ACTIVE PROJECT ABSTRACTS

As of October, 2018

1196-RP ***Develop Software to Calculate the Application Seasonal Efficiency of Commercial Space Heating Boiler Systems Based on ASHRAE Standard 155P***

September 2000 – July 2019 (P) (Completion tied to Standard 155) Iowa State University, **Principal Investigator**, Ron Nelson **TC 6.1**, Hydronic and Steam Equipment and Systems; Co-sponsors: none

Boilers are estimated to account for 42% of space heating energy use in the commercial and multifamily sectors in the U.S. Significant energy savings could be achieved in commercial and multifamily buildings by optimizing the selection of commercial boiler systems in new buildings and at the time of boiler replacement. Currently, however, commercial boilers and all other types of commercial heating equipment are rated only in terms of steady-state efficiency at full load, which does not provide a meaningful indication of relative operating costs. The objective of this research project is to develop user-friendly windows-based software will greatly accelerate adoption of seasonal efficiency analysis for commercial boiler systems. A significant obstacle to the use of any new standard is the learning curve for users to become familiar with the new terminology and inputs and learn how to do the computations. With this software, the level of effort required of new users of the standard will be dramatically reduced, and can be focused on the more important tasks of evaluating outputs and developing an intuitive sense of the factors that affect the seasonal efficiency of commercial boiler systems.

1399-RP ***Survey of Particle Production Rates from Process Activities in Pharmaceutical and Biological Cleanrooms***

April 2014 – January 2019 (P); University of Oklahoma; **Principal Investigator**, Li Song; **TC 9.11**, **Clean Spaces**; Co-sponsors: none

The intent of this research project is to gather empirical data on particulate generation rates for various cleanroom processes. That empirical data, correlated to the surveyed activities and operations will then be used to develop a design guideline which will show a range of particulate generation rates for different cleanroom operations. This guideline will help engineers, owners and contractors to arrive at a better design solution which meets the required performance levels but does not yield an oversized or inefficient system. The guideline would be included in the Handbook Chapter or in a separate Cleanroom Design Guideline if such a document were to be published by ASHRAE. As there is no other compendium of particle generation rates across the affected industries, we anticipate that this guide would take the dominant position in the marketplace.

1507-RP ***Binary Refrigerant Flame Boundary Concentrations***

September 2009 – June 2019 (P); Safety Consulting Engineers; **Principal Investigator**, Andrew Kusmierz; **TC 3.1**, Refrigerants and Secondary Coolants; Co-sponsors: none; **AHRTI** $17,500 Co-funder

ASHRAE and the industries they serve are faced with the need for new refrigerants to meet environmental, energy, and safety requirements. SSPC 34 will classify these working fluids for safe handling. To ensure the validity of flammability safety classifications issued by SSPC34, standard reference data is needed. Tools such as the proposed flammability property database will allow for the development of blends that are properly investigated and classified to meet demanding future needs.

1569-RP ***CFD Study of Hydraulic Shock in Two-Phase Anhydrous Ammonia***

September 2014 – January 2019 (P); ASCOMP – USA INC.; **Principal Investigator**, Djamel Lakehal; **TC 10.3**, Refrigerant Piping, Controls and Accessories; Co-sponsors: none;

This computational fluid dynamic (CFD) research project is the extension of the empirical work completed in the prior laboratory study research project. Refrigeration system design engineers, refrigeration system controls engineers, valve manufacturers, and evaporator coil designers would be aided by this research. The research would provide the basis for design criteria for two-phase ammonia piping and evaporator coils. With the results from this research, the “Safety Considerations” section of Chapter 2, “Ammonia Refrigeration Systems,” in the Refrigeration Handbook could be expanded as well as the tabular data for hot gas defrost. Definitive results could become the basis for certain design requirements in ASHRAE Standard 15 not currently included. Design information and criteria could be written within one year of completion of the research project.

1573-RP ***Determination of Suitable Replacement for SF6 When Used As a Tracer Gas In Accordance with ANSI/ASHRAE Standard 110***

April 2017 – September 2018; Exposure Control; **Principal Investigator**, Tom Smith;
TC 9.10, Laboratory Systems; Co-sponsored by: TC 5.8, Industrial Ventilation

The primary objective of this proposed research is to identify and validate one or more substitute tracer gases that could be incorporated into ANSI/ASHRAE Standard 110. There are a number of criteria that need to be considered in alternate gases including: availability and cost; ease of measurement; cost of measurement; environmental impacts; chemical stability; toxicity; accuracy of the measurement; correlation of alternate gas test results with existing Standard 110 tests; and others.

1579-RP ***Testing and Evaluation of Ozone Removal Air Cleaning Devices for Improving IAQ***

September 2018 – February 2020; University Texas- Austin; **Principal Investigator**: Atila Novoselac, PhD
Co-P.I.: Richard L. Corsi, PhD;
TC 2.3, Gaseous Air Contaminants and Gas Contaminant Removal Equipment; Co-sponsored by: Environmental Health committee (EHC), and SSCP 62.1

ASHRAE Standard 62.1 requires reduction of ozone in ventilation air under NAAQS nonattainment conditions. Therefore, building design professionals, filter manufacturers, and building owners and operators are in critical need of information relating to the performance of ozone removal devices under a variety of environmental conditions for both design and operating requirements. In the future, there may possibly be a parallel requirement for residences in Standard 62.2. It is anticipated that the testing will utilize existing laboratory test rigs (with modifications depending on types of devices selected). This will help to keep costs down, and increase acceptance of the results in the industry.

1604-RP ***Demand Based Flow Control for Cleanrooms***

September 2011 – January 2019 (P); Engsysco, Inc.; **Principal Investigator**, Wei Sun; **TC 9.11**, Clean Spaces; Co-sponsors: none

Very little research has been done on dynamic control of airflow to control particles in cleanrooms - matching airflow to the desired contamination limits. The high energy use and resulting cost for typical systems today and concern over availability of electricity suggests that the ventilation rate should be adjusted in order to achieve the desired cleanliness yet minimizing excess airflow.

Up till now, this technology was not applied, as real time particle measurement systems did not have both sufficient precision, reliability, and cost effectiveness, and controls did not have adequate reaction time. Also owners and operators of industrial cleanrooms have been hesitant to make changes to the air exchange rates in cleanrooms due to misconceptions that varying flow rates through cleanroom filters will disrupt the flow and cause particle counts to increase.

The main objective of this project is to establish a scientific approach to implement demand controlled filtration (ventilation rate) for cleanrooms for the two cleanroom classes (ISO, 7 and 8, (10 000 and 100 000) that have the broadest application. For example, these two classes comprise 85 to 90% of pharmaceutical class rooms. Based on the results of this research, a future project could well research applying this approach to other more stringent classes.

1614-RP ***Developing a Test Method to Determine the Effectiveness of UVC Systems on Commercial Cooking Effluent***

September 2017 – April 2019 (P); Syracuse University; **Principal Investigator**, Jianshun Jiang;
TC 5.10, Kitchen Ventilation; Co-sponsors: none

If the photochemical and oxidative processes taking place within a UV system are proven to be effective and safe, a UV system can offer many benefits. These benefits include: reduced duct cleaning intervals, a decreased likelihood of a duct fire, increased commercial kitchen ventilation heat exchanger efficiencies, and possible reductions of VOC's and grease particulate emissions. Quantitative testing will allow for a recommendation to be made on how effective a UV system will be when installed and quantify the benefits based on data from third party analysis.

