Shaping Tomorrow's Built Environment Today

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Michael R. Vaughn, P.E.
Manager Research & Technical Services

mvaughn@ashrae.org

TO: Richard Peters, Chair TC 4.4, rp@tbs-engineering.com

FROM: Michael R. Vaughn
Manager of Research and Technical Services

CC: Michael Pouchak, Research Liaison 4.0, mike.pouchak@honeywell.com
Christopher Schumacher, Research Subcommittee Chair TC 4.4, chris@buildingsciencelabs.com
Manfred Kehrer, Work Statement Author(s), MKehrer@wje.com

DATE: September 19, 2018

SUBJECT: Work Statement (1718-WS), "Development of a method to determine the moisture transport properties through an asphalt shingle roof system under hot and humid conditions"

During their recent fall meeting, the Research Administration Committee (RAC) reviewed the subject Work Statement (WS) and voted 6-4-2, CNV to conditionally accept it for bid provided that the RAC approval conditions are addressed to the satisfaction of your Research Liaison in either written responses or revisions to the work statement.

1. Budget too high, duration too low.
2. Must provide milestones with tasks and deliverables?
3. Need higher level of testing which is gold standard.
4. Need further investigation into the ability to accomplish goals and the ability of the Bidders to understand and bid this work statement.

See the bottom of the attached WS review summary for the approval conditions.

The WS review summary also contains comments from individual members of RAC that the TC may or may not choose to also consider when revising the WS; some of these comments may indicate areas of the WS where readers require additional information or rewording for clarification.

If PES roster changes are required, please review them with your RL, Michael Pouchak, mike.pouchak@honeywell.com, for approval.

Lastly, please provide ASHRAE staff with the final names and contact information for the Proposal Evaluation Subcommittee (PES) roster, and the Technical Contact that will respond to questions from prospective bidders during the bid posting period (typically this is a WS author or PES member). The technical contact and all members of the PES must also agree to not bid on this project.

Please coordinate changes to this Work Statement with your Research Liaison, mike.pouchak@honeywell.com, or RL4@ashrae.net. Once he is satisfied that the approval conditions have been met, the project will be ready to bid.

The first opportunity that you will have for this project to possibly bid is winter 2019. To be eligible for this bid cycle, a revised work statement that has been approved for bid by your research liaison should be sent (electronically) to Mike Vaughn, Manager of Research and Technical Services, mvaughn@ashrae.org or morts@ashrae.net, before December 15, 2018. The next opportunity for bid after that will be spring 2019.

