INVITATION TO SUBMIT A RESEARCH PROPOSAL ON AN ASHRAE RESEARCH PROJECT

1855-TRP, Determination of the Impact of Combustion Byproducts on the Safe Use of Flammable Fluorinated Refrigerants

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: MTG.LowGWP, Lower Global Warming Potential Alternative Refrigerants

Budget Range: $40,000 may be more or less as determined by value of proposal and competing proposals.

Scheduled Project Start Date: November 1, 2019 or later.

All proposals must be received at ASHRAE Headquarters by 8:00 AM, EDT, September 27, 2019. NO EXCEPTIONS, NO EXTENSIONS. Electronic copies must be sent to rpfbids@ashrae.org. Electronic signatures must be scanned and added to the file before submitting. The submission title line should read: 1855-TRP, Determination of the Impact of Combustion Byproducts on the Safe Use of Flammable Fluorinated Refrigerants”, 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:
Steve Kujak
Ingersoll Rand
3600 Pammel Creek Road
LaCrosse, WI 54601
Phone: 608-787-3766
E-Mail: skujak@trane.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 September 13, 2019 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 rpfbids@ashrae.org.

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 Application for Grant of Funds (signed) and

ASHRAE reserves the right to reject any or all bids.
State of the Art (Background)
Nonflammable halogenated refrigerants (which typically contain fluorine and/or chlorine, but could contain bromine and iodine) have been determined to be safe in the presence of thermal decomposition sources based on the successful use of these materials over the last 70 years. Nonflammable halogenated refrigerants have been studied and will form small amounts of various halogenated byproducts, including hydrofluoric acid (HF) and carbonyl fluoride (COF₂) among others. One of the hazards of using flammable halogenated refrigerants is the potential for the formation of large quantities of various halogenated decomposition products through either thermal decomposition or combustion, that possess very low acute toxicity limits.

It is necessary to clarify the decomposition products from these new flammable halogenated refrigerants to analyze the risks of using lower-GWP refrigerants. Complicating this understanding is that there is limited industry experience in handling and using flammable halogenated refrigerants. For example, today’s nonflammable refrigerants, in the presence of air, do not allow small combustion events to occur when a flame or strong electrical source is present. Only thermal decomposition products are formed, which have been investigated previously, and it has been shown that exposure to very small amounts of hydrogen fluoride (HF), hydrogen chloride (HCl), carbonyl fluoride (COF₂) or phosgene (COCl₂) is not a concern. However, when using flammable refrigerants, the possibility of combustion events leads to the potential for much higher concentrations of decomposition products. The high reactivities of products such as COF₂ and HF make this quantification difficult when conducting experiments. These materials can react with local materials to be neutralized, or they can react with water vapor in the air to form solutions which can coat materials and form potential latent exposure risks. In addition, the toxicity of HF can be problematic at best since it can act as a strong mineral acid and attack tissue. However, of more concern is that HF exposure can lead to latent toxicity effects that take hours to develop and from which it is not possible to recover.

Advancement to the State-of-the-Art
This work will advance the state-of-the-art by providing essential knowledge related to the consequences associated with combustion events of fluorinated low GWP refrigerants during operation and servicing. Also included would be recovery procedures from these potential events.

Justification and Value to ASHRAE
ASHRAE has a strong interest in promoting the use of safe, environmentally friendly, naturally occurring refrigerants and synthetic low GWP refrigerants. There are safety concerns related to the combustion byproducts of low GWP refrigerants, and this may create a hurdle in adopting these refrigerants into codes and standards. By collecting available information concerning the combustion byproducts of low GWP refrigerants and generating a needed 3rd party independent assessment, ASHRAE can use the results either to further revise its ASHRAE Standard 15 or substantiate the effectiveness of the standard. This will directly support the adoption of ASHRAE 15 into the model building codes.

This research will also be a valuable addition to the society as it will collect/generate basic data to support industry risk assessments to determine what potential issues that flammable or toxic refrigerants may have once they are ignited so that necessary steps can be taken to improve safety. The results can be used to further update the ASHRAE RP-1806.

Objectives
The overall objective of the project is to understand the HF and COF₂ exposure risk if ignitions of new flammable halogenated refrigerants occur and how to clean up following a variety of ignition events, as well as to identify knowledge gaps.

Scope
This project is divided into two phases, and this Work Statement will only address Phase I of the project. The Phase I include the following tasks:

Task 1. Literature survey and summary of existing fluorinated refrigerant risk assessment of HF/COF₂ formation. Provide exposure studies/knowledge and mitigation procedures after exposure to HF/COF₂. The existing test methods, test data and potential deficiencies and gaps should be summarized for the Project. The Project Monitoring Subcommittee (PMS) will review and approve the summary.
Task 2. Literature survey and summary of byproduct formation from fluorinated refrigerant exposed to flames or hot surfaces during servicing or other related operations, e.g., processing released refrigerant through electrically heating devices or open flames in the room. This review is not limited to flammable halogen containing refrigerant but should include studies with nonflammable refrigerants as well. This study should include all work conducted on CFCs, HCFCs, HFCs, and flame suppression refrigerants which could lead to a good understanding of potential byproducts and the amounts formed.