1629-RP ***Testing and Modeling Energy Performance of Active Chilled Beam Systems***

December 2013 – January 2019 (P); University of Colorado; **Principal Investigator**, John Zhai; **TC 5.3**; Co-sponsored by: TC 4.7, Energy Calculations

Quantifying the operational performance of active chilled beams and the resulting sensible cooling capacity is necessary to correctly design, model or implement this equipment as part of building mechanical systems. Energy modeling software packages include chilled beam models, but no published data exist that document the range of accuracy achieved for these components. The results of the project will provide a detailed assessment of the simulation capabilities of building energy simulation programs to predict the performance of active chilled beams and the resulting system performance of net-zero energy design strategies. Recommended modeling improvements will be available for program developers to implement in their respective energy simulation programs.

1645-RP ***Development of New Accelerated Corrosion Test(s) for All-Aluminum Microchannel and Tube and Fin Heat Exchangers***

April 2014 – January 2019 (P); University North Texas; **Principal Investigator**, Seifollah Nasrazdari; **TC 8.4**, Air-to-Refrigerant Heat Transfer Equipment; Co-sponsored by: TC 8.11, Unitary and Room Air Conditioners and Heat Pumps; **AHRTI** $26,888 co-funder

The objective of this research is to develop a new corrosion test, or justify the use of an existing standardized accelerated test, for both all-aluminum tube and fin and brazed microchannel heat exchangers. The PI will first need to perform extensive literature searches to determine if existing accelerated tests are deficient. The PI will work with the approach discussed above by Scott *et al* and ISO standards to connect the work to what is known of atmospheric corrosive severity. The corrosion system takes into account the operating mode and the resulting temperature-humidity complex. The PI may work with an existing standard test or another corrosion-accelerant loading protocol if the literature survey points in that direction, particularly with respect to the corrosion morphologies. Regardless of any literature review findings, there must be a plausible and reasonable linkage between a measureable atmospheric corrosion system and the corrosion damage accumulation of aluminum heat exchangers. Therefore, it is expected that the final outcome of this work will be a standardized test that ASHRAE members can use to better predict HVAC&R component and system performance for a given family of alloy systems based upon the atmospheric conditions and mode of operation of an HVAC/HEX.

1649-RP ***IAQ and Energy Implications of High Efficiency Filters in Residential Buildings***

April 2016 – April 2019; University of Toronto; **Principal Investigator**, Jeffrey Siegel

TC 2.4, Particulate Air Contaminants and Gas Contaminant Removal Equipment; Co-sponsors: none;

Filters are usually present in well-maintained forced air systems in the U.S., including in residential systems with recirculation airstreams. The intent of this research is to quantify the actual impact that high efficiency filters have on in-home PM concentrations, and it will result in a database of simultaneous measurements of indoor/outdoor aerosol concentrations, system operational values (e.g. run times, pressure drops), and system energy use. This work will directly inform existing ASHRAE Standards including minimum filtration aspects of 62.2-2007, which has been incorporated into existing state energy codes (e.g., for California), and the discharge addendum in 52.2-2007. Finally, this work will provide data to better inform the residential consumer on: 1) IAQ impacts of high efficiency purchases, which were estimated as an annual revenue stream of $150 million to the filter market; 2) how often higher efficiency filters (both standard and electrostatic) should be changed to maintain their effectiveness of PM concentration reduction; and 3) any associated energy costs with using higher efficiency filtration.

1650-RP ***Training Requirements for Sustainable, High Performance Building Operations***

November 2016 – January 2019; Montana State University, **Principal Investigator**, Jaya Mukhopadhyay

TC. 7.3, Operation and Maintenance Management, Co-sponsored by: TC 7.6, Building Energy Performance, TC 7.8, Owning and Operating Costs and TC 2.8, Building Environmental Impacts and Sustainability

Support of operating engineers and operations is critical to realizing ASHRAE's core mission of creating better building environments. If we stop at design, we fall short of fulfilling the potential of our knowledge. ASHRAE has a great deal of credibility to gain by taking on responsibility for achieving high performance buildings across their full life-cycle. In doing so, ASHRAE stands to gain strength and prominence as a

source of fundamental knowledge in alliances with major national organizations such as USGBC, BOMA, IFMA, NIBS and agencies such as US DOE, NIST, FEMP, GSA and state level energy agencies.

1661-RP ***Development and Validation of Dynamic Models for the Control of Chiller Plants with Water Side Economizer***

August 1, 2017 to October 31, 2018; University of Colorado, **Principal Investigator**, Wangda Zuo, **TC 4.7**, Energy Calculations; Co-sponsors: none;

This project will evaluate the performance of current control sequences for water side economizers published in ASHRAE publications and recommend a new near-optimal control sequence. It will also provide validated dynamic models to ASHRAE and will demonstrate their use for control sequence evaluation. The project allows the close interaction among experts in energy modeling (TC 4.7), controls (TC 1.4) and smart building systems (TC 7.5) using dynamic modeling of energy transports, control systems and smart control algorithms.

1663-RP ***Residential IAQ Guide***

September 2015 – August 2018; Schoen Engineering, Inc.; **Principal Investigator,** Larry Schoen; **EHC,** Environmental Health Committee; Co-sponsors: none;

In 2009, ASHRAE published the Indoor Air Quality Guide, which presents best practices for design, construction, and commissioning of the commercial and institutional buildings covered by Standard 62.1. However, it is not directly appropriate for residential buildings in which people spend the majority of their time and where IAQ improvements have the potential to yield the largest health benefits. This research project will develop a document that leads to improved residential indoor air quality by providing practical guidance on actions to take throughout the process of building design, construction, and commissioning, including those that affect operation and maintenance.

1666-RP ***Experimental Evaluation of the Thermal and Ventilation Performance of Stratified Air Distribution Systems Coupled with Passive Beams***

April 2016 – August 2019; Purdue University; **Principal Investigator**, Qingyan Chen; **TC 5.3**, Room Air Distribution; Co-sponsors: none;

The experimental results and recommendations will produce previously unavailable new design and operating guidelines for the combined system of displacement ventilation with passive beams. The improved understanding achieved from this project will allow this promising integrated technology to be considered more confidently by system designers. This will reinforce the value of ASHRAE guidelines to building system designers and help to ensure mechanical system design and installation provides comfort while supporting ASHRAE's net-zero energy design strategies.

1675-RP ***Guidance for CFD Modeling of Data Centers***

April 2016 – March 2019; Florida International University; **Principal Investigator**, Cheng-Xian Lin

TC 4.10, Indoor Environmental Modeling; Co-sponsored by: **TC 9.9**, Mission Critical Facilities, Data Centers, Technology Spaces and Electronic Equipment

The primary objective of this research project is to provide CFD modeling guidance for data center applications. The guidance will be based on experimental and CFD analyses of several data center configurations to be conducted as part of this study as well as other work available in the literature.

1677-RP ***Measurements and Prediction of Waterside Fouling Performance of Internally Enhanced Tubes in Cooling Tower Applications***

September 2013 – February 2020; University of Illinois, Urbana- Champaign., **Principal Investigator**, Xinlei Wang & Tony Jacobi; **TC 8.5**, Liquid-to-Refrigerant Heat Exchangers; Co-sponsors: none;

The objective of this research project will be to: 1) experimentally determine the fouling resistance on smooth and enhanced tubes using water representative of cooling tower applications. Experiments should make use of water having varying levels of fouling potential. In addition to a baseline test using a smooth tube, fouling tests of at least 5 internally enhanced tubes shall be conducted. 2) Using the results of the experimental study, as well as additional data from previous ASHRAE research and other published works, a model of the fouling resistance shall be confirmed, modified, or developed. The model shall not preclude application to non-cooling tower applications, such as might occur in enhanced tubes applied to

evaporators. 3) Propose a generalized calculation procedure or approach to determining an appropriate fouling resistance for a "typical" application of enhanced tubes in a cooling-tower water heat exchanger application. Such a procedure should be suitable for publication as part of ASHRAE or AHRI standards, such as AHRI Guideline E or AHRI Standard 550/590. A method that represents an improvement in accuracy over the current method of specifying a specific, constant fouling resistance regardless of application conditions or enhanced geometry characteristics is desired.

