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FROM: Michael Vaughn, MORTS, [mvaughn@ashrae.org](mailto:mvaughn@ashrae.org)

DATE: November 6, 2018

SUBJECT: Research Topic Acceptance Request (1866-RTAR), "Assess Refrigerant Detector Characteristics for Use in HVACR Equipment"

During their fall meeting, the Research Administration Committee (RAC) reviewed the subject Research Topic Acceptance Request (RTAR) and voted to accept it for further development into a work statement (WS).

Please address in the work statement the following items with the help of your Research Liaison prior to submitting the work statement to the Manager of Research and Technical Services for further consideration by RAC:

1. The work statement should state which refrigerants will be tested.
2. Requires more details.

In addition, a separate document providing a response to the above comment must be submitted with the work statement. The response to this item should explain how the work statement has been revised to address the comment, or a justification for why the Technical Committee feels a revision is unnecessary or inappropriate. The work statement and response to this comment must be approved by the Research Liaison prior to submitting it to RAC.

An RTAR evaluation sheet is attached as additional information and it provides a breakdown of comments and questions from individual RAC members based on specific review criteria. This should give you an idea of how your RTAR is being interpreted and understood by others. Some of these comments may indicate areas of the RTAR and subsequent WS where readers may require additional information or rewording for clarification.

The first draft of the work statement should be submitted to RAC no later August 15, 2020 or it will be dropped from display on the Society's Research Implementation Plan. The next realistic submission deadline for new work statements is May 15, 2019 for consideration at RAC's 2019 annual meeting. The submission deadline after that for work statements is August 15, 2019 for consideration at RAC's 2019 fall meeting.

<b>Project ID</b>	<b>1866</b>	
<b>Project Title</b>	Assess Refrigerant Detector Characteristics for Use in HVACR Equipment	
<b>Sponsoring TC</b>	TC-3.8, Refrigerant Containment	
<b>Cost / Duration</b>	\$23,000 / 7 Months	
<b>Submission History</b>	1st Submission	
<b>Classification: Research or Technology Transfer</b>	Basic/Applied Research	
<b>RAC 2018 Fall Meeting Review</b>		
<b>Essential Criteria</b>	<b>Voted NO</b>	<b>Comments &amp; Suggestions</b>
<b>Background:</b> The RTAR should describe current state of the art with some level of literature review that documents the importance/magnitude of a problem. References should be provided. If not, then note it in your comments.		<b>9</b> - Clearly explains the need for small robust sensors for leak detection of new low GWP refrigerants, especially for residential applications. References listed but not cited in text.
<b>Research Need:</b> Based on the background provided is the need for additional research clearly identified? If not, then the RTAR should be rejected.		<b>2</b> - Clear Objectives. <b>9</b> - Identifies need to clarify requirements for new emerging standards
<b>Relevance and Benefits to ASHRAE:</b> Evaluate whether relevance and benefits are clearly explained in terms of: a. Leading to innovations in the field of HVAC & Refrigeration b. Valuable addition to the missing information which will lead to new design guidelines and valuable modifications to handbooks and standards. Is this research topic appropriate for ASHRAE funding? If not, Reject.		<b>9</b> - Will support Codes and Stds
<b>IF ABOVE THREE CRITERION ARE NOT ALL SATISFIED - MARK "REJECT" BELOW &amp; CONTINUE REVIEW BELOW</b>		
<b>Other Criteria</b>	<b>Voted NO</b>	<b>Comments &amp; Suggestions</b>
<b>Project Objectives:</b> Based on the background and need, evaluate whether the project objectives are: 1. Aligned with the need 2. Specific 3. Clear without ambiguity 4. Achievable If not, then appropriate feedback should be provided.		<b>9</b> - Clear objective, but which refrigerants will be scrutinized? <b>10</b> - Please list, at least partially, refrigerant sensor and refrigerant detector performance requirements.
<b>Expected Approach and Budget:</b> Is there an adequate description of the approach in order for RAC to be able to evaluate the appropriateness of the budget? If not, then the RTAR should be returned for revision. Anticipated funding level and duration:		<b>9</b> - Three clear steps. AHRI is funding 80% of this phase (two further phases are envisaged for later on), so this is good value for ASHRAE and work done in 7 months, for \$23k. <b>8</b> - would like further refinement of the assessment of response time criteria, location criteria, and further identification of the research parameters.
<b>References:</b> Are the references provided?		<b>10</b> - References should be cited along the text of the RTAR. Some more peer-reviewed papers would help identify critical aspects.
<b>Decision Options</b>	<b>Initial Decision?</b>	<b>Final Approval Conditions</b>
ACCEPT AS-IS		<b>7</b> - RTAR is well written and almost suitable as a Work Statement. <b>9</b> - The WS could say which refrigerants will be tested. <b>10</b> - Detail refrigerant sensor and refrigerant detector performance requirements. Search scientific literature to find about innovative testing protocols and sensor performance assessment. <b>12</b> - Important to the HVAC&R industry for commissioning of systems and repair of existing systems. <b>8</b> - update approach per comments above
ACCEPT W/COMMENTS		
REJECT		

