from the 2010 version. This course focuses on the importance of the significant changes in the lighting and envelope requirements and how they reduce loads on the HVAC systems and on overall energy use. Topics include significant changes in mandatory requirements for air barriers and daylighting.

Instructor: Joseph Deringer, AIA, Life Member ASHRAE, LEED® AP

Complying with Standard 90.1-2016: Envelope/Lighting

ASHRAE/IES’s Standards 90.1-2010 and 90.1-2013 together produce almost 40% energy savings from the 2004 version, with the envelope and lighting requirements contributing substantially to these reductions. This course focuses on the importance of the recent

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Seminars/Courses subject to change without notice.
changes in the lighting and envelope requirements and how they reduce loads on the HVAC systems and on overall energy use. Topics include the significant new mandatory requirements for air barriers and daylighting. The 2016 update of ASHRAE/IES Standard 90.1 contains 8.5% source energy savings, 7.6% site energy savings, and more than 100 changes from the 2013 version. This course is highly interactive and includes several in-class exercises with problems that participants can solve individually or in teams. Participants are strongly encouraged to bring their laptops.

**Instructor:** Joseph Deringer, AIA, Life Member ASHRAE, LEED® AP

Complying with Standard 90.1-2013: HVAC/Mechanical Design professionals, code officials, and building owners must keep up with the new, more stringent requirements to comply with the quickly evolving ASHRAE/IES Standard 90.1-2013. This course describes the new and updated mandatory and prescriptive requirements for HVAC and service water heating systems, along with insights on how to comply during building design and construction. The 2013 edition added an 8.5% source energy savings and 7.6% site energy savings, for a total of nearly 40% below that required for a 2004-compliant building. The U.S. Department of Energy issued a ruling that establishes ASHRAE/IES Standard 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings, as the commercial building reference standard for state building energy codes.

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

Complying with Standard 90.1-2016: HVAC/Mechanical ASHRAE/IES's Standard 90.1-2016, Energy Standard for Buildings Except Low-Rise Residential Buildings, has received a determination issued by the U.S. Department of Energy stating that this standard would achieve greater energy efficiency in commercial buildings subject to the code and that buildings meeting this standard would result in national energy cost savings of approximately 8.2% (as compared to the 2013 edition). Design professionals, code officials, and building owners must now keep up with the new, more stringent requirements to comply with this quickly evolving standard.

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

Complying with the Requirements of Standard 62.1-2016 This seminar provides an overview of the requirements of ASHRAE Standard 62.1-2016, Ventilation for Acceptable Indoor Air Quality, with an emphasis on changes from the previous version and practical application of the standard to modern VAV systems.

New requirements to the indoor air quality procedure for determining minimum ventilation rates are discussed. In the 2016 version, changes were made in determining air class for laboratory exhaust systems and the use of sensors for demand control ventilation. The course presents sample calculations for code review and for physical operation using the latest ASHRAE spreadsheet.

**Instructors:** Hoy Bohanon, P.E., Member ASHRAE, BEAP, LEED® AP; and Chandra Sekhar, Ph.D., Fellow ASHRAE

Designing for IAQ: Complying with the Requirements of Standard 62.1 (MENA) This seminar focuses on the basic requirements of ASHRAE Standard 62.1-2016, Ventilation for Acceptable Indoor Air Quality. The newest version of the standard includes a major change to the scope of the standard by which residential occupancies are moved from ASHRAE Standard 62.1 to 62.2. This course provides an overview of the requirements of the new standard with emphasis on changes from the previous version and practical application of the standard to modern VAV systems. New requirements to the indoor air quality procedure for determining minimum ventilation rates are discussed. In the 2016 version, changes were made in determining air class for laboratory exhaust systems and the use of sensors for demand control ventilation, and these changes are discussed as well. The course presents sample calculations for code review and for physical operation. This course has been customized for the Middle East by instructors well versed in the concerns for professionals in the region.

**Instructor:** Joseph Deringer, AIA, Life Member ASHRAE, LEED® AP

Exceeding Standard 90.1-2013 to Meet LEED® Requirements (Available as a half-day course and full-day seminar) This course explores how to obtain significant energy savings and obtain LEED® credits by following the new, more stringent requirements of ASHRAE/IES Standard 90.1-2010 and 2013, and using Appendix G rules and procedures. Appendix G is especially applicable to LEED® credits and to U.S. energy tax credits. ASHRAE/IES Standards 90.1-2010 and 90.1-2013 together produce almost 50% energy savings from the 2004 version. So, by substantially surpassing the 2013 standard requirements, buildings should achieve well over 50% energy savings. This course uses OpenStudio/ EnergyPlus examples, including live demos and hands-on exercises in OpenStudio, to present an overview of applying key ASHRAE/IES Standard 90.1-2010/2013 requirements and Appendix G rules. This course is targeted at design professionals and building owners.

**Instructors:** McHenry Wallace, P.E., Member ASHRAE, LEED® AP; and Joseph Deringer, AIA, Life Member ASHRAE, LEED® AP

Fundamentals and Applications of Standard 55 Based on ASHRAE Standard 55, Thermal Environmental Conditions for Human Occupancy, this course covers the theory and principles of the standard. It is intended to bridge the gap between the design practitioner's knowledge of the built environment and its thermal relationship to the occupant's physiology and psychology. Using examples, the course illustrates how to achieve compliance with the standard for the purposes of satisfying the requirements of various building performance programs such as LEED®.

**Instructors:** Peter Alspach, P.E., Member ASHRAE, LEED® AP; Robert Bean, R.E.T, P.L. (Eng.), Member ASHRAE; and Lawrence Schoen, P.E., Fellow ASHRAE

Fundamental Requirements of Standard 62.1-2013 This introductory course focuses on the basic requirements of ASHRAE Standard 62.1-2013, Ventilation for Acceptable Indoor Air Quality. The course covers the scope, application, and multiple compliance paths available in the standard including the ventilation rate procedure, indoor air quality procedure, and natural ventilation procedure. Many of the standard's general requirements apply regardless of the procedure used. The different application conditions for the ventilation rate procedure are also described. In the 2013 version, changes were made affecting filtration, humidification, and some ventilation rates. This course is highly recommended for all HVAC designers and engineers.