Project ID	**1718**	
Project Title	**Development of a method to determine the moisture transport properties through an asphalt shingle roof system under hot and humid conditions**	
Sponsoring TC	TC 4.4 (Building Materials and Building Envelope Performance)	
Cost / Duration	$160,000 / 18 Months	
Submission History	**2nd WS Submission, 1st WS Returned F15, RTAR accepted 14.06**	
Classification: Research or Technology Transfer	Basic/Applied Research	
RAC 2018 Fall Meeting Review	**RTAR STAGE FOLLOWED**	
Check List Criteria	**Voted NO**	**Comments & Suggestions**
State-of-the-Art (Background): 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. **RTAR Review Criterion**		
Advancement to the State-of-the-Art 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. **RTAR Review Criterion**		
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.		
IF THE THREE CRITERIA ABOVE ARE NOT ALL SATISFIED - MARK "REJECT" BELOW BUT ADDRESS THE FOLLOWING CRITERIA AS APPROPRIATE		
Detailed Bidders List Provided? The contact information in the bidder list should be complete so that each potential bidder can be contacted without difficulty.		**6** - Missing telephone numbers. **13** - I suspect shingle manufacturers may want to bid on this since they would be set up to conduct the experiments most easily. **11** - 4 identified.
Proposed Project Description Correct? Are there technical errors and/or technical omissions that the WS has that prevents it from correctly describing the project? If there are, than the WS needs major revision.		**13** - You should require more than a single material specimen for validation since there will be variability in even known materials and standard measurement methods. Grammar in Task 2 description needs work. You probably want to specify exact shingle configurations for test, and to include roofing felt and plywood or OSB since shingles are never used without these other roofing materials.
Task Breakdown Reasonable? 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.		**13** - In your scope section, you never mention the simulation part that you listed in the objectives. **11** - 4 Tasks are defined with intermediate deliverables for each.
Adequate Intermediate Deliverables? 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.		**6** - nice format of tasks and deliverable
Proposed Project Doable? 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.		**6** - Don't know. Developing a test method with 95 to 100% RH on one side of a shingle and controlling it at temperatures from 70 to 170F will be difficult at best if not practical for a test method. **7** - I am not completely convinced that the moisture research results can be completely duplicated at another facility without additional specification of details of the new measurement techniques and apparatus that are developed. **13** - You probably want to specify exact shingle configurations for test, and to include roofing felt and plywood or OSB since shingles are never used without these other roofing materials. Also, since you want tests with liquid water, you will probably want to specify at least three roof slopes for the tests.
Time and Cost Estimate Reasonable? 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.		**13** - Level of effort seems to be low and budget seems to be high. 5 months of effort at $100k/year plus 70% overhead/fringes would be only about $80k, so total would be less than $100k.
Proposed Project Biddable? 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.		**7** - Not sure if the bidders will be able to understand what they need to do to create the new measurement method. Is this within the capability of the bidder to accomplish? **13** - I think bids would be all over the map since the test configurations are not specified and bidders would likely have very different interpretations of what is intended or considered acceptable.
Decision Options	**Initial Decision**	**Final Approval Conditions**
ACCEPT		**12 - t**his WS has been significantly improved. Furthermore, this project is highly relevant to the ASHRAE mission and objectives. **6 -** This a well written WS. I don't see project milestones with task and schedule breakdown over the 24 month period. Need to include**. 5 -** No milestones included. I feel the deliverables section could be customized and made more relevant to the actual work being performed. **7** - Need further investigation into the ability to accomplish goals and the ability of the Bidders to understand and bid this WS. **13** - The work statement needs to be more specific in the task definitions with a close review of effort and cost, and proofread the document to correct multiple grammar errors. I suspect shingle manufacturers may want to bid on this since they would be set up to conduct the experiments most easily. In background, AIR at 50% RH on the other side. In Objectives, I don't know what the following means "A combined method out of measurement and hygrothermal simulation is supposed to be successful…". You should require more than a single material specimen for validation since there will be variability in even known materials and standard measurement methods. Grammar in Task 2 description needs work. You probably want to specify exact shingle configurations for test, and to include roofing felt and plywood or OSB since shingles are never used without these other roofing materials. Also, since you want tests with liquid water, you will probably want to specify at least three roof slopes for the tests. In your scope section, you never mention the simulation part that you listed in the objectives. Level of effort seems to be low and budget seems to be high. 5 months of effort at $100k/year plus 70% overhead/fringes would be only about $80k, so total would be less than $100k. I think bids would be all over the map since the test configurations are not specified and bidders would likely have very different interpretations of what is intended or considered acceptable. The work statement needs to be more specific in the task definitions with a close review of effort and cost, and proofread the document to correct multiple grammar errors. **11** - This is a well written WS. It covers all the required elements of a WS.
COND. ACCEPT	**X**	
RETURN		
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: August 22, 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	
Project Duration in Months	X
Professional-Months: Principal	X
Professional-Months: Total	X
Estimated $ Value	X
L. Other Information to Bidders (optional)	X
M. Proposal Evaluation Criteria & Weighting Factors	X
N. References	X

Title: Development of a method to determine the moisture transport properties through a roof shingle system under hot and humid conditions