**ACCEPT Vote** - Topic is ready for development into a work statement (WS).

**ACCEPT W/COMMENTS Vote** - Minor Revision Required - RL can approve RTAR for development into WS without going back to RAC once TC satisfies RAC's approval condition(s)

**REJECT Vote** - Topic is not acceptable for the ASHRAE Research Program

**Research Topic Acceptance Request Cover Sheet**

Date: **August 14, 2018**

(Please Check to Insure the Following Information is in the RTAR)

- A. Title
- B. Executive Summary
- C. Background
- D. Research Need
- E. Project Objectives
- F. Expected Approach
- G. Relevance and Benefits to ASHRAE
- H. Anticipated Funding Level and Duration
- I. References

Title: **Assess Refrigerant Detector Characteristics for Use in HVACR Equipment**

RTAR # **1866**  
(To be assigned by MORTS)

Results of this Project will affect the following Handbook Chapters, Special Publications, etc.:

- Research Classification:
- Basic/Applied Research
  - Advanced Concepts
  - Technology Transfer

Responsible Committee: **TC-3.8 Refrigerant Containment**

Date of Vote: **08/14/2018**

For		<b>7</b>
Against	*	<b>0</b>
Abstaining	*	<b>0</b>
Absent or not returning Ballot	*	<b>0</b>
Total Voting Members		<b>7</b>

RTAR Authors

Lead: **Mark Adams / Xudong Wang**

Others: **Daniel Miles  
Ivan Rydkin**

Co-sponsoring TC/TG/MTG/SSPCs (give vote and date)

**None**

Expected Work Statement Authors

Lead: **Mark Adams / Xudong Wang**

Others: **Daniel Miles  
Ivan Rydkin**

Potential Co-funders (organization, contact person information):

**Air-Conditioning, Heating, and Refrigeration Technology Institute (AHRTI) 80% Xudong Wang**

Has an electronic copy been furnished to the MORTS?  
Has the Research Liaison reviewed the RTAR?

Yes	No
<b>x</b>	
<b>x</b>	

\* Reasons for negative vote(s) and abstentions

**Title:**

Assess Refrigerant Detector Characteristics for Use in HVACR Equipment

**Executive Summary**

This is a collaborative project between ASHRAE and AHRI to evaluate stationary refrigerant leak detection systems for applicability to use with flammable refrigerants. This is the first of three phases of this total project. This phase includes development of requirements for these systems, complete evaluation of current sensors and testing of the most promising sensors. Follow on phases focus on reliability of these sensors. AHRI is funding 80% of this first phase and requesting that ASHRAE fund 20% (\$23K).

