INVITATION TO SUBMIT A RESEARCH PROPOSAL ON AN ASHRAE RESEARCH PROJECT

1955-TRP, Healthcare Anteroom Ventilation

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 9.6, Health Care Facilities
Co-sponsored by: SSPC 170, Ventilation of Health Care Facilities

Budget Range: $256,685 may be more or less as determined by value of proposal and competing proposals.

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

All proposals must be received at ASHRAE Headquarters by 8:00 AM, EDT, May 15th, 2026. 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: 1955-TRP, Healthcare Anteroom Ventilation, 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
P. Ted Cantin
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For Administrative or Procedural Matters:
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Contractors intending to submit a proposal must notify the Research Administrator by email no later than May 1, 2026. This notification will ensure that any late or additional information regarding the RFP can be provided prior to the proposal due date. The deadline for submitting technical questions is also Monday, May 1st, 2026.

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, May 15, 2026.**
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)

The Covid-19 pandemic initiated a renewed interest in the use of anterooms as microbial barriers to contain the spread of the virus.

Anterooms were one of the topical subcategories addressed in ASHRAE Research Project CO-RP3. This research project reviewed *ANSI/ASHE/ASHRAE Standard 170-2013- Ventilation of Healthcare Facilities* to determine whether the requirements in the standard were supported by engineering and (or) scientific evidence (Mousavi, et al. 2019). The study identified 25 requirements in the ASHRAE 170 Standard relating to anterooms in healthcare facilities. The study pointed out that healthcare staff indicated that the maintenance of specific pressure differential requirements in standard 170 was a burden on the facilities maintenance staff. They further stated that" certainty about the impact of air flow paths and desired pressure differentials is critical to justify these regulations." After extensive literature review the study determined that less than 30% of requirements related to pressurization and airflow including anterooms were supported in published literature. Further, the "vast majority of evidence-based literature is based on experiments or numerical studies under conditions that may or may not be representative of actual acute care environments." The study concludes that "the use of anterooms is highly supported by evidence," however ventilation rate, temperature range, pressure relationship and boundary conditions must be identified.

ASHRAE Research Project-1431 (Wei Sun, 2011). addresses the use of airlocks and using them as particle, chemical or microbial barriers, it does not specifically address the use of anterooms in health care facilities. A recent research project outlines a potential approach to designing a simplified AII room utilizing an anteroom (Merethe Lind, 2019). The US Department of Veterans Affairs has specific requirements for anterooms in several healthcare spaces at their hospitals. These are specified in 1) HVAC Design Manual, 2) PG-18-12: Design Guide for Sterile Processing Service and Logistics Service, 3) PG-18-9 – Space Planning Criteria 285-Sterile Processing Service.

Justification and Value to ASHRAE

This proposed research project is of excellent value to ASHRAE. It is a direct and immediate response to ASHRAE Research Project CO-RP3: A Literature Review of ASHRAE Standard 170. This research project (completed June 2018) identified 25 requirements in the ASHRAE 170 Standard relating to anterooms in healthcare facilities. After extensive literature review the study determined that less than 30% of requirements related to pressurization and airflow including anterooms were supported in published literature. Further, the "vast majority of evidence-based literature is based on experiments or numerical studies under conditions that may or may not be representative of actual acute care environments." The study concludes that "the use of anterooms is highly supported by evidence," however ventilation rate, temperature range, pressure relationship and boundary conditions must be identified. The proposed research activity focuses on identifying, classifying, and collecting in-situ and lab data for the healthcare anterooms selected. Subsequent development of a numerical model guided by the data obtained can then be used as a tool to provide the minimum design requirements referenced above that can be included in the ASHRAE Standard 170. This will provide designers with the information needed to provide healthcare facility owners, personnel, and patients with anterooms with a much higher level of confidence that they control migration of potentially infectious microbiological agents in or out of the areas they protect.

Technical Approach

Vestibules, Anterooms and Airlocks all function to minimize the migration of undesirable airborne contaminants into areas to protect them or stop the migration of them from areas where they originate. The following Table (Sun, 2018) outlines the common applications and function of each type.

TABLE 1 Common practices and functions among vestibule, anteroom and airlocks.

