INVITATION TO SUBMIT A RESEARCH PROPOSAL ON AN ASHRAE RESEARCH PROJECT

1879-TRP, “Foamability Properties of LGWP Refrigerant and Oil Mixtures”

Attached is a Request-for-Proposal (RFP) for a project dealing with a subject in which you, or your institution have expressed interest. Should you decide not to submit a proposal, please circulate it to any colleague who might have interest in this subject.

Sponsoring Committee: TC 3.4, Lubrication
Co-sponsored by: TC 8.1, Positive Displacement Compressors

Budget Range: $150,000 may be less as determined by value of proposal and competing proposals.

Scheduled Project Start Date: September 1, 2020 or later.

All proposals must be received at ASHRAE Headquarters by 8:00 AM, EDT, May 15, 2020. NO EXCEPTIONS, NO EXTENSIONS. Electronic copies must be sent to rpbids@ashrae.org. Electronic signatures must be scanned and added to the file before submitting. The submission title line should read: 1879-TRP, “Foamability Properties of LGWP Refrigerant and Oil Mixtures”, and “Bidding Institutions Name” (electronic pdf format, ASHRAE’s server will accept up to 10MB).

If you have questions concerning the Project, we suggest you contact one of the individuals listed below:

For Technical Matters
Ivan Rydkin
Daikin America
21 Delaware Street
Rochester, NY 14607-1118
Phone: 315-489-3667
E-Mail: ivan.rydkin@gmail.com

For Administrative or Procedural Matters:
Manager of Research & Technical Services (MORTS)
Michael R. Vaughn
ASHRAE, Inc.
1791 Tullie Circle, NE
Atlanta, GA 30329
Phone: 404-636-8400
Fax: 678-539-2111
E-Mail: MORTS@ashrae.net

Contractors intending to submit a proposal should so notify, by mail or e-mail, the Manager of Research and Technical Services, (MORTS) by May 4, 2020 in order that any late or additional information on the RFP may be furnished to them prior to the bid due date.

All proposals must be submitted electronically. Electronic submissions require a PDF file containing the complete proposal preceded by signed copies of the two forms listed below in the order listed below. ALL electronic proposals are to be sent to rpbids@ashrae.org.

All other correspondence must be sent to ddaniel@ashrae.org and mvaughn@ashrae.org. In all cases, the proposal must be submitted to ASHRAE by 8:00 AM, EDT, May 15, 2020. NO EXCEPTIONS, NO EXTENSIONS.

The following forms (Application for Grant of Funds and the Additional Information form have been combined) must accompany the proposal:

1. ASHRAE Application for Grant of Funds (electronic signature required) and
2. Additional Information for Contractors (electronic signature required)

ASHRAE reserves the right to reject any or all bids.
**State of the Art (Background)**

The foaming interaction of HFO/HCFO refrigerants with lubricating oil is not fully understood. An ASTM test method D892 utilizes a bubble diffuser to introduce air bubbles at various flow rates to a refrigerant/lubricant mixture at atmospheric pressures at temperatures of 24°C and 93.5°C and measuring the volume of foam bubbles formed after the aeration and after a 10 minute settling period.

Previous work conducted by Goswami et al. at the University of Florida (ARTI MCLR project #665-53200) consisted of work on refrigerant/lubricant mixtures of chlorofluorocarbon (CFC) 12 and hydrochlorofluorocarbon (HCFC) 22 with mineral oil (MO), as well as hydrofluorocarbons (HFC) 32, 125, 134a, 143a, 404A, 407C and 410A with synthetic polyester (POE) lubricants. With experimental measurements of viscosity, static and dynamic surface tension, foamability, foam stability, absorption and desorption rates. Data were reported for the nine refrigerant & lubricant pairs: consisting of one CFC/MO pairs, one HCFC/MO and 7 HFC/POE pairs. The objectives of the investigation were to experimentally determine the absorption and desorption rates of HFC and blended refrigerants in POE lubricant, and to define the characteristics of the foam formed when the refrigerant left the refrigerant/lubricant mixture after a pressure drop.