**Background**

Most refrigerants we use today in air conditioning and refrigeration applications have low toxicity and are non-flammable (CFC's, HCFC's & HFC's classified in safety group A1). These gases have relatively high global warming potential (GWP). Over the past several years lower GWP alternative synthetic gases have been developed to replace the current family of refrigerants used. Several of these proposed refrigerants fall into ASHRAE safety group A2L. As a result, codes and standards will require the use of sensors to detect a refrigerant leak for both residential and commercial applications to mitigate the potential for a combustion event. The requirement for sensors will be dictated by charge size which takes in account room size and the lower flammability limit (LFL) for that refrigerant.

Refrigerant detectors are required in restricted-access machine rooms that contain chillers with several hundred (or thousand) pounds of refrigerant charge. These detectors use a set point value not exceeding the Occupational Exposure Limit (OEL) to trigger an alarm and mechanical ventilation, to reduce the risk of exceeding flammability, toxicity, and oxygen deprivation limits in the case of a large leak. These detection systems are large and relatively high cost as they are typically designed to take readings in multiple locations throughout the machinery room. When codes and standards allow the use of flammable refrigerants in residential and other commercial applications sensors will need to be relatively small and easily fit within the constraints of the system. These sensors need to be robust to handle temperature and humidity changes, household and industrial contaminants, and provide acceptable responses and accurate readings.

## Research Need

Refrigerant detectors will need to align with the code and standard requirements such as:

UL 60335-2-40  
UL 60335-2-89  
ASHRAE 15  
ASHRAE 15.2P (proposed)  
IEC 60079-29-1, -29-2  
IEC 60079-?-? (Possible new standard to be developed by IEC TC72/WG12)  
IEC 60730-? (Possible new standard)

However, new editions for several of the standards listed above are still under development and this research will help to clarify the necessary refrigerant detector requirements and how to specify them.

## Project Objectives

The objective of the project is to assess refrigerant sensor and refrigerant detector performance requirements for class 2L, 2, 3 flammable refrigerants for use with indoor HVACR equipment, whether in an occupied space or a machinery room.

## Expected Approach

This project is broken into three parts.

1. The contractor will review existing and proposed requirements for refrigerant detectors as found in safety standards and public review documents. Some of the requirements are summarized in AHRTI Report 9009. The contractor will develop a requirements document for this type of sensor system. - 1 month \$20,000
2. The contractor will assess the capability of current commercially available refrigerant detectors to meet the response time requirements, when installed in one or more locations as required by the safety standards, with set point(s) determined in a manner to meet the safety standard requirements, considering related issues such as upper detection limits, accuracy and calibration, drift over time, sensitivity to environmental conditions (temperature, pressure, humidity, vibration). This initial assessment will be limited to a paper study based on published specifications for refrigerant detectors (either by the manufacturer or as found in the literature). – 1 month \$20,000
3. The promising candidate refrigerant detectors will be tested to evaluate the capability to meet the response time requirements. Detectors will be configured and setup in a test fixture, then exposed to time-varying concentrations of refrigerant-air mixtures, and response time characteristics measured. – 5 months \$75,000

The total budget is \$115,000 and ASHRAE's 20% of \$23,000. Expected duration is 7 months.

### Relevance and Benefits to ASHRAE

This research will provide information on the use of leak detector systems that will be critical to the use of Low GWP flammable refrigerants and will benefit ASHRAE in the following ways:

1. The information will support development of Codes for use of these fluids such as ASHRAE 15.
2. Provide guidance to other standards.
3. These results would be used to develop a method of test standard for these types of systems. Due to the critical nature of these systems with flammable fluids there is a need to develop a certification program and a need to create a method of test similar to ASHRAE 173 – “Method of Test to Determine the Performance of Halocarbon Refrigerant Leak Detectors” for hand held leak detectors.

This project is directly tied to Goal 8 of the Strategic Research Plan - Facilitate the use of natural and low global warming potential (GWP) synthetic refrigerants and seek methods to reduce their charge. This project supports objective number 5 for the safe use of low GWP fluids.

