INVITATION TO SUBMIT A RESEARCH PROPOSAL ON AN ASHRAE RESEARCH PROJECT

1959-TRP, Update People Load Data for Cooling Load calculations

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 4.1 Load Calculations Data and Procedures

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

Scheduled Project Start Date: **April 1st, 2026,** or later.

All proposals must be received at ASHRAE Headquarters by 8:00 AM, EDT, December 15th, 2025. 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: 1959-TRP, Update People Load Data for Cooling Load calculations, 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
Chris Wilkins
Phone: 617.789.6515
E-Mail: cwilkins@rfsengineering.com

For Administrative or Procedural Matters:
Manager of Research & Technical Services (MORTS)
Steve Hammerling
ASHRAE, Inc.
180 Technology Parkway, NW
Peachtree Corners, GA 30092
Phone: 404-636-8400
Fax: 678-539-2111
E-Mail: MORTS@ashrae.net

Contractors who plan to submit a proposal must notify the Manager of Research and Technical Services (MORTS) via email by December 1st. This will ensure that they receive any late or additional information regarding the RFP before the bid due date. Monday, December 1st, 2025, is the deadline for submitting technical inquiries.

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 shammerling@ashrae.org. In all cases, the proposal must be submitted to ASHRAE by 8:00 AM, EDT, Monday, December 15th, 2025. 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)

To accurately calculate the internal heat gain portion of the overall cooling load for a space or building, an accurate calculation of the heat gain from the occupants (people load) is required. Data that is currently used is based on a sedentary met rate of 58 W/m2 and a surface area of 1.8 m2 . These were based on a European male. More recent work [2,3,4] has shown that the met rate and the surface area can vary based on ethnicity and sex. Work by Zhai [2] determined more precise met rates for various activities for males and females based on the Level 4 method provided by ISO 8996 [5]. This work was limited to the overall heat gain only. There was no breakdown between sensible and latent heat gain. Other work [3,4] was done to determine the CO2 generation rate for different ethnicities and activities (including sleeping) but this work did not determine met rate or surface area as would be required to determine heat gain. The conclusions /variations found for CO2 generation are expected to correlate to heat gain. People load is only one component of the overall internal heat gain. Internal heat gains overall and heat gain from people specifically increase in importance to the overall cooling load as envelope gains decrease. Low energy/carbon designs and net zero energy designs require a highly detailed and accurate load calculation. This level of accuracy is not possible with the currently available data for heat gain from people. The work proposed would expand on the recent work to include sensible and latent heat gain from people for males and females, for various activity categories, and for more than just European ethnicities.

Justification and Value to ASHRAE

Any load calculation or energy model is only as good as the inputs to the calculation or model. Currently, the data available for heat gain from people is not sufficiently developed to support highly accurate load or energy calculations. Accurate data for both sensible and latent gains are required for low energy/low carbon designs. Accurate and transparent data are required so that engineers can determine accurate load calculations, particularly when dealing with low energy/carbon or net zero energy buildings. It is critical that the available data be accurately broken down between sensible and latent components. Differentiation between males and females or ethnicity will allow greater flexibility and accuracy in cases where the population dictates. Accurate latent load components are also important. Traditionally, the sensible load drives the design of cooling systems. Systems are also generally controlled (through a thermostat) based on the temperature of a space or zone. This approach works when the latent or dehumidification demand is lower than the sensible demand. The current trend is that sensible loads overall are decreasing in buildings and in many cases, the people density is increasing. Accurate latent load calculations are more important now than in the past. In many cases, people will be the primary driver of the latent load. Accurate data for latent heat gain from people is needed.

