



Shaping Tomorrow's
Built Environment Today

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TO: Franco Cincotti, Chair TC 5.1, FCINCOTTI@comefriusa.com
Brian Reynolds, Research Subcommittee Chair TC 5.1, breynolds@trane.com

CC: Dennis Loveday, Research Liaison 5.0, d.l.loveday@lboro.ac.uk

FROM: Michael Vaughn, MORTS, mvaughn@ashrae.org

DATE: July 19, 2017

SUBJECT: Research Topic Acceptance Request (1829-RTAR), "Inlet and Outlet System Effects on Multiple Plenum Fans in a Parallel Arrangement (Fan Arrays) for Air and Sound Performance"

During their annual meeting, the Research Administration Committee (RAC) reviewed the subject Research Topic Acceptance Request (RTAR) and voted to accept with comments it for further development into a work statement (WS) provided that the approval comment(s) below are addressed to the satisfaction of your Research Liaison in a revision to the RTAR.

1. The RTAR should describe the condition of motors.
2. The RTAR does not state what information is actually being sought.
3. The background and research need do not give a clear picture of what specific questions are going to be answered as part of this work.

Please coordinate changes to the RTAR with the help of your Research Liaison, Dennis Loveday, d.l.loveday@lboro.ac.uk, or RL5@ashrae.net in response to the approval comment(s) only so that the revised RTAR can be submitted to the Manager of Research and Technical Services and posted by ASHRAE as part of the Society's Research Implementation Plan.

Once the revised RTAR is posted, please develop a work statement also with the help of your Research Liaison prior to submitting it to the Manager of Research and Technical Services for consideration by RAC. The work statement must be approved by the Research Liaison prior to submitting it to RAC.

An RTAR evaluation sheet is attached as additional information and it provides a breakdown of comments and questions from individual RAC members based on specific review criteria. This should give you an idea of how your RTAR is being interpreted and understood by others. Some of these comments may indicate areas of the RTAR and subsequent WS where readers require additional information or rewording for clarification.

The first draft of the work statement should be submitted to RAC no later than **May 15, 2018** or it will be dropped from display on the Society's Research Implementation Plan. The next likely submission deadline for work statements **August 15, 2017** for consideration at RAC's 2018 winter meeting. The submission deadline after that for work statements is **May 15, 2018** for consideration at the RAC's 2018 Annual meeting.

Project ID	1829	
Project Title	Inlet and Outlet System Effects on Multiple Plenum Fans in a Parallel Arrangement (Fan Arrays) for Air and Sound Performance	
Sponsoring TC	TC 5.1, (Fans)	
Cost / Duration	\$120,000 / 18 Months	
Submission History	1st Submission	
Classification: Research or Technology Transfer	Basic/Applied Research	
RAC 2017 Annual Meeting Review		
Essential Criteria	Voted NO	Comments & Suggestions
Background: The RTAR should describe current state of the art with some level of literature review that documents the importance/magnitude of a problem. References should be provided. If not, then note it in your comments.		#3- There is no description of motors of fans. I think types of motors such as an induction motor or an synchronized motor will give the different results. Maybe RTAR should describe the conditions of driving motors for fans. #8 - The RTAR does not give a clear statement of the problem
Research Need: Based on the background provided is the need for additional research clearly identified? If not, then the RTAR should be rejected.		#14 - Provide citation to support the statement: "Even at a stable operating point, total airflow is not the sum of the individual fans". #8 - The background and research need do not give a clear picture of what specific questions are going to be answered as part of this work. The RTAR states that they want to address "system effect factors" which is vague.
Relevance and Benefits to ASHRAE: Evaluate whether relevance and benefits are clearly explained in terms of: a. Leading to innovations in the field of HVAC & Refrigeration b. Valuable addition to the missing information which will lead to new design guidelines and valuable modifications to handbooks and standards. Is this research topic appropriate for ASHRAE funding? If not, Reject.		#14- his project is of more benefit to AMCA and AHRI member firms, than ASHRAE. I would want to see a commitment from each of these trade associations before approving ASHRAE funds. Provide citation to support the statement: "Multiple, parallel plenum fans help to maximize efficiency ...". It is difficult to understand why multiple small fans are more efficient than a single large fan. #5 - This would be a valuable work for multiple plenum fans design
IF ABOVE THREE CRITERION ARE NOT <u>ALL</u> SATISFIED - MARK "REJECT" BELOW & CONTINUE REVIEW BELOW		
Other Criteria	Voted NO	Comments & Suggestions
Project Objectives: Based on the background and need, evaluate whether the project objectives are: 1. Aligned with the need 2. Specific 3. Clear without ambiguity 4. Achievable If not, then appropriate feedback should be provided.		#8 - The RTAR does not state what information is actually being sought
Expected Approach and Budget: Is there an adequate description of the approach in order for RAC to be able to evaluate the appropriateness of the budget? If not, then the RTAR should be returned for revision. Anticipated funding level and duration:		#14 - The approach could easily grow to twice the expected budget and schedule.
References: Are the references provided?		#14 - Linkage to Research Needs is not well established. #6 - Reference format not adequate. #5 - RP1420 is referred to in the document, but not referenced
Decision Options		Final Approval Conditions
ACCEPT AS-IS		#14- This project is of more benefit to AMCA and AHRI member firms, than ASHRAE. I would want to see a commitment from each of these trade associations before approving ASHRAE funds. Provide citation to support the statement: "Multiple, parallel plenum fans help to maximize efficiency ...". It is difficult to understand why multiple small fans are more efficient than a single large fan. #3 - The RTAR should describe the condition of motors. The static pressure fluctuation in the plenum chamber will affect the torque of fans and the rotating speed. #8 - Nearly 40% of the TC members did not vote, why? #4 - An extension of RP1420, clearly needed. It is unclear why 5 TC members did not provide vote; ASHRAE Goals could be better articulated. #5 - RTAR lays out the need and a good start of a plan to move on to a work statement
ACCEPT W/COMMENTS		
REJECT		

