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Built Environment Today

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TO: Jin Wen, Chair TC 7.5, [jinwen@drexel.edu](mailto:jinwen@drexel.edu)  
Li Song, Research Subcommittee Chair TC 7.5, [lsong@ou.edu](mailto:lsong@ou.edu)  
Heejin Cho, Work Statement Author(s),

FROM: Michael Vaughn, Manager of Research and Technical Services (MORTS)

CC: William Murphy, Research Liaison 7.0, [william.murphy@uky.edu](mailto:william.murphy@uky.edu)

DATE: July 16, 2019

SUBJECT: Work Statement (1809-WS), "Updating Reference Guide for Dynamic Models of HVAC"

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During their annual meeting, the Research Administration Committee (RAC) reviewed the subject Work Statement (WS) and voted to return with comments.

Below are the issues, concerns, and questions that must be addressed in your next submission of the WS if you choose to resubmit.

1. The main concern is the budget and the required effort. The budget is still very high for essentially a literature review and publication update.
2. The work statement either needs to give more guidance on what should go into the updated guide document, or perhaps include a task that challenges a proposer to present ideas for how they would make the guide more useful.

Please coordinate changes to this Work Statement with your Research Liaison, William Murphy, [RL7@ashrae.net](mailto:RL7@ashrae.net) or [william.murphy@uky.edu](mailto:william.murphy@uky.edu) prior to resubmitting it to the Manager of Research and Technical Services for further consideration by RAC.

Also, it is necessary that you provide a new TC vote on the revised Work Statement, and a letter describing how each of the above items were addressed in the revision.

If you wish for this work statement to be reconsidered at the next RAC meeting, the revised Work Statement must be sent (electronically) to Michael Vaughn, Manager of Research and Technical Services ([morts@ashrae.net](mailto:morts@ashrae.net)) by **August 15, 2019**. The next opportunity for consideration after this deadline is **December 15, 2019** or consideration at RAC's 2020 winter meeting.

