INVITATION TO SUBMIT A RESEARCH PROPOSAL ON AN ASHRAE RESEARCH PROJECT

1977-SP, Expand and update the ASHRAE Service Life Table in the HVAC Applications Handbook

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 2.8 Building Environmental Impacts and Sustainability
Co-sponsored by: TC 7.3 Operation, Maintenance and Cost Management

Budget Range: $180,000 may be more or less as determined by value of proposal and competing proposals.

Scheduled Project Start Date: **September 1, 2025** or later.

All proposals must be received at ASHRAE Headquarters by 8:00 AM, EDT, Friday, July 18th, 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: "1977-SP, Expand and update the ASHRAE Service Life Table in the HVAC Applications Handbook" 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
Natalie MacDonald
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For Administrative or Procedural Matters:
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Contractors intending to submit a proposal should notify, by mail or e-mail, the Research Administrator by July 1st, 2025 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. Hardcopy submissions are not permitted. **In all cases, the proposal must be submitted to ASHRAE by 8:00 AM, EDT, Friday, July 18th, 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)

Research and data regarding equipment service life has typically been developed through opinion surveys from those who are deemed knowledgeable or experts on specific equipment. Only few scientifically performed equipment life studies have been published in which actual equipment installation and removal dates are tracked over long periods of time, for substantial numbers of similar equipment (Hiller 2000). There have been few independent studies conducted on this topic overall, with several gaps in what is included in these studies, which emphasizes the need for a comprehensive independent study (Skumatz 2012).

The existing ASHRAE data regarding equipment service life can be found in the HVAC Application Handbook – Owning and Operating Costs Chapter; this chapter also contains the Comparison of Service Life Estimates Table. This table provides information on the service life of various types of HVAC equipment. The Table includes data from two ASHRAE research projects: RP-186 (Akalin 1978) and TRP-1237 (Abramson et al. 2005). Data from RP-186 was developed based on 68 surveys conducted in 1976. This data is not reflective of advances in technology, maintenance practices, control systems, materials, or manufacturing techniques. For these reasons, in addition to the limited number of survey participants, the validity of these data is questionable, and presently, dated.

Consequently, ASHRAE developed a Service Life and Maintenance Cost Database as a part of Research Project TRP-1237 (Abramson et al. 2005) which created an interactive internet-based database (www.ashrae.org/database) and has lists and summaries of service life data to match various criteria such as building type, equipment type, size, etc. In addition, another table, Table 3 – Median Service Life in the HVAC Application Handbook – Owning and Operating Costs Chapter, shows median service life based on analysis of survival curves (Hiller 2000). Hiller's ASHRAE Journal Article "Determining Equipment Service Life" published in Volume 42, Issue 8 in 2000 also discussed the need for the Service Life and Maintenance Database to have scientifically valid data regarding equipment service life, rather than relying solely on opinion surveys. The article also discusses the important differences between service life and age of replacement; where replacement information only includes the equipment population which has been replaced while service life includes all equipment, including those still in service. Typically, opinion surveys represent average age at replacement rather than median service life. The need for more scientifically valid data for equipment service life is described in detail in Hiller's article, along with recommended approaches to further research on this topic.

Some organizations outside of ASHRAE, but overlapping domains, such as CIBSE and BOMA, have developed similar tables with estimated equipment average useful life. In Appendix 7 of BOMA's Preventative Maintenance Guidebook, a table is provided with average useful life (in years) of various HVAC equipment types (Schoen 2010). This table is described as the opinion of the author based on experience. CIBSE published similar data, albeit a more comprehensive equipment list that was inclusive of building components beyond just HVAC equipment but was also noted to be developed through surveys of industry experts (CIBSE 2020). Neither of these reports cited independent data and noted that results were based on survey data and not confirmed to be statistically significant.

Another study – Estimated Normal Useful Life Study – published by the American Society of Appraisers (ASA) Machinery & Technical Specialties Committee, was conducted in 2010 and updated in 2024 (ASA 2024). The Normal Useful Life (NUL) ranges provided in this study are the result of qualitative research and consultation with industry experts. It is noted in that study that no individual quantitative research, such as statistical analyses, were performed.

A study conducted by Lawrence Berkeley National Laboratory involved estimating lifetimes of residential appliances using publicly available data from the Association of Home Appliance Manufacturers, the Air-Conditioning, Heating and Refrigeration Institute, and the EIA's Residential Energy Consumption Survey to gather data about appliance shipments and number of in-use appliances in stock (Litz et. al. 2011). A separate study, also conducted by Lawrence Berkeley National Laboratory, estimated residential boiler lifetimes based on a similar methodology utilizing data from AHRI and EIA's RECS database (Franco et. al. 2018). This study's methodology consisted of applying a survival function to the number of appliances shipped in a given year to estimate the number of appliances still in use the following year. Although these two studies involve residential equipment, they are

further examples of data collection and methodologies for determining equipment service life which could be transferable to this research project. The Weibull distribution is commonly used across these studies to determine survival probabilities of equipment. There are likely other existing studies utilizing a similar or varying methodology or statistical distributions.