1692-RP ***Effects of Shielding on the Wind Loads on Roof Mounted Equipment***

September 2015 – **October 2018 (P)**; Insurance Institute for Business & Home Safety (IBHS); **Principal Investigator**, Murray J. Morrison; **TC 2.7**, Seismic and Wind Resistant Design; Co-sponsors: none;

The goal of this project is to examine the effects that architectural screening has on wind loads on roof mounted equipment. To meet this objective, an experimental study is proposed to examine the effect numerous screen configuration has on the wind loads on roof mounted equipment.

1696-RP ***Thermal and Moisture Transport Property Values for New Building and Insulating Materials***

September 2015 – **June 2019**; Building Science Consulting, Inc.; **Principal Investigator**, Christopher J. Schumacher; **TC 4.4**, Building Materials and Building Envelope Performance; Co-sponsors: none;

The principal justification of this project is to ensure that the hygrothermal materials properties in the ASHRAE Handbook – Fundamentals continue to be representative of the materials currently in use especially in view of the use of different envelope systems and design and HVAC solutions for very low energy and net-zero energy buildings. Designers will be able to more confidently perform hygrothermal modeling to optimize their buildings, as well as promote the advantages of energy and hygric modeling to their clients. The results of this project will support the calculations required in ASHRAE 90.1, 90.2, 189.1, and 160, making those standards easier to use and increasing their likelihood of adoption in more jurisdictions.

1705-RP ***Investigation of Airside Fouling on Outdoor Heat Exchangers***

December 2015 – October 2018; University of Nebraska-Lincoln; **Principal Investigator**: David Yuill;

TC 8.4, Air-to-Refrigerant Heat Transfer Equipment, Co-sponsored by: **TC 8.11**, Unitary and Room Air Conditioners and Heat Pumps

Heat exchangers are key components in all heating, refrigerating, and air-conditioning systems. Even fractional improvement on heat exchanger performance may have the potential to acquire significant energy savings. The intent of this research is to build a better base of knowledge regarding airside fouling for outdoor heat exchangers and the impact that it has on performance. Based upon this, a fouling test method can be developed. Understanding these impacts and developing a scientifically valid test method that replicates fouling in field observations will help ASHRAE members reduce costs significantly. ASHRAE as a professional society for engineers and building energy professional may help provide fouling information from various resources, particularly operating units retrieved from the field, while still protecting members' interests.

1707-RP ***Annoyance Thresholds of Tones in Noise as Related to Building Services Equipment***

September 1, 2018 – February 28, 2020; Purdue University; **Principal Investigator**: Patricia Davies;

TC 2.6, Sound and Vibration, Co-sponsored by: **TC 2.1**, Physiology and Human Environment

As problems with noise can impact building owners, designers, developers, contractors and policy makers, this research has great value to the society. We estimate that a large part of the society in total will be affected within 10 years, as the data gathered in this project are embedded into the ASHRAE Handbooks and eventually into design criteria, regarding noise from building services equipment. A further benefit is that manufacturers of building services equipment will have quantitative guidelines with which to benchmark their equipment. Eventually the data will lead to or inform the development of an industry-accepted metric to quantify the tonal nature of equipment noise. The likelihood of this progress is high and is expected to be adopted by the industry smoothly as there is currently a vacuum of information. We do not foresee any intellectual property rights resulting from this project.

1710-RP ***Effects of Dynamic Shading Devices on Daylighting and Energy Performance of Perimeter Zones***

September 2016 – January 2019; Iowa State University; **Principal Investigator**: Kristin Cetin;
TC 4.5, Fenestration; Co-sponsors: none;
Indoor environment and occupant comfort is a key aspects of ASHRAE's contribution to the industry. The proposed research will provide detailed and accurate results of the measured and verified daylighting performance and lighting energy savings using dynamically controlled shading devices –primarily interior roller shades and venetian blinds, most commonly used in commercial buildings in North America. These results will be beneficial in developing the guidelines for engineers and building designers involved with envelope options and energy use.

1711-RP ***Advanced Sequences of Operation for HVAC Systems - Phase II Central Plants and Hydronic Systems***

September 2017 – August 2019; Taylor Engineering; **Principal Investigator**, Steve Taylor
TC 1.4, Control Theory and Application; Co-sponsors: none;
ASHRAE members will benefit due to the reduced time to prepare, program, and commission control systems, as noted above. It is expected that most DDC system manufacturers will program the ASHRAE sequences into their systems so that they can be used or easily adapted for most any HVAC system application, reducing the cost and improving the performance of DDC systems.

1719-RP ***Design Guide for Cool Thermal Storage – Update/Revision***

April 2017 – January 2019 (P); GARD Analytics; **Principal Investigator**, Jason Glazer; **TC 6.9**, Thermal Storage; Co-sponsors: none;
ASHRAE is the worldwide recognized authority on the application of thermal energy storage to cooling applications. A recent web search revealed no fewer than eight (8) energy storage conferences slated for a typical year. There is an undeniable realization that energy storage is a critical component of our energy future. It should be recognized that thermal energy storage is one of the few (if not the only) storage technologies that has developed into a commercially successful, economically justifiable, widely accepted system for individual buildings or multi-building facilities. ASHRAE must maintain its leadership role in this technology by providing accurate, current and complete design guidance – guidance only obtainable through the technical expertise of ASHRAE.

1720-RP ***Validation of Gas Phase Air Cleaner Performance Test Method (Standard 145.2) by Laboratory Testing of Commercially Available Filtration***

September 2017 – August 2019; RTI International; **Principal Investigator**, Kathleen Owen; **TC 2.3,**
Gaseous Contaminants/Removal Equipment , Co-sponsored by: SSPC 145: Test Methods for Assessing Performance of Gas Phase Air Cleaning Equipment & SSPC 62.1: Ventilation for acceptable indoor air quality
Validating the 145.2 Standard will facilitate the use of the IAQ Procedure ASHRAE Standard 62.1 "Ventilation for acceptable indoor air quality" by providing the quantitative information from this test validation of gas phase filters that can be used during the IAQ Procedure and provide the end user with quantitative information for gas phase filter selection. Potentially a large percentage of ASHRAE's engineer members could be influenced, in addition to building operators, HVAC contractors, and equipment installers. The results from this project will also facilitate development of an improved gas-phase filter Users' Guide for engineers, contractors and installers, and guidelines for laboratories wishing to implement the Standard and incorporate the filters.

1721-RP ***Oil Return and Retention in Unitary Split System Gas Lines with HFC and HFO Refrigerants***

ril 2017 – March 2019; Purdue University; Principal Investigator; Eckhard Groll, **TC 8.11**, Unitary and Room Air Conditioners and Heat Pumps, Co-sponsored by: TC 10.3 Refrigerant Piping, Controls and Accessories; TC 3.4, Lubrication; **AHRTI** $12,070 co-funder
The objective of this project will be to develop rules for sizing refrigeration interconnecting gas piping in unitary split systems to ensure oil return to the compressor in both air-conditioning and heat pump applications. Both horizontal and vertical lines would need to be addressed. The rules that are developed would be such that they would be applicable to all existing refrigerant-oil combinations currently in use as well as new.