ACCEPT Vote - Topic is ready for development into a work statement (WS).

ACCEPT W/COMMENTS Vote - Minor Revision Required - RL can approve RTAR for development into WS without going back to RAC once TC satisfies RAC's approval condition(s)

REJECT Vote - Topic is not acceptable for the ASHRAE Research Program

Research Topic Acceptance Request Cover Sheet

Date: **20 June 2016**

(Please Check to Insure the Following Information is in the RTAR)

- A. Title
- B. Executive Summary
- C. Background
- D. Research Need
- E. Project Objectives
- F. Expected Approach
- G. Relevance and Benefits to ASHRAE
- H. Anticipated Funding Level and Duration
- I. References

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Title:
Inlet and Outlet System Effects on Multiple Plenum Fans in a Parallel Arrangement (Fan Arrays) for Air and Sound Performance

RTAR # **1829XXXX**
 (To be assigned by MORTS)

Results of this Project will affect the following Handbook Chapters, Special Publications, etc.:

Systems & Equipment S21, ASHRAE Standard 51/AMCA 210, AMCA Publication 201

Research Classification:
 Basic/Applied Research
 Advanced Concepts
 Technology Transfer

<input checked="" type="checkbox"/>
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<input type="checkbox"/>

Responsible Committee: **TC 5.1 "Fans"**

Date of Vote: **January 30, 2017**

For		8
Against	*	0
Abstaining	*	0
Absent or not returning Ballot	*	5
Total Voting Members		13

RTAR Authors

Lead: **Dustin Meredith**
 Others: **Z. Patrick Chinoda**

Co-sponsoring TC/TG/MTG/SSPCs (give vote and date)

TC 2.6 "Sound and Vibration"
TC 5.2 "Duct Design"

Expected Work Statement Authors

Lead: **Dustin Meredith**
 Others: **Patrick Chinoda**

Potential Co-funders (organization, contact person information):

AMCA International
AHRI

Has an electronic copy been furnished to the MORTS?
 Has the Research Liaison reviewed the RTAR?

Yes	No
<input type="checkbox"/>	<input type="checkbox"/>

* Reasons for negative vote(s) and abstentions

Title:

Inlet and Outlet System Effects on Multiple Plenum Fans (Fan Arrays) in a Parallel Arrangement for Air and Sound Performance

Executive Summary

Describe in summary form the proposed research topic, including what is proposed, why this research is important, how it will be conducted, and why ASHRAE should fund it (50 words maximum)

The results of this research project will help to optimize building energy use and IEQ through an improved understating of multiple plenum fans (fan arrays) in a parallel arrangement. The project will test a variety of configurations to develop system effect factors and offer guidance on such configurations.