## Anticipated Funding Level and Duration

Funding Amount Range: \$23K

Duration in Months: 7

## References

1. AHRTI. Pravinray Gandhi, George Hunter, Randall Haseman, and Brian Rodgers. AHRTI Report 9007-01, "Benchmarking Risk by Whole Room Scale Leaks and Ignitions Testing of A2L Refrigerants". June 2017.  
[http://www.ahrinet.org/App\\_Content/ahri/files/RESEARCH/Technical%20Results/AHRI\\_9007-01\\_Final\\_Report.pdf](http://www.ahrinet.org/App_Content/ahri/files/RESEARCH/Technical%20Results/AHRI_9007-01_Final_Report.pdf)
2. AHRTI. Mark Wagner and Rebecca Ferenchiak. AHRTI Report 9009, "Leak Detection of A2L Refrigerants in HVACR Equipment". June 2017.  
[http://www.ahrinet.org/App\\_Content/ahri/files/RESEARCH/Technical%20Results/AHRTI\\_9009\\_Final\\_Report.pdf](http://www.ahrinet.org/App_Content/ahri/files/RESEARCH/Technical%20Results/AHRTI_9009_Final_Report.pdf)
3. ASHRAE Standard 15-2016. "Safety Standard for Refrigeration Systems". ASHRAE, Atlanta, GA. 2016.
4. ASHRAE, Addendum d to Standard 15-2016 (Third Public Review Draft). ASHRAE, Atlanta, GA. 2018.
5. ASHRAE, Addendum h to Standard 15-2016 (Second Public Review Draft). ASHRAE, Atlanta, GA. 2018.
6. ASHRAE, proposed Standard 15.2 (Advisory Public Review Draft). ASHRAE, Atlanta, GA. 2018.
7. IEC 60079-29-1:2016, edition 2.0. Explosive atmospheres - Part 29-1: Gas detectors - Performance requirements of detectors for flammable gases. International Electrotechnical Commission, Geneva, Switzerland, July 2016.  
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8. IEC 60335-2-40:2018, edition 6.0. Household and similar electrical appliances – Safety – Part 2-40: Particular requirements for electrical heat pumps, air-conditioners and dehumidifiers. International Electrotechnical Commission, Geneva, Switzerland, January 2018.  
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9. NFPA. Davis, Scott. "Evaluation of the Fire Hazard of ASHRAE Class A3 Refrigerants in Commercial Refrigeration Applications". National Fire Protection Association, Fire Protection Research Foundation. October 2017.  
<https://www.nfpa.org/refrigerants>
10. Paul Papas, Shiling Zhang, Hai Jiang, Parmesh Verma, Ivan Rydkin, Richard Lord & Larry Burns (2016) Computational fluid dynamics modeling of flammable refrigerant leaks inside machine rooms: Evaluation of ventilation mitigation requirements, Science and Technology for the Built Environment, 22:4, 463-471, DOI: 10.1080/23744731.2016.1163240.
11. JRA 4068T:2016R, "Requirements of refrigerant leak detector and alarm for air conditioning and refrigeration equipment". Standard of The Japan Refrigeration and Air Conditioning Industry Association (English translation). Published 23-May-2016, amended 26-Sep-2016.  
[https://www.jraia.or.jp/pdf/JRA4068T\\_2016R.pdf](https://www.jraia.or.jp/pdf/JRA4068T_2016R.pdf)
12. UL 60335-2-40, Preliminary Comment Draft (PR001h), proposed revisions for edition 3.
13. UL 2075 edition 2. Standard for Safety for Gas and Vapor Detectors and Sensors, Underwriters Laboratories, Inc., Northbrook, IL, 2013.

**Feedback to RAC and Suggested Improvements to RTAR Process**

The Word version of the form is an improvement over the .pdf.