AHRI’s *TechUpdate* e-newsletter is published three times a year and includes the latest information on AHRI’s research initiatives, including recently concluded research reports and ongoing projects. Learn more and subscribe [here](#).

**AHRI Begins Second Phase of Low-GWP AREP Testing**

AHRI’s Low-Global Warming Potential Alternative Refrigerants Evaluation Program (Low-GWP AREP) entered its second phase of testing in 2014. Of the 25 new low-GWP refrigerant candidates proposed for testing in Phase II, 15 were selected by 22 test entities from the United States, Europe, Asia, and South America, according to the test companies’ interests. The Low-GWP AREP Technical Committee approved nine compressor calorimeter test plans, 14 drop-in test plans, and seven soft-optimization test plans. AHRI will continue accepting test plans from interested parties, provided that they can complete tests and submit test reports for review by April 10, 2015. Companies interested in conducting tests are encouraged to contact Xudong Wang, Director of Research, at xwang@ahrinet.org, to request a copy of the Participants’ Handbook for test protocols, plan submission guidelines, and a list of refrigerants available for testing.

This ongoing industry-wide cooperative research program will identify and evaluate promising alternative refrigerants for major product categories including air conditioners, heat pumps and heat pump water heaters, chillers, ice makers, and refrigeration equipment. The program does not prioritize these alternatives; rather, it seeks to identify potential refrigerant replacements for high-GWP refrigerants, and present the performance of these replacements in a consistent and standard manner.

**AHRI Completes Four Research Projects in 2014**

AHRI recently completed research project 8007, *Material Compatibility & Lubricants Research for Low-GWP Refrigerants*. The final report is available for [AHRI Members only](#). This project was completed in two parts: (1) chemical compatibility (i.e., evaluation of the impact of materials on the chemical stability of the fluids) and (2) material compatibility (evaluation of the impact of fluids on material properties).

Chemical compatibility experiments were conducted in sealed glass tubes with a composite blend of R-1234yf, R-1234ze(E), and R-32 (33.3 percent by weight of each) in combination with one POE and one PVE lubricant, and 41 different materials of construction. Control baseline samples with the same materials and lubricants were prepared with R-134a for comparison.

The material compatibility studies were conducted in Parr pressure vessels with R-1234yf, R-1234ze(E), and a three-refrigerant composite blend of R-1234yf, R-1234ze(E), and R-32 (33.3
percent by weight of each), with nine types of elastomers, three different gaskets, five types of polymers, and 10 various motor materials. Material compatibility assessments were conducted in 100 percent refrigerant, 50 percent refrigerant: 50 percent lubricant, and 100 percent lubricant baseline control conditions, to encompass the range of refrigerant and lubricant compositions that may be present in different areas of operating systems.

This year, AHRI also published the final reports of the following research projects. The reports are available to the public on the AHRI website.

AHRI 8002: Study of Impact of Duct Design on Life Cycle Cost of Residential HVAC Systems. This project conducted a life cycle cost analysis of typical residential air conditioning systems (i.e., cooling equipment, furnace, and ductwork) to determine what operating conditions (e.g., airflow rate and static pressure) result in minimum life cycle system costs (i.e., first costs and energy costs). The project used annual energy simulations of two new single-family homes in two separate climates in the United States (Austin, Texas, and Chicago, Ill.) to predict the impacts of low, medium, and high external static pressure ductwork designs from independent HVAC contractors (using both flexible and rigid sheet metal ductwork materials) on annual space conditioning energy use. Results from the simulations are combined with estimates of the initial installation costs of each duct design made by each contractor to evaluate the total life cycle costs or savings of using lower pressure duct designs in the two homes over a 15-year life cycle.

AHRI-8010: Universal Vent for Common Venting High-Efficiency and Draft-Hood Equipped Gas Appliances. In principle, the universal vent accommodates the common venting of a category IV furnace (positive pressure, condensing) with a natural draft water heater into a category I, type B common venting (negative pressure, non-condensing). The project tested the universal vent concept for a larger, modulating furnace paired with a natural draft water heater and with an approximately 10 mph wind applied at the vent exit. In addition to verifying acceptable venting through parametric testing with and without wind applied at the vent exit, the testing also examined the performance of a single-stage furnace with a blocked vent.