<b>Project ID</b>	<b>1809</b>	
<b>Project Title</b>	Updating Reference Guide for Dynamic Models of HVAC	
<b>Sponsoring TC</b>	TC 7.5, Smart Building Systems	
<b>Cost / Duration</b>	\$140,000 / 24 Months	
<b>Submission History</b>	1st WS Submission, RTAR Accepted F16	
<b>Classification: Research or Technology Transfer</b>	Basic/Applied Research	
<b>RAC 2019 Annual Meeting Review</b>	<b>COMPLETE RTAR CHECK LIST CRITERIA BELOW IF RTAR STAGE WAS SKIPPED BY TC</b>	
<b>RTAR Check List Criteria</b>	<b>Voted NO</b>	<b>Comments &amp; Suggestions</b>
<b>State-of-the-Art (Background):</b> The WS should include some level of literature review that documents the importance/magnitude of a problem. If not, then the WS should be returned for revision. <b>RTAR Review Criterion</b>		
<b>Advancement to the State-of-the-Art</b> Is there enough justification for the need of the proposed research. Will this research significantly contribute to the advancement of the State-of-the-Art. <b>RTAR Review Criterion</b>		
<b>Relevance and Benefits to ASHRAE:</b> 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. <b>RTAR Review Criterion</b>		
<b>IF THE THREE CRITERIA ABOVE ARE NOT ALL SATISFIED - MARK "REJECT" BELOW BUT ADDRESS THE FOLLOWING CRITERIA AS APPROPRIATE</b>		
<b>RTAR STAGE FOLLOWED</b>		
<b>WS Check List Criteria - START HERE</b>		<b>Comments &amp; Suggestions</b>
<b>Detailed Bidders List Provided?</b> The contact information in the bidder list should be complete so that each potential bidder can be contacted without difficulty.		
<b>Proposed Project Description Correct?</b> Are there technical errors and/or technical omissions that the WS has that prevents it from correctly describing the project? If there are, then the WS needs major revision.		
<b>Task Breakdown Reasonable?</b> Is the project divided into tasks that make technical and practical sense? Are the results of each task such that the results of the former naturally flow into the latter? If not, then major revisions are needed to the WS that would include: adding tasks, removing tasks, and re-structuring tasks among others.		<b>#9</b> - One task was removed from the RTAR but the WS still references a TASK 3. While experimental validation would likely be too complex and expensive for such a broad document, there still needs to be something between the TASK 1 literature review and the TASK 2 document update. If there are multiple HEX models for example, how would a reader know which to choose? Perhaps a task could be inserted for model comparisons and let that be the basis for Item 2 of the Proposal Evaluation Criteria. Experimental data would be hard to come by and its validity always subject to question, but subjecting multiple models to a consistent set of inputs and then comparing their outputs may have some merit. A literature review that just says Smith did this and Jones did that and Chen did something else may be of limited value to someone looking to incorporate such a model for their application.
<b>Adequate Intermediate Deliverables?</b> The project should include the review of intermediate results by the PMS at logical milestone points during the project. Before project work continues, the PMS must approve the intermediate results.		
<b>Proposed Project Doable?</b> Can the project as described in the WS be accomplished? If difficulties exist in the project's WS that prevent a successful conclusion of the project, then the project is not doable. In this situation, major revision of the WS is needed to resolve the issues that cause the difficulty.		
<b>Time and Cost Estimate Reasonable?</b> The time duration and total cost of the project should be reasonable so that the project can be as it is described in the WS.		<b>#8</b> - I think this project doesn't need to be extended for 2 years as described, hence the budget could also be reduced. I think if it is just a matter of literature review and listing of existing dynamic models - it should not be more than 1 year. However, if there is a level of evaluation of the available models, then I don't think 2 years and \$140k would suffice!. <b>#9</b> - Although the budget was reduced from the RTAR with the reduced scope of work, the budget is still VERY high for essentially a literature review and publication update. This budget may be more appropriate if an additional task is added to perform some sort of evaluation of competing models. In its present WS form, no new information is being discovered, only existing material is being edited and rearranged in the current document, which can be done with modest effort.
<b>Proposed Project Biddable?</b> Examining the WS as a whole, is the project described in the WS of sufficient clarity and detail such a potential bidder can actually understand and develop a proposal for the project? This criterion combines the previous three criteria into an overall question concerning the usefulness of the WS. If the WS is considered to not be biddable, then either major revisions are in order or the WS should be rejected.		<b>#8</b> - Again, we have to be quite clear what is required - listing of available dynamic modeling or differentiating between available models and listing the most appropriate?
<b>Decision Options</b>	<b>Initial Decision</b>	<b>Suggested Approval Conditions</b>
ACCEPT		
COND. ACCEPT		
RETURN	X	<b>#8</b> - Please see above, my main concern is the budget and the required effort. <b>#9</b> - The work statement has reduced the tasks (perhaps because of RAC comments) but in so doing has now reduced the total project to essentially a detailed literature review. It is not clear how Criterion 2 of the Proposal Evaluation Criteria will be applied to competing proposals of literature reviews. The WS either needs to give more guidance on what should go into the updated guide document, or perhaps include a task that challenges a proposer to present ideas for how they would make the guide more useful. <b>#6</b> - This update is useful to a wide audience and is in need of updating.
REJECT		

**ACCEPT Vote** - Work statement(WS) ready to bid as-is

**CONDITIONAL ACCEPT Vote** - Minor Revision Required - RL can approve WS for bid without going back to RAC once TC satisfies RAC's approval condition(s) to his/her satisfaction

**RETURN Vote** - WS requires major revision before it can bid

**REJECT Vote** - Topic is no longer considered acceptable for the ASHRAE Research Program due to duplication of work by another project or because the work statement has a fatal flaw(s) that makes it unbiddable