1729-RP ***Experimental Verification of Cooling Load Calculations for Spaces with Non-Uniform Temperature Radiant Surfaces***

September 2016 – January 2019; University Texas – Austin; **Principal Investigator**, Atila Novoselac; **TC 4.1**, Load Calculation Data and Procedures Co-sponsors: none;

The results of the project will improve the cooling load methods described in ASHRAE Handbook of Fundamentals by enhancing their applicability to radiant systems that utilize radiation heat transfer to directly remove space heat gains from the conditioned space. Knowledge of the dynamic interaction of radiant systems with various heat sources will produce guidelines for modeling space conditioning systems that involve radiation heat transfer, which include radiant and stratified systems (UFAD and displacement ventilation) that will create non-uniform surface temperatures in the space. The results and improved modeling methods from this project could also be used in future efforts to update the Radiant Time Series method for radiant cooling applications or the weighting factor method for energy performance modeling.

1733-RP ***Develop Design Criteria for Psychrometric Air Sampler and Mixer Apparatus for use in ASHRAE Test Standards;***

August 1, 2018 – March 31 2020; Oklahoma State University, **Principal Investigator**: Christian Bach; **TC 8.11**, Unitary and Room Air Conditioners and Heat Pumps; Co-sponsors: none; **AHRTI** $15,000 Co-funder

This research will improve the consistency between the manufacturer and audit test facilities, which will result in less risk and improved verification of compliance standards. This project will provide technical detail to HVAC testing laboratories that test unitary systems where the air must be sampled for both dry bulb temperature and humidity. This sampling impacts all users of psychrometric test facilities from the development of performance ratings to the verification of compliance with energy efficiency standards.

1734-RP ***Reproducing a Representative Urban Atmospheric Aerosol Distribution at High Concentration in the Laboratory for Air Filter Ageing to be used in ASHRAE GPC 35P for Determining the Energy Consumption Caused by Air Filters***

August 2017 – July 2019; Purdue University, **Principal Investigator**: Brandon Boor; **TC 2.4**, Particulate Air Contaminants and Particulate Contaminant Removal Equipment, Co-sponsored by: SSPC 52. Method of Testing General Ventilation Air Cleaning Devices for Removal Efficiency by Particle Size

The results from this work statement would affect the energy usage and design criteria for several ASHRAE Handbook Chapters and Standards. The Handbook chapters that would be affected are Chapter 29 - Air Cleaners for Particulate Contaminants, HVAC Systems and Equipment Handbook; and Chapter 46 - Control of Gaseous Indoor Air Contaminants, Applications Handbook.

1741-RP ***Understanding Fan Coil Components and How They Relate to Energy Consumption and Energy Modeling***

January 2017 – December 2019; University Louisiana Lafayette; **Principal Investigator**, Peng Yu **TC 5.3**, Room Air Distribution, Co-sponsored by: TC 7.7, Test & Balance; **AHRTI** $16,084 Co-funder

The experimental results and recommendations will result in previously unavailable part load capacity and efficiencies maps for fan coil systems. The new tools and modeling options developed will improve the ability of design engineers to evaluate and predict the energy and comfort performance of buildings using fan coil systems. The better understanding of efficiencies at part load operations achieved from this project will allow more confident applications by system designers. This will reinforce the value of ASHRAE guidelines to building systems, and support ASHRAE's net-zero energy design strategies. This research will be of great value to the Engineering community, and provide more pertinent and accurate information in the selection of fan coils for any given application. In obtaining the accurate information needed for fan coil selection, sizing issues will decrease and reduce overall energy consumption significantly.

1743-RP ***Effect of Inlet Duct and Damper Design on ASHRAE 37/116 Fan Performance and Static Pressure Measurements***

August 2017 – January 2019; Oklahoma State University, **Principal Investigator**; Christian Bach, **TC 8.11**, Unitary and Room Air Conditioners and Heat Pumps; Co-sponsors: none; **AHRTI** $15,000 Co-funder

The major benefit of this project is to provide technical clarification to HVAC testing laboratories when testing samples. This subject impacts all users of unitary air-conditioning equipment such as DOE, California Energy Commission, independent test facilities and manufacturers of unitary equipment. Standardization will provide more consistent setups and repeatability between manufacturer's laboratories and 3rd party certification laboratories.

1745-RP ***Evaluation of Climate Reanalysis Data for use in ASHRAE Applications***

September 2017 – August 2018; Klimaat Consulting & Innovations; **Principal Investigator**, Michael Roth; **TC 4.2**, Climatic Information; Co-Sponsors: None

Climate reanalysis data provides ASHRAE with the possibility of having climatic data for any location in the world, thus promising to solve for all time and place the problem of weather data availability. Unfortunately, although increasing numbers of atmospheric scientists have been using climate reanalysis in their work, there has yet to be a thorough analysis of the accuracy and reliability of these data for the needs of ASHRAE members, such as the calculation of ASHRAE Design Conditions or the creation of hourly weather files for use in building energy analysis. The net benefit for ASHRAE is that members and contractors will have a good understanding of what climate reanalysis data can provide in expanding the amount of available weather data, and the means to obtain and utilize this new data source.

1747-RP ***Implementation of RP-1547 CO2-based Demand Controlled Ventilation for Multiple Zone HVAC Systems in Direct Digital Control Systems***

September 2015 – January 2019 (P); University of Alabama; **Principal Investigator,** Zheng O'Neill; **TC 4.3**, Ventilation Requirements and Infiltration; Co-sponsor: TC 1.4 Control Theory and Application

This research project will provide the following: Practical sequences for VAV system DCV, articulated in English and represented in a logic flow diagrams. Simulation studies to evaluate energy and ventilation performance, including the impact of sensor error. Functional performance test scripts to allow for field or factory commissioning of DCV sequences. Thorough field testing of the sequences to ensure stability under a wide variety of operating conditions. Greatly simplified design procedure for HVAC engineers, which will result in significant reduction in engineering effort and eliminate the errors commonly found in applying Standard 62.1's Multiple Spaces Equation.

1755-RP ***Impact of Gaseous Contamination and High Humidity on the Reliable Operation of Information Technology Equipment in Data Centers***

July 2016 – January 2019; Syracuse University; **Principal Investigator**, Jianshun Zhang; **TC 9.9**, Mission Critical Facilities, Data Centers, Technology Spaces and Electronic Equipment; Co-sponsored by: TC 2.3, Gaseous Air Contaminants and Gas Contaminants Removal Equipment

The project will address the impact that gaseous contamination has when adopting the expanded thermal guidelines for data processing equipment. Specifically, it will look at the impact that the expanded acceptable humidity envelope has on IT equipment reliability when subject to environments that have higher than normal concentrations of gaseous contaminants.

1756-RP ***Evaluation of Particle Sensors for Indoor Air Quality Monitoring and Smart Building Systems***

January 2018 – June 2019; Ohio State University; **Principal Investigator,** Andrew May; **TC 2.4**, Plant and Animal Environment, Co-sponsored by: TC 7.5, Smart Building Systems

The objectives of this proposed research are to fully test and document the performance of a large number of commercially available PM sensors and to provide recommendations for developing ASHRAE standards and guidelines for evaluating their performance for applications in IAQ monitoring and integration into smart building systems.

