

INVITATION TO SUBMIT A RESEARCH PROPOSAL ON AN ASHRAE RESEARCH PROJECT

1797-TRP, Assessment of the A/B toxicity classification used in Standard 34

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 3.1, Refrigerants and Secondary Coolants

Budget Range: \$190,000 may be more or less as determined by value of proposal and competing proposals.

Scheduled Project Start Date: **April 1, 2024** or later.

All proposals must be received at ASHRAE Headquarters by 8:00 AM, EDT, December 15, 2023. 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: 1797-TRP, Assessment of the A/B toxicity classification used in Standard 34, 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

Technical Contact
Steve Kujak
303 S Marina Dr
Brownsville, MN 55919-8815
Phone: (608)787-3766
E-Mail: skujak@tranetechnologies.com

For Administrative or Procedural Matters:

Manager of Research & Technical Services (MORTS)
Michael R. Vaughn
ASHRAE, Inc.
180 Technology Parkway, NW
Peachtree Corners, GA 30092
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 December 1, 2023 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. Hardcopy submissions are not permitted. **In all cases, the proposal must be submitted to ASHRAE by 8:00 AM, EDT, December 15, 2023. 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 Application for Grant of Funds (signed) and

ASHRAE reserves the right to reject any or all bids.

State of the Art (Background)

STD 34 is a standard for refrigerants that describes a shorthand way of naming refrigerants and assigns safety classifications and refrigerant concentration limits based on toxicity and flammability data. Members of the STD 34 committee have established a uniform system for toxicity safety classification and RCL for refrigerants that is used by STD 15. Refrigerants are assigned to one of two toxicity classes - A or B - based on allowable chronic toxicity exposure (OEL – Occupation Exposure Limit) or long-term toxicity effects (40-hour work week) while the RCL is based on acute toxicity related or escape impairment effects. STD 15 uses the toxicity classification (Class A or B) along with the RCL (Refrigerant Concentration Limit) to specify safe design, construction, installation, and operation of refrigeration systems (Figure 1).

The RCL, in air, is determined in accordance with this standard and intended to reduce the risks of acute toxicity (immediate short-term exposures rather than long term lower level exposure), which includes asphyxiation, and

F L A M M A B I L I T Y	SAFETY GROUP	
	Higher Flammability	A3 B3
	Lower Flammability	A2 B2 A2L* B2L*
	No Flame Propagation	A1 B1
	Lower Toxicity	Higher Toxicity

flammability hazards in normally occupied enclosed spaces. The RCL value is either controlled by a toxicity limit or flammability limit as determined by the standard. The toxicity limit is called the acute toxicity limit (ATEL) which is the refrigerant concentration limit intended to reduce the risks of acute toxicity hazards in normally occupied, enclosed spaces.

→
INCREASING TOXICITY

* A2L and B2L are lower flammability refrigerants with a maximum burning velocity of ≤ 10 cm/s (3.9 in./s).

Figure 1 Refrigerant safety group classification.
(from ANSI/ASHRAE Standard 34-2013)

ATEL values are similar to the immediately dangerous to life or health (IDLH) concentrations set by the National Institute of Occupational Safety and Health (NIOSH). ATELS include explicit, additional components for cardiac sensitization and anesthetic effects, but they do not address flammability like stated above. The lowest of the ATEL, 50,000 ppm by volume, or 10% of the lower flammability limit, therefore, provides a conservative approximation to IDLH concentrations when needed for refrigerants without adopted IDLH values. The conflict and need for this study is that the A-B toxicity classification is based on the OEL (chronic toxicity) but the ATEL (acute toxicity) sets the safety hazard limit so the OEL is not an appropriate measure of refrigerant toxicity safety in the application of HVACR product in occupied enclosed spaces. The OEL is still necessary to be set by ASHRAE Standard 34 since no other regulatory body sets chronic toxicity limits for refrigerant blends.