Justification and Value to ASHRAE

This research will advance ASHRAE's commitment to accelerating innovation and developing technical guidance and other tools to support building decarbonization while assuring high levels of indoor environmental quality, sustainability, and resilience. This Work Statement aligns with ASHRAE's Research Strategic Plan and directly supports ASHRAE's efforts to focus on Building Decarbonization with support from ASHRAE's CEBD.

Objectives

The overall proposed objective of this research is to determine average service life expectancy of a wide array of commercial HVAC equipment types and identify factors affecting service life such as building type, region, equipment size, and maintenance practices. The intent is for these service life expectancies to be used by industry professionals to support life cycle analyses and better quantify the whole life carbon emissions of major HVAC equipment over the life of a building, including both embodied and operational carbon emissions. This will improve the accuracy of life-cycle cost analyses as well. This research is intended to expand and update the existing out-of-date tables and databases previously developed by ASHRAE and to ensure the inclusion of equipment relevant to building electrification such as VRF systems, air-to-water heat pumps, heat pump DHW heaters, and geothermal well field components.

The detailed objectives for the study are listed below:

1. Determine equipment types and variations to be included in the study as well as quality of data required for each equipment type.
2. Evaluate different methods of obtaining data regarding equipment life and the associated quality of this data to determine appropriate approach for methodology of each equipment included in study.
3. Gather sufficient data to develop statistically significant estimates of life expectancy for major HVAC equipment and components (including compressors, PEX tubing, heat exchangers, coils, etc.). Data should include relevant factors which could affect service life, such as climate, building type, size, and maintenance practices.
4. Analyze data in a manner appropriate to the equipment type based on methodology of data collection used and develop service life expectancies of various HVAC equipment to expand and update existing available data from ASHRAE, particularly the Comparison of Service Life Estimates Table in the ASHRAE Handbook – HVAC Applications.

Scope:

The project is intended to entail 5 sub-tasks described below. There shall be "stage gates" after the completion of sub-tasks 2 and 3, giving ASHRAE the option to discontinue the research project should the Project Monitoring Subcommittee (PMS) determine that the further research will not result in useful data.

1. Selection of Equipment & Required Source Quality

In support of Objective 1, the selection and determination of equipment types and variations shall be determined to ensure a comprehensive analysis and inclusiveness of equipment critical to building electrification. Equipment studied shall include, but is not limited to, various sizes of the following:

- Split-System Air Conditioners (residential & commercial)
- Modular Air Handling Units
- Custom Air-Handling Units
- Packaged Air-Handling Units (cooling only, heat pump)
- Air-to-water heat pumps

- Water-to-water heat pumps
- Heat Recovery Chillers
- Variable Refrigerant Flow (VRF) Systems
- Fan-Coil Units
- Domestic Water Heaters (including gas, electric, and heat pump)
- Furnaces
- Boilers (water tube, fire-tube, cast iron, condensing, electric)
- Chillers (air-cooled, water-cooled, various compressor types)
- Unit Heaters
- Radiant Heaters
- Heat Exchangers
- Fans (centrifugal, axial, propeller, in-line, plenum, roof-top)
- Coils (DX, water, steam, electric)
- Compressors (rotary, scroll, reciprocating)
- Cooling Towers (stainless steel, galvanized steel, FRP, HDPE)
- Controls (DDC, Electronic, Pneumatic)
- Pumps (Base-mounted, in-line, condensate)
- Insulation
- Motors
- Ground-Source Heat Pump Wells (Horizontal, Vertical, Pond/Lake, open-loop)
- Thermal Storage Systems (water, ice)
- Ductwork
- Piping

In addition to selection of equipment included in this research, it is recognized that some equipment requires higher reliability for service life data to others. This could be due to higher priority or importance but also due to high variability of data, such as newer equipment without significant failure data. It is understood that varying levels of data can be obtained in terms of reliability, and not every piece of equipment included in this research study requires the same approach.

Newer equipment and those critical and/or commonly used in building electrification should be considered for requiring higher reliability studies. Equipment less commonly used in new construction and/or considered obsolete should be determined to be either not be included in study or only require low reliability data, such as qualitative surveys. Other equipment can use medium-to-high quality data, depending on cost and effort of the high-quality methods.

This task will require approximately 1 month. A written report shall be submitted for approval upon completion of Task 1. The report will justify the selection of the equipment to include in this study and include justification for what level of relative quality is anticipated for that equipment. This list should be simple yet comprehensive. Approval of the report by the PMS is necessary before moving to Task 2.