**Instructor:** Hoy Bohanon, P.E., Member ASHRAE, BEAP, LEED® AP
Fundamental Requirements of Standard 62.1-2016
This introductory course focuses on the basic requirements of ASHRAE Standard 62.1-2016, Ventilation for Acceptable Indoor Air Quality. The course covers the scope, application, and multiple compliance paths available in the standard including the ventilation rate procedure, indoor air quality procedure, and natural ventilation procedure. Many of the standard’s general requirements apply regardless of the procedure used. The different application conditions for the ventilation rate procedure are also described. In the 2016 version, changes were made affecting residential scope, demand control ventilation, IAQ procedure, and some ventilation rates. This course is highly recommended for all HVAC designers and engineers.
Instructor: Hoy Bohanon, P.E., Member ASHRAE, BEAP, LEED® AP

Guideline 36: Best in Class HVAC Control Sequences
This course introduces the current version of ASHRAE Guideline 36, which focuses on variable-air-volume (VAV) systems. The discussion will include the research underlying the current sequences and ongoing and planned future research intended to develop additional advanced sequences for other HVAC system types. In this course, attendees will learn about the ASHRAE Guideline 36 sequences and how they improve energy efficiency, thermal comfort, and indoor air quality. Attendees will also learn how to specify sequences for this guideline.
Instructor: Steven T. Taylor, P.E., Fellow/Life Member ASHRAE

IgCC and ASHRAE Standard 189.1 Technical Provisions
(co-sponsored with ICC)
The IgCC and ASHRAE Standard 189.1 Technical Provisions course covers how ASHRAE/ICC/USGBC/IES Standard 189.1, Standard for the Design of High-Performance Green Buildings, forms the technical basis for the International Green Construction Code® (IgCC). This course provides a detailed look at the technical standard and its application as a building code, including a description of key requirements contained in the IgCC and ASHRAE/ICC/USGBC/IES Standard 189.1 on the topics of sites, water, energy, indoor environmental quality, and materials. Consulting engineers, architects, facility managers, contractors, and code officials will learn to distinguish between the two compliance path options (prescriptive and performance) and their associated provisions in the IgCC, as well as how to apply these paths in design.
Instructors: Thomas Lawrence, Ph.D., P.E., Member ASHRAE, LEED® AP; and Anthony Floyd, Member ASHRAE, BEAP, LEED® AP; Fellow AIA

Save 30% Complying with Standard 90.1-2013
The 2013 version of ASHRAE/IES Standard 90.1 is widely used by many state and government entities. Learn the background and development of ASHRAE/IES Standard 90.1, its requirements and compliance paths, and how to understand and apply the requirements. Key updates for each of the major building systems will be discussed. This includes the HVAC system, lighting system, building envelope, service water heating, and power. You will learn key mandatory and prescriptive requirements applicable to each system, as well as whole-building compliance options. Case studies and in-class exercises are included as appendices to the classroom presentation. During the course, a number of examples are provided for how to improve building energy efficiency and save money.
Instructors: McHenry Wallace, P.E., Member ASHRAE, LEED® AP; and Joseph Deringer, AIA, Life Member ASHRAE, LEED® AP

Save Over 35% Using Appendix G of ASHRAE Standard 90.1-2016
Learn how to use the innovative new performance rating method in Appendix G of ASHRAE/IES Standard 90.1-2016. Learn to apply the new rules and procedures via whole-building energy simulations to demonstrate that a building has much better energy performance than a building that just meets the requirements of ASHRAE/IES Standard 90.1-2016. See how Appendix G-2016 can be used to show compliance with ASHRAE/IES Standard 90.1-2016; this is the first time Appendix G has been usable in this manner. Also learn to use Appendix G-2010 in conjunction with LEED® V4 to obtain LEED® points. Key performance rating method rules and requirements for HVAC, lighting, and building envelope systems are also discussed.
Instructors: McHenry Wallace, P.E., Member ASHRAE, LEED® AP; and Joseph Deringer, AIA, Life Member ASHRAE, LEED® AP

Standard 90.1: HVAC/Mechanical Design and Appendix G (MENA)
This course focuses on the major requirements of ASHRAE/IES Standard 90.1-2016, including incorporated addenda. The Standard 90.1: HVAC/Mechanical and Appendix G (MENA) course will also cover highlights of the envelope, mechanical, HVAC, and lighting requirements in Appendix G and its new compliance path and performance rating method. Baseline building conditions and climate zone information on many cities in the MENA region will also be provided.
Instructor: Samir Traboulsi, Ph.D., P.Eng., Fellow/Life Member ASHRAE

Successfully Managing the Risk of Legionellosis Using ASHRAE Standard 188
Legionellosis is a health and safety concern for facility owners and operators and those who manage and oversee building water systems and devices. ASHRAE Standard 188-2018 establishes the minimum legionellosis risk management requirements for the design, construction, installation, commissioning, operation, maintenance, and service of premise plumbing, centralized building water systems and components. This course describes the environmental conditions that promote the growth of Legionella in building water systems and the locations where Legionella control measures can be applied. A comprehensive management strategy for the prevention of legionellosis is also discussed in addition to a thorough introductory background on Legionella bacteria and legionellosis. The course focuses on the compliance with ASHRAE Standard 188-2018 to provide a safer and healthier building environment.
Instructors: Michael Patton, Member ASHRAE; and William Pearson, P.E., Member ASHRAE

Understanding Standard 189.1-2014 for High-Performance Green Buildings
Based on ASHRAE Standard 189.1-2014, Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings, this course provides a summary of the standard’s specifications for minimum requirements in the design, construction, and plans for operation of high-performance, green buildings. The standard applies to new buildings and their systems, new portions of buildings and their systems, and new systems and equipment in existing buildings. The course covers the topical areas of water-use efficiency, indoor environmental quality, energy efficiency,
Upon completion of this course, participants will understand the basic requirements of ASHRAE Standard 189.1, understand the background that led to the development of these requirements, and become familiar with how to apply the requirements in the standard to new commercial buildings and major renovation projects.

**Instructor:** Thomas Lawrence, Ph.D., P.E., Member ASHRAE, LEED® AP

**Understanding Standard 189.1-2014 for High-Performance Green Buildings (MENA)**

Based on ANSI/ASHRAE/USGBC/IES Standard 189.1-2014, this course provides the minimum requirements for the design, construction, and plans for operation of high-performance green buildings, including new buildings and their systems, new portions of buildings and their systems, and new systems and equipment in existing buildings. Water-use efficiency, indoor environmental quality, energy efficiency, site sustainability, and a building’s impact on the atmosphere are covered. The course presents the goals of establishing mandatory criteria in all topical areas, providing simple compliance options, and the complement of green building rating programs for ASHRAE Standard 189.1. Upon completion of this course, participants will understand the basic requirements of ASHRAE Standard 189.1, learn the background that led to the development of these requirements, and become familiar with how to apply the requirements in the standard to new commercial buildings and major renovation projects.