WS# 1718

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

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

HOF Chapter 26; HOA Chapter 44
ASHRAE Standard 90.1
ASHRAE Standard 90.2
ASHRAE Standard 160
ASHRAE Standard 189.1

Responsible TC/TG: TC 4.4 – B. Materials and B. Env. Performance

Date of Vote: 1/22/2018

For		11
Against	*	0
Abstaining	*	1
Absent or not returning Ballot	*	-
Total Voting Members		13 (CNV)

This W/S has been coordinated with TC/TG/SSPC (give vote and date):
TC 1.12 (Vote: 10,0,0) on 1/20/18, Fitsum Tariku as PES,PMS member

Has RTAR been submitted ?	Yes
Strategic Plan	Goals, 1,3,7 & 10
Theme/Goals	Tools and Applications

Work Statement Authors: **
Manfred Kehrer

Proposal Evaluation Subcommittee:
Chair: Sam Glass
Members: Diana Fisler
Florian Antretter

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

Recommended Bidders (name, address, e-mail, tel. number): **
Oak Ridge National Laboratory, Andre Desjarlais, desjarlaisa@ornl.gov
R&D Services, Stuart Ruis, stuart@rdservices.com
Fraunhofer CSE, Jan Kosny, jkosny@cse.fraunhofer.org
WJE, Manfred Kehrer MKehrer@wje.com (Author of Work Statement)
(Three qualified bidders must be recommended, not including WS authors.)

Potential Co-funders (organization, contact person information):
Representatives from GAF (Sudhir Railkar), Owens Corning (Achilles
ARMA (Marcin Pacera) have been asked with no response

	Yes	No	How Long (weeks)
Is an extended bidding period needed?		x	
Has an electronic copy been furnished to the MORTS?	x		
Will this project result in a special publication?		x	
Has the Research Liaison reviewed work statement?	x		

* Reasons for negative vote(s) and abstentions

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

WORK STATEMENT # 1718
TC 4.4 Building Materials and Building Envelope Performance
TC 1.12

Title: Development of a method to determine the moisture transport properties through an asphalt shingle roof system under hot and humid conditions.

Executive Summary:
Moisture transfer through residential asphalt shingle roof systems is a necessary input value for whole-building simulations, but is not sufficiently understood. Measures to increase energy efficiency have to be studied for potential moisture damage due to moisture accumulation and rot in the roof sheathing, but this cannot be done as the rate of moisture transfer through shingled roof systems is unknown under actual in-service conditions. A shingle roof system is considered to be the combination of the bituminous shingles and the overlaps including the nails.

Applicability to the ASHRAE Research Strategic Plan:

This research project applies to the following goals in the ASHRAE Research Strategic Plan (2010-2015):

Goal 1: Maximize the actual operational energy performance of buildings and facilities;
Goal 3 – To reduce significantly the energy consumption for HVAC&R, water heating, and lighting in existing homes.
Goal 7: Support development of tools, procedures and methods suitable for designing low energy buildings
Goal 10: Significantly increase the understanding of energy efficiency, environmental quality and the design of buildings in engineering and architectural education;

Reasoning for Goals 1, 7, and 10: Building research and forensic investigations in the last two decades have shown that measures to increase energy efficiency in building-envelope assemblies (e.g. walls, roofs) increase the risk of moisture-related failures. Understanding the behavior of asphalt shingle-roof systems in terms of moisture permeance is necessary to evaluate any measure for energy-efficiency improvements in terms of potential moisture problems.

Reasoning for Goal 3: This project is intended to provide accurate and representative material properties leading to realistic estimates of building and system performance, thus enabling better relative comparisons of alternative solutions using simulation tools.

Nearly all designers and contractors involved with new construction and retrofit of buildings with attics will benefit from this research. A better description of the system performance will allow designers to calculate the risk of moisture damage, as these risks become more predictable. In addition, manufacturers and distributors of HVAC system will benefit as this research will help to clarify those circumstances in which HVAC systems and their interaction with attic air may be involved in elevated moisture contents of the air and the roof deck.