SPACE	TYPICAL APPLICATIONS IN CONTROLLED ENVIRONMENTS	MAIN FUNCTIONS (PURPOSES)	CONTROLLED PARAMETERS				
			TEMP/ RH%	AIRFLOW (MIN. ACH OR VELOCITY)	PRESSURE	TIME DELAY (BETWEEN DOOR OPERATIONS)	AIR CLEANLINESS (PARTICLE, MICROBIAL OR CHEMICAL CONCENTRATION)
Vestibule	At multistory or high-rise building's entrance	To reduce untreated OA entry to building due to stack effect	Not Required	Optional	Typically pressurized in large vestibules	Not Required	Not Required
Anteroom	Operating room, isolation room, protective environment. Sometimes in chemical lab, and BSL-2 lab	To minimize human contact with contaminated air from particles, microbial agents or chemicals	Optional	Yes	Various pressure arrangements similar as for Cascading, Sink or Bubble airlocks	Optional, but recommended	Optional
Airlock	Cleanroom, BSL-3/4 lab	To minimize human, process, and product contact with contaminated air from particles, microbial agents or chemicals	Optional	Yes	Various pressure arrangements as Cascading, Sink, Bubble or Dual-compartment airlocks	Yes	Yes

"Anterooms" exist in areas within healthcare facilities where minimizing human contact with contaminated air from particle, microbial agents or chemicals is desired. This is accomplished primarily through establishing a minimum airflow (ACH or Velocity) and/or positive or negative pressure. Time delay between entry and exit door operation is also an important factor in controlling the migration of contaminated airflow. This is required in an Airlock whereas it is optional but recommended in an Anteroom.

The ASHRAE Research Project RP-1431 (Sun, Analysis of Transient Characteristics, Effectiveness, And Optimization of Cleanroom Airlocks, 2011) developed a criteria to quantify the effectiveness of particle containment in preventing airborne contaminated particle migration into protected or out of isolated areas. This approach uses an aerosol particle sensing method to measure the degree of contamination in a protected area (i.e. Clean, Operating, AII or PE Rooms). The risk level of clean area airborne particle contamination is expressed as the "Contamination Ratio (CR)" and is expressed as (Sun, Analysis of Transient Characteristics, Effectiveness, And Optimization of Cleanroom Airlocks, 2011; Sun, PE, 2018):
$CR = (Pc - Pb)/Po$ Or $CR = Pc/Po$ (When $Pc >> Pb$)

Where,
CR = Particle Contamination Ratio, in Percentage
PC = Particle Concentration Inside Cleanroom Behind Door Under Challenge
PB = Initial Particle Concentration Inside Cleanroom Behind Door Without Challenge
PC-PB = Particle Concentration Gain Inside Cleanroom Behind Door Under Challenge
PO = Particle Concentration In Corridor, or In Front of Cleanroom Entrance Door as Contamination Challenge

CR is defined as airborne particle concentration gain above the initial background concentration in a protected area over the particle concentration outside an area which is the source of the airborne particle contaminants (i.e., the challenge area).

Furthermore, ASHRAE Research Project RP-1431 (Sun, Analysis of Transient Characteristics, Effectiveness, And Optimization of Cleanroom Airlocks, 2011) established "Barrier Effectiveness (BE)" that utilizes the CR.
BE = 1-CR

Where,
BE = Barrier Effectiveness Against Particle Migration under challenge, in Percentage
The BE is a criterion that quantifies the effectiveness of an anteroom to provide a barrier for airborne particle contaminants entering a protected or exiting an isolated area. The higher the BE percentage the more effective barrier the anteroom is.

This provides the technical basis to evaluate healthcare anterooms and develop an objective, quantitative basis to provide design guidelines.

Scope
The first objective involves the identification of the areas within inpatient healthcare facilities where anterooms are currently being used with the intent of providing microbial barriers for effective infection control. This would be

accomplished by a review of hospital design drawings and/or field surveys. Once these areas are identified, the researchers would then classify the anterooms as containment (i.e. clean to dirty / positive pressure) or protective (i.e. dirty to clean / negative pressure). Healthcare anterooms are typically

"Cascading" or "Bubble" design type airlocks which have the best performance (Sun, PE, 2018). The design type of each healthcare area anteroom should also be recorded. In addition to Protective Environment (PE) and Airborne Infection Isolation (AII) anterooms, six additional healthcare anterooms should be selected for further research. This selection should be based on prevalence in healthcare facilities, type representation/containment strategy, and infection risk to patients and hospital personnel.

The second objective involves the collection of anteroom performance data in a controlled lab setting and in-situ (operational) healthcare anterooms. Note: Proposals should include a description of the test facilities available for the Lab testing portion of the research project.