This empirical approach provided information on factors that influenced foamability, and enabled comparison of specific refrigerant/lubricant pairs under controlled conditions. However, it would be of tremendous value to the industry to have a means to correlate specific measured properties to foamability predictions consistent with performance in specific categories of equipment.

**Objective**

Test method for evaluation of foaming would be developed and correlated to in system performance. Results from foaming evaluations of LGWP refrigerant and lubricant pairs, as well as an existing refrigerant and lubricant pair will be generated and presented to facilitate the assessment of foaming tendencies and test efficacy.

**Scope**:

Task 1. Literature review and summary for the PMS of the existing test methods, test data and potential deficiencies and gaps.

Task 2. Propose a system or set of systems for foaming correlation and down selection by PMS. Selection should be based on compressor and system types with the highest probability of foaming. Bidder should propose the range of refrigerant lubricant concentrations that would most likely result in foaming and occur in a realistic system.

Test methodology and apparatus should be constrained to bench scale as to allow for ease of reproduction and propagation through the industry.

PMS: Go – No Go gate based on the proposed method and apparatus; PMS needs to identify if the work so far will accomplish the tasks of the project. Evaluate the Refrigerant lubricant list for task 4. PMS will determine specific type and viscosity oils for task 4.

Task 3. Obtain the following refrigerant lubricant pairs. PMS may modify the final list after task 3

- Commercial: R1234ze + POE; R1234ze + PVE; R1234yf + POE; R1234yf + PVE; R1233zd + MO; R1233zd + POE;
- Residential: R32/R125/R1234yf (e.g. XL55) + POE; R32/R125/R1234yf +PVE; R32 + POE; R32 + PAG;
- Baseline: R134a +POE
- Baseline: R22 + MO
- Baseline: R123 + MO
Task 4: Evaluate 3 baseline refrigerant lubricant pairs via the proposed test method and correlated equipment. Total of 3 bench experiments and 3 correlated system experiments are expected for this work with an appropriate number of repetitions to produce significant results.

PMS: Go – No Go based on initial results and correlations

Task 5. Evaluate 8 to 10 LGWP refrigerant lubricant pairs via the proposed test method and correlated equipment. Total of 8 to 10 bench experiments and 8 to 10 correlated system experiments are expected for this work with an appropriate number of repetitions to produce significant results.

Task 6. Compare results of the test method to those generated with correlated equipment (in previous work and this study), and comment on relative parameters that influence foaming. If possible, generate equations incorporating factors that impact foaming to predict system performance.

**Deliverables:**
- After Task 1, present a summary to the PMS; agree to a list of X refrigerant/lubricant pairs.
- After Task 3 present to the PMS a proposed list of chemicals and baseline systems
- After Task 5 a progress update with the PMS should be made after initial R22/R-134a control sample results are compiled and compared to results from earlier studies and update on test method effectiveness
- After task 7, update the PMS with results from the corresponding lower GWP refrigerant sample results with a projected completion timeline of the tasks below not already covered.

Progress, Financial and Final Reports, Technical Paper(s), and Data shall constitute the deliverables (“Deliverables”) under this Agreement and shall be provided as follows:

a. Progress and Financial Reports

Progress and Financial Reports, in a form approved by the Society, shall be made to the Society through its Manager of Research and Technical Services at quarterly intervals; specifically, on or before each January 1, April 1, June 10, and October 1 of the contract period.

Furthermore, the Institution’s Principal Investigator, subject to the Society’s approval, shall, during the period of performance and after the Final Report has been submitted, report in person to the sponsoring Technical Committee/Task Group (TC/TG) at the annual and winter meetings, and be available to answer such questions regarding the research as may arise.

b. Final Report

A written report, design guide, or manual, (collectively, “Final Report”), in a form approved by the Society, shall be prepared by the Institution and submitted to the Society’s Manager of Research and Technical Services by the end of the Agreement term, containing complete details of all research carried out under this Agreement, including a summary of the control strategy and savings guidelines. Unless otherwise specified, the final draft report shall be furnished, electronically for review by the Society’s Project Monitoring Subcommittee (PMS).