**Instructor:** Walid Chakroun, Ph.D., P.E., Fellow ASHRAE, LEED® AP
Omar Abdelaziz, Ph.D., Member ASHRAE, has 15 years of R&D and project management experience in building energy-efficient technologies, sustainable energy production and utilization, energy storage, technology evaluation and prioritization, thermodynamic analysis, thermofluid engineering, computational fluid dynamics, engineering optimization, alternative cooling and heating technologies, and alternative lower global warming refrigerants. He actively collaborates with leading appliance and equipment manufacturers on the development of advanced and state-of-the-art HVAC&R equipment. He has strong academic and research connections and is quite involved in ASHRAE.

Fiona Aldous, Member ASHRAE, is a principal with Wiss, Janney Elstner Associates. She has performed comprehensive, technical building enclosure commissioning on numerous buildings. Ms. Aldous has extensive, hands-on knowledge of building enclosures and the commissioning process. Her experience includes design, detailing, and installation of various high-performance enclosures, comprising curtain wall and window systems, air barriers, waterproofing of below-grade and plaza systems, low slope and steep roofs, and the interfaces of the various enclosure components.

José Luís Coelho Alexandre, Ph.D., Member ASHRAE, is an assistant professor at the Department of Mechanical Engineering at the University of Porto, Portugal. Dr. Alexandre performs research in mechanical, environmental, and industrial engineering. His main area of scientific knowledge is thermal performance and energy conservation in buildings and HVAC systems. His expertise includes building thermal simulation design tools (including HVAC), commissioning, and energy facility management. Dr. Alexandre is also well versed in computational fluid dynamic (CFD) applications in HVAC systems and energy management (as it applies to buildings and industry).

Peter Alspach, P.E., Member ASHRAE, LEED® AP, is an associate principal with Arup, the mechanical discipline leader in Arup’s Seattle office, and Arup’s regional mechanical engineering skills leader. He is a specialist in the design of low-energy buildings, focusing on HVAC, energy systems, thermal comfort, and the indoor environment. As a mechanical engineer, building physicist, and façade engineer, Mr. Alspach develops holistic solutions to the built environment.

David Altenhofen, AIA, is the East Coast Director for The Facade Group LLC, a consulting firm specializing in assisting owners, architects, and builders in the delivery of durable and high-performing building enclosures. His focus is the application of practical field experience and building science combined with multiple forms of digital modeling to ensure that performance goals set during design are delivered in the constructed building. At The Facade Group Mr. Altenhofen has lead building enclosure commissioning efforts on three net zero projects and provided consulting services for many projects with an emphasis on energy savings.

Karim Amrane, Ph.D., Member ASHRAE, is owner and president of KA Consulting Services, LLC, where he provides strategic consulting services to HVAC&R businesses regarding federal and state regulations, legislation, codes and standards, alternative refrigerants, and energy efficiency. He is also an adjunct professor at the University of Maryland, where he teaches graduate courses in mechanical engineering. Dr. Amrane has over 25 years of experience in the air-conditioning and refrigeration industry. He is a member of ASHRAE, the International Institute of Refrigeration (IIR), and ASME. He is the recipient of ASHRAE’s Distinguished Service Award.

Vikrant Aute, Ph.D., Member ASHRAE, serves as director of the Integrated Systems Optimization Consortium. He has twelve years of experience in the development of simulation and optimization software for thermal systems. His current research focuses on approximation-assisted multi-objective, multidisciplinary optimization and its application to design of thermal systems and the continued development of heat exchanger and vapor compression system simulation tools.

William P. Bahnfleth, Ph.D., P.E., Fellow/Presidential Member ASHRAE, is a professor and director of the Indoor Environment Center in the Department of Architectural Engineering at The Pennsylvania State University—University Park, PA. He holds a doctorate in Mechanical Engineering from the University of Illinois and is a registered professional engineer. Dr. Bahnfleth has served ASHRAE in a variety of capacities, including Student Branch Advisor, Chapter Governor, Technical Committee and Standing Committee Chair, and as Director-at-Large, Vice President, Treasurer, and 2013-14 Society President.

Robert Bean, R.E.T., P.L. (Eng.), Member ASHRAE, is president of Indoor Climate Consulting Inc. and director of www.healthyheating.com. He is a past ASHRAE Distinguished Lecturer and recipient of ASHRAE’s Lou Flagg Award. Currently, he serves on ASHRAE SSPC 55, TC 6.1, TC 6.5, and TC 7.4. He is also the SSPC 55 liaison to SSPC 62.2 and SSPC 90.2. He has developed and teaches numerous courses related to the business and engineering of buildings, indoor climates, and radiant-based HVAC systems.

Don Beatty, P.E., Fellow ASHRAE, has over 30 years experience in consulting engineering and founded DLB Associates Consulting Engineers in 1980. He is a licensed professional engineer in over 40 states and has international licenses as well. Mr. Beatty co-founded and was the first Chair of ASHRAE TC 9.9 and currently serves as its publications Chair. He is also a frequent keynote speaker on behalf of ASHRAE TC 9.9 for the data center industry, having presented over 100 times and in more than 37 countries on various data center topics. He has also served on ASHRAE Standards Committee 90.1 (energy), including as Vice Chair; Standards Committee 127 (Method for Testing for Rating Computer and Data Processing Room Unitary Air-Conditioners) as secretary; and ASHRAE TC 7.6 (Systems Energy Utilization). Beatty is a major contributor to many data center books (including ten ASHRAE books).
Hoy Bohanon, PE, Member ASHRAE, BEAP, LEED® AP, is president of Hoy Bohanon Engineering PLLC. He has written technical papers and articles on indoor air quality, operations, and maintenance and is very active in ASHRAE. He is Chair of ASHRAE SSPC 62.1, past Chair of the Building Energy Quotient Committee, and a member of the Environmental Health Committee. He is a member of ISO-TC 205 and corresponding member of TCs 5.5 and 9.10. He is an ASHRAE Distinguished Lecturer, writes and teaches courses for the ASHRAE Learning Institute, and is a recipient of the ASHRAE Distinguished Service Award.

Donald Brandt, CEM, Life Member ASHRAE, BEAP, has devoted his career to the HVAC industry. During his decades-long tenure with the Trane Company, he has been active in ASHRAE, serving at the Chapter, Regional and Society Levels, including DRC for Region X from 2002–2005, Standards Committee from 2005–2009, and Nominating Committee from 2010–2016. He received the ASHRAE Distinguished Service Award in 2005 and the Exceptional Service Award in 2015. He serves as an ASHRAE Director-at-Large.