AHRI-09006: Joining Techniques Assessment. This project aimed to develop a method of rating the tightness of different types of joints based on laboratory data, and to provide guidelines so manufacturers can reduce leaks from their products by selecting high-performing joints. The overall goal was to determine what types of joining technologies are and are not acceptable for HVACR applications. Thirty-five components commonly used in refrigeration equipment were tested in this study. It concluded that though several components are, by design, very sensitive to improper mounting or require correct tightening, if components are well-chosen and properly mounted, the leak flow rates of refrigeration systems can be very low.

New Research Projects Planned This Year
AHRI began a new research project in June. AHRI-8015: Leak Rates Assessment for Air Conditioning and Refrigeration Equipment, will analyze the information on leakages in refrigeration equipment. The outcome will be a useful input for equipment life cycle climate performance (LCCP) analysis and risk assessment for systems using mildly flammable refrigerants. The project is ongoing at ICF Incorporated, LLC, and expected to be completed in March 2015.

In addition, AHRI plans to begin the following research projects in the second half of 2014:
AHRI-8011: Field Evaluation for Combustion Appliance Auditing. This project will identify currently recognized or commonly utilized procedures for evaluating the safety and performance of installed combustion equipment; compare and contrast those procedures; and provide information either to identify the correct procedure or to develop such a procedure if none exist.

AHRI-8014: The Effect of Lower Return Air Temperatures on Furnace Heat Exchangers. Furnace installation manuals limit the return air temperature to 55 or 60°F, but many thermostats have the ability to regulate to as low as 40°F. Low return air temperatures may compromise the life and robustness of heat exchangers. This project will establish what return air temperature is appropriate to avoid unnecessary stress on the heat exchanger. It will also establish guidelines for setback and extended absences set points to allow maximum energy savings while preserving heat exchanger integrity.

AHRI-8016: Risk Assessment for Rooftop Units Using A2L Refrigerants. The objective of this project is to use fault tree analysis to conduct refrigerant ignition risk assessment for rooftop units using A2L flammable refrigerants. The scope of the risk assessment is to evaluate the refrigerant ignition risks during operation and service from using HFC-32 (GWP of 675) or HFO-1234yf (GWP of 4), or HFO-1234ze (GWP of 6) in rooftop units.

Upon completion, test reports will be available on the AHRI website.

Ongoing Research Projects Cover Wide Range of Products
AHRI’s research projects often take several months or even years to complete. The following projects will continue this year:

AHRI-8009: Risk Assessment of Refrigeration Systems Using A2L Flammable Refrigerants. The objective of this project is to use fault tree analysis to conduct risk assessment for small commercial refrigeration equipment using A2L flammable refrigerants. The scope of the risk assessment is to evaluate risks during the operation and service of HFC-32 (GWP of 675), HFO-1234yf (GWP of 4), or HFO-1234ze (GWP of 6) in a self-contained reach-in cooler and a single condensing unit connected to refrigeration unit(s).

The contractor recently completed refrigerant release testing. The refrigerant dispersion data was collected for validating computational fluid dynamics modeling results. The project is ongoing at Gradient and expected to be completed in February 2015.

AHRI-8012: Developing Fan Power Terminal Unit Performance Data and Models Compatible with EnergyPlus. This project will develop a broad range of fan/motor efficiency data that can be readily used in EnergyPlus. Models for alternative configurations/operations of series and parallel units will be developed. A leakage model is planned to be incorporated into the EnergyPlus model. The project is ongoing at Baylor University and expected to be completed July 2015.

AHRI-8013: A Study of Methods to Represent Compressor Performance Data Over an Operating Envelope Based on a Finite Set of Test Data. This project will determine the optimal method to represent performance data over the application envelope, which maximizes accuracy for a given number of test points. The project will also develop an estimate of the level of uncertainty in each method as a function of measurement reproducibility and/or product-to-product variation, especially at the typical rating points given in the performance rating standard. The project is ongoing at Optimized Thermal Systems and expected to be completed in 2014.
Research Staff Monitors DOE Building Technologies Office Activities

AHRI staff participated in the Department of Energy (DOE) Building Technologies Office (BTO) Program Review on April 22-24, in Arlington, Va. This second annual review encompassed active work done by the office, where independent experts assessed the progress and contributions of each project toward its mission and goals. The presentations of BTO’s current research projects are available here.

The BTO offered research and development roadmaps on Emerging HVAC Technologies and Next Generation Low-GWP Refrigerants. The first roadmap was created to provide guidance to DOE on how best to facilitate research and development (R&D) initiatives to enable HVAC energy savings. The scope covered innovative and emerging HVAC technologies for both residential and commercial buildings.

