

INVITATION TO SUBMIT A RESEARCH PROPOSAL ON AN ASHRAE RESEARCH PROJECT

1926-TRP, Update of U-factors, Solar Heat Gain Coefficients and Visible Transmittances of Standard Fenestration Units made from Representative Fenestration Frame and Glazing Systems in the Fenestration Chapter of the Handbook of Fundamentals

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 4.05, Fenestration

Budget Range: \$100,000 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: **1926-TRP, Update of U-factors, Solar Heat Gain Coefficients and Visible Transmittances of Standard Fenestration Units made from Representative Fenestration Frame and Glazing Systems in the Fenestration Chapter of the Handbook of Fundamentals, 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
Mahabir Bhandari, PhD
R&D Staff
Oak Ridge National Laboratory
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Oak Ridge, TN 37830
Phone: 865-574-0989
E-Mail: bhandarims@ornl.gov

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)

In the absence of more detailed information, generic window performance values are provided in tables within Chapter 15 of the Handbook of Fundamentals. Tables 1 and 4 in Chapter 15 contain a large number of U-factors, and Table 10, contains Solar Heat Gain Coefficients (SHGC) and Visible Transmittance values (VT) for typical fenestration systems. This data is frequently used and referenced by various professions, from fenestration manufacturers to architects and HVAC system designers. These tables are clearly the most commonly referenced information in Chapter 15.

These tables were last updated in 1996, through an ASHRAE supported research project. The tables were produced using the VISION/F-RAME (Enermodal 1992) and WINDOW 4.1 (Finlayson et al. 1993) computer programs, in accordance with NFRC 100 (NFRC 2020), NFRC 300 (NFRC 2020), and NFRC 200 (NFRC 2020). A series of experiments, performed at a number of accredited laboratories both in the US and Canada, were used to validate many of the results (ASHRAE RP 578). At the time, the table reflected the most up-to-date procedures and products available. After more than twenty years, this is no longer the case.

Justification and Value to ASHRAE

Almost all buildings have fenestration. The accurate characterization of the energy performance of the glazing in structures is critical to determine the energy-efficiency of buildings. Architects, building professionals, and code officials can use the values provided by these fenestration tables for hand calculations during schematic design, and for comparison with actual products during specification.

It is also useful to compare the performance data in the fenestration tables with the product characteristics of an actual product when a simulation is conducted. Upon completion of the project and its publication into the Handbook, this research will impact most practitioners in the building industry. Even for those practitioners that don't use the Handbook, these values will affect energy code default tables and fenestration energy efficiency standards (i.e., IECC, ASHRAE 90.1, and USGBC).

Objectives

This project would update the tables 1, 4, and 10 in the Fenestration Chapter of the Fundamentals Handbook to reflect the most current methodology used for simulation of fenestration systems by industry and rating organizations. This new methodology is based on ISO 15099 (ISO 2003), which in turn was developed based on ASHRAE SPC 142P. No experimental work is expected in this project. In addition, the tables will be updated to reflect the most common fenestration types currently used in the marketplace.

Scope:

Task 1 – Develop work plan and methodology.

The draft work plan developed for this task will:

- Describe the methodology proposed for developing the new fenestration data.
- Using published data for current NFRC certified products, determine the appropriate categories of product configurations, frame materials and glazing details to update Tables 1, 4 and 10, based on statistical usage of the products. These categories should align between all three tables.
 - Provide a range of the variation in performance for each type of products selected.
- Propose the steps for adjusting the tabular data for use in building energy simulation programs, including:
 - Split between directly transmitted solar gain and the inward flowing fraction.
 - Adjusting window properties for sizes other than the default sizes in the tables
 - Adjusting SHGC and VT with respect to incidence angle
- This work plan shall be submitted to the Project Monitoring Subcommittee (PMS) and approved prior to beginning Task 2.

Task 2 – Conduct analyses, document validation methodologies and generate data for tables.

Analysis will be conducted based on the final work plan developed in concert with, and approved by, the PMS. This analysis will be compatible with the current rating standards (NFRC 100, 101, 102, 200, and 201) as reflected in the revised calculation methods in WINDOW and THERM. This analysis will:

- Determine U-factors, visible transmittances and SHGCs for each product and glazing and spacer option from the available published data for certified products, using statistical analysis to determine mean and range of performance at standard NFRC sizes.
- Document performance values for components of the window (i.e., frame, edge-of-glazing, and center-of-glazing which are needed for performing whole building energy calculations.
- Collect and compare U-factor and SHGC test results to simulation result. The PMS shall review and approve the list of test results and their sources that will be compared to the simulation results. The Principal Investigator (PI) will explain or resolve differences between test and simulation results.
- Provide data to update Tables 1, 4, and 10, and Figure 2 and 4, in Chapter 15.