Richard Casault, PE, Member ASHRAE, is the president of Seattle-based Casault Engineering, founded in 1994. He provides new building commissioning services from planning through occupancy, retrocommissioning services for existing systems, and building commissioning master planning. He has commissioned hospitals, offices, greenhouses, libraries, corrections facilities, performing arts centers, teaching and research lab facilities, boiler plants, and schools.

Walid Chakroun, Ph.D, PE, Fellow ASHRAE, is a professor in the Mechanical Engineering Department at Kuwait University. His interests include experimental and numerical thermal and fluid sciences in general and in air-conditioning systems and indoor air quality in particular. He served previously as Director for the Region At Large for ASHRAE, and he is currently serving as Vice President for the ASHRAE Publishing and Education Council and a liaison coordinator between ASHRAE and UNEP. Dr. Chakroun has authored and co-authored more than 75 journal articles and conference papers. He also co-authored a book, An Experimental Course in Thermal Engineering. He is the recipient of the prestigious ASHRAE John F. James Award and Distinguished Service awards.

Brad Cochran, PE, Member ASHRAE, has over 25 years of experience conducting wind-tunnel, analytical, and computational fluid dynamic (CFD) modeling studies of airflow in and around man-made structures. In recent years, Cochran has led the development of new design and control techniques to minimize the energy consumption for laboratory exhaust stacks through the implementation of variable-air-volume (VAV) technologies. He has successfully designed and employed VAV exhaust systems for more than 100 laboratories throughout the United States, Canada, and the United Kingdom. He holds a B.S. and M.S. in mechanical engineering, an M.B.A., and a P.E. license (CO). Cochran is the author of the chapter on exhaust stack design in the ASHRAE Laboratory Design Guide. He serves on the ASSE Z9.5 standards committee and is Chair of ASHRAE's TC9.10, Laboratory Systems.

Dr. Chakroun has led the development of new design and control techniques to minimize the energy consumption for laboratory exhaust stacks through the implementation of variable-air-volume (VAV) technologies. He has successfully designed and employed VAV exhaust systems for more than 100 laboratories throughout the United States, Canada, and the United Kingdom. He holds a B.S. and M.S. in mechanical engineering, an M.B.A., and a P.E. license (CO). Cochran is the author of the chapter on exhaust stack design in the ASHRAE Laboratory Design Guide. He serves on the ASSE Z9.5 standards committee and is Chair of ASHRAE's TC9.10, Laboratory Systems.

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Drury Crawley, Ph.D, AIA, Fellow ASHRAE, BEMP, LEED® AP, is a Bentley Fellow and Director of Building Performance Research with Bentley Systems Inc., focusing on building performance, BIM, zero-energy buildings, resilience, sustainability, and smart cities. With more than 40 years of experience in energy efficiency, renewable energy, and sustainability, Dr. Crawley has worked in engineering software development, government research, and standards development organizations, as well as building design and energy consulting companies. He is also active in IBPSA.

Joseph Deringer, AIA, Life Member ASHRAE, LEED® AP, is executive director of the Institute for the Sustainable Performance of Buildings (SuPerB). Mr. Deringer has over 35 years' experience in the design, analysis, and simulation of sustainable, energy-efficient buildings worldwide. His work has focused especially on energy codes, design assistance, training, and the development of interactive online design and training tools. He has over 20 years' involvement in developing energy codes for buildings, and has helped seven countries develop first-generation energy codes. Mr. Deringer has served on ASHRAE's Standard 90.1 committee for 15 years and chaired its envelope subcommittee for 10 years. He is also active as international energy and environmental consultant to the World Bank, UNDP, and USAID, consulting on projects in over a dozen countries in Southeast Asia, the Caribbean, Latin America, the Middle East, and Eastern Europe.

James Dirkes II, Member ASHRAE, BEMP, BCxP, LEED® AP, is the president and founder of The Building Performance Team. While HVAC systems have been his principal focus, Dirkes also has extensive experience designing, programming, and troubleshooting many mechanical systems. He has conducted energy analysis for numerous new and existing facilities using EnergyPlus, Retrofitency, EZ Sim, and bin method tools. Dirkes has authored several energy analysis tools including ASEAM-UM and a spreadsheet-based HVAC front end for EnergyPlus.

E. Curtis Eichelberger, PE, Member ASHRAE, LEED® Green Associate, is a senior staff engineer with Johnson Controls in York, PA. He has over 45 years of experience in engineering projects relating to acoustic and vibration technologies. Currently, he is responsible for the sound quality and application of YORK/Johnson Controls brand HVAC equipment and systems. He is a member of the Institute of Noise Control Engineering and a member of ASME.

Charles Eley, PE, AIA, CEM, Member ASHRAE, BEMP, LEED® AP, is an architect, mechanical engineer, and author with 40 years’ experience in energy-efficient and sustainable design. During his career, Eley has made significant contributions to the California energy standards, ASHRAE/IES Standard 90.1, and energy codes in Hong Kong, Hawaii, Guam, American Samoa, and Australia. He has also developed a number of important technical manuals and publications, served as the founding executive director of the Collaborative for High Performance Schools, developed a number of energy analysis software applications, and served as energy consultant for a number of landmark green buildings.
David Eldridge, P.E., Member ASHRAE, BEMP, BEAR, HBDP, LEED®, AP is a project manager at Grumman/Butkus Associates in Chicago. His specialty is sustainable consulting services including analysis of energy efficient MEP design, energy modeling, performance of energy audits of all levels, LEED® and Green Globes consulting services, and tax deductions for energy-efficient commercial property. Mr. Eldridge has served on the IBPSA-USA Board of Directors since 2008, has been a research assistant at Oklahoma State University (1999–2001), and has served in the BLAST support office at the University of Illinois (1998–1999). He is a voting member on several ASHRAE committees: TC 7.6, TC 9.6, Certification Committee, and SPC 211, developing a new standard for energy audits.

Jay Enck, Member ASHRAE, HBDP, CPMP, BEAP, LEED® AP, is co-founder and chief technical officer of Commissioning and Green Building Solutions, Inc. He has conducted commissioning for more than $4 billion in construction projects, of which 80% have included building enclosure commissioning. Enck has 40 years of experience in building operation, design, and construction, and over 20 years investigating the causes of building enclosure problems. He holds the certifications of LEED® Fellow, CxAP, HBDP, CPMP, BEAP, and LEED® AP BD+C.

David Fisher, Member ASHRAE, is president of PolarSoft Inc., a Pittsburgh-based company specializing in BACnet software development, consulting, and training. He was a charter voting member of ASHRAE’s SPC135P and has been very active in the development of ANSI/ASHRAE Standard 135-2012, BACnet -- A Data Communication Protocol for Building Automation and Control Networks since its inception. He remains very involved with the SSPC-135 standing committee as a participant and a principal author.