1759-RP ***Impact of Air-Flow on Thermal Performance of Air-Spaces behind Cladding (Phase 1 of 2)***

September 2018 – August 2019; Ecole Polytechnique; **Principal Investigator:** Dolaana Khovalyg; **TC 4.4**, Building Materials and Building Envelope, Co-sponsors: None

The objective of this project is to quantify the effect of and establish testing and design recommendations to account for the impact of air exchange rates (or ventilation air flow) on the thermal resistance of vertical air spaces behind selected cladding systems that are exterior to the air barrier. It is envisioned that the air space behind the selected claddings will include assemblies with and without at least one surface that is perpendicular to the primary direction of heat flow with an initial total hemispherical emittance less than 0.10. Air exchange rates or ventilation flows into and out of the airspace and the impact on thermal resistance will be assessed and used in testing and analysis of thermal performance. Results will be used to recommend changes and additions to applicable test standard(s), the ASHRAE Handbook of Fundamentals [9], and ASHRAE Standard 90.1

1760-RP ***Update of Clothing Database for Existing and New Western Clothing Ensembles, Including Effects of Posture, Body and Air movement***

April 2018 – June 2019; Loughborough University; **Principal Investigator**: George Havenith; **TC 2.1** Physiology and Human Environment, Co-sponsors: None

To improve the clothing database, to provide data that are not presently available for input into Standard 55 and other models, and to make these standards and methodologies more accurate in their application to situations where western attire is worn.

1762-RP ***Update the ASHRAE Design Guide for Combustion Turbine Inlet Air Cooling Systems Published in 1999***

January, 2018 – January 2019; Avalon Consulting, Inc.; **Principal Investigator:** Dharam V. Punwani; **TC 1.10**, Cogeneration Systems; Co-sponsored by: TC 6.9, Thermal Storage & TC 6.2, District Energy; **Turbine Inlet Cooling Association** $5,000 Co-funder

The overall objective of the proposed project is to update the CTIC Design Guide published in 1999. The results of the project will create a source of revenue by selling the design guide, and benefit handbook chapters for CHP and CTIC and the professional development course (PDC) in Cogeneration/Combined Heat & Power.

1764-RP ***Determine the Absolute Roughness of Phenolic Duct***

September 2017 – October 2018 (P); Tennessee Technological University; **Principal Investigator:** Steven Idem; **TC 5.2**, Duct Design; Co-Sponsors: None

Phenolic ducts are a new product in the HVAC industry, and they need additional technical data to support their use by designers. Subject research will result in new data for inclusion in the ASHRAE Duct Fitting Database (Exhibit 1) and the Duct Design chapter in the Handbook of Fundamentals.

1766-RP ***Development of a Unified Tool for Analysis of Room Loads and Conditions***

December 2015 – January 2019 (P); Building and Systems Analytics LLC; Principal Investigator, Peter Simmonds; **TC 6.5**, Radiant Heating and Cooling

The objective of the proposed work is to produce a unified space analysis application that calculates and displays room conditions, heating and cooling loads (delivered by air-based and/or radiant systems), and mean radiant temperature (MRT). We provisionally name this application RPEHB, since it is an integration of RPE with the HB (heat balance) load calculation method. The inputs for RPEHB calculations will be room shape, construction, operational requirements (e.g. control set points), and design-day weather conditions. Preparation of geometric input data will be supported by import from 3D tools such as SketchUp.

1767-RP ***Moist Air Transport Properties Research***

September 2015 – December 2018; Kretzschmar Consulting Engineers; **Principal Investigator,** Mark DeRoo; **TC 5.1,** Fans; Co-Sponsors: None

The objective of this project is to make the ASHRAE technical literature and ASHRAE Handbook of Fundamentals the most current and most accurate source of data for the transport properties of the substances air, moist air, and water. Therefore, new SI and IP Moist Air Property tables Transport Properties of Moist Air at Standard Atmospheric Pressure (101.325 kPa) for the ASHRAE Handbook of

Fundamentals, Psychrometrics Chapter will be prepared. The new tables will contain values for viscosity, thermal conductivity, temperature diffusivity, Prandtl number, and kinematic viscosity, as well as density at atmospheric pressure in the temperature range of −70 to 300°C. This incorporates the research of Lemmon and Jacobsen (2004) for dry air viscosity and thermal conductivity, the International IAPWS standards on the properties of H2O for viscosity and for thermal conductivity as well as the latest International values for the Universal Gas Constant and the Relative Molar Masses of H2O and the gases that make up dry air.

1769-RP ***Experimental Evaluation of the Efficiency of Belt Drives for Fans***

September 2018 – August 2020; AMCA International, Inc; **Principal Investigator**, Mark DeRoo; **TC 5.1** Fans; Co-sponsors: None; **AHRTI** $12,000 Co-funder

The results of this research effort will provide tools to air system designers to allow them to separate out the impacts of belt part-load efficiency on system efficiency, to compare the efficiency levels of belt- and direct-driven fans, and to balance energy savings with other requirements used in the fan system selection process.

1771-RP ***Energy Modeling of Typical Commercial Buildings in Support of ASHRAE Building Energy Quotient Energy Rating Program***

April 2016 – April 2019; University of Colorado - Boulder; **Principal Investigator**, Wangda Zuo**; bEQ**, Building Energy Quotient Energy Rating Program; Co-sponsored by: TC 7.6, Building Energy Performance, TC 4.7, Energy Calculations;

The overall objective of the proposed research is to reconcile the differences between the empirical and modeled baselines for energy performance comparison for new commercial building designs and existing commercial buildings, allowing seamless translation of building energy performance metrics among LEED, Standard 90.1, Standard 189.1, Standard 100, and the bEQ *As Designed* and *In Operation* ratings. The proposed research will contribute to a better understanding of the role of neutral variables in building energy modeling predictions. The research will also lead to consistency of energy performance metrics for Standard 90.1 (and LEED), Standard 189.1, and Standard 100.

1774-RP ***Effects of System Chemicals on Breakdown of Lubricants and Lower GWP Refrigerants***

September 2017 – September 2018; Spauschus Associates; **Principal Investigator**, Ngoc Dung (Rosine) Rohatgi; **TC 3.2**, Refrigerant System Chemistry; Co-sponsored: TC 3.3, Refrigerant Contaminant Control and, TC 3.4, Lubrication; **AHRTI** $9,658 Co-funder

Information is needed to ensure short- and long-term reliability of air-conditioning and refrigeration equipment using lower GWP refrigerants and synthetic lubricants. Contaminants in refrigerant systems can lead to lower efficiency or even system failure, and there have been no study published to date on the potential process chemical reactivity with lower GWP refrigerants compared to currently applied system chemistries. Process chemicals in use today are not expected to change as refrigerant chemistries are changed; thus, it is necessary to understand the magnitude of any increased system chemistry risks with lower GWP refrigerants, to identify classes of contaminants that could potentially promote breakdown, and compare these risks to those managed today.

1778-RP ***Heat and Moisture Load from Commercial Dishroom Appliances and Equipment***

September 2018 - February 2020; Frontier Energy, Inc. **Principal Investigator**, Richard Swierczyna; **TC 5.10**, Kitchen Ventilation; Co-Sponsors: None

The research need for this project is driven by the needs of the design engineer. ASHRAE consultants and designers complain about inadequate design data to calculate the internal loads from dishroom equipment. The result is undersized HVAC equipment and poor distribution that leads to hot and humid kitchens. The hot and humid kitchens have resulted in poor working conditions, low productivity and bad morale (ASHRAE RP-1469, 2013). The data and procedures developed by this project would provide guidance for a comfortable and healthy dishroom environment, with ASHRAE as the authoritative, ‘go to’ source, for the necessary information, thereby raising ASHRAE’s profile internationally.