**WORK STATEMENT COVER SHEET**

Date: **11/28/2018**

(Please Check to Insure the Following Information is in the Work Statement )

A. Title	X
B. Executive Summary	X
C. Applicability to ASHRAE Research Strategic Plan	X
D. Application of the Results	X
E. State-of-the-Art (background)	X
F. Advancement to State-of-the-Art	X
G. Justification and Value to ASHRAE	X
H. Objective	X
I. Scope	X
J. Deliverables/Where Results will be Published	X
K. Level of Effort	X
Project Duration in Months	X
Professional-Months: Principal Investigator	X
Professional-Months: Total	X
Estimated \$ Value	X
L. Proposal Evaluation Criteria & Weighting Factors	X
M. References	X
N. Other Information to Bidders (Optional)	X

Title: **Updating Reference Guide for Dynamic Models of HVAC**

WS# **1809**  
(To be assigned by MORTS - Same as RTAR #)

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

**ASHRAE Reference Guide for Dynamic Models of HVAC Equipment**

Responsible TC/TG: **TC7.5 Smart Building Systems**

Date of Vote: \_\_\_\_\_

For	*	<b>6</b>
Against	*	<b>0</b>
Abstaining	*	<b>1 (chair)</b>
Absent or not returning Ballot	*	<b>1</b>
Total Voting Members		<b>8</b>

This W/S has been coordinated with TC/TG/SSPC (give vote and date):

**TC1.4 Control Theory and Application**

Has RTAR been submitted?  
Strategic Plan  
Theme/Goals

**Yes**

Work Statement Authors: \*\*

**Heejin Cho**

Proposal Evaluation Subcommittee:

Chair:  
Members:

Project Monitoring Subcommittee:  
(If different from Proposal Evaluation Subcommittee)

Recommended Bidders (name, address, e-mail, tel. number): \*\*

**Weimin Wang, Univ. of North Carolina, [weimin.wang@unc.edu](mailto:weimin.wang@unc.edu), 704-687-5066**

**Daeho Kang, New York City College of Tech, [dkang@citytech.cuny.edu](mailto:dkang@citytech.cuny.edu), 718-260-5160**

**James Braun, Purdue University, [jbraun@purdue.edu](mailto:jbraun@purdue.edu), 765 49-49157**

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

(Three qualified bidders must be recommended, not including WS authors.)

- Is an extended bidding period needed?
- Has an electronic copy been furnished to the MORTS?
- Will this project result in a special publication?
- Has the Research Liaison reviewed work statement?

Yes	No	How Long (weeks)
X		

\* Reasons for negative vote(s) and abstentions

\*\* Denotes WS author is affiliated with this recommended bidder  
Use additional sheet if needed.

**WORK STATEMENT#**

1809

**Title:**

Updating Reference Guide for Dynamic Models of HVAC Equipment

**Sponsoring TC/TG/MTG/SSPC:**

TC7.5 Smart Building Systems

**Co-Sponsoring TC/TG/MTG/SSPCs (List only TC/TG/MTG/SSPCs that have voted formal support)**

TC1.4 Control Theory and Application

**Executive Summary:**

This project proposes to perform an extensive review of the literature on dynamic models of HVAC equipment and update the existing ASHRAE Reference Guide for Dynamic Models of HVAC Equipment, published in 1998. The outcomes of this project will provide a categorized and organized summary of newly developed dynamic models of HVAC systems and will provide ASHRAE members with newly developed dynamic models and identify future research needs for dynamic modeling of HVAC equipment. Since 1998, a substantial number of new dynamic models for HVAC equipment have been introduced in the literature. However, no update on the existing reference guide was made so far. Many ASHRAE students and professional members still use this reference guide in an extensive manner to learn the basic principles and fundamentals of HVAC dynamic models, and they have expressed needs of updating the existing reference guide.