The A or B classification is not only used in STD 15. It is used directly by other similar standards, such as EN378 (Refrigerating systems and heat pumps - Safety and environmental requirements), ISO 5149 (Refrigerating systems and heat pumps - Safety and environmental requirements), IEC 60335-240, GB/T 7778 (Number designation and safety classification of refrigerants). The A or B classification is used indirectly and inappropriately implies that all Class B

refrigerants are highly toxic while STD 34 indicates that Class B refrigerants are refrigerants with higher toxicity. Refrigerants have some of the lowest acute and chronic toxicity characteristics as a group of compounds.

Since there is a toxicity classification inconsistency between acute and chronic limits, STD 34 is in need of a technically sound classification system to properly classify refrigerants for toxicity and identify their RCL to drive the safe use of refrigerants. SSPC 34, with input from SSPC 15, requests that the same - A or B - classification system be employed to limit the impact on changes to STD 15 and related codes. This research request focuses on safety knowledge gaps in setting the acute based limits for the Class A or B classification system.

Justification and Value to ASHRAE

As a consequence of societal demands to lower the global warming impact of refrigerants, the industry is looking to the development of new refrigerants that are both safe and functional. Understanding the application of acute versus chronic toxicity and setting limits based on technically sound toxicity criteria for HVACR products will

- increase the safety understanding of refrigeration based products
- facilitate the adoption of lower GWP refrigerants including natural refrigerants
- further the application and understanding of refrigerants and products for the industry

An improved, technically sound approach to refrigerant classification for toxicity will aid in the development of standards and codes for the relevant equipment areas. Additionally, this will enhance the likelihood of acceptance and use of refrigerants including the newer low GWP candidates. Faster adoption of lower GWP refrigerants will help with the sustainability of HVAC&R products. Adoption could occur within 5 years of the completion of this work. No intellectual property is expected from this work.

STD 34 assesses the safety of submitted newly-proposed refrigerants and identifies safety classifications following a peer-review process. Since the modifications to the toxicity classification would be incorporated into STD 34, those interested in introducing new refrigerants through the STD 34 process would be compelled to adopt the modifications.

Objectives

Select a contractor to perform the following tasks:

1. **Literature and Toxicity Classification Standards Review:** Provide a compiled review of applicable acute- and chronic-based safety limits or classification systems used by governments and relevant industry associations, groups, or companies.
 - a. Study and report on how these limits relate to the toxicity classifications and RCLs of the refrigerants published in STD 34.
 - b. Identify the basis, acute- or chronic-based, used by each system and offer, where possible, the rationale for this choice.
2. **Review of Available Risk Assessments:** Provide a review of applicable risk assessment studies based on flammability, toxicity, or other similar safety studies conducted on refrigerants or other chemicals.
 - a. Propose how these studies could be used as part of the rationale for the selection of acute- or chronic-based values for the toxicity classification and the RCL calculation in STD 34.
3. **Risk Assessment Study using Standard 15 Occupancy Classifications:** Propose a risk assessment study to obtain the necessary information to justify setting an A or B acute toxicity system based on the RCL of refrigerants using Standard 15 occupancy classifications (institutional, public assembly, commercial, large mercantile, large industrial, and mixed occupancy). This plan may include reviewing existing studies and modifying them appropriately to apply to acute and chronic toxicity limits, i.e. conversion of existing data on flammability to toxicity parameters. The plan could include further computational fluid dynamics (CFD) and testing which would include various leak rate scenarios, room size and different HVACR equipment. This work would include monitoring the OEL concentrations in these studies as appropriate for various leak rate scenarios.

- a. The proposed study must be approved in advance by the Project Monitoring Subcommittee (PMS) before starting.
 - b. Report and summarize findings to include comparison or studies of various refrigerants with RCLs >10,000 ppm, between 10,000 and 1,000 ppm, and <1000 ppm.
 - c. Propose potential classification limits (acute or a combination of an acute/chronic) for A or B or other classification system and potential application safety factors to be recommended in the event of use of a B-classified refrigerant.
4. Document these findings in a report and prepare / present to the ASHRAE community as requested.