1785-RP ***Experimental Validation of Refrigerant Charge Models in Coils for Residential Split Systems***

August 2017 – January 2020; Oklahoma State University; **Principal Investigator**: Christian Bach; **TC 8.11**, Unitary and Room Air Conditioners and Heat Pumps, Co-sponsored by: TC 8.4, Air-to-Refrigerate Heat Transfer Equipment and TC 6.3, Central Forced Air Heating and Cooling Systems; **AHRTI** $13,691 Co-funder

This project will improve equipment models so that they may more accurately reflect the real performance of actual systems in the field. This is of value to BEM practitioners as well as to equipment designers. The ASHRAE Handbook of Fundamentals (2013) outlines several energy modeling tools that are widely used in the industry (e.g., DOE2, EnergyPlus, TRNSYS) and the current methodologies for equipment modeling (Regression Models and First-Principle Models). Unitary split systems, especially heat pumps, which are used widely in both Residential and Commercial applications pose unique challenges. Since not every rated split system match is lab tested, modeling is leaned on heavily. A weak link in this process is refrigerant charge inventory. Improving the robustness of charge migration modeling will result in greater confidence in the design and selection process for engineers in the field, rating agencies, and manufacturers.

1794-RP ***White paper investigation relating to the use of odorants in flammable refrigerants***

September 2018 – January 2018; Jensen Hughes, Inc.; **Principal Investigator**: Eric Forsell, PE; **TC 3.1**, Refrigerants and Secondary Coolants; Co-Sponsors: None

Currently, odorants are not approved for use in HVAC&R refrigerants despite their obvious utility and there are no known public initiatives to qualify them. Many people in the HVAC&R industry are wondering why odorants are not being used. Given this, the industry needs a starting point and the goal of this project is to consolidate information in one place to help the industry understand the magnitude of the challenge (or lack thereof) and to set a path forward. It is unclear how many previous studies within HVAC&R have been performed and there is no one-stop resource to communicate this information. It is also the goal of this research to highlight the research gaps still in existence relative to the incorporation of odorants and to propose future research in this area within ASHRAE.

1800-RP ***Spray Evaporation on Enhanced Tube Bundles with Low GWP pure Refrigerants and Refrigerant/Miscible Oil Mixture***

September 2018 – February 2021; Auburn University; **Principal Investigator**: Lorenzo Cremaschi; **TC 1.3**, Liquid to Refrigerant Heat Exchangers; Co-Sponsors: None

This study would help the industry to understand the physics of thin film evaporation phenomenon for pure low GWP refrigerants and refrigerant/miscible oil mixtures on structured 3-D enhanced tubes and help optimize such exchangers for air-conditioning and refrigeration applications. The basic objective of this project will be to perform spray evaporation heat transfer and pressure drop tests on a tube bundle with low GWP refrigerants and refrigerant/miscible oil mixtures at various temperature and pressure conditions of interest to air-conditioning and refrigeration industry. The universal correlations and/or charts would be developed for the general benefit of the stakeholders. The investigator(s) is/are expected to present the results of the study in a manner that clearly and quantitatively shows the enhancement factors achieved compared to conventional flooded evaporators and its impact on the overall COP of a chiller.

1801-RP ***Standardizing and Utilizing ASHRAE Online BIM Data Exchange Protocols***

September 2018 – February 2021; Hitchcock Consulting; **Principal Investigator**: Robert J. Hitchcock; **TC 1.5**, Computer Applications; Co-Sponsors: MTG-BIM, MTG, Building Information Modeling & TC 7.1, Integrated Building Design

The objective of this research project is to bring data exchange protocols based on ASHRAE publications, to useable completion and availability by aligning ASHRAE exchange protocols with relevant existing BIM standards, creating neutral format data content downloadable from the new ASHRAE data repository (data.ashrae.org) documenting end-user guidance to support ASHRAE members in implementing these data exchange protocols in the adoption of BIM in their professional practice. A long term objective is to

use this example to encourage ASHRAE committees to develop additional data exchange protocols based on their publications.

1806-RP ***Flammable Refrigerants Post-Ignition Simulation and Risk Assessment Update***
January 2017 – June 2019 (P); Gexcon, US; **Principal Investigator**: Scott Davis; **MTG.LowGWP**, Low Global Warming Potential Alternative Refrigerants
The objective of this project is to understand the Severity of events where flammable refrigerants are ignited under different scenarios for various HVAC&R products. Such understanding will allow for the assessment of the overall risks of using flammable refrigerants in HVAC&R products, taking into account both event Probability and Severity.

1807-RP ***Guidelines for Flammable Refrigerant Handling, Transporting, Storing and Equipment Servicing, Installation and Dismantling***
March 2017 – October 2018 (P); Navigant Consultant Inc.; **Principal Investigator**: William Goetzler; **MTG.LowGWP**, Low Global Warming Potential Alternative Refrigerants
This proposed project will investigate current information related to installation practices as well as servicing and handling aspects for all equipment that use A2, A2L and A3 refrigerants. There are varied skill levels that exist within the HVAC&R industry in the US, and introduction of flammable refrigerants could increase the need for specialized processes, training, and/or certifications as part of risk mitigation.

1808-RP ***Servicing and Installing Equipment using Flammable Refrigerants: Assessment of Field-made Mechanical Joints***
May 2017 – November 2018 (P); Creative Thermal Solutions, Inc.; **Principal Investigator**, Stefan Ebel; **MTG.LowGWP**, Low Global Warming Potential Alternative Refrigerants
It is necessary to identify those joining techniques used in the HVAC&R industry that are prone to failure if precaution is not used during equipment installation, servicing and repair, particularly when using flammable refrigerants. The information generated from this project will be crucial to the development of ASHRAE Standard 15.2, which will specify the safe design, installation, operation and maintenance of residential air-conditioning and heat pump systems containing flammable refrigerants. In addition, the results of this research will inform proposed changes to ASHRAE Standard 15 and other relevant codes and standards regarding permissible types of joints to be used during field installation and repair of a wide range of HVAC&R equipment containing flammable refrigerants.

1814-RP ***Actual Energy Performance of Secondary Schools and Medium Offices Designed to Comply with ASHRAE Standard 90.1-2010***
September 2018 – May 2020; Seventhwave; **Principal Investigator**: Xiaohui Zhou; **TC 2.8**, Building Environmental Impacts & Sustainability; Co-Sponsor: TC 7.6, Building Energy Performance
This project will help ASHRAE maintain its leadership position by developing energy standards and other publications targeted to commercial buildings that will help engineers, designers, contractors and owners build and operate progressively more energy-efficient facilities that deliver acceptable indoor environmental quality.

1819-RP ***CO2 Demand Controlled Ventilation in Multiple Zone VAV Systems with Multiple Recirculation Paths***
September 2018 – May 2020; University of Alabama; **Principal Investigator**: *Zheng O'N*eill; **TC 4.3**, Ventilation Requirements and Infiltration; Co-Sponsors: None
This research project is intended to address the second shortcoming: expanding DCV to include multiple zone VAV systems with multiple recirculation paths, such as systems with fan-powered terminals and dual duct systems.