Objectives

The objective of this research is to provide accurate and comprehensive people heat gain data, broken down by sensible and latent, by activity level, by sex, by ethnicity, and potentially by other factors that emerge as relevant through the course of the research. The data will be compiled in a clear and concise manner to allow direct use by engineers in their load and energy calculations. To achieve this objective, it will be necessary to build on recent work that has been completed that addressed the overall heat gain but did not provide a breakdown between sensible and latent heat gain. There is no definitive approach for determining the sensible/latent breakdown of the total heat gain. It will be necessary to evaluate previously referenced methods for this and to refine and improve them where possible. Once the appropriate methodology for developing the split between sensible and latent gains is identified, the method can be applied to the available data to produce the necessary sensible and latent data.,

Scope:

Task-1 Review Available Literature: Zhai [2], identified that data in both ISO and ASHRAE standards, “are largely taken from the 1967 Passmore and Durnin review” [1]. The Zhai study determined metabolic rate for subjects in a variety of activities, based on the Level 4 method provided by ISO 8996 [5], and compared the results to predictions based on heart rate. Their work also provides data for Oxygen consumption, carbon dioxide output, and heart rate for the various activities. In addition, there are existing well established databases, such as HMDB: the Human Metabolome Database [6] by NIH, which provides standard data and methods for calculating human metabolic rate. MIMIC-II [7] and CapnoBase [8] are other standard databases for human respiratory rates for different activities, age, and ethnicity. It is expected that there will be additional literature available that provides guidance on metabolic rates. Provide a compilation of all relevant work to include a summary of the specific aspects that will inform this research project. The contractor will then determine the best database, or compilation of databases to use as the basis for the additional tasks defined below.

Task-2 Method for Determining Sensible/Latent Split: This work must determine the most appropriate method to determine the sensible/latent split of the overall heat rate for the population cohorts established in Task 2. Data for overall heat rate from people is widely available, directly or derived from metabolic data, as discussed in Task 1. Existing available data for overall gain will be used as the basis. The analysis for this task will focus on determining the sensible latent split of the overall or total heat gain. The following are potential approaches to determining the split:

1. Calculate the sensible heat exchange between a clothed body and the environment using traditional heat transfer approaches including the small sensible heat gain from exhalation. Then define the latent gain as the difference between the total heat and the sensible heat.
2. Calculate the total evaporation heat loss (latent heat) based on respiratory rate (oxygen consumption) and then define the sensible gain as the difference between the total heat and the latent heat.
3. Review literature to determine if there are any other analytical approaches that warrant consideration for deriving the sensible latent split of the overall heat gain from people.

For Approach 1, it is expected that the use of a multi-segmented human body model will be explored. Calculations for sensible heat transfer are very sensitive to assumed heat transfer coefficients (such as convection coefficients). Available published research must be vetted to determine the most appropriate coefficients to use and incorporated into the final recommended approach. For Approach 2, Equations (49) and (50) in Chapter 9 of the 2021 ASHRAE Handbook of Fundamentals provide a means to calculate the total evaporative heat loss (respiratory and skin) based on oxygen uptake (there is no reference for the origin of these equations). Oxygen consumptions rates were measured by Zhai and likely by others. It is expected that this research will evaluate this method but also evaluate if there are other approaches that can be used to determine latent heat gain from available metabolic data such as oxygen consumption.

The analytical methods identified as part of the Task must be evaluated by the research team and prioritized based on the accuracy of the results. A preferred approach must be recommended/presented to the TC 4.1 PMS for approval. Relative accuracy of the considered approaches can be determined based on sensitivity analysis or comparison to published experimental data (if available). It is expected that the determination of the "best" method will include both qualitative and quantitative judgement.

Task-3 Generate Data: Based on data available as identified in Task 1, and using the preferred methodology as evaluated and recommended in Task 2, data for sensible and latent heat gain will be generated. The generated data must be collated to address various activity levels, similar to how these data are currently presented in ASHRAE Handbook of Fundamentals. In addition, the available data for total heat gain is expected to support a breakdown between male vs. female, between child vs. adult, and between European vs. other ethnicities. The objective of this task is to generate the "bulk" data set that can then be collated and distilled in Task 4 to present the data in a generalized format.

Task-4 Prepare Consolidated Tables: The ultimate goal of this research is to produce distilled data suitable for publication in ASHRAE Handbooks or potentially other ASHRAE publications. The research must produce "camera ready" images of the final consolidated tables, graphs, or other imagery. It is expected that the research team will work closely with the TC 4.1 Handbook Subcommittee chair, and as necessary, with ASHRAE Publications staff. The expectation of this task is that the bulk data generated as part of Task 3 will be generalized and presented in summary tables to allow more direct access to the specific data that practicing engineers and energy modelers need to produce their load calculations and energy use predictions.

