Updated 17.04.30

RECENTLY COMPLETED RESEARCH

The projects listed below were recently completed by ASHRAE this Society year. The final reports for these projects are available for purchase and download from the ASHRAE online bookstore or for free download to ASHRAE members logged into www.ashrae.org.

1467-RP
BALANCING LATENT HEAT LOAD BETWEEN DISPLAY CASES AND STORE COMFORT COOLING

Completed April 2016
University of Colorado
Principal Investigator, Michael Brandemuehl
TC 10.7, Commercial Food and Beverage Cooling Display and Storage
AHRTI $84k co-funder

Supermarket energy costs for heating, cooling, dehumidification, and refrigeration are a major store operating cost and often exceed store profits. While most of this cost is associated with maintaining refrigerated conditions for products, much is also spent to maintain suitable environmental conditions in the supermarket sales area. Each of these requirements is inexorably linked to the other. Failure to control store temperature and humidity can cause excessive energy consumption by refrigeration equipment and hamper product marketing due to frost build-up on frozen products and fogging of display cases. Conversely, most of the energy used to operate the refrigeration equipment serves to reduce the building cooling and dehumidification requirements.

The overall objective of this project is to provide a comprehensive assessment of the potential for energy savings in supermarkets by optimized design and operation of the combined HVAC and refrigeration systems. The assessment will include the effects of climate, space temperature and humidity set-point controls, HVAC system type and characteristics, and the design and operation of the refrigerated cases. Furthermore, the project will address the overall layout of HVAC and refrigeration system components in supermarkets, including HVAC zoning, the location of supply and return air, and the overall air distribution patterns in the supermarket.

1529-RP
FULL-FREQUENCY NUMERICAL MODELING OF SOUND TRANSMISSION IN AND RADIATION FROM LINED DUCTS

Completed May 2016
Secat, Inc.
Principal Investigator, David Herrin
TC 2.6, Sound and Vibration Control

The objective of this project is to develop procedures to enable first-principles analytical acoustic models that will ultimately unify all of the empirical data in the handbook -- as well as data from the various research projects upon which they were based -- and extend the results to a wider variety of duct element configurations and frequency ranges. The models will combine the in-duct acoustic attenuation and breakout noise components that are treated separately in the Handbook.

This will be accomplished by applying a combination of Boundary Element Analysis (BEA), Finite Element Analysis (FEA), and Statistical Energy Analysis (SEA) methods (6, 7) to the modeling of acoustical and structural (vibratory) characteristics of various duct systems. The models will employ methods developed in Ref (1), applied to the specific duct configurations of RP-1408, to develop models which include details such as the lining and structural-acoustic coupling. Using SEA techniques, the frequency range of the models will be extended, from the previously investigated “low” range below 1 kHz, to the full 10 kHz range of the test data. In all cases, interior duct

Insertion Loss, duct vibration, and duct breakout (exterior) sound power simulation models will be validated against test data obtained in RP-1408.

1535-RP
A HEAT TRANSFER AND FRICTION FACTOR CORRELATION FOR LOW AIR-SIDE REYNOLDS NUMBER APPLICATIONS OF COMPACT HEAT EXCHANGERS"

Completed January 2016
Florida International University
Principal Investigator, Chung Xian Lin
TC 8.4, Air-to-Refrigerant Heat Transfer Equipment
AHRTI $41k co-funder

The objective of this research is to develop airside heat transfer and pressure drop correlations for high performance compact heat exchangers under low air velocity conditions. ASHRAE members who design large refrigerant to air condensers, especially residential A/C and commercial rooftop applications will benefit from this work. Other ASHRAE members who design medium temp (refrigeration) and low temp (freezer) vapor compression systems will be affected, and will benefit even from the development of dry (frost-free) correlations. Automotive heat exchanger manufacturers could also benefit from this work by applying it to automotive condenser at idling conditions. Depending on the region where the automobile is sold, it could spend most of its operating life in the idle condition (i.e. at stop lights and in traffic jams). Heat exchanger manufacturers who supply OEM customers or system manufacturers will also be affected, since larger coils are needed to meet the higher efficiency ratings required in industry. It is estimated over 50% of the society members could be aided by having such a correlation available for use in their heat exchanger design tools. If lower airflow off peak conditions begin to be regulated more closely, even more members could benefit from this work. After successful completion of the work, such correlations could be implemented by members immediately. Guidance from new convective data at these low airflows will help facilitate more efficient design of optimal louver-fin-pitch for AC system, freezer and refrigeration applications. Having these tools available will enable designers to produce more energy efficient systems and heat exchangers.