Application of Results:

- ASHRAE Handbook – Fundamentals: Chapter 26 Heat, Air, and Moisture Control in Building Assemblies—Material Properties
- ASHRAE Handbook – Applications: Chapter 44 Building Envelopes
- ASHRAE Standard 160 – Criteria for Moisture-Control Design Analysis in Buildings
- ASHRAE Standard 90.1 – Energy Standard for Buildings Except Low-Rise Residential Buildings
- ASHRAE Standard 90.2 – Energy Efficient Design of Low-Rise Residential Buildings
- ASHRAE Standard 189.1 – Standard for the Design of High-Performance Green Buildings
- Published results in technical papers through ASHRAE Transactions and a scientific paper through the International Journal of HVAC&R research
- Further upgrade of energy simulation and heat, air, moisture simulation tools such as WUFI, Delphine, hygIRC, and EnergyPlus

The current 2013 Handbook of Fundamentals does not contain any moisture related material properties for shingles. This project's goal is intended to deliver material properties for water-vapor permeance of asphalt shingles to complete the material properties for a roof deck.

State-of-the-Art (Background):

The effect of high temperatures and high moisture contents of the roof shingles system (especially between the overlapping of the shingles), which clearly have a major impact on the moisture transport through the shingle system, is not considered in the ASTM E96 Test method at all. Standard test conditions for the water method is only covered to 90 degF. The evidence that problems occur comes from research carried out by the Oak Ridge National Laboratory [6].

Recent studies have been carried out by Owens Corning Corporation and the Building Science Corporation [1]. They found that the vapor permeance of an individual asphalt shingle was 0.9 perms using the ASTM E96 [2] dry cup measurement method, which can address only homogeneous materials. The dry cup method uses desiccant on one side of the material and 50% relative humidity on the other side. They modified the method to measure vapor transfer through an asphalt roof shingle assembly consisting of overlapping shingles, presumably with the dry cup method at room temperature, and reported a value of 0.65 perms. Although this study made an improvement over the standard method by using a shingle assembly, the effects of high temperature, high relative humidity, and liquid water on the shingle surfaces and between the overlappings were not addressed in this study.

In the last 10 years, many new underlayments have entered the market without any published scientific data on their as-installed performance. Their impact on the overall performance of the roof deck cannot be quantified as long as the moisture transport through the roof shingle system remains unknown.

Recent publications [4], [5] at the 2013 Buildings XII Conference address the moisture problem in attics, but were only partially successful, as both publications were not able to explain the elevated relative humidities measured in unvented attics

The latest research results [6] show that a significant amount of liquid water vapor transport in attics does not happen. This conclusion is only based on a building in a mixed-humid climate, and only disproves that moisture is transmitted by pure liquid transport.

Recent studies from Building Science Corporation [7], [8] claim that moisture transfer through shingles are not significant, but this claim is without any supporting data. Furthermore there remains the question "which realistic moisture transport properties for roof shingles are to be used for design calculations?".

Recent studies in [9] show that at least a liquid transport through the joints of the shingles are unlikely. Though, this conclusion has been done by numerical simulation only. A final result by measurement regarding the moisture transport characteristics of a roof shingles system is still missing.

Advancement to the State-of-the-Art:
As the moisture permeance of the asphalt shingle roof systems is unknown at high temperature and high relative humidity or in contact with liquid water, a method of measurement must be developed. This is the intended deliverable of this project to ASHRAE.

Evidence exists according to recent field tests [6] carried out by the Oak Ridge National Laboratory that this permeability may change significantly at high temperatures and relative humidities. The existing ASTM Standard E96 does not cover this effect. Furthermore, it is technically challenging to apply high temperature and RH to the specimen and also to measure the still expected small amounts of moisture transfer. Both problems are not covered by ASTM E96. The results of this RP could result in an updated ASTM E96.