Task 3 – Document findings in Project Report, ASHRAE Paper, and Proposed Text for Fenestration Chapter of ASHRAE Fundamentals Handbook

Contractor shall:

- Document all assumptions and their rationales, methodologies and data in a draft project report. This report shall provide enough detail so that this study could be replicated from the data presented in the report. This project report will contain the proposed changes to the Fenestration Chapter of the Fundamentals Handbook and the supporting data and rationale. This draft report will be reviewed by the PMS.

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. 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 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 (1926-RP) at the end of the title in parentheses, e.g., (1926-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, 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

Duration: 12 Months (1Year) at \$ 100,000

Efforts: 450 person hours (@ \$150/hr)

Other Information to Bidders (Optional):

Project Milestones:

No.	Major Project Completion Milestone	Deadline Month
1	Interim project report: Summary of research gaps for PMS discussion and approval of the next steps	3
2	Preliminary report on the analyses and document validation methodologies and generate data for tables	12
3	Project Report, ASHRAE Paper, and Proposed Text for Fenestration Chapter of ASHRAE Fundamentals Handbook.	18

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	20%
2	Qualifications of personnel included in proposal	25%
3	Probability of contractor's research plan meeting the objectives of the Work Statement	25%
4	Probability that proposed research plan will meet work statement objectives	20%
5	Performance of contractor on prior ASHRAE projects or similar projects of similar size (no penalty for new contractors) (5%)	5%

Proposal Evaluation Criteria

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

References

1. ASHRAE 2014. "ASHRAE Strategic Plan Starting 2014". American Society of Heating Refrigeration and Air Conditioning Engineers, Atlanta GA.
2. ASTM. 2014. "ASTM C 1199-14: Standard Test Method for Measuring the Steady-State Thermal Transmittance of Fenestration Systems Using Hot Box Methods". American Society for Testing and Materials, Conshohocken, PA.
3. ASTM. 2019. "ASTM C 1363-19: Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus". American Society for Testing and Materials, Conshohocken, PA.
4. ASTM. 2014. "ASTM E 1423-14 Standard Practice for Determining the Steady State Thermal Transmittance of Fenestration Systems". American Society for Testing and Materials, Conshohocken, PA.
5. Enermodal. 1992. "FRAME 3.0," Enermodal Engineering, Ltd., Waterloo, ON, Canada.
6. Enermodal. 1997. "Determination of Window System U-Values for the Handbook of Fundamentals (RP 578)" ASHRAE Research Report, American Society of Heating, Refrigeration and Air Conditioning Engineers, 1791 Tullie Circle, N.E. Atlanta, GA.
7. Finlayson, E.U., Arasteh, D.K., Huizenga, C., Rubin, M.D., and Reilly, M.S. 1993. "WINDOW 4.0: Documentation of Calculation Procedures", Energy and Environmental Lawrence Berkeley National Laboratory.
8. ISO. 2003. "ISO 15099: Thermal Performance of Windows, Doors and Shading Devices — Detailed Calculations", International Organization for Standardization, Geneva
9. NFRC. 2020. "100-2020: Procedure for Determining Fenestration Product U-Factors", National Fenestration Rating Council. Greenbelt, MD.
10. NFRC. 2020. "300-2020: Determining the Solar Optical Properties of Glazing Materials and Systems", National Fenestration Rating Council. Greenbelt, MD.
11. NFRC. 2020. "NFRC 200-2020: Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence", National Fenestration Rating Council. Greenbelt, MD.
12. NFRC. 2020. "NFRC 100-2020: Procedure for Determining Fenestration Product U-Factors". National Fenestration Rating Council. Greenbelt, MD.
13. NFRC. 2020. "NFRC 102-2020: Procedure for Measuring the Steady-State Thermal Transmittance of Fenestration Systems", National Fenestration Rating Council. Greenbelt, MD.

14. NFRC. 2020. "NFRC 102-2020: Procedure for Measuring the Steady-State Thermal Transmittance of Fenestration Systems", National Fenestration Rating Council. Greenbelt, MD.
15. NFRC. 2020. "NFRC 300-2020: Test Method for Determining the Solar Optical Properties of Glazing Materials and Systems", National Fenestration Rating Council. Greenbelt, MD.
16. NFRC. 2020. "NFRC 101-2020: Procedure for Determining Thermo-Physical Properties of Materials for Use in NFRC-Approved Software Programs". National Fenestration Rating Council. Greenbelt, MD.
17. NFRC. 2020. "THERM 7.7 / WINDOW 7.7 NFRC Simulation Manual". Lawrence Berkeley National Laboratory. July 2020.
18. Wright, J.L. 1994. "VISION, Glazing System Thermal Analysis Program", Advanced Glazing System Laboratory, University of Waterloo, Waterloo, Ontario, Canada.
19. NFRC will provide the required data to awardee upon request