Background

Provide the state of the art with key references (at the end of this document) substantiating it (300 words maximum)

Multiple plenum fans in parallel are a trending design practice in both duct systems and air-handling units. They help to maximize efficiency, offer redundancy, are easy to maintain, and offer much-needed flexibility. 2-fan, 3-fan, 4-fan, and 6-fan arrangements are very common with even higher quantities being widespread.

Parallel fans are somewhat addressed in AMCA Publication 201, *Fan Engineering*, and even the ASHRAE handbook chapter on fans. However, industry information on multiple plenum fans is limited to airflow performance (not sound) and only address housed (not plenum), 2-fan arrangements.

There are no governing guidelines to help fan and system designers design a more efficient system both in terms of air and sound performance.

This is an extension of RP 1420 which addressed single plenum fans only.

Research Need

Use the state of the art described above as a basis to specify the need for the proposed effort (250 words maximum)

System effect factors need to be developed for those systems that deviate from established guidelines.

There has been no in-depth, published study to understand system effects surrounding multiple, plenum arrangements. A few manufacturers have performed in-house testing and have presented the results of such testing to industry committees (namely, a disbanded AMCA committee). Note that there were a few issues with the in-house testing, including the need for a test rig that minimizes any impact structural resonance may have on sound performance.

Even at a stable operating point, total airflow is not the sum of the individual fans. Significant deviations from predictions based on industry literature have been witnessed—both airflow and sound. If not designed correctly, the correction for a deviation in expected airflow can have a significant effect on fan energy consumption and space sound levels.

This project will establish system effect factors and guidelines for system designers and equipment manufacturers.

Investigate conditions that may result in -parallel fan instability.

Project Objectives

Based on the identified research need(s), specify the objectives of the solicited effort that will address all or part of these needs (150 words maximum)

The objectives of this project will be to:

- Investigate both contained and uncontained, parallel plenum fans
- Address both the fan inlet and outlet for each factor listed below
- For any factor not addressed in prior research, establish a single-fan baseline
- Develop system effect factors for air and sound performance through laboratory testing
- Provide spacing guidelines
 - Push the limits, don't use conventional rules-of-thumb (e.g., 0.5D)
 - Include mismatched walls
- Include rotation direction in the study
- Include a straight entry and a 90 degree turn upstream of the fan array

Expected Approach

Describe in a manner that may be used for assessment of project viability, cost, and duration, the approach that is expected to achieve the proposed objectives (200 words maximum).

Check all that apply: Lab testing , Computations , Surveys , Field tests , Analyses and modeling , Validation efforts , Other (specify)

Conventional laboratory testing using an air test chamber and a reverberation room. The following configurations shall be tested (WxH): single-fan not addressed in a prior research project, 2-fan (2x1), 3-fan (3x1), 4-fan (2x2), & 6-fan (3x2). For each configuration, on both the inlet and the outlet, test a number of wall spacings (reference RP 1420 for an example; plus the addition of mismatched walls). Test at least one configuration to determine if rotation direction is a factor. If so, add this variable as well.

Relevance and Benefits to ASHRAE

Describe why this effort is of specific interest to ASHRAE, its impact, and how it will benefit ASHRAE and the society. How does it align with ASHRAE Strategic Plans and Initiatives? How does it advance the state of the art in this area in general? Are there other stakeholders that should be approached to obtain relevant information or co-funding? (350 words maximum)

Multiple, parallel plenum fans help to maximize efficiency, offer redundancy, are easy to maintain, and offer much-needed flexibility; by minimizing the direction of airflow distance in particular. Energy use and IEQ can be optimized if good application guidelines are developed.

Engineers, system designers, and many equipment manufactures rely on unproven theories when it comes to parallel plenum fan system design. Thus, many members in the ASHRAE community will benefit from the results of this research. ASHRAE will offer leadership and guidance to system designers if such guidelines are established. ASHRAE will be viewed and remain in the forefront of energy conservation endeavors through cutting edge research.

AMCA International, AHRI, and the DOE would all be logical stakeholders.

Anticipated Funding Level and Duration

Funding Amount Range: \$120K

Duration in Months: 18

References

List the key references cited in this RTAR

- AMCA Publication 201 Fans and Systems
- *Fan Engineering* Howden Buffalo Inc.
- ASHRAE Standard 51 Laboratory Methods of Testing Fans for Rating
- ASHRAE Handbook chapter on fans