Tabulated values for all measurements shall be provided as an appendix to the final report (for measurements which are adjusted by correction factors, also tabulate the corrected results and clearly show the method used for correction).

Following approval by the PMS and the TC/TG, in their sole discretion, final copies of the Final Report will be furnished by the Institution as follows:
- An executive summary in a form suitable for wide distribution to the industry and to the public.
- Two copies; one in PDF format and one in Microsoft Word.

c. *Science & Technology for the Built Environment* or *ASHRAE Transactions* Technical Papers
One or more papers shall be submitted first to the ASHRAE Manager of Research and Technical Services (MORTS) and then to the “ASHRAE Manuscript Central” website-based manuscript review system in a form and containing such information as designated by the Society suitable for publication. Papers specified as deliverables should be submitted as either *Science & Technology for the Built Environment* or *ASHRAE Transactions*. Research papers contain generalized results of long-term archival value, whereas technical papers are appropriate for applied research of shorter-term value, ASHRAE Conference papers are not acceptable as deliverables from ASHRAE research projects. The paper(s) shall conform to the instructions posted in “Manuscript Central” for an *ASHRAE Transactions* Technical or HVAC&R Research papers. The paper title shall contain the research project number (1879-RP) at the end of the title in parentheses, e.g., (1879-RP).

All papers or articles prepared in connection with an ASHRAE research project, which are being submitted for inclusion in any ASHRAE publication, shall be submitted through the Manager of Research and Technical Services first and not to the publication's editor or Program Committee.

d. Data

Data is defined in General Condition VI, “DATA”

e. Project Synopsis

A written synopsis totaling approximately 100 words in length and written for a broad technical audience documenting: (i) the main findings of the research project, (ii) why the findings are significant, and (iii) how the findings benefit ASHRAE membership and/or society in general.

The Society may request the Institution submit a technical article suitable for publication in the Society’s *ASHRAE Journal*. This is considered a voluntary submission and not a Deliverable. Technical articles shall be prepared using dual units; e.g., rational inch-pound with equivalent SI units shown parenthetically. SI usage shall be in accordance with IEEE/ASTM Standard SI-10.

The above deliverables are necessary, *but not sufficient*, to monitor a research project. The PMS and the sponsoring TC have the responsibility to review the contractor’s on-going activities and intermediate results, to ensure that the methods used and results obtained will be valid and well-enough substantiated to be labeled as “ASHRAE-approved findings.” Proper oversight cannot wait until the final report, when most of the budget has already been expended.

Therefore, each major task or phase of the research method outlined in the Scope should also be linked to a deliverable report, memorandum, or summary. These in-progress deliverables should not add to the cost of the project, as they will most likely become chapters of the final report. However, they should help the TC avoid unpleasant surprises due to the research not being conducted according to the TC’s expectations. Examples of deliverables that could be required during the project include:

- If one task is a literature review, then the deliverable could be an annotated list of references and conclusions/summary of the current state of the art.
- If the contractor must propose specific sites (e.g., buildings), experiment topologies (e.g., duct configurations), materials (e.g., refrigerants, appliances, insulation or building materials), experiment protocols, and/or instrumentation, then short memos describing those proposed methods, materials, etc. should be deliverables to be reviewed and approved by the PMS before moving on to the next research task.
- If analysis of preliminary data or results will decide how to proceed (e.g., CFD models of 12 duct configurations will be used to select 2 duct configurations to be built and subjected to wind tunnel tests), then the contractor should write up the results of the initial analysis, recommend the areas for further more detailed investigation, and justify those recommendations.
- If data from the research are expected to modify or update a *Handbook* table, then the procedure for developing the updated table from the data should be specified and provided to the PMS as a deliverable.
In short, the technical approach for a research project should be broken down into tasks or phases, and where a task will yield results of interest to the TC and the PMS, or where the results of a task will significantly define how subsequent tasks will be carried out. The Work Statement should specify such deliverables for the PMS to review. This approach will make it easier for the PMS and MORTS to gauge progress and technical merit of ongoing ASHRAE research projects and will provide a framework for the cognizant TCs to provide technical oversight and assistance to identify and correct problems as they occur.