1546-RP
EXPANSION AND UPDATING OF THE AIR DIFFUSION PERFORMANCE INDEX METHOD

Completed January 2016
University of Texas Austin
Principal Investigator, Atila Novoselac
TC 5.3, Room Air Distribution

Validate the current Tv/L and corresponding ADPI values currently presented in the ASHRAE Handbook.
Develop Tv/L and obtainable ADPI values for products not included in the currently literature but currently available in the commercial market. Evaluate the ADPI calculation methodology to recommend an ADPI calculation for spaces in heating mode, and spaces at low loads, to better correlate with the ASHRAE comfort standard. Create an updated database of ADPI values, with the revised ADPI calculation, for overhead mixing heating and cooling systems for a selected range of typical spaces (classrooms, office spaces, restaurants, supermarket, retail spaces) and air outlet types that will be used by mechanical engineers to determine the optimum diffuser selection and spacing for these spaces at today's lower loads. Update the ADPI tables and text presented in the ASHRAE Applications and Fundamentals Handbook. Determine the values of ADPI that prove compliance to ASHRAE Standard 55's vertical temperature stratification limits, and update the ASHRAE Table.

1564-RP
MEASUREMENT OF OIL RETENTION IN THE MICROCHANNEL HEAT EXCHANGERS

Completed January 2016
Oklahoma State University
Principal Investigator: Lorenzo Cremaschi

TC 8.4 - Air to Refrigerant Heat Transfer

This work will provide essential design data for state-of-art micro channel heat exchangers by showing how much oil is held up, causing the heat transfer performance degradation and additional pressure drops at various operating conditions. This is an excellent opportunity for ASHRAE to provide important design information that has not been clearly answered before and falls in the gap between manufacturers, designers, and installers. This work provides key information that may challenge compressor manufacturers and installers to more carefully measure how much oil to add to systems. This work may also show that over-charging a system with oil is just as bad — or worse — than over-charging a system with refrigerant. While the practice of overcharging systems may seem like a reasonable practice in the field from a durability standpoint, it may actually be a tremendous waste of oil, refrigerant, money and energy.

1587-RP
CONTROL LOOP PERFORMANCE ASSESSMENT

Completed August 2016
University of Alabama
Principal Investigator, Zheng O'Neill
TC 1.4 Control Theory and Applications

Fair, objective methods to evaluate loop performance will encourage new technologies (e.g. auto-tuning, fuzzy logic, model-based, model-free, neural networks, pattern recognition) to come forward and be compared to each other and to conventional PID loops on a level field. In this way ASHRAE can help move closed loop control forward without favoring any one technology.

1600-RP
METHODS TO INCREASE MAXIMUM VELOCITY OF MAKEUP AIR FOR ATRIUM SMOKE CONTROL - CFD STUDY

Completed January 2016
University of Maryland
Principal Investigators, Arnaud Trouve and James Milke
TC 5.6, Control of Fire and Smoke

Specifically, the proposed research would more thoroughly investigate the effects on the fire and smoke layer when makeup air is supplied below the limiting elevation of the fire, with the expectation that makeup air could be supplied in this region at velocities greater than the current limits. Design tools (equations, graphs, models, etc.) that help designers determine the effect of makeup air velocity and elevation on smoke layer height shall also be developed. If these design tools are to be accepted for use in guidelines and standards, they will need to be validated against full-scale experimental results.

The main objective of this project is to develop tools that can be used by smoke control system designers to create make-up air systems that supply air at a velocity greater than 200 fpm (1 m/s) at the supply grille while maintaining safe conditions in exit pathways within the atrium.

1602-RP
THERMAL-FLUID BEHAVIOR OF MIXED REFRIGERANTS FOR CRYOGENIC APPLICATIONS

Completed January 2016
University of Wisconsin-Madison
Principal Investigator, Greg Nellis
TC 10.1, Custom Engineered Refrigeration Systems
Co-Sponsored by: TC 1.3 Heat Transfer and Fluid Flow

The objective of the proposed work is the measurement of the heat transfer coefficient under heating conditions and pressure drop associated with mixed gas working fluids flowing at cryogenic temperatures while evaporating and

condensing. These data will be correlated in a manner that is familiar to refrigeration equipment designers. Mixed refrigerants are widely used to extend vapor compression type cycles to lower temperatures. The thermodynamic and thermal-fluid behavior of these mixtures is critically important to the industrial designer. This work is relevant to ASHRAE's stated strategic plan of advancing the science of refrigeration and directly addresses New Applications for HVAC&R (see Tools and Applications) and Alternative Technologies (see Equipment, Components and Materials) from the 2005-2010 Research Strategic Plan.