2. Determine Data Source Methodology

In support of Objective 2, once the required reliability for each piece of equipment is determined, the methodology for data collections can be selected. Relative Quality of various sources for deriving service life can be seen in the table below (Skumatz 2012). This is not a comprehensive list but is intended to be a reference for various methods for collecting information and data for this study. The researcher should conduct a comprehensive review of other possible methods based on other equipment service life expectancy studies and determine the most appropriate method based on required reliability and quality of data for each equipment type. Other methods could include, for example:

- Gathering data from manufacturers who have maintenance or service agreements to understand service life of their installed equipment.
- Use of other studies of similar materials used in other applications, such as underground polyethylene gas piping compared to polyethylene geothermal wells

Source Data	Relative Quality	Description
Statistical EUL	Med-High	Research on the effective useful life of a measure carried out

Studies		using statistically valid samples of installations, conducted by independent third parties following established protocols. There are recognized best practices and protocols for these studies, which include guidelines from various states, frameworks, and other documents
ASHRAE Service Life Database	Med	ASHRAE's existing equipment database. Equipment covered in this database may be limited but is valuable given the large sample size and primary quantitative data.
Manufacturer Warranty and Lifetime Information	Low-Med	Lifetime information provided by manufacturers offers a potential source for data to estimate service life. Reliability of data depends on if information is collected via a third party and not influenced by skewed or biased data.
Stock / turnover Data	Med	Statistical studies conducted using stock, turnover, age cohorts, and other data from surveys or shipments sources to estimate lifetimes, similar to methods described in Lutz (2011) and Franco (2018).
Review of adopted lifetime tables from other agencies	Low-Med	Gathering data from existing estimated lifetimes tables from other agencies or publications and attempt to identify their underlying sources of data and associated quality. Values can be assigned based on various criteria and determine consensus of lifetimes and reliability of estimates. Quality can range depending on if source of estimates are well-documented or if documentation of sources is missing or unclear.
Delphi Method with experts	Low	Involved anonymous opinions of a panel or group deemed "experts" and asked to respond to baseline service life values. New ranges/estimates are then computed, and experts are again asked to respond, and then final revised values are used. This method typically results in lower quality findings but may be sufficient for less important equipment.
Stakeholder / expert discussion:	Low	Less formal discussions & surveys/conference calls to negotiate estimated service life usually starting with values from secondary source. This method typically results in lower quality findings but may be sufficient for less important equipment.

This task will require approximately 3 months. A written report shall be submitted for approval upon completion of Task 2. The report will justify what method for data collection will be used for each equipment or component type. Approval of the report by the PMS is necessary before moving to Task 3. Completion of this task is the first stage gate for this project. If the sources of data are deemed inadequate, ASHRAE has the discretion to stop the project.

3. Data Gathering and Review of Existing Research

In support of Objective 3, this Task involves the data gathering and collection process for this research. The details for collecting data for each equipment type is dependent on methods determined in Task 1. Methods for collecting data will likely vary for different equipment depending on reliability requirements and quality of data needed for each component/equipment type.

This task shall include all necessary steps to collect all data required for analysis in this research. Tasks will include, but is not limited to:

- Preparation of surveys to be completed
- Documenting qualitative and quantitative data on equipment usage, maintenance practices, lifespan, and other pertinent information

- Conducting surveys and interviews to various target audiences (manufacturers, service contractors, maintenance and facility managers across building types and regions, etc.)
- Review and documentation of past studies and data sources
- Review and documentation of public surveys or stock/shipment records
- Gathering data from manufacturers who have maintenance or service agreements to understand service life of their installed equipment.
- Use of other studies of similar materials used in other applications, such as underground polyethylene gas piping compared to polyethylene geothermal wells

Surveys conducted for this task shall include multiple methods of contact, including mail, email, and phone surveys. It is crucial that for high priority equipment that both failure data and data for equipment still in service is collected.

It is recognized that identifying reliable equipment life source data will be a challenge. ASHRAE's Center of Excellence for Building Decarbonization (CEBD) has been involved in discussions with several large real estate firms that may be able to provide data on equipment life. This data will be shared with the successful bidder once the contract has been approved. It is important to note that this data will not be exhaustive. It is critical that the researcher identifies additional sources of data through the research process.

This task will require at least 6 months. A written report shall be submitted for approval upon completion of Task 3. The report will describe the source data and methodology for each equipment type and should include sources of data with letters of support as relevant. These sources should be reviewed with the PMS and approval of the report by the PMS is necessary before moving to Task 4. Completion of this task is the second stage gate for this project. If no reliable or substantial source data can be identified, ASHRAE has the discretion to stop the project.

4. Data Compilation & Analysis & Draft Report

The researcher shall combine data from surveys, historical records, interviews, and other sources into a single database. Ensure that the data is organized by equipment type and source of data. Normalize the data to account for different units of measurement or reporting styles. For example, if some records report lifespan in years and others in hours of operation, convert them to a common unit.