The selected anteroom types should be set up as pre-configured room arrangements in the lab setting. Aerosol particle sensing should be completed under repeatable conditions (i.e. temperature, relative humidity, and airflow) to understand the airflow characteristics (i.e. leak rate in steady state/doors closed and migration to the protected/isolated space in dynamic state/door openings). Door openings with personnel and equipment/material travel through space should also be considered to understand the impact of these operational conditions. The three anteroom sizes should be tested at pressure differentials in the 0.005 to 0.06 in. w.g. range to adjacent protected and/or isolated areas. The Containment Rate (CR) and subsequent optimal Barrier Effectiveness (BE) can then be determined from the CR, (i.e. BE=1-CR) (Sun, 2011).

Field measurements in 2 operational healthcare anterooms of each type should then be completed to validate that the lab data findings are feasible and practical in application in the actual healthcare setting.

The third objective is to develop a numerical model/s of the selected anteroom types. Following is a recommended approach that is intended to utilize the data collected in objective two to validate a numerical model/s that becomes an effective tool for identifying appropriate design conditions for the selected healthcare anteroom types.

1. Select boundary conditions to represent the following: supply and exhaust flows, conditions at doors, thermal loads (equipment, occupants, lighting, etc.), factors affecting RH, release of other contaminants into the space.
2. Ensure air speed patterns of diffusers and turbulent characteristics of inlet diffusers are appropriately represented.
3. Determine how the doors to the space will be represented and how the impacts of the pressurization of adjacent spaces will be represented.
4. Construct 3D models of the spaces including room geometry and furniture which would have a significant impact on airflow and ventilation system.
5. Perform steady-state (RANS) simulations and compare with measured performance values to assess correlation.
6. If required, re-visit assumptions made for boundary conditions to see if improvements can be made to comparison.

Further assessments can be done looking at the impact of using transient (time-varying) simulations instead of steady-state to see if further improvements can be made. This will allow the visualization of air/particle behavior and allow comparison to the lab and operational setting data. The goal of this comparison would be to establish a potential correction to the theoretical model to produce a more robust tool.

The fourth objective utilizes the lab and operational data and the validated numerical model/s to determine how design parameters (room configuration, pressurization, airflow temperature, relative humidity and door openings) influence the ability of the anteroom design to provide an effective microbial barrier for the healthcare selected area anterooms. The goal of this research is to establish recommended minimum design guidelines (i.e., Physical Configuration, Pressure Relationship to Adjacent Areas, Minimum ACH, Design Relative Humidity and Temperature Ranges) for the selected area healthcare anterooms.

Tasks/Deliverables/Where Results Will Be Published:

The project is currently envisioned to be divided into the following tasks mirroring the primary objectives with the included deliverables along with the dissemination of the research results (i.e. final report, data to technical committees and ASHRAE publications).

1. Review of current healthcare facilities to identify anterooms currently in use and rank, classify and select 8 (six plus Protective Environment/PE & Airborne Infection Isolation/AII) to focus the research on. Collect a minimum of 3 sets of data for each type of anteroom selected at separate acute hospitals. Deliverables- Data chart containing:
   a. Anteroom; area protecting (i.e. Protective Environment, Airborne Isolation Infection, Sterile Processing/Decon. or Sterile, OR, etc.), purpose (protective or containment), design type (bubble, cascading or other), intended use (personnel only or personnel and/or material & equipment), size (volume & footprint), Airflow (design supply and return or exhaust) and Pressurization.
   b. A list of eight anteroom types (AII, PE & 6 others selected in the "Scope/Technical Approach – First Objective" with rationale for selection.

2. Conduct lab and in-situ (field) testing in selected anteroom types to collect relevant condition controlled and operational anteroom data.
3. Generate anteroom numerical model/s for the selected anteroom types and validate it/them. Deliverables-
   a. Steady state (RANS) simulations of the selected anteroom types.
   b. Comparison with measured performance values in task/objective 2.

4. Use the validated model to determine how design parameters influence the ability of each size and type of anteroom to provide an effective microbial barrier. Establish recommended minimum design guidelines for each type of healthcare anteroom being researched.

Deliverables-

a. Provide recommended minimum design guidelines (i.e., Physical Configuration, Pressure Relationship to Adjacent Areas, Minimum ACH, Minimum Filter Efficiency, Design Relative Humidity and Temperature Ranges) with rationale based on lab, in-situ data and numerical analysis for Healthcare Anterooms identified in task/objective 1.