1608-RP
DEVELOPMENT OF A LOAD-BASED METHOD OF TEST FOR LIGHT COMMERCIAL UNITARY HVAC

Completed August 2016
Oklahoma University
Principal Investigator: Lorenzo Cresmaschi
TC 8.11, Unitary and Room Air Conditioners and Heat Pumps
Co-sponsored by: TC 7.6, Building Energy Performance

Ultimately the goal is to develop a testing and performance projection procedure for unitary HVAC equipment operating as a system with accessories or control strategies to determine the performance in terms of return air to supply air temperature and enthalpy difference vs. system energy input. This research proposal only deals with the first phase (Phase 1) of a RSP development effort, with future phases needed to develop the method for projecting annual energy use based upon testing results. The objective of this work statement is to develop and validate a preliminary method of test for unitary systems at a constant load condition using an environmental lab; resulting in a preliminary method of test. If successful, this preliminary or preliminary method of test could form the proof of concept for development of a final method of test through the ASHRAE consensus process.

1627-RP
AN EVALUATION OF THE ACTUAL ENERGY PERFORMANCE OF SMALL OFFICE AND K-12 SCHOOL BUILDINGS DESIGNED IN ACCORDANCE WITH THE 30% ASHRAE ADVANCED ENERGY DESIGN GUIDES

Completed September 2016
Group 14 Engineering
Principal Investigator:
Sponsoring Committee: TC 2.8 (Building Environmental Impacts and Sustainability)
Co-sponsored by: Advanced Energy Design Guide Steering Committee

Compare Energy Utilization Indices (EUIs; site energy use per unit area per year), normalized based on standard hours of operation and plug load energy use, for a sample of small office and K-12 school buildings designed in accordance with the first (30%) ASHRAE AEDGs to the modeled EUIs of small office and K-12 school buildings in the same climate zone that meet the requirements of ASHRAE Standard 90.1-1999. The normalized EUIs of a "control group" of buildings designed in accordance with Standard 90.1-1999 will also be calculated and compared to those of the buildings designed in accordance with the AEDGs.

Determine the factors common to relatively well-performing buildings, as well as the factors common to relatively poorly-performing buildings, based on building surveys.

Provide recommendations for how future AEDGs for small office and K-12 school buildings could be made more effective in achieving better energy performance than required by ASHRAE Standard 90.1 while providing acceptable indoor environmental quality.

1630-RP

UPDATE THE SCIENTIFIC EVIDENCE FOR SPECIFYING LOWER LIMIT RELATIVE HUMIDITY LEVELS FOR COMFORT, HEALTH AND IEQ IN OCCUPIED SPACES

Completed March 2016
Kansas State University
Principal Investigator: Melanie Derby
TC 5.11, Humidifying Equipment

Co-sponsored by: TC 9.6, Health Care Facilities

To determine and quantify the effect of low level of relative humidity *(10-40%*) on the comfort, health, and IEQ for humans in residences and non-industrial workplaces, including adolescents and the population over 65 years old. The project will entail comprehensive literature review, detailed data analysis, developing conclusions and recommendations, and preparation of the final report.

1631-RP

COUNTERTOP COMMERCIAL APPLIANCE EMISSIONS

Completed July 2016
Syracuse University
Principal Investigator: Jianshun Zhang
TC 5.10, Kitchen Ventilation

The value of this research to ASHRAE, the HVAC industry, restaurant designers, consulting engineers, and end-users is significant though only quantifiable after the research is performed. The research will ensure that ASHRAE increases the expertise it currently maintains in providing design guidance for commercial kitchen ventilation systems. This knowledge is crucial for directing future revisions of the handbooks, design guides, codes, and standards that impact kitchen ventilation. Restaurant designers and consulting engineers will benefit by gaining a better understanding of impacts on IEQ and energy when deciding if an appliance should be unhooded or hooded. Results will be translated into better operating kitchens for owners and customers. Restaurant owners may experience reduced energy costs and better indoor air quality, but even more importantly, the project can facilitate development of standard designs within the foodservice industry. The results of this research will also allow the various model codes and standards to clearly identify which appliances may be unhooded or which require kitchen hood.