Once reliable values for the moisture permeability of roof shingle systems exist, advanced models to simulate the Heat, Air, and Moisture exchange in residential and light commercial attics and unvented roof assemblies with steep slope roofs can be used to understand the conditions under which moisture damage occurs. Further action can then be taken to design new energy-efficient roof assemblies and better re-roofing strategies of existing buildings to reduce the moisture risk.

Beside this, having realistic moisture transport properties for the shingles will results in realistic calculation of the moisture flow into and out of the attic which has an influence on the air-conditioning latent loads.

Justification and Value to ASHRAE:
The principal justification of this project is to ensure that the hygrothermal material properties in the ASHRAE Handbook – Fundamentals continue to be representative of the materials currently in the market and relevant to the conditions to which they are exposed. Asphalt shingle roof systems are the most commonly used for residential homes. Unfortunately, no hygric properties are given in the current tables of material properties in Chapter 26.

The results of this research project are intended to assist designers to more confidently perform hygrothermal modeling to optimize their buildings, as well as promote the advantages of energy and hygric modeling to their clients. The results of this project will support the requirements in ASHRAE Standard 90.1 and 90.2 as they require that insulation must be protected from moisture, and 189.1, and 160 as no calculation input data for shingles are available now.

Objectives:
The main focus will be to develop a method to measure moisture transfer through an asphalt roof shingle assembly under high temperature conditions and a range of moisture conditions.

- Develop a method for the determination of moisture flow due to combined air, liquid and vapor transmission of roof shingle systems under hot and humid conditions. A combined method out of measurement and hygrothermal simulation is supposed to be successful at this time.
- Validate the measurement method with specimen of known materials.
- Deploy the measurement method on several new roof shingle systems and expand the hygric material properties and assembly properties listed in the ASHRAE Handbook – Fundamentals.

Scope/Technical Approach:

Task 1: Compilation of existing research.

Literature shall be reviewed that deals with moisture transfer measurement methods applied to temperatures higher than ASTM E96 or that have put a material surface in contact with liquid water, and field measurements that have monitored temperatures of asphalt shingles and roof decks for the purpose of establishing realistic boundary conditions for laboratory tests.

Deliverables:

- Compilation report on existing research results

Task 2: Development of the principle for the new measurement method.

The basic principle of the new measurement technique and the apparatus shall be developed in this task. The method shall be able to determine the rate of moisture transfer through a shingle assembly over a range of temperatures (70 °F to 170°F), range of RH conditions (95% to 100%, and in contact with liquid moisture). The technical challenge are how to apply high temperatures and rel. humidities to one side of the specimen, the measurement of the still small amount of moisture flow through the relative big specimen, and the evidence that the high vapor pressure on one side will not lead to moisture flows which are erroneous interpreted as moisture flows through the shingle roof system.

Deliverables:

- Description report of the measurement method and apparatus
- A complete list of the measured variables, the way they are measured, measurement error analysis, and evidence of the feasibility of the measurements.
- Evidence that the measurement method is able to measure moisture transport through a roof shingle system at warm and humid conditions.

- Description on how the above mentioned technical challenges have been addressed.

Task 3: Validation of the measurement method/apparatus.

In this task the validation of the measurement method shall be done using two assemblies: 1) a known material applied at low temperatures according to ASTM E96, and 2) sheet metal, which will serve as an impermeable material to confirm that zero moisture transfer is actually measured.

Deliverables:

- Validation report which compares measurement results of the new method when applied at temperatures with results from ASTM E96 measurements and when a applied to sheet metal.

Task 4: Exemplary measurements of several roof shingle systems.

In this task several roof shingle systems shall be measured and evaluated using the new method. At a minimum, three asphalt roof shingle systems from three different manufacturers shall be included with at least one repeated measurement for each.