### **Applicability to the ASHRAE Research Strategic Plan:**

The proposed research directly supports Goal 10 to “significantly increase the understanding of energy efficiency, environmental quality and the design of buildings in engineering and architectural education.” An updated reference guide can serve as a significant source to train students and early career engineers to better understand current knowledge of dynamic HVAC systems behavior and to practice transient modeling techniques for HVAC equipment. This effort also directly contributes to Goal 1 to “maximize the actual operational energy performance of buildings and facilities” by enhancing understanding regarding dynamic behaviors of HVAC equipment.

### **Application of Results:**

After the ASHRAE Reference Guide for Dynamic Models of HVAC Equipment was published in 1998, a substantial number of dynamics HVAC models has been introduced in the literature. Recently there have been numerous requests through ASHRAE to the technical committee (TC) 7.5 for updating the reference guide to include lately developed and improved dynamic models of HVAC equipment. TC 7.5 also learned that the existing reference guide had been actively used by the ASHRAE student and professional members to teach the basic principles and fundamentals of HVAC dynamic models even though the reference guide has not been updated for almost 20 years. The reference guide and its project report have been cited more than 60 times in scientific journal articles. Many ASHRAE advisors and researchers expressed that they still use the existing guide to train their students and early career engineers to develop dynamic models of HVAC systems and to provide a better resource to researchers and practitioners to perform model analysis for controls. From the inputs of various ASHRAE members, there is an urgent need to update the reference guide and significantly help ASHRAE members enhance their understanding on most recent developments and improvements regarding dynamic modeling of HVAC equipment and identify research gaps in the area of dynamic HVAC modeling.

### **State-of-the-Art (Background):**

The existing ASHRAE Reference Guide for Dynamic Models of HVAC Equipment was published in 1998. Over 500 references were analyzed in this guide to cover: duct and pipe models, heat and mass exchanger models, air flow dynamics models, boiler and furnace models, heat pump and chiller models (including vapor compression and absorption systems, compressors, condensers, evaporators and expansion valves and control) controllers, sensors and actuators. The existing reference guide has been actively used as a manual and textbook by the ASHRAE student and professional members to understand the basic principles and fundamentals of HVAC dynamic models. The reference guide and its project report have been cited more than 60 times in scientific journal articles [1-3].

However, since 1998, a substantial number of lately developed or improved HVAC equipment have been introduced in the literature [4, 5]. Along with this, numerous research project have been carried out on the topic of dynamic modeling for those new and improved HVAC systems. Some examples of newly developed dynamic models are introduced below.

#### **(a) Heat exchanger technologies**

Over the past decade various novel heat exchanger technologies have been introduced in the field of HVAC, e.g., ground loop heat exchangers, night sky radiators, radiant cooling and heating panels, energy recovery ventilators (ERV), brazed plate heat exchangers, thermally activated building surfaces and etc. Numerous research articles have been published on dynamic modeling of these components and existing systems (e.g., [6-12]).

#### **(b) Air distribution systems**

Numerous research regarding dynamic modeling and simulation of air distribution systems (e.g., air-side economizers, variable air volume (VAV) systems, dedicated outdoor air systems (DOAS), etc.) has also been performed recently (e.g., [13-14]).

#### **(c) Vapor compression systems**

Novel vapor compression technologies, such as variable refrigerant flow (VRF), desiccant cooling systems, and

geothermal heat pumps, have been drawing great research attention recently. Dynamic modeling and simulation of these technologies has been presented in the literature (e.g., [15-19]).

(d) Thermal energy storage

Thermal energy storage concepts have gained remarkable attention in the HVAC industry in recent past years due to their potential in load shifting and consecutive savings in operational cost. Researchers have investigated performance, control, and feasibility of ice storage and hot water tank with/without phase change materials (PCM) through dynamic modeling, simulation, and experiments (e.g., [9-12, 18, 20-23]).

There is an urgent need to update the reference guide so that it can serve ASHRAE members with most advanced information.