Additionally, ensure data includes factors which were found to affect service life. The intent for this research is also to provide guidance on normalizing data for different unique scenarios. For example, an average service life range may be determined, with certain factors leading to longer service life and others leading to shorter service life.

For equipment requiring high reliability data and therefore utilizing statistical methods for analysis, the researcher shall use standard industry practices for such an analysis, specifically the parametric survival analysis approach to estimate the "survival" curve of each equipment. Multiple distributions can be used for this method, however, for the purposes of this study, the Weibull distribution shall be used given its commonality and wide-use for other estimated life studies.

For other methods of data collection, average life expectancy shall be determined in a manner appropriate to the method of collection. For example, for equipment using basic expert opinion data, the source of data, relevant variables, and final determination shall be provided.

Average service life expectancy of each equipment shall be developed into a comprehensive yet simple table for use by industry professionals. Factors affecting service life that can be identified throughout the research project shall be included in the table for relevant equipment and as informative notes. Guidance on normalizing service life based on these factors should also be provided. A draft report and draft equipment service life table shall be developed and submitted for review by the PMS.

This task will require approximately 6 months.

Deliverables:

a. Interim Report

For equipment requiring high reliability data and therefore utilizing statistical methods for analysis, the researcher shall use standard industry practices for such an analysis, specifically the parametric survival analysis approach to estimate the "survival" curve of each equipment. Multiple distributions can be used for this method, however, for the purposes of this study, the Weibull distribution shall be used given its commonality and wide-use for other estimated life studies.

For other methods of data collection, average life expectancy shall be determined in a manner appropriate to the method of collection. For example, for equipment using basic expert opinion data, the source of data, relevant variables, and final determination shall be provided.

Average service life expectancy of each equipment shall be developed into a comprehensive yet simple table for use by industry professionals. Factors affecting service life that can be identified throughout the research project shall be included in the table for relevant equipment and as informative notes. Guidance on normalizing service life based on these factors should also be provided. A draft report and draft equipment service life table shall be developed and submitted for review by the PMS.

This task will require approximately 6 months.

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

b. 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.

c. Final Report

In support of all Objectives, the researcher shall produce a final written report for the project detailing all work undertaken in the project, including data collection, methodologies used, raw data collected, data analysis, and final results. Create a simplified summary table (1-2 standard paper size pages) for inclusion in the ASHRAE Handbook – HVAC Applications that includes final results from the analysis. Additionally, recommendations for further research and continuous development & updating of this table shall be provided.

This task will require approximately 2 months.

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 (1977-SP) at the end of the title in parentheses, e.g., (1977-SP).

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

The level of effort is expected to include approximately 260 hours (about thirty-two 8-hour days) for the principal investigator and 1,076 hours (about one-hundred and thirty-four 8-hour days) for a research assistant/engineer. The estimated cost is $180,000, with 15% contingency and 35% profit and overhead included in this cost. The project is expected to take approximately 18 months to complete.

Project Milestones:

No.	Major Project Completion Milestone	Deadline Month
1	Finalize Equipment List and Source Quality	1

2	Develop Data Source Methodology	4
3	Data Collection	10
4	Data Analysis and Deliver Draft Findings and Draft Service Life Estimate Table	16
5	Complete & deliver final project report and final Service Life Table to include in ASHRAE 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	35%
2	Quality of methodology proposed for conducting research based on 1. Proposed method for data collection 2. Proposed data analysis techniques 3. Estimated uncertainties in the data obtained from the system	20%
3	Qualifications of personnel for this project based on: 1. Completion of previous ASHRAE projects 2. Experience managing funded project work with timely completion 3. Evidence of timely publication of project results. 4. Performance on prior, similar projects demonstrated via references 5. Administrative support capabilities 6. Experience with other estimated equipment service life studies	20%
4	Student Involvement	5%
	Probability that proposed research plan will meet work statement objectives 1. Detailed and logical work plan with major tasks and key milestones 2. All technical and logistical factors considered 3. Reasonableness of project schedule	20%

References

1. Abramson, B., D. Herman, and L. Wong. 2005. Interactive Web-based owning and operating cost database (TRP-1237). ASHRAE Research Project Final Report.
2. Akalin, M.T. 1978. Equipment life and maintenance cost survey (RP-186). ASHRAE Transactions 84(2):94-106.
3. Appraisers Association of America. (2024). MTSC normal useful life study update 2024.
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7. Lancaster, I W, and Lovvorn, N C. Survey of heat pump service life. Final report. United States: N. p., 1985. Web.
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10. Skumatz, L.A. 2012. What Makes a Good EUL? Analysis of Existing Estimates and Implications for New Protocols for Estimated Useful Lifetimes (EULs). International Energy Program Evaluation Conference.