1821-RP ***Design Guide for Low-to-Mid-Rise Multifamily Residential Buildings***
January 2018 – November 2018; New Building Institute; **Principal Investigator**: *Sean Denniston*; **RBC**, Residential Building Committee; Co-Sponsors: None
While ASHRAE has made numerous contributions to HVAC&R, there is no documentation enabling the Society and its members to describe the magnitude, breadth and importance of those contributions. This project will document specific impacts and value of ASHRAE's standards and technology (standards,

guidelines, design guides, other publications, research, and certification and training activities). Impact assessments will be objective, verifiable, and data-driven to estimate their magnitude (quantitative) and/or significance (qualitative). Since ASHRAE collaborates with other organizations and stakeholders, impacts are those for which ASHRAE's contribution is significant. It is not necessary to limit impacts to those for which ASHRAE is solely responsible or to estimate the magnitude of ASHRAE's "share."

1823-RP ***Improved Exhaust-to-Intake Dilution (Concentration) Calculations***
September 2018 – June 2019; Ohio State University; **Principal Investigator**: Jordan Clark; **RBC,** Residential Building Committee; Co-Sponsors: None
The objective of the proposed study are to determine whether the h_{top} criterion in Chapter 45 of the 2015 HVAC Applications volume of the ASHRAE Handbook is needed or can be improved upon and to simplify the methodology so that one surface roughness calculation can be utilized. If the h_{top} criterion can be eliminated, dilution estimates will be much less conservative for many real-world exhaust/intake design applications. If only one surface roughness calculation is needed, the method will be much simpler to apply. The method currently used for calculating $\tilde{A}_y$ and $\tilde{A}_z$

1844-URP ***Estimating Internal Moisture Generation Rates in New, Occupied Homes – Pending that Contract is finalized***
September 2018 – February 2021; University of Central Florida; **Principal Investigator**: Eric Martin; **TC 1.12**, Moisture Management in Buildings; Co-Sponsors: None
This URP intends to collect data for use in updating estimates of internal moisture generation rates as a function of the number of occupants. This URP intents to accomplish this objective by capitalizing on an existing US Department of Energy funded study already planning to 1) recruit a sample of new, occupied homes and 2) carry out a detailed data collection protocol yielding much of the information needed. This URP proposes to increase the number of homes where key measurements related to internal moisture generation estimates are being taken from 15 homes with just DOE funding to 45 with DOE and ASHRAE funding, and inform the data collection and analysis procedures by conducting validation in simulated occupancy laboratory homes.

POTENTIAL PROJECTS PENDING BID, REBID, OR AWARD THIS FALL

1644-TRP, *Smoke Control in Long Atria*; **TC 5.6**, Control of Fire and Smoke; Co-Sponsors: None
This project will use CFD simulations to develop limits and guidelines for use in designing smoke control systems for long atria such as malls, airport terminals, and concourses in stadiums and arenas. The few guidelines that currently exist were based on committee beliefs about what might be appropriate, but were not determined from experimental data. Current design tools do not address cooling of smoke due to heat transfer from the smoke to the surrounding walls, ceiling, or other building structures and the resulting descent of the smoke into occupied space. This project will establish the maximum design distance for horizontal smoke travel before the smoke layer is expected to start descending toward the floor. This will provide designers with guidance on when a smoke zone should be subdivided, or when additional exhaust fans are needed. Without this knowledge, systems may be under-designed resulting in a life safety hazard and a liability for the designer, or over-designed leading to additional cost and excess energy usage.

1683-TRP-R, *Experimental Evaluation of Two-Phase Pressure Drop and Flow Pattern in U-Bends with Ammonia*; **TC 1.3**, Heat Transfer and Fluid Flow; Co-sponsored by: TC 8.4, Air-to-Refrigerant Heat Transfer Equipment.
Ammonia has historically been the preferred refrigerant in industrial refrigeration systems. However, due to increasing interest in natural refrigerants engineers are investigating its use in commercial refrigeration and HVAC systems as well. A good estimate of refrigerant pressure drop is important to design a compact and effective heat exchanger. Heat exchangers used for ammonia are of the conventional fin and tube type which has return bends and U-bends. The objective of this project is to generate data regarding the pressure drop in U-bends in fin and tube heat exchangers used in ammonia applications. The data generated will be used to develop pressure drop correlations and associated void fraction models for U-bends.

1740-TRP-R, *Hydrogen Fluoride Capacity of Desiccants*; **TC 3.3**, Refrigerant Contaminant Control; Co-sponsored by: TC 3.2, Refrigerant System Chemistry

The overall task is to develop a method of testing the equilibrium hydrogen fluoride capacity of desiccants and use the method to determine the equilibrium hydrogen fluoride capacity of molecular sieve and activated alumina desiccants at the conditions specified in the scope section of this WS.

Since hydrogen fluoride is a potentially dangerous chemical, it is paramount that the contractor fully understand the hazards involved in working with it. The contractor shall, in the proposal, identify in detail the measures to be taken to reduce hazards through use of proper Personal Protective Equipment, laboratory facilities, and procedures. In the selection process weight will be given based on the quality of safety measures.

1780-TRP *Test Method to Evaluate Cross-Contamination of Gaseous Contaminant within Total energy Recovery Wheels*; **TC 9.10**, Laboratory Systems; Co-sponsored by: TC 2.3, Gaseous Air Contaminants and Gas Contaminant Removal Equipment; TC 9.6, Healthcare Facilities; SSPC 62.1, Ventilation for Acceptable Indoor Air Quality

This project will develop a test procedure to evaluate the cross contamination recapture of gaseous contaminants in Air to Air Total Energy recovery devices wheels when used for laboratory ventilation. Without knowledge of the risk associated with cross-contamination appropriate methods to measure recapture, the practitioner will not be able to specify this type of high efficiency equipment. Laboratory tests will be conducted to evaluate the gaseous contaminant transfer under different operating conditions and with different types of gases.

This research is very important to ASHRAE as it will help to improve the energy efficiency of laboratory buildings while ensuring safe environments by maintaining a high level of indoor air quality. It will also allow design engineers to evaluate any potential impact on the indoor air quality of more traditional buildings when employing this technology

Laboratory tests will be conducted to evaluate the gaseous contaminant transfer under different operating conditions and with different types of gases. Research will be conducted to identify appropriate exemplar gasses and acceptable measurement methods thereof, and assess the ranges of operating conditions under which measurements must be performed in the process of validating of exchangers installed in laboratories ventilation systems for specific purposes.

1784-TRP, *Repeatability and Reproducibility Assessment of ASHRAE Standard 52.2 as currently Amended*; **TC 2.4**, Particulate Air Contaminants and Particulate Contaminant Removal Equipment; Co-sponsored by: SSPC 52.2, Method of Testing General Ventilation Air Cleaning Devices for Removal Efficiency by Particle Size;

ASHRAE Standard 52.2 – Method of Testing General Ventilation Air Devices for Removal Efficiency by Particle Size was issued in 1999 and it is under continuous maintenance. The main goal of this project is to evaluate the repeatability and reproducibility of ASHRAE Standard 52.2-2017, and to identify additional sources of variability. This project will test selected commercially available particle air filters to validate recent changes to ASHRAE Standard 52.2. The PI will procure, pre-test and distribute the filters, coordinate laboratory testing, and analyze the results to form conclusions and recommendations. ASHRAE should fund this research to help establish the reliability and tolerance of this key standard.

Because Standard 52.2 is under continuous maintenance for continuous improvement, the results from this project will contribute directly to improving reliability and credibility of ASHRAE Standard 52.2.