Anthony Floyd, Member ASHRAE, BEAP, LEED® AP, Fellow AIA, is a licensed architect and certified sustainability professional. Since 1997, he has served as the Green Building Program Manager for the City of Scottsdale and is a former Scottsdale building official (1988–1995). He helped to establish Arizona’s first Green Building Program. Floyd is responsible for education, outreach, project qualification, and maintaining Scottsdale’s regionally based green and energy-efficiency criteria. He was instrumental in Scottsdale’s adoption of the International Green Construction Code (IgCC), International Energy Conservation Code (IECC), and LEED® Gold city facility policy. Floyd currently serves on the ASHRAE 189.1 project committee and the ICC Sustainability, Energy & High Performance Code Action Committee (SEHPCAC).

Laurie Gilmer, P.E., Member ASHRAE, LEED® AP, is a vice president at Faculty Engineering Associates (FEA) and leads FEA’s facility asset management, building energy management, and sustainability services. She has assisted facility managers in improving building systems operations, creating and implementing energy management plans, identifying energy saving opportunities, and obtaining LEED® certification for existing buildings. Her experience includes sustainability/LEED®, systems analysis, energy audits, commissioning, building systems planning, and controls review.

Jack Glass, P.E., Member ASHRAE, was the director of Global Data Center Planning with Citigroup in New York City. He has over 20 years experience in the planning and operation of technology environments supporting the financial industry. He is a professional engineer and a long-time member of ASHRAE. He is the past Chair of TC 9.9, contributed to the publication of several books in the ASHRAE Datacom series, and led the development of the book Green Tips for Data Centers. He currently serves on the ASHRAE Publications Committee.

Walter Grondzik, P.S., Fellow/Life Member ASHRAE, LEED® AP, is an architectural engineer and a professor of architecture at Ball State University. He is author of Principles of Building Commissioning and co-author of Mechanical and Electrical Equipment for Buildings (12th Ed.) and The Green Studio Handbook (2nd Ed.). His interests include building commissioning, sustainability and high-performance building initiatives, and all areas of environmental control systems and their effects on buildings and occupants.

Charles Gulledge, III, P.E., Member ASHRAE, HBDP, LEED® AP, is a senior mechanical engineer with Environmental Air Systems LLC in High Point, North Carolina. A licensed professional engineer, he has over 20 years experience in the HVAC industry. Currently, he is a member of the ASHRAE Handbook Committee and Building Information Modeling and Interoperability Ad Hoc Committee, and liaison to the Construction Specifications Institute (CSI). Mr. Gulledge has received the Chapter Service Award, Regional Award of Merit, Distinguished Service Award, and Dan Mills Technical Award.

Arthur D. Hallstrom, P.E., Fellow/Life Member ASHRAE, BEMP, has over 35 years of extensive applications and equipment experience in air-side systems, equipment, and computer modeling with a major HVAC manufacturer. He became an ASHRAE Fellow for his work in innovative acoustical modeling software. Mr. Hallstrom was one of the DOAS systems consultant on the ASHRAE Headquarters redesign project. Since retiring, he has become executive director and president of AD Hall and focuses on teaching building energy codes.

Lew Harriman, Fellow ASHRAE, is the emeritus director of research and consulting at Mason-Grant in Portsmouth, NH. He has over 43 years of experience with humidity control and moisture management in a broad variety of commercial, industrial, and institutional applications. Lew was the lead author of both ASHRAE’s Humidity Control Design Guide and the ASHRAE Guide for Buildings in Hot and Humid Climates. He has served as Chair of ASHRAE Technical Committee 1.12 (Moisture Management in Buildings) and as Chair of the ASHRAE Task Group for developing a quantitative definition of a damp building (one which is damp enough to pose a health risk). He acted as the lead reviser for Chapter 64 (Moisture and Mold) of the 2019 ASHRAE Handbook—HVAC Applications.

Charlie Henck, P.E., CEM, Fellow/Life Member ASHRAE, LEED® AP, both designed and renovated healthcare systems, office buildings, laboratories, data centers, and more. Henck has served on many ASHRAE committees and acted as past DRC for Region III. He is the current chair of the PDC and secretary for TC 9.1, Large Building Air-Conditioning Systems. Henck wrote, edited, and revised portions of ASHRAE Laboratory Design Guide, Second Edition, with a focus on air treatment, particularly the requirements for allowable concentration limits and the technologies available to achieve acceptable levels. Henck is also actively involved in revising portions of ASHRAE Handbook—HVAC Systems and Equipment.
Lucas B. Hyman, P.E., Member ASHRAE, LEED® AP, has planned and designed central heating and cooling plants, TES systems, cogeneration plants, steam plant systems, utility distribution systems, laboratory systems, HVAC improvements, energy conservation measures, landfill gas collection systems, fuel storage and distribution systems, as well as other mechanical systems. His engineering experience includes developing studies, master plans, construction documents (designs), performing construction management, and acting as commissioning agent. He has also participated as the mechanical engineer member in value engineering project reviews and conducted and led forensic engineering studies.

Steve Kavanaugh, Ph.D., Fellow ASHRAE, is professor emeritus of mechanical engineering at the University of Alabama-Tuscaloosa. He is a past Chair of ASHRAE TC 6.8 and past Chair of Applied Heat Pumps and Heat Recovery. He is also a Fellow of ASME. Dr. Kavanaugh is the author of several ASHRAE publications including Geothermal Heating and Cooling: Design of Ground-Source Heat Pump Systems, HVAC Simplified, and Ground-Source Heat Pumps: Design of Geothermal Systems for Commercial and Institutional Buildings.

Julia Keen, Ph.D., P.E., Fellow ASHRAE, HBDP, BEAP, is a professor of Architectural Engineering and Construction Science at Kansas State University with a specialty in HVAC, energy codes, and integrated building design. She has a doctorate in Curriculum and Instruction from Kansas State University and where she also received a Bachelor's and Master's degrees in Architectural Engineering. She owns her own consulting engineering company, Keen Designs, PA. Dr. Keen is a licensed professional engineer and an ASHRAE-certified High-Performance Building Design Professional (HBDP) and Building Energy Assessment Professional (BEAP). She currently serves as an ASHRAE Vice President and Vice Chair of Publication and Education Council.