**Advancement to the State-of-the-Art:**

The proposed project will not directly advance the state-of-the-art, however it will update the existing reference guide with newly developed “state-of-the-art” dynamic HVAC models found in the literature. As stated before, no update on the existing reference guide was made since 1998 and a substantial number of new HVAC equipment and their dynamic models have been introduced in the literature since then. Therefore, it is crucial to perform a thorough literature review and update the existing reference guide with the current state-of-the-art knowledge.

**Justification and Value to ASHRAE:**

Knowledge dissemination through handbooks, standards and reference guides is one of core values of ASHRAE. This effort, surveying literature in a systematic way and making all HVAC component dynamic models accessible in a single source compilation, directly supports knowledge dissemination. The outcome of this research is a categorized and organized summary of newly developed dynamic models of HVAC systems. For ASHRAE students and early HVAC career engineers, it will provide most updated information to assist their learning and for advanced HVAC engineers and researchers, it will help them identify future research needs for dynamic modeling of HVAC equipment. This effort also directly contributes to HVAC control related goals in ASHRAE Strategic Plan by enhancing understanding regarding dynamic behaviors of HVAC equipment.

**Objectives:**

The following objectives are required to complete the proposed project:

1. Perform a comprehensive review of literature and/or relevant projects on currently covered and newly introduced dynamic models of HVAC equipment since 1998.
2. Update the existing ASHRAE Reference Guide for Dynamic Models of HVAC Equipment.

**Scope/Technical Approach:**

The following tasks describe the expected approach to meet the project objectives:

**Task 1: Literature review**

Task 1 will involve performing a critical comprehensive review of literature in terms of the currently published research articles regarding dynamic models of HVAC equipment. Search of references should include but not necessarily be limited to renowned journals (i.e., ASHRAE transactions, ASME transactions, the International Journal of Refrigeration, Energy and Buildings, etc.), references cited by papers obtained, and relevant project reports. Task 1 will also involve surveying relevant projects on newly introduced dynamic models of HVAC equipment since 1998. The number of articles and projects reviewed at Task 1 should be large enough to cover all HVAC equipment in terms of dynamic models of HVAC systems, which are newly developed. Note that only models that are validated with the experimental data should be considered in this task.

A quarterly interim report for Task 1 (i.e., six (6) reports during 18 months) describing the literature survey results and report writing progress shall be submitted to the PMS for review and approval.

**Task 2: Updating the existing ASHRAE Reference Guide for Dynamic Models of HVAC Equipment**

Finally, in Task 3 the contractor will provide the needs of updates for the new ASHRAE Reference Guide for Dynamic Models of HVAC Equipment. If completed, this will form the updated version of the ASHRAE Reference Guide for Dynamic Models of HVAC Equipment. Bidders may propose and justify additional steps and/or alternate sequences as needed. It should also be made clear that results from this project are not meant to be used as a marketing tool by manufacturers.

A quarterly interim report for Task 2 (i.e., one (1) report during 6 months) describing the guide writing progress shall be submitted to the PMS for review and approval. A final report (i.e., an updated reference guide) shall be submitted before the end of project period.

### **Deliverables/Where Results Will Be Published:**

Progress, Financial and Final Reports, Research or Technical Paper(s), and Data shall constitute required 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 (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 updated reference guide (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, six 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, 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 bound copies
- One unbound copy, printed on one side only, suitable for reproduction.
- Two copies on CD-ROM; one in PDF format and one in Microsoft Word.

#### c. HVAC&R Research or ASHRAE Transactions Technical Paper

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 paper. The paper title shall contain the research project number (XXXX-RP) at the end of the title in parentheses, e.g., (XXXX-RP).

Note: A research or technical paper describing the research project must be submitted after the TC has approved the Final Report. Research or technical papers may also be prepared before the project’s completion, if it is desired to disseminate interim results of the project. Contractor shall submit any interim papers to MORTS and the PMS for review and approval before the papers are submitted to ASHRAE Manuscript Central for review.