1789-TRP-C, *Optical and Thermal Performance of Hollow Glass Block Units;*

TC 4.5, Fenestration; Co-Sponsors: None

Glass block windows are made of a group of hollow glass block (HGB) units joined together with an interface material consisting of mortar/adhesive and structurally reinforcing metallic elements. HGB are used in exterior envelopes of commercial and residential buildings as durable masonries and fenestration systems. HGB industries have recently evolved to include new energy-efficient technologies to stay at the competitive edge with high performance flat glass windows. The ASHRAE HOF includes very old (since

1965) performance data of HGB. Furthermore, current energy rating procedures of HGB windows use measurement for VT, SHGC and U-factor of HGB windows due to their complex geometry and glazing types. This project will develop a methodology to predict the optical (VT) and thermal (SHGC and U-factor) performance of HGB windows (panels). Validation procedures will also be developed to validate the models with measurement and three-dimensional heat transfer computer simulation. The project deliverable will be a research report presenting the following:

(1) Literature review on HGB component design and performance;
(2) Prediction models for the optical performance (transmittance and pane absorptances) of HGB windows;
(3) Prediction models for the thermal performance (SHGC, U-factor) of HGB windows;
(4) Experimental validation of the optical models; and
(5) Experimental and CFD validation of the thermal models.

A full set of all experimental data collected and CFD simulation results will accompany the final report. Upon completion of the project, at least one technical paper will be prepared to summarize the results of the research, including producing representative performance data of HGB windows to update the Fenestration Chapter of the ASHRAE HOF.

1790-TRP-R, *Distribution of Water between Vapor and Liquid Phases for LowGWP Refrigerants*;
TC 3.3, Refrigerant Contaminant Control; Co-Sponsors: None
The proposed research enables the AC&R systems using these low GWP refrigerants to perform effectively, efficiently, and reliably. In addition, proper contamination control of moisture can extend the effective life and reduce repair costs of a system making them a financial success for the building owner or user.

1810-TRP, *Development of Reference Building Information Model (BIM Test Cases for Improving Usage of Software Interoperability Schemas*;
TC 1.5, Computer Applications; Co-Sponsors: None
ASHRAE members and the Society as a whole have expressed increasing interest in adopting Building Information Modeling (BIM) to improve professional work processes and the overall performance of the built environment.
This research project will promote the usage of BIM-enabled work processes as it will make it easier for practitioners to take advantage of software tools such as building energy analysis software that communicate with BIM-authoring tools. The overall objectives of this research project are: 1) to develop 20+ gbXML test case documents that software vendors can follow to develop their own gbXML files that will then be uploaded to a web-based validator that will provide feedback on the validity of the files.; 2) Develop 20+ corresponding gbXML files, 1 for each test case, that provide templates for software vendors to base their outputs upon; 3) Further develop an existing web-based validator software tool that will validate the 20+ test cases; 4) Upload all deliverables including software vendor output files to data.ashrae.org. This is all in the name of improving the interoperability experience between BIM authoring tools and building analysis software tools.

1816-TRP, *Reporting the Energy use and Heat Gain from Imaging Equipment;*
TC 9.6, Healthcare Facilities; Co-sponsored by: TC 4.1, Load Calculations and Data Procedures and TC 4.7, Energy Calculations
This research will determine heat gain and energy use for large, often multi-component, imaging systems in the field. Results will be used to update and expand current data in multiple ASHRAE publications. It will also provide energy use metrics for energy modeling and medical equipment comparisons in HVAC designs.

1830-TRP, *CO2 Demand Controlled Ventilation in Multiple Zone VAV Systems with Multiple Recirculation Paths*; **TC 9.3**, Transportation Air Conditioning; Co-Sponsors: None
Detecting certain bleed air contaminants is a key provision in ASHRAE Standard 161, Air Quality within Commercial Aircraft, and was instrumental to consensus. Unfortunately, there is no defined method to meet this requirement. A recent, NASA - Air Force - FAA project indicates that ultrafine particle sensing

has good potential to meet this requirement. However, there are unanswered questions in the information the project provided as it was not addressed at Standard 161. For modest cost, the proposed research will answer these questions and determine the extent to which ultrafine particle sensing will meet the needs of Standard 161.

1833-TRP-C, *Literature Review for Evidence of the Basis for Specified Air Change Rates (ACR) for Cleanrooms, Laboratories, Laboratory Animal Facilities, and Healthcare Facilities with Medium to High ACR*; **MTG.ACR**, Air Change Rates; Co-Sponsors: None;
Develop a "Best Practices" Design Guide for stakeholders in the low-to-mid-rise multifamily building sector to improve energy efficiency and indoor environmental quality. This guide is not to be a "minimum" guide as is common with many standards but should instead direct users toward high performance buildings. Final materials beyond a formal "book" are welcome, e.g. online content, videos, etc. are welcome and encouraged, e.g. online.

1836-TRP-C, *Improved Exhaust-to-Intake Dilution (Concentration) Calculations*; **TC 4.3**, Ventilation Requirements and Infiltration; Co-Sponsors: None
The objective of the proposed study are to determine whether the h_{top} criterion in Chapter 45 of the 2015 HVAC Applications volume of the ASHRAE Handbook is needed or can be improved upon and to simplify the methodology so that one surface roughness calculation can be utilized. If the h_{top} criterion can be eliminated, dilution estimates will be much less conservative for many real-world exhaust/intake design applications. If only one surface roughness calculation is needed, the method will be much simpler to apply. The method currently used for calculating S_Y and S_Z will also need to be improved.

1837-TRP, *The Effects of Ventilation in Sleeping Environments*; **TC 2.1**, Physiology and Human Environment; Co-sponsors: None;
Energy conservation, privacy and security considerations result in low ventilation rates in sleeping environments in many different climatic zones. A first experiment has shown that this may lead to reduced sleep quality that affects next-day performance. Reduced sleep duration and quality has been implicated in many negative outcomes, including earlier-onset dementia, but is increasingly common. The proposed work may lead to a revision of ASHRAE Standards 62.1 and 62.2: in two different climatic zones, it will document current air change rates in bedrooms and perform field intervention experiments to determine the effects of low outdoor air supply rates on sleep

1847-TRP, *Updating Climatic Design Information for 2021 ASHRAE Handbook, Standard 169, and the Handbook of Smoke Control Engineering;*
TC 4.2, Climatic Information; Co-Sponsors: TC 4.1, Load Calculations Data and Procedures, TC 5.6, Fire and Smoke Control
The tables of climatic design information in chapter 14 (Climatic Design Information) of the Handbook – Fundamentals provide key data to ASHRAE members and the profession at large in support of design and sizing methods for heating and cooling systems. The data is used by many other chapters (Fenestration, Infiltration, Cooling and Heating Load Calculations, Energy Estimating Methods). The data forms also the backbone of Standard 169, Climatic Data for Building Design Standards.
Data in the last edition (2017) of the Handbook was based on years 1990-2014 and included over 8,000 locations covering all continents. In the context of a changing climate, the approach taken for the last three editions of the Handbook to keep this information up-to-date is to update it every four years, in sync with the update cycle of the Handbook. The update also typically results in a significant increase in the number of locations as the quality of the data improves and more weather stations come online or have a longer period of record. The present work statement delineates the work to be performed for the next update in anticipation of the publication of the 2021 Handbook – Fundamentals.
Furthermore, the work statement requests the addition of several elements not available in the current tables. Temperature trends, listed by station or by region, will enable designers to examine how climatic design conditions have changed in the past and are expected to change in the future, so that they can design 'for the future' rather than 'for the past'. At the request of TC 5.6, new elements related to fire and smoke control will also be calculated.

This update will result in improved, more up-to-date and more geographically diverse climatic design data that will help ASHRAE in its mandate to foster the betterment of building energy technologies in a changing climate.