Task 3. Identify knowledge gaps and future work if any.

At a minimum, the above tasks should answer the following specific questions or identify future efforts to be performed to answer these questions:

- How much HF/COF$_2$ forms during a thermal decomposition or combustion event, and does the amount formed affect the recovery actions afterwards?
- What happens to the HF/COF$_2$ formed after combustion of a class A2L refrigerant?
- For how long do the decomposition products persist?
- Do the decomposition products deposit on surfaces, and how long do they persist there?
- What special precautions need to be taken by first responders or others entering a room after an ignition event?
- What minimum ignition event is considered dangerous?
- Does a torch near a class A2L refrigerant create a situation much different from that of a class A1 refrigerant?
- How does the magnitude of the ignition event (size) affect the danger? Is there a threshold for concern?

As part of Task 3 effort, the contractor shall propose a Phase II study per the gap analysis, focusing on experimental validation of identified knowledge gaps from Phase I related to potential HF or COF$_2$ formation from HVAC&R equipment manufacturing, transportation, installation, operation or servicing operations.

The potential contractor should prepare the bid for Phase I only. The award of Phase I does not guarantee the subsequent phase. ASHRAE reserves the right to seek bidders for Phase II or cancel Phase II entirely upon the completion of Phase I.

**Deliverables:**

Progress, Financial and Final Reports, Research or Technical Paper(s), and Data shall constitute required 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/Multidisciplinary Task Group (TC/TG/MTG) 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. Unless otherwise specified, six copies of the final report shall be furnished for review by
the Society’s Project Monitoring Subcommittee (PMS).

Following approval by the PMS and the MTG, 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 or ASHRAE
Transctions Technical Paper

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 Research Papers for HVAC&R Research or
Technical Paper(s) for 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 paper. The paper title shall contain the research project number (1855-
RP) at the end of the title in parentheses, e.g., (1855-RP).

Note: A research or technical paper describing the research project must be submitted after the
TC/TG/MTG has approved the Final Report. Research or technical papers may also be prepared before the
project’s completion, if it is desired to disseminate interim results of the project. Contractor shall submit
any interim papers to MORTS and the PMS for review and approval before the papers are submitted to
ASHRAE Manuscript Central for review.

d. Data

The Institution agrees to maintain true and complete books and records, including but not limited to
notebooks, reports, charts, graphs, analyses, computer programs, visual presentations etc., (collectively,
the “Data”), generated in connection with the Services. Society representatives shall have access to all such
Data for examination and review at reasonable times. The Data shall be held in strict confidence by the
Institution and shall not be released to third parties without prior authorization from the Society, except as
provided by GENERAL CONDITION VII, PUBLICATION. The original Data shall be kept on file by the
Institution for a period of two years after receipt of the final payment and upon request the Institution will
make a copy available to the Society upon the Society’s request.

e. Project Synopsis

A written synopsis totaling approximately 100 words in length and written for a broad technical audience,
which documents 1. Main findings of research project, 2. Why findings are significant, and 3. How the
findings benefit ASHRAE membership and/or society in general shall be submitted to the Manager of
Research and Technical Services by the end of the Agreement term for publication in ASHRAE Insights.

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.

All Deliverables under this Agreement and voluntary 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

In addition to the general deliverables mentioned above, the following specific deliverables will be required:
Review initial investigation into Phase 1a, present a summary to the PMS and discuss various breakdown
• products and toxicity risk associated with potential exposures.
• After initial investigations into Phase 1b, present a summary to the PMS and discuss potential knowledge
gaps
• After Phase 1b work completion, present to the PMS a proposed list of knowledge gaps and propose a
Phase 2 plan to close these knowledge gaps.
• A final report.
• Any data obtained from the research.
• A project summary.

Level of Effort
Phase 1 is expected to cost $40,000 over a 4-month project duration.

The cost and duration of Phase II of the program is pending, based on the findings from Phase I, but is estimated based on the
technical needs to conduct potential laboratory testing to be $200,000 over a duration of 12 to 18 months. This level of effort
may be changed.

Proposal Evaluation Criteria

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<tr>
<th>No.</th>
<th>Proposal Review Criterion</th>
<th>Weighting Factor</th>
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<tr>
<td>1</td>
<td>Contractor's understanding of Work Statement as revealed in proposal.</td>
<td>20%</td>
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<td></td>
<td>a) Logistical issues</td>
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<td>b) Technical issues</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>b) Experience and corporate position of project manager</td>
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<td>c) Team members’ qualifications and experience</td>
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<td>Time commitment of Principal Investigator</td>
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<td>5</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 logistical factors considered</td>
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<td>c) Reasonableness of project schedule</td>
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<td>6</td>
<td>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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References
   Atlanta, GA: American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE).
2. ASHRAE. 2017. ASHRAE Handbook of Fundamentals. Atlanta, GA: American Society of Heating,
   Refrigerating and Air-Conditioning Engineers (ASHRAE).
   Refrigerating and Air-Conditioning Engineers (ASHRAE).