5. Task 5 addresses Where Results Will Be Published:
   Deliverables-
   a. Final Report that covers at least:
      1. Cover Page
      2. Table of Contents
      3. Executive Summary
4. A narrative report that addresses the methods and results for each task and a discussion of limitations and ramifications of the research findings
   5. Conclusions
   6. Recommendations

   b. Verbiage prepared for each of the handbook chapters and publications cited in the Application of Results.
   c. Share the results with ASHRAE SSPC 170, TC's - 4.3, 5.3, 7.7, 7.9, and 9.6.
   d. A journal article for Science and Technology for the Built Environment or ASHRAE Transactions.

Each of the 5 tasks will require a report that includes the deliverables outlined above to be transmitted to the PMS by email. Task reports shall be approved by the PMS before the next task begins unless the PMS approves a different, perhaps parallel, order of performance or the contractor suggests another scheme in the proposal. PMS will review and respond to reports in accordance with established agreements between the PI and the PMS chair.

Input from the PMS should be sought if any roadblocks are found. Biweekly updates to let the PMS know that progress is being made are required but may take the form of short emails with a bulleted list of recent accomplishments.

Deliverables:
Progress, Financial and Final Reports, Research Paper(s), and Data shall constitute the only 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, electronic 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 TC/TG/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. Research Paper(s)

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 for publication in the Science and Technology for the Built Environment (STBE). The paper(s) shall conform to the instructions posted in "Manuscript Central" for Science and Technology for the Built Environment papers. The paper title shall contain the research project number at the end of the title in parentheses, e.g., (1955-RP). ASHRAE Conference papers are **not** acceptable as deliverables from ASHRAE research projects unless explicitly approved by a vote of the PMS and TC and communicated to MORTS. Conference paper(s) shall conform to the instructions posted in "Manuscript Central" for ASHRAE Conference papers and the title shall contain the research project number at the end of the title in parentheses, e.g., (1955-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

$256,685, Duration in Months: 24, PI Months: 4, Total Professional Months: 16

Proposal Evaluation Criteria

No.	Proposal Review Criterion	Weighting Factor
1	Contractor's understanding of Work Statement as revealed in proposal and quality of methodology proposed for conducting the research.	20%
2	Contractor's capability in terms of access to required health care professionals at appropriate facilities.	15%
3	Contractor's capability in terms of access to required lab facilities.	15%
4	Qualifications of personnel for this project.	25%
5	Probability of contractor's research plan meeting the objectives of the Work Statement.	25%

Project Milestones:

No.	Major Project Completion Milestone (See pages 8&9 for Deliverables & Proposed Payment Schedule)	Deadline Month
1	Review current health care anteroom types, classify, AII & PE rooms and select 6 additional for further research.	4
2	Selected anteroom type lab and field testing and data collection.	12
3	Selected anteroom type validated numerical model/s. Determination of design parameter influence on anteroom effectiveness and recommended minimum design guidelines for the selected healthcare anteroom types.	22
4	Final Report, Journal Article and sharing results (Technical Committees and Handbook Chapters)	24

References

1. Johnson, D. L., R. A. Lynch, and K. R. Mead. 2009. Containment effectiveness of expedient patient isolation units. *American Journal of Infection Control*, *37*(2):94–100.
2. Kokkonen, A., M. Hyttinen, R. Holopainen, K. Salmi, and P. Pasanen. 2014. Performance testing of engineering controls of airborne infection isolation rooms by tracer gas techniques. *Indoor and Built Environment*, *23*(7):994–1001.
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6. Mousavi, Lautz, Betz and Grosskopf. 2019. *Academic Research to Support Facility Guidelines Institute & ANSI/ASHRAE/ASHE Standrd 170.* Atlanta, GA: ASHRAE.
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9. Wei Sun, K. F. (2011). *Analysis of Transient Charasteristics, Effectiveness, and Optimization of Cleanroom Airlocks.* Atlanta, GA: ASHRAE.
10. Adams, N. J., D. L. Johnson, and R. A. Lynch. 2011. The effect of pressure differential and care provider movement on airborne infectious isolation room containment effectiveness. *American Journal of Infection Control*, *39*(2):91–97.Emmerich, S. J., D. Heinzerling, J. il Choi, and A. K. Persily. 2013. Multizone modeling of strategies to reduce the spread of airborne infectious agents in healthcare facilities. *Building and Environment*, *60*:105–115.
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12. Hayden, C. S., O. E. Johnston, R. T. Hughes, and P. a. Jensen. 1998. Air Volume Migration from Negative Pressure Isolation Rooms during Entry/Exit. *Applied Occupational and Environmental Hygiene*, *13*(7):518–527.
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