Scope:

Task 1: Literature and Toxicity Classification Standards Review:

Write a summary report to show comparisons of the current state of the art. This report is to include:
a review of comparable acute- and chronic- based classification safety limits findings with an annotated list of references
a summary of each classification system or limits

Task 2: Review of Available Risk Assessment and Proposed Risk Assessment Plan:

Report from the contractor on risk assessment study proposal and methodology. This report is to include:

a summary of published related risk assessment studies

a risk assessment proposal and methodology which may consist of:

CFD and/or leak testing with varying conditions and physical setups to measure difference in results.

Conducting CFD and/or leak testing to compare various toxicity risks potential with the various Standard 15 occupancy classification of institutional, public assembly, commercial, large mercantile, large industrial, and mixed occupancy.

- report findings and proposal must be reviewed with the PMS and the proposal refined and approved by the PMS before moving on to Task 3.

Task 3: Risk Assessment Study using Standard 15 Occupancy Classifications.

Conduct risk assessment(s) as approved in Task 3 with the anticipation that the contractor will recommend a technically sound A or B toxicity limit or other classification system and a lower threshold B limit safety factors and controls if different than currently used in Standard 15 (detection and ventilation)

If gaps in understanding are identified, the contractor will propose future work to close these knowledge gaps.

Deliverables:

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.

The following deliverables shall be provided to the Project Monitoring Subcommittee (PMS) as described in the Scope/Technical Approach section above, as they are available:

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. Intermediate reports:

- At the completion of Task 1 – report on the current state of art:
 - a report on the applicable acute- and chronic- based safety limits or classification systems with how these limits relate to various refrigerants RCL published in ASHRAE Standard 34
 - At the completion of Task 2 – report on current and proposed risk assessments:
 - a summary of published related risk assessment studies
 - a risk assessment proposal and methodology
 - note that the proposal must be approved by the PMS before moving to Task 3

c. 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.

d. *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 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 papers. The paper title shall contain the research project number (1864-RP) at the end of the title in parentheses, e.g., (1864-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.

e. Data

Data is defined in General Condition VI, “DATA”

f. 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. 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.

Level of Effort

Total dollars: \$190,000

Professional Months:

Principal: to be determined

Total: 18 months

Duration:	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17	M18
1	x	x	x															
2			x	x	x	x												
3							x	x	x	x	x	x	x	x	x	x		
report			x			x										x	x	x

M = Month

Other Information to Bidders (Optional):

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 representations 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.

Principal Investigator presence at ASHRAE Conference

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.

Project Milestones:

No.	Major Project Completion Milestone	Deadline Month
1	TO BE PROVIDED	
2	TO BE PROVIDED	
3	TO BE PROVIDED	

Proposal Evaluation Criteria

Proposals submitted to ASHRAE for this project should include the following minimum information:

No.	Proposal Review Criterion	Weighting Factor
1	Contractor's understanding of work statement as expressed in proposal. a) Logistical problems associated b) Technical problems associated	15%
2	Quality of methodology proposed for conducting research. Organization of project Management plan	20%
3	Contractor's capability in terms of facilities. a) Managerial support b) Data collection Technical expertise	25%
4	Qualifications of personnel for this project. Project team 'well rounded' in terms of qualifications and experience and related work a) Project manager person directly responsible; experience and corporate position b) Team members' qualifications and experience c) Time commitment of Principal Investigator	25%
5	Probability of contractor's research plan meeting the objectives of the Work Statement. a) Detailed and logical work plan with major tasks and key milestones b) All technical and logistic factors considered c) Reasonableness of project schedule	10%
6	Performance of contractor on prior ASHRAE or other projects. (No penalty for new contractors.)	5%

References

1. ANSI/ASHRAE Standard 34-2022 ("Designation and Safety Classification of Refrigerants")
2. ANSI/ASHRAE Standard 15-2022 ("Safety Standard for Refrigeration Systems")