Deliverables:

- Result report which contains measurement results of the new measurement method.

An approval by the Project Monitoring Subcommittee (PMS) is required upon completing each task.

Deliverables/Where Results Will Be Published:

Progress, Financial and Final Reports, Research or Technical Paper, 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 final report containing the description of the experimental apparatus, the measurement method, and full results for water-vapor permeance of several roof shingle systems. 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 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 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 (1718-RP) at the end of the title in parentheses.

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 the research project;

2. Why the findings are significant; and
3. How the findings benefit ASHRAE membership and the 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.

Note: Bidders should review detailed requirements regarding deliverable format and other requirement posted at www.ashrae.org/research.

Level of Effort:
The project anticipates 2.5 months for the principal investigator/researcher and 2.5 months for a research technician and approximately $10,000 material costs and $5,000 travel costs. The estimated cost is $160,000 and the project is expected to take 18 months.

Other Information for Bidders (Optional):

Bidders must prove their expertise in laboratory measurement of heat and moisture transport and hygrothermal simulation. Bidder must have significant experience in the application and testing of products using ASTM E96.

Proposal Evaluation Criteria:

1. Contractor's demonstrated understanding of Work Statement as revealed in proposal. (15 points)
2. Quality of methodology proposed for conducting research. (25 points)
3. Contractor's capability in terms of facilities and relevant prior research. (20 points)
4. Qualifications of personnel for this project. (20 points)
5. Student involvement. (5 points)
6. Probability of contractor's research plan meeting the objectives of the Work Statement. (15 points)

References:

[1] Lstiburek J., Karagiozis AN, Gassman, P. 2011. Vapor Permeability provides No Performance Benefit for Roofing Underlayments in Ventilated Attics. Owens Corning Technical Services Bulletin RD-10102011

[2] ASTM E96 / 96M – 15 – Standard Test Method for Water Vapor Transmission of Materials.

[3] Dodge, F.W. 2002. "Construction Outlook Forecast." www.fwdodge.com. F.W. Dodge Market Analysis Group, Lexington, Mass.

[4] Pallin, S.; Kehrer M. .A hygrothermal probabilistic risk analysis applied on residential unvented attics; Proceedings of Conference on Thermal Performance of the Exterior Envelopes of Whole Buildings XII, 2013, Clearwater, FL.

[5] Miller, William et al. Roof and Attic Design Guidelines for New and Retrofit Construction of Homes in Hot and Cold Climates; Proceedings of Conference on Thermal Performance of the Exterior Envelopes of Whole Buildings XII, 2013, Clearwater, FL.

[6] Boudeaux, P., Pallin,S., Jackson, R. Moisture Performance of Sealed Attics in Mixed-Humid Climate, ORNL Report ORNLTM-2013/525.

[7] Lstiburek, J., Cool Hand Luke Meets Attics
http://www.buildingscience.com/documents/insights/bsi-077-cool-hand-luke-meets-attics#F02

[8] Lstiburek, J. , Mea Culpa Roofs, ASHRAE Journal, January 2015.

[9] Boudeaux, P., Pallin,S., Jackson, R. Moisture Performance of Sealed Attics in Mixed-Humid Climate, Journal of Building Physics 2017, Vol 40(4) 311-323.

Point-By-Point Response to ASHRAE RAC for WS-1718

"Development of a method to determine the moisture transport properties through an asphalt shingle roof system under hot and humid conditions."

6/22/2018

1. RTAR acceptance letter asked to identify potential co-funders cover sheet does not list any

Response:
The section has been updated.

2. A list of bidder must be supplied.

Response:
A list of potential bidders has been incorporated.

3. Work statement should cover ASTM E96 and how it relates to this project.

Response:
The relation of ASTM E96 is now extensively covered in sections "State-of-the-art", "Advancement to the State-of-the-Art", "Scope/Technical Approach".