#### d. Data

The Institution agrees to maintain true and complete books and records, including but not limited to notebooks, reports, charts, graphs, analyses, computer programs, visual representations etc., (collectively,

the “Data”), generated in connection with the Services. Society representatives shall have access to all such Data for examination and review at reasonable times. The Data shall be held in strict confidence by the Institution and shall not be released to third parties without prior authorization from the Society, except as provided by GENERAL CONDITION VII, PUBLICATION. The original Data shall be kept on file by the Institution for a period of two years after receipt of the final payment and upon request the Institution will make a copy available to the Society upon the Society’s request.

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.

All Deliverables under this Agreement and voluntary 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:**

It is estimated that the project will require two years to complete the project with the budget of \$140K including the support of graduate student(s), time for principal investigator, and two trips to ASHRAE meetings per year for the two year project duration.

**Proposal Evaluation Criteria:**

<b>No.</b>	<b>Proposal Review Criterion</b>	<b>Weighting Factor</b>
1	Contractor's understanding of Work Statement as revealed in the proposal	15%
2	Quality of methodology proposed for conducting research	35%
3	Qualifications of personnel for this project	30%
4	Student involvement	10%
5	Probability of meeting the objectives and schedule of the Work Statement	10%

**Project Milestones:**

<b>No.</b>	<b>Major Project Completion Milestone</b>	<b>Deadline Month</b>
1	Task 1	18
2	Task 2	6

**Authors:**

Heejin Cho, Ph.D., Associate Professor, Mississippi State University, Mississippi State, MS, 39759 USA.

## References:

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- [25] M. Wetter, "A Modelica-based library for building energy and control systems," 8<sup>th</sup> International IBPSA Conference, Jul. 2009.

**Other Information for Bidders (Optional):**

### **Feedback to RAC and Suggested Improvements to Work Statement Process**

Now that you have completed the work statement process, RAC is interested in getting your feedback and suggestions here on how we can improve the process.



Shaping Tomorrow's  
Built Environment Today

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Manager Research & Technical Services

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CC: Christopher Wilkins, Research Liaison Section 7.0, [chris.wilkins@crbusa.com](mailto:chris.wilkins@crbusa.com)  
FROM: Michael Vaughn, MORTS, [mvaughn@ashrae.org](mailto:mvaughn@ashrae.org)  
DATE: November 16, 2016  
SUBJECT: Research Topic Acceptance Request (1809-RTAR), "Updating Reference Guide for Dynamic Models of HVAC Equipment"

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During their fall meeting, the Research Administration Committee (RAC) reviewed the subject Research Topic Acceptance Request (RTAR) and voted to accept it with comments for further development into a work statement (WS) provided that the key comment(s) and question(s) below are addressed to the satisfaction of your Research Liaison, Christopher Wilkins, [chris.wilkins@crbusa.com](mailto:chris.wilkins@crbusa.com), or [RL7@ashrae.net](mailto:RL7@ashrae.net), in the work statement draft.

1. TC 7.5 should find other TCs or SSPCs to co-sponsor the project.
2. Reduce the budget, it is extremely high, and reduce the timeline.
3. Clarify how the modules will be tested.

The work statement draft 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 **August 15, 2018** or it will be dropped from display on the Society's Research Implementation Plan. The next likely submission deadline for a new work statement on this topic is **May 15, 2017** for consideration at RAC's 2017 Annual meeting. The submission deadline after that for work statements is **August 15, 2017** for consideration at the RAC's 2017 fall meeting.