Task-5 Provide Recommendations for Update to Relevant ASHRAE Publications: The primary "user" of this data will be TC 4.1 Load Calculations Data and Procedures. TC 4.1 authors Handbook of Fundamentals Chapter 18 Nonresidential Cooling and Heating Load Calculations and 17 Residential Cooling and Heating Load Calculations. It is expected that data developed through this work will be presented in both of these chapters. Many of the calculations related to heat gain from people are based on procedures and data presented in Handbook of Fundamentals Chapter 9 Thermal Comfort. It is expected that through the course of this research, there will be the opportunity to provide recommendations for updates and/or revised or updated data and formulations for these chapters. In addition to providing these recommendations in the final report, it is expected that the research team will make themselves available to facilitate incorporation of the results into these chapters (and potentially others) where appropriate.

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*

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 to Research Papers for Science & Technology for the Built Environment 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 Papers for Science & Technology for the Built Environment papers. The paper title shall contain the research project number (1959-RP) at the end of the title in parentheses, e.g., (1959-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

The project anticipates 3 professional months for the principal investigator and 15 months for a PhD candidate or Postdoc Fellow level researcher. The estimated cost is $150,000 and the project is expected to take 15 months.

Project Milestones:

No.	Major Project Completion Milestone	Deadline Month
1	Presentation of results of literature review.	2 months
2	Presentation of recommended analysis method and approval by PMS.	3 months
3	Presentation of generated bulk data to PMS.	3 months
4	Preparation/Presentation of consolidated data tables intended for presentation in ASHRAE Handbook	2 month
5	Presentation of recommended updates/enhancements to current ASHRAE publications.	2 month
6	Close out and Final Report	3 months

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 manifests in the quality of the proposed technical approach and methodology, including the proposed method to select the preferred analytical method for deriving sensible latent split from total heat gain from people.	**30%**
2	Familiarity with the technical aspects of heat gain from people and recently completed work on the subject.	**20%**
3	Qualifications/experience of key personnel.	**25%**
4	Overall likelihood of meeting the objectives of the work statement, including logistical work plan, technical factors, and schedule.	**25%**

References

1. Passmore, R., and J.V.G. Durnin. 1967. Energy, work and leisure. Heinemann Educational Books, London
2. Indirect calorimetry on the metabolic rate of sitting, standing and walking office activities; Yongchao Zhai, et al; Building and Environment, Sept 2018
3. Emission rate of carbon dioxide while sleeping; Xiaojun Fan, et al; Indoor Air. 2021;00:1–16
4. Carbon dioxide generation rates for building occupants; A. Persily, et al; Indoor Air. 2017;27:868–879
5. ISO 8996: 2004. Ergonomics of the thermal environment - Determination of metabolic rate. 21 International Organization for Standardisation, Geneva. 2004.
6. Wishart DS, Tzur D, Knox C, Eisner R, Guo AC, Young N, Cheng D, Jewell K, Arndt D, Sawhney S, Fung C, Nikolai L, Lewis M, Coutouly MA, Forsythe I, Tang P, Shrivastava S, Jeroncic K, Stothard P, Amegbey G,

Block D, Hau DD, Wagner J, Miniaci J, Clements M, Gebremedhin M, Guo N, Zhang Y, Duggan GE, Macinnis GD, Weljie AM, Dowlatabadi R, Bamforth F, Clive D, Greiner R, Li L, Marrie T, Sykes BD, Vogel HJ, Querengesser L. HMDB: the Human Metabolome Database. Nucleic Acids Res. 2007 Jan;35(Database issue):D521-6. doi: 10.1093/nar/gkl923. PMID: 17202168; PMCID: PMC1899095.

7. Charlton P.H. et al. Waveform analysis to estimate respiratory rate, in Secondary analysis of Electronic Health Record Data, Springer International Publishing, pp.377-390, 2016
8. Karlen, Walter. 2021. CapnoBase Respiratory Event Benchmark. DOI: 10.5683/SP2/B1DDKP https://borealisdata.ca/dataset.xhtml?persistentId=doi:10.5683/SP2/B1DDKP