Jim Kelsey, P.E., Member ASHRAE, BEAP, LEED® AP, is the founder and President of KW Engineering. He chairs the committee for ASHRAE Standard 211 and is a committee member of ASHRAE Standard 100. Mr. Kelsey led the development of TC 4.7’s revision of the ASHRAE publication Procedures for Commercial Building Energy Audits. He serves on the Board of the California Energy Efficiency Industry Council where he works with industry, utilities, and state regulators to develop energy-efficiency policies that meet environmental and business goals.

Rob Kister, AIA, Member ASHRAE, is a principal of The Facade Group LLC, which focuses on design and documentation solutions in all aspects of the building enclosure, from subgrade to facade to roof. Mr. Kister has over 25 years of experience as an architect and consultant and over 15 years as a contractor. He established the Portland chapter of the Building Enclosure Council and was Chair from 2006-2010. He was also co-chair of the Building Enclosure Council National from 2007–2011 and served as Chair of the Building Enclosure Technology and Environmental Council.

Daniel Koenigshofer, P.E., Member ASHRAE, MSPH, HFDP, is the vice president for Health Care at Dewberry Engineers Inc. He has over 40 years of engineering and project management experience, specializing in master planning, troubleshooting, and solving engineering problems in healthcare facilities. Koenigshofer has presented numerous training sessions on health-care design, both nationally and internationally. He has taught classes for the ASHRAE Learning Institute in over 25 major cities worldwide, using entertaining stories of “mistakes he has made” in engineering.

Erik Kolderup, P.E., Member ASHRAE, BEMP, LEED® AP, has provided energy consulting services since 1990, serving as Vice President of Eley Associates and Associate Principal at Architectural Energy Corporation in San Francisco, before starting Kolderup Consulting in 2007. He has trained design professionals through organizations such as the Collaborative for High Performance Schools, PG&E, and the State of Hawaii, and has taught hundreds of engineers and architects in the use of VisualDOE. He is a lecturer at Stanford University where he teaches a course on energy-efficient building systems.

Dennis Knight, P.E., Fellow ASHRAE, has over 43 years of experience providing engineering, design-, and construction-related services within the building industry. Active at the local, state, and national levels with various agencies and professional societies, he works to help develop sustainable, integrated building design guidelines. Nationally, as a member of ASHRAE, Mr. Knight is the recent past Chair of the BIM Multi-Disciplinary Task Group (MTG), is the former Chair of TC 7.1 on integrated building design, and served as the Chair of the ASHRAE Building Performance Analysis Specialty Conference for six of the past eight years it has been held.

Thomas (Tom) Lawrence, Ph.D., P.E., Fellow ASHRAE, LEED® AP, is a professor of practice and coordinator for the mechanical engineering degree program at the University of Georgia. He has over 35 years of professional engineering experience. Among his many roles of service to ASHRAE, Dr. Lawrence served as a Director-at-Large on the ASHRAE Board of Directors from 2016-2019, as past chair of ASHRAE TC 2.8, and a member of the committee that wrote ASHRAE Standard 189.1 on high-performance green buildings. As an ASHRAE Distinguished Lecturer, he gives presentations and workshops on high-performance and smart buildings around the world. Dr. Lawrence was also the chair of the editorial committee that produced ASHRAE GreenGuide, 5th Ed and is the primary author of the new ASHRAE book titled High-Performance Buildings Simplified.

Thomas J. Leck, Ph.D., Member ASHRAE, has a consulting practice that deals primarily with policy and regulatory affairs impacting the use of refrigerant gases. He also advises on legal and safety-related matters relating to refrigerant gas usage. His familiarity with industry trends and business direction has been developed over the past 28 years of working directly with the global cooling industry. During his 36 years with the DuPont and Chemours companies he worked to develop, characterize, and teach customers about new refrigerants. Dr. Leck has been a teacher, developing training materials and teaching customers, industry groups, and academic groups about new refrigerant technologies and regulations. He is the past Chairman and currently a member of ASHRAE’s TC 3.2, Refrigerant System Chemistry, and ASHRAE Standard 34, Designation and Classification of Refrigerants. He is a contributor to other ASHRAE technical committees, including TC 3.1, Refrigerants and Blends; TC 3.4, Refrigeration System Lubricants; and TC 3.3, Contaminant Control in Refrigeration Systems. He is a contributor to other ASHRAE technical committees, including Refrigerants, Refrigeration Lubricants, and Refrigerant Contaminant Control.

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Ken Loudermilk, PE, Member ASHRAE, is a senior chief engineer at Titus Products with over three decades of experience in engineering, sales, and marketing management and an extensive knowledge of building systems. His specialties include underfloor air distribution and chilled beam, both technologies that Loudermilk helped advance from their beginnings. In addition to roles in research and design and as a product manager, he has worked closely with design professionals in the planning of chilled-beam systems for office buildings, educational facilities, and laboratory applications. He is a member of several ASHRAE committees, the author of numerous ASHRAE Journal articles, and has lectured all over the world.

Jocelynn Léger, P.Eng, CEM, Member ASHRAE, LEED® AP, is a commercial sales manager in the HVAC Division at Mitsubishi Electric Sales Canada Inc. He has over 7 years of experience in the mechanical contracting side and 17 years as an equipment specialist on the HVAC design and manufacturing side. Having a certified energy manager (CEM) and LEED® AP titles, he is very interested in and passionate about VRF, efficient HVAC designs and equipment, green and net zero energy buildings, sustainable development, and energy modeling.

Dunstan Macauley, PE, Member ASHRAE, HBDR, LEED® AP, has nearly 16 years of experience in the HVAC industry specializing in the design of a variety of systems for commercial and institutional projects. He joined Encon Group in 2008 as an associate director and currently serves as the mechanical department manager. Mr. Macauley is actively involved in project management and design, including several projects for the pharmaceutical and biotechnology, telecommunications, and broadcast communication industries. He is ASHRAE Region III Director and Regional Chair for the 2018-2019 term.

Annie Marston, Ph.D, Member ASHRAE, BEMP, LEED® AP, is head of the Building Performance Group at Ebert & Baumann Consulting Engineers. She is an expert in energy modeling and related simulation applications, such as CFD modeling and daylight modeling. Her energy modeling experience includes simulating single buildings for LEED®, conducting parametric studies for conceptual design work, choosing energy-efficient solutions for high-profile projects, and modeling scenarios to reduce the energy consumption of entire cities and counties by 30%-50%. Dr. Marston is proficient in many modeling and simulation programs and related applications, such as EnergyPlus, DesignBuilder, Google SketchUp, IES, Ecotect, Radiance, Star CCM+, and FLUENT.