4. Barely Majority of the TC in favor

Response:
The ballot does not contains any negatives. The high amount of abstains is because of non-returned letter ballots.

5. Need to provide more guidance on the test method for task 2

Response:

The following section has been added in task 2:

"The technical challenge are how to apply high temperatures and rel. humidities to one side of the specimen, the measurement of the still small amount of moisture flow through the relative big specimen, and the evidence that the high vapor pressure on one side will not lead to moisture flows which are erroneous interpreted as moisture flows through the shingle roof system.

Deliverables:

• Description on how the above mentioned technical challenges have been addressed."

Kind Regards,

Manfred Kehrer

Shaping Tomorrow's Built Environment Today

1791 Tullie Circle NE ▪ Atlanta, Georgia 30329-2305 ▪ Tel 678.539.1211 ▪ Fax 678.539.2211 http://www.ashrae.org

Michael R. Vaughn, P.E.
Manager Research & Technical Services

TO: Peter Adams, TC 4.4, padams@morrisonhershfield.com
Samuel Glass, Research Subcommittee Chair TC 4.4, svglass@fs.fed.us
Xudong Yang, Research Liaison 4.0, xyang@tsinghua.edu.cn

FROM: Michael Vaughn, MORTS, MORTS@ASHRAE.net

DATE: November 20, 2015

SUBJECT: Work Statement (1718-WS), "Development of a method to determine the moisture transport properties through an asphalt shingle roof system under hot and humid conditions"

During their fall meeting, the Research Administration Committee (RAC) reviewed the subject Work Statement (WS) and voted 3-0-0 CNV to return with comments.

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

1. RTAR acceptance letter asked TC to identify potential co-funders. Cover sheet does not list any.
2. Author's institution is the only listed bidder. A list of bidders must be supplied.
3. Work statement should cover ASTM E96 and how it relates to this project.
4. Barely a majority of the TC in favor.
5. Need to provide more guidance on the test method for task 2

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

Please coordinate changes to this Work Statement with your Research Liaison, Xudong Yang, xyang@tsinghua.edu.cn or RL4@ASHRAE.net prior to resubmitting it again to the Manager of Research and Technical Services for further consideration by RAC.

Also, it is necessary that you provide with your next submission 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) by **December 15, 2015**. The next opportunity for consideration after this deadline is May 15, 2016.

Project ID	**1718**	
Project Title	**Development of a method to determine the moisture transport properties through an asphalt shingle roof system under hot and humid conditions**	
Sponsoring TC	TC 4.4 (Building Materials and Building Envelope Performance)	
Cost / Duration	$160,000 / 24M	
Submission History	**1st WS Submission, RTAR accepted 14.06**	
Classification: Research or Technology Transfer	Basic/Applied Research	
RAC 2015 Fall Meeting Review	**RTAR STAGE FOLLOWED**	
Check List Criteria	**Voted NO**	**Comments & Suggestions**
Detailed Bidders List Provided? The contact information in the bidder list should be complete so that each potential bidder can be contacted without difficulty.	**5, 7, 8, 11, 4**	**7** - Only ORNL is listed without specific contact information. **8** - Only see Oak Ridge National Laboratory - not enough info. Is this a single source WS? **11** - only one listed (ORNL, which is not eligible). Also, the WS author and the PES chair are ORNL employees! **4** - only 1 bidder listed without any email or other address
Proposed Project Description Correct? Are there technical errors and/or technical omissions that the WS has that prevents it from correctly describing the project? If there are, than the WS needs major revision.		**8** - There is a method of test per the WS: ASTME96. Maybe the objective of the WS would be to modify the test?
Task Breakdown Reasonable? 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.		
Adequate Intermediate Deliverables? 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.		
Proposed Project Doable? 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.	**4**	**4** - Not sure as the WS relies on the contractor to develop the test method in task 2 without giving much guidance in the WS
Time and Cost Estimate Reasonable? 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.	**8, 4**	**7** - Estimated budget ($160K) is reasonable. A duration of 24 months is a bit long (can it be reduced to 18 months?). **8** - Seem like $160K is way to high. Doesn't seem like it should take 9 months of research. **4** - seems high given the level of effort in the WS but is reasonable considering the work outlined elsewhere in the WS
Proposed Project Biddable? 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.	**8, 4**	**8** - WS is proposing single source. **4 -** Since the test method is to be developed without much guidance, could see significant variation from bidders
Decision Options	**Initial Decision**	**Final Approval Conditions**
ACCEPT		**5** - Reasonably good WS. However, RTAR acceptance letter asked TC to identify potential co-funders. Cover sheet does not list any. Also, the fact that the author's institution is the only listed bidder is unacceptable. A list of bidders must be supplied. **7** - Ready to bid after addressing the few minor comments above. **8** - Need to know why they have single bidder. Also, WS should cover ASTM E96 and how it relates to this project. Should ASTM be involved? **11** - Barely a majority of the TC in favor. No response to comments on RTAR noted need for co-funding - this is a topic where ASHRAE really shouldn't be the sole funder. **4** - Need to provide more guidance on the test method for task 2
COND. ACCEPT		
RETURN PH /DJ		
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: **August 17, 2015**