The objective of the second workshop was to create an updated R&D roadmap to enable DOE to support R&D projects that address key barriers to the implementation of next-generation low-GWP refrigerants. Among several presentations from the industry and research institutes, the National Institute of Standards and Technology (NIST) presented its research on an extensive thermodynamic evaluation of low-GWP refrigerants. NIST researchers explored the thermodynamic performance limits for four different vapor compression cycles and identified optimal refrigerant thermodynamic parameters that lead to the best performance [1]. Furthermore, they applied screening criteria to narrow the list of fluids that might be suitable low-GWP refrigerants from more than 56,000 down to 62 candidates. The NIST study concluded that no fluid among the 62 is ideal in all regards, and all have one or more negative attributes, including poor thermodynamic properties, toxicity, chemical instability, low to moderate flammability, or very high operating pressures [2]. For details, see the publications below:


AHRI Research Offered at Industry Conferences

AHRI’s research projects were presented at several industry conferences this year.


- Majurin, J.A., Staats, S.J., Gilles, W., Material compatibility of HVAC&R system materials with low GWP refrigerants, 15th International Refrigeration and Air Conditioning Conference at Purdue, 2014

- Wang, X., Amrane, K., AHRI Low Global Warming Potential Alternative Refrigerants Evaluation Program (Low-GWP AREP) – Summary of Phase I Testing Results, 15th International Refrigeration and Air Conditioning Conference at Purdue, 2014
Co-funded Projects Leverage AHRI Resources, Benefit Members

AHRI works closely with ASHRAE to leverage the AHRI research program by co-funding with ASHRAE on projects that are of AHRI members’ interest, some of which are listed below. All AHRI co-funded ASHRAE project final reports are available to AHRI members upon request.

Published Reports in 2014:

AHRTI-ASHRAE-1584: Assessment of Alternative Approaches to Predicting the Burning Velocity of a Refrigerant. The objective of this project was to determine if there are less expensive, but reliable alternative methods to calculating refrigerant flame speeds to direct measurements. Researchers studied relationships between laminar burning speed and minimum ignition energy, and developed two different correlations between laminar burning speed and minimum ignition energy.

Ongoing ASHRAE Projects:

AHRTI-ASHRAE-1467: Balancing the Latent Heat Load between Display Cases & Store Comfort Cooling. This project seeks to provide a comprehensive assessment of energy savings potential in supermarkets by optimized design and operation of the combined HVACR systems.

AHRTI-ASHRAE-1507: Binary Refrigerant Flame Boundary. The project aims to develop, through a literature search, a database of past pertinent binary flame boundary concentrations, and to determine, through laboratory measurements, values for 10 additional refrigerant component pairs of commonly used and newly introduced flammable/nonflammable refrigerants pairs. This project is ongoing at Safety Consulting Engineers.

AHRTI-ASHRAE-1535: A Heat Transfer and Friction Factor Correlation for Low Air-Side Reynolds Number Applications of Compact Heat Exchangers. 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. The project is ongoing at Florida International University.

AHRTI-ASHRAE 1634: Guide for Sustainable Refrigerated Facilities and Refrigeration Systems. The objective of the project is to develop a guide for sustainable refrigerated facilities and refrigeration systems. Information in the guide will be used for the design of new facilities, expansions, and remodels, as well as provide guidance on improvements and operating methods that may also be applied to existing facilities. ASHRAE awarded the contract to Massey University.

AHRTI-ASHRAE1641: Effect of Unsaturated Fluorocarbon Contaminants on the Reliability and Performance of HVACR Equipment. This project will develop chemical reactivity information on unsaturated fluorocarbon contaminants to help the HVACR and water heating industry understand its impact on the performance and reliability of products. The results from this work will advance knowledge to support the HVACR and water heating industry in revising the limits for unsaturated compounds in various refrigerants in operating equipment, as well as new and reclaimed refrigerants. This project is ongoing at Spauschus Associates.

AHRTI-ASHRAE 1665: R-40 Stability with HVACR System Materials. This project will determine the stability of R-40 (monochloromethane) with HVACR system materials, so that all industries that use refrigerants can determine the reliability and safety impacts that R-40 has on equipment. R-40 has recently been determined as the primary contaminant in mobile R-134a
HVACR systems and, to a more limited extent, reported in R-22 and R-410A systems as well. This project is ongoing at McCampbell Analytical, Inc.

For more information, contact Xudong Wang.