Sam Mason, PE, Member ASHRAE, BEMP, LEED® AP, BD+C, is the principal at Encompass Energy LLC. He provides energy analysis, code assessment, and design assistance services for developers, contractors, architects, and engineering firms across North America, Europe, and the Middle East. He has over ten years of experience in the design and construction industry, with a focus on pragmatic approaches to energy efficiency and sustainability. His expertise includes detailed HVAC design and he is an expert in whole-building energy simulation and optimization.

Dermot McMorrow, P.Eng., C.Eng., Member ASHRAE, Member CIBSE, is the National Engineered Systems Manager of VRF & ERV Technologies with Mitsubishi Electric Sales Canada. He has over 20 years of experience in building services engineering including HVAC system design, HVAC product application and development, project and program management, and engineering education. Mr. McMorrow is a co-author of Chapter 18, “Variable Refrigerant Flow,” in the 2012 ASHRAE Handbook—HVAC Systems and Equipment and co-author of CSA B52 Code Document 2013 + Safety Bulletin. He is also the Vice Chair of ASHRAE TC 8.7 and a member of CSA B52 TC.

Frank Mills, C.Eng., Member ASHRAE, is in design, management, supervision, construction, and operation of building services engineering projects, including education, healthcare/hospitals, research, industrial, process, commercial, retail, computer/data suites, and shopping centers, including town centers and residential (housing, hotels, and apartment buildings). He has also worked closely with the Building Research Establishment in the UK and with ASHRAE TC 2.8 to develop new environmental design and rating systems to aid developers and their designers toward low carbon and environmentally friendly developments.

Mark Nunnely, P.E., Member ASHRAE, CxA, LEED® AP, has been involved in the construction, engineering, and HVAC industry since 1982. Since 2000 his professional interests in projects have primarily pertained to commissioning, retrocommissioning, humidity control consulting, and energy management for commercial, institutional, and industrial buildings. He has presented numerous training seminars on commissioning, dehumidification technologies (desiccant and mechanical-based), and their applications, as well as psychrometrics and designing for proper humidity control. Nunnely is also recognized as one of ASHRAE’s Distinguished Lecturers and has conducted training seminars both domestically and internationally.

Michael Patton, Member ASHRAE, is currently the executive vice president for Griswold Water Systems. For more than 20 years Patton has been a technical sales leader in the environmental, energy, and water industry. He has more than 35 years of mechanical engineering experience, including stints with mechanical contractors and with a manufacturers’ representative. An ASHRAE Member, Patton is active on ASHRAE SPC 188 on Legionellosis and ASHRAE Standard 191P.

Richard (Dick) Pearson, PE, Fellow/Life Member ASHRAE, is a regular presenter at professional development courses at the University of Wisconsin and elsewhere on subjects related to energy audits, HVAC design, energy management, system analysis, and renovation of buildings. He holds multiple ASHRAE Technology awards and the University of Wisconsin-Madison Department of Engineering Distinguished Service Citation. He has been awarded the membership grade of Fellow for his pioneering work with building automation systems and has received the Distinguished Service Award from ASHRAE. He has been Chairman of the Energy Management Committee and has served on the Board of Directors, as well as serving on the Finance, Professional Development, TC 7.6, and Environmental Health committees, and the Technology Council.

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Douglas Reindl, PhD., PE, Fellow ASHRAE, is a registered professional engineer in the State of Wisconsin and a professor in the College of Engineering at the University of Wisconsin-Madison, with appointments in the Department of Engineering Professional Development (EPD) and Mechanical Engineering. Dr. Reindl has expertise in several areas related to industrial refrigeration systems including system safety, optimization, assessment of design alternatives, conceptual design, energy conservation measures, system modeling, and field evaluation.

Roger Schmidt, Ph.D., PE, Member ASHRAE, IBM Fellow, National Academy of Engineering Member, IBM Academy of Technology Member, ASME Fellow, has over 35 years experience in engineering and engineering management in the thermal design of IBM's large scale computers. He was IBM's chief engineer on data center energy efficiency. He has led development teams in cooling mainframes, client/servers, parallel processors, and test equipment utilizing such cooling mediums as air, water, and refrigerants.

Chandra Sekhar, PhD., Fellow ASHRAE, is currently a professor and programme director (Building Performance and Sustainability) and co-director (Centre for Integrated Building Energy and Sustainability in the Tropics) in the Department of Building at the National University of Singapore (NUS). He is also a founding director of Enhanced Air Quality Pte Ltd, a NUS spin-off company. Sekhar is an ASHRAE Fellow and a Fellow of ISIAQ. He has been an ASHRAE Distinguished Lecturer since 2006. Dr. Sekhar is a past Chair of the Environmental Health Committee, was a member of the IEO Global Alliance Ad Hoc Committee (2013-2016) and is currently a member of SSPC 62.1, TC 2.1, EHC, and TC 4.3. He has also served the ASHRAE Singapore Chapter in various capacities, including as its President during 2010-2011 and as a BOG member. Dr. Sekhar is ASHRAE Director-at-Large for the 2018-2019 term.
Michael Sheerin, PE., Member ASHRAE, LEED® AP, is a chief executive officer of TLC Engineering for Architecture. He serves as the director of Healthcare Engineering for TLC, leading their design, planning, and marketing efforts. He has focused solely on healthcare facility design since joining TLC in 1995. Sheerin is a mechanical engineer licensed in multiple states and currently serves as Chairman of TC 9.6. He is the Vice Chairman of ASHRAE SSPC 170 and has been involved in this standard since its inception. He also serves as Chair of ASHRAE SPC 189.3.

Peter Simmonds, Ph.D., Fellow ASHRAE, is managing director/principal of Building and Systems Analytics LLC. Dr. Simmonds has been involved in the design and operation of tall, supertall, and megatall buildings around the world for more than 30 years. An ASHRAE member since 1989, Dr. Simmonds has twice chaired TC 9.12 and is a member of TC 2.1. TC 6.5, and TC 7.5. He is a consultant for both the Standard 55 and Standard 62.1 groups and is a past President of the College of Fellows. Dr. Simmonds is a recognized authority in the field of radiant heating and cooling systems, low energy buildings and systems, and occupant comfort. The main goals of his research and applications have been to understand the heat transfer and performance of radiant systems and occupant comfort for both heating and cooling. His studies on the thermal performance of radiant systems led to a unique way to enhance these systems. He is the author of the ASHRAE Design Guide for Tall, Supertall and Megatall Building Systems and a co-author of the ASHRAE/REHVA Active and Passive Beam Application Design Guide.