<b>Project ID</b>	<b>1809</b>	
<b>Project Title</b>	Updating Reference Guide for Dynamic Models of HVAC Equipment	
<b>Sponsoring TC</b>	TC 7.5, Smart Building Systems	
<b>Cost / Duration</b>	\$200,000 / 24 Months	
<b>Submission History</b>	1st RTAR Submission	
<b>Classification: Research or Technology Transfer</b>	Basic/Applied Research	
<b>RAC 2016 Fall Meeting Review</b>		
<b>Essential Criteria</b>	<b>Voted NO</b>	<b>Comments &amp; Suggestions</b>
<b>Background:</b> 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.		#6 - well described #4 - Literature review. #14 - Background and references are very comprehensive, and importance to ASHRAE is convincing.
<b>Research Need:</b> Based on the background provided is the need for additional research clearly identified? If not, then the RTAR should be rejected.	#7	#6 - well described #7 - The scope of this project is to conduct literature review on dynamic models of HVAC equipment in order to update the ASHRAE Reference Guide. It will also intend to "validate" the models collected from the literature. As mentioned in the RTAR, a lot of efforts have been made in the past 20 years. Tons of publications and reports have been published in this area as well, which makes a meaningful literature search very challenging. On the other hand, verifying the HVAC system models through literature review is challenging without conducting rigorous tests. Hence, I am concerned that this work might become an open-ended exercise only. One possibility might be to invite a few experienced experts to update the Guide. They would still need literature search but should have a much better chance of success. #14- Description of need is compelling. #5- Current guide is out of date
<b>Relevance and Benefits to ASHRAE:</b> 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.		#9 - ASHRAE's Guide is 18 years old. It's due for an update. #6 - well described. #14 - Valuable addition to missing information ...Having a standard/vetted library of dynamic models available to both researchers and practitioners will increase the pace of innovation, provide more realistic system feedback needed to deliver robust designs and lastly provide a consistent basis for comparing alternative algorithms for controls optimization and building modeling.
<b>IF ABOVE THREE CRITERION ARE NOT <u>ALL</u> SATISFIED - MARK "REJECT" BELOW &amp; CONTINUE REVIEW BELOW</b>		
<b>Other Criteria</b>	<b>Voted NO</b>	<b>Comments &amp; Suggestions</b>
<b>Project Objectives:</b> 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.	#7	#6 - Generally, I can understand the project objective. I cannot find the relationship between the TC 7.5 and other TCs or SSPCs such as SSPC 140. The project objectives are closely related with the building energy analysis and there are other TC where the same topic is argued. ASHRAE Standard 140-2014 has less descriptions for HVAC Equipment and I feels it is good that this RTAR will cover the future ASHRAE Standard 140.
<b>Expected Approach and Budget:</b> 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:	#9, #7, #5	#6 - no problems. #9 - It seems like a lot of time and money for what appears to me as essentially a literature review and update of a Guide. #7 - Budget seems high for updating the Guide. I have some doubt whether one month PI + 2 research assistants (not much experienced) could adequately do this work. #4 - This is a literature review and no experimental work is foreseen therefore I would reduce the budget to say USD k150. #5 - Budget seems high for an update to an existing reference guide. I would also expect the timeline to be shorter.
<b>References:</b> Are the references provided?	#6	#6 -ASHRAE Standard 140-2014 -- Standard Method of Test for the Evaluation of Building Energy Analysis Computer Programs (ANSI Approved) should be cited.#14 - Extensive
<b>Decision Options</b>	<b>Initial Decision?</b>	<b>Final Approval Conditions</b>
ACCEPT AS-IS		#6 - There are other TCs where the same topics are argued. TC 7.5 should find other TCs or SSPCs sponsors. #1 - Budget is extremely high. This WS should not be approved until the budget is substantially reduced. #4 - Budget should be lowered. DY - Reassess the expected budget and timeline and align with the scope.
ACCEPT W/COMMENTS RPS: 3-0-0CNV RAC: 10-0-0 CNV		
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



## DRAFT RTAR Template

Title: \_\_\_\_\_

### 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)

### Background

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

**Research Need**

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

**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)

### **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) (  )

### **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)

Anticipated Funding Level and Duration

Funding Amount Range: \$ \_\_\_\_\_

Duration in Months: \_\_\_\_\_

**References**

List the key references cited in this RTAR