1635-RP
SIMPLIFIED PROCEDURE FOR CALCULATING EXHAUST/INTAKE SEPARATION DISTANCES

Completed January 2016
CPP Inc.
Principal Investigator: Ronald L. Petersen
TC 4.3 - Ventilation Requirements & Infiltration

This research will improve Standard 62.1 and 62.2 and model building codes by providing techniques for accurately yet simply determining outdoor air and exhaust air separation distances. The primary objective of this RP is to provide a simple procedure for calculating the minimum distance required between the outlet of an exhaust system and the outdoor air intake to a ventilation system. The procedure shall be developed from existing and new research.

1641-RP
EFFECT OF UNSATURATED FLUOROCARBON CONTAMINANTS ON THE RELIABILITY AND PERFORMANCE OF HVAC&R EQUIPMENT

Completed January 2016
Spauschus Associates

Principal Investigator: Ngoc Dung Rohatgi
TC 3.3, Refrigerant Contaminant Control

Understanding the reliability and performance implications of higher levels of unsaturated fluorocarbons would be beneficial to any manufacturer by; -increasing the sustainability of refrigerant by allowing less restrictive use of HCFC and HFC's in the market place by potentially allowing higher levels of unsaturants. 1) Improving system reliability and performance. 2) Reducing the efforts by reclaimers to maintain unnecessarily low levels of unsaturants in reclaimed or recycled refrigerants. 3) Extending testing methodology developed as a model to evaluate the new HFO refrigerants for potential reliability and performance issues. The objectives of the work to determine chemical reactivity of unsaturated fluorocarbon contaminants in refrigerants and their impact on performance and reliability of HVAC&R systems.

1651-RP
DEVELOPMENT OF MAXIMUM TECHNICALLY ACHIEVABLE ENERGY TARGETS FOR COMMERCIAL BUILDINGS (ULTRA LOW ENERGY USE BUILDING SET)

Completed January 2016
GARD Analytics Inc.
Principal Investigator, Jason Glazer
MTG.ET, Energy Targets

This research will provide information that can be considered by relevant ASHRAE standard project committees (PCs) in planning advancements to Standard 90.1, Standard 189 and the Advanced Energy Design Guides. ASHRAE Standard 90.1 is referenced in the U.S. Energy Policy Act and sets a minimum efficiency level for state energy codes. Standard 189.1 provides a benchmark for design of high performance green buildings. The Advanced Energy Design Guides enjoy wide distribution and provide a prescriptive path to low energy buildings.

1681-RP
LOW ENERGY LED LIGHTING HEAT GAIN DISTRIBUTION IN BUILDINGS

Completed September 2016
Iowa State University
Principal Investigator, Ran Liu
TC 4.1 Load Calculation Data and Procedures

The objective of this research is to better document the interaction of the heat generated by LED luminaires and the surrounding space. Data for the most typical arrangements would be presented in Chapter 18 of the Handbook of Fundamental as an extension to or supplement to Table 3. This information will also be included in a future update to the ASHRAE Load Calculation Applications Manual. Data on the distribution of heat gain from Low Energy LED lighting fixtures is critical to load calculation, especially low energy or highly optimized buildings, but is currently not available.

Updated 17.04.30

1682-RP
STUDY TO IDENTIFY CFD MODELS FOR USE IN DETERMINING HVAC DUCT FITTING LOSS COEFFICIENTS

Completed December 2016
Embry-Riddle Aeronautical University
Principal Investigator: Ahmed Sleiti
TC 5.2, Duct Designs

The objective of this research is to develop CFD techniques that are capable of predicting pressure drop in close-coupled round five-gore elbows accurate to within 15% of the experimental loss coefficients. It should investigate the significance of potential effects due to compressibility, variation in thermal properties, surface roughness and other effects. An important aspect of this project is that detailed pressure loss measurements will be performed in the laboratory on individual elbows and the close-coupled elbows in order to assist with the development of the CFD models, and to corroborate the numerical predictions. Only well-established CFD methods should be employed in this study.

1738-RP
FIELD MEASUREMENTS AND MODELING OF UVC COOLING COIL IRRADIATION FOR HVAC ENERGY USE REDUCTION

Completed January 2017
Pennsylvania State University
Principal Investigator: William Bahnfleth
TC 2.9, Ultraviolet Air and Surface Treatment

There is anecdotal evidence that UVGI is effective for bio-fouling mitigation with an associated increase in system efficiency, but no independent, third party research exists to back up these claims. With the inclusion of the research in the appropriate handbook chapters, ASHRAE will enable the adoption of and energy saving technology and will assist vendors, design engineers, and owner/operators in the design and maintenance of healthy, high-performing buildings. This research directly supports the mission statement of TC 2.9: Ultraviolet Air and Surface Treatment.