**Level of Effort**
The estimated cost is $150,000 and the project is expected to take 18 months.

**Proposal Evaluation Criteria**

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<tr>
<th>No.</th>
<th>Proposal Review Criterion</th>
<th>Weighting Factor</th>
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<tbody>
<tr>
<td>1</td>
<td>Contractor's understanding of Work Statement as revealed in proposal.</td>
<td>15%</td>
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<td></td>
<td>a) Logistical problems associated</td>
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<td></td>
<td>b) Technical problems associated</td>
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<td>2</td>
<td>Quality of methodology proposed for conducting research.</td>
<td>25%</td>
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<td>a) Organization of project</td>
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<td>b) Management plan</td>
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<td>3</td>
<td>Contractor's capability in terms of facilities.</td>
<td>15%</td>
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<td>a) Managerial support</td>
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<td>b) Data collection</td>
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<td></td>
<td>c) Technical expertise</td>
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<td>4</td>
<td>Qualifications of personnel for this project.</td>
<td>20%</td>
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<td>a) Project team 'well rounded' in terms of qualifications and experience in related work</td>
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<td></td>
<td>b) Project manager person directly responsible; experience and corporate position</td>
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<td></td>
<td>c) Team members' qualifications and experience</td>
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<td>d) Time commitment of Principal Investigator</td>
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<td>5</td>
<td>Student involvement</td>
<td>5%</td>
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<td></td>
<td>a) Extent of student participation on contractor's team</td>
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<td>b) Likelihood that involvement in project will encourage entry into HVAC&amp;R industry</td>
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<td>6</td>
<td>Probability of contractor's research plan meeting the objectives of the Work Statement.</td>
<td>15%</td>
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<td>a) Detailed and logical work plan with major tasks and key milestones</td>
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<td>b) All technical and logistic factors considered</td>
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<td>c) Reasonableness of project schedule</td>
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<td>7</td>
<td>7. Performance of contractor on prior ASHRAE or other projects.</td>
<td>5%</td>
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<td>(No penalty for new contractors.)</td>
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**Project Milestones:**

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<th>Deadline</th>
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(The final report may also require the contractor to prepare a proposed updated table based on the observed data.)
<table>
<thead>
<tr>
<th>No.</th>
<th>Major Project Completion Milestone</th>
<th>Month</th>
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<tbody>
<tr>
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- Residential: R32/R125/R1234yf (e.g. XL55) + POE; R32/R125/R1234yf + PVE; R32 + POE; R32 + PAG;  
- Baseline: R134a + POE  
- Baseline: R22 + MO  
- Baseline: R123 + MO

4 | Evaluate 3 baseline refrigerant lubricant pairs via the proposed test method and correlated equipment. Total of 3 bench experiments and 3 correlated system experiments are expected for this work with an appropriate number of repetitions to produce significant results.  

PMS: Go – No Go based on initial results and correlations |       |
| 5   | Evaluate 8 to 10 LGWP refrigerant lubricant pairs via the proposed test method and correlated equipment. Total of 8 to 10 bench experiments and 8 to 10 correlated system experiments are expected for this work with an appropriate number of repetitions to produce significant results. |       |
| 6   | Compare results of the test method to those generated with correlated equipment (in previous work and this study), and comment on relative parameters that influence foaming. If possible, generate equations incorporating factors that impact foaming to predict system performance. |       |

**References**

1. ASHRAE Refrigeration Handbook, 2014 Chapters 6, 7, and 12  
2. ASHRAE Standard 97  