Mark Stetz, PE., Member ASHRAE, BEAP, is principal and co-owner of Stetz Consulting LLC. His company provides energy-efficiency consulting services, energy audits, measurement and verification, economic analysis, and training. With over 20 years in the energy efficiency field, he has contributed to the IPMVP and FEMP measurement and verification protocols, supported the DOE FEMP performance contracting program, provided input into LEED® 2012, and conducted training workshops worldwide.

Harshal Surange, Member ASHRAE, is Director and CEO at ACR Project Consultants in Pune, India. Surange has nearly 20 years of industry experience and has designed and consulted on over 200 cold chain projects for logistics providers and governments. His work includes integrated cold chain projects with refrigerated containers, multipurpose cold stores, frozen stores, CA stores, and ripening units. Surange serves as a recognized resource person for the National Horticulture Board (NHB) for the Government of India and is an NHB-certified engineer and trainer. Surange is the founder and President of the International Institute of Ammonia Refrigeration (IIAR) Western India Chapter and the National Chair for the Refrigeration Committee of the Indian Society of Heating, Refrigerating and Air Conditioning Engineers (ISHRAE). He works as an instructor for ASHRAE’s Global Training Center for Building Excellence in Dubai and participates in joint activities for ASHRAE and the United Nations Environment Program (UNEP) to promote sound management of refrigerants and to talk on energy efficiency in air conditioning and refrigeration.

Steven T. Taylor, PE., Fellow/Life Member ASHRAE, is the founding principal of Taylor Engineering, Alameda, CA. He is a registered mechanical engineer specializing in HVAC system design, control system design, indoor air quality engineering, computerized building energy analysis, and HVAC system commissioning. Taylor has over 40 years of commercial HVAC system design and construction experience. He was one of the primary authors of the HVAC sections of ASHRAE/IES Standard 90.1 and California’s Title 24 energy standards and ventilation standards. Other ASHRAE projects and technical committees Taylor has participated in include ASHRAE Standard 62.1, ASHRAE Standard 55, Guideline 13, Guideline 16, Guideline 36, TC 1.4, and TC 4.3. He is past vice-chair of USGBC LEED Indoor Environmental Quality Technical Advisory Group, a member of the CSU Mechanical Review Board, and an 18-year member of the IAPMO Mechanical Technical Committee administering the Uniform Mechanical Code.

Samir Traboulsi, PhD., P.Eng., Fellow/Life ASHRAE, BEAP, is currently a senior lecturer at the American University of Beirut and has taught a variety of subjects including building services technical courses, MEP design of green buildings, HVAC design courses, thermodynamics, operations research, the engineering economy, and engineering ethics. Dr. Traboulsi is the founder and was the president of the Lebanese chapter of ASHRAE, as well as a former Director-at-Large for ASHRAE. He also served as co-founder and former president of the Lebanon Green Building Council. Dr. Traboulsi is the author of numerous publications and is the recipient of both the ASHRAE Distinguished Service Award and the ASHRAE Exceptional Service Award.

Rafael Úrculo, Member ASHRAE, has assumed the presidency of the Spanish Association of Engineering and Installation Cosnultant (AECI). Úrculo has worked in building services and as an associate professor at the School of Architecture at the Polytechnic University of Madrid. In addition to being a member of ASHRAE, Úrculo is also a member of IES and the CIBSE.

John Varley, PE., Member ASHRAE, HBDP, LEED® AP, has been a professional in the building sciences industry for over 30 years. He has extensive design experience in a variety of laboratory types, including wet chemistry, biomedical, microbiological, animal, and academic laboratories. Mr. Varley is a past Chair of ASHRAE TC 9.10 and TC 9.11. His work and ideas on laboratory design and industrial ventilation have been published in the ASHRAE Journal, ASHRAE Transactions, and STBE.

Alan (Al) Veeck, Life Member ASHRAE, worked in the air filtration industry at Tidewater Air Filter as Vice President of Sales and opened and managed the Bio-Tec division of Tidewater. He then advanced to General Manager of Airpure in 1999. In the same year, Veeck was elected President of the National Air Filtration Association (NAFA). He also served on the committee that wrote NAFA’s first and second books on air filtration, NAFA Guide to Air Filtration and Installation, Operation and Maintenance of Air Filtration Systems. Veeck later became NAFA’s executive director and is the recipient of the NAFA Distinguished Service Award. Veeck has headed ASHRAE’s Technical Committee (TC) 2.4 on air filtration and received the ASHRAE Distinguished Lecturer and ASHRAE Distinguished Service awards. He is a certified instructor for Dale Carnegie Training™ and is certified by NAFA as an Air Filter Specialist and Certified Technician Level II.

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**Mack Wallace**, P.E., Member ASHRAE, LEED® AP, has been a mechanical contractor, consulting engineer, and a registered engineer in Texas for over 30 years. Mr. Wallace is heavily involved on the front lines of the energy conservation industry, having served the past 19 years on the ASHRAE/IES Standard 90.1 Committee. Mr. Wallace was the engineer of record for many award-winning projects, including the Historic Preservation of the Texas State Capitol Building. He was also director of design/build services for TXU Energy and responsible for developing and guaranteeing the savings on many energy savings projects. Mr. Wallace has trained thousands of engineers and architects worldwide on ASHRAE/IES Standard 90.1, and he is the co-author of Significant Changes to International Energy Conservation Code and ANSI/ASHRAE/IES Standard 90.1.

**Dennis Wessel**, P.E., Fellow/Life Member ASHRAE, LEED® AP, retired as a senior vice president and director of marketing with Karpinski Engineering and has more than 45 years of engineering experience. Wessel was an ASHRAE Director-at-Large (2012–2015) and past Chair of the Planning Committee, the Conferences and Expositions Committee, and Handbook Committee. He is currently a member of the ASHRAE Foundation, Development Committee, and the Technical Activities Committee, and is a TC Section Head.

**Hassan Younes**, Member ASHRAE, BEAP, BEMP, HBDE, CPMP, HFDP, OPMP, is a technical director and partner at Griffin Consultants. He has extensive experience in the fields of design, sustainability, commissioning, project execution and management, energy efficiency, and value engineering. He holds all ASHRAE certifications and is a certified energy manager, a certified measurement and verification professional, and a LEED®-accredited professional. Younes is a Grassroots Government Advocacy Committee (GGAC) member in the ASHRAE Region-at-Large, as well as a GGAC Chair in the UAE local chapter. Younes was awarded the Middle East Energy Professional of the Year award in 2015 by AEE, Middle East Young Engineer of the Year 2010, and was part of the Griffin Consultant's team awarded the Energy Consultant of the Year 2017 award by Retrofit Tech and the Middle East Boutique Consultancy of the Year 2014 award.