(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	
Project Duration in Months	X
Professional-Months: Principal	X
Professional-Months: Total	X
Estimated $ Value	X
L. Other Information to Bidders (optional)	X
M. Proposal Evaluation Criteria & Weighting Factors	X
N. References	X

Title: **Development of a method to determine the moisture transport properties through a roof shingle system under hot and humid conditions**

WS# **1718**

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

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

HOF Chapter 26; HOA Chapter 44
ASHRAE Standard 90.1
ASHRAE Standard 90.2
ASHRAE Standard 160
ASHRAE Standard 189.1

Responsible TC/TG: **TC 4.4 – B. Materials and B. Env. Performance**

Date of Vote: **Letter Ballot ending 8/14/15**

For		11
Against	*	0
Abstaining	*	0
Absent or not returning Ballot	*	8
Total Voting Members		20 (CNV)

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

Has RTAR been submitted ? **Yes**
Strategic Plan **Goals, 1,3,7 & 10**
Theme/Goals **Tools and Applications**

Work Statement Authors: **

Manfred Kehrer

Proposal Evaluation Subcommittee:

Chair: **Andre Desjarlais**
Members: **Sam Glass**
Diana Fisler
Florian Antretter

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

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

Oak Ridge National Laboratory

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

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

	Yes	No	How Long (weeks)
Is an extended bidding period needed?		x	
Has an electronic copy been furnished to the MORTS?	x		
Will this project result in a special publication?		x	
Has the Research Liaison reviewed work statement?	x		

* Reasons for negative vote(s) and abstentions
Chair not voting

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

WORK STATEMENT # 1718
TC 4.4 Building Materials and Building Envelope Performance
TC 1.12
SSPC 160

Title: Development of a method to determine the moisture transport properties through an asphalt shingle roof system under hot and humid conditions.

Executive Summary:
Moisture transfer through residential asphalt shingle roof systems is a necessary input value for whole-building simulations, but is not sufficiently understood. Measures to increase energy efficiency have to be studied for potential moisture damage due to moisture accumulation and rot in the roof sheathing, but this cannot be done as the rate of moisture transfer through shingled roof systems is unknown under actual in-service conditions. A shingle roof system is considered to be the combination of the bituminous shingles and the overlaps including the nails.

Applicability to the ASHRAE Research Strategic Plan:

This research project applies to the following goals in the ASHRAE Research Strategic Plan (2010-2015):

Goal 1: Maximize the actual operational energy performance of buildings and facilities;
Goal 3 – To reduce significantly the energy consumption for HVAC&R, water heating, and lighting in existing homes.
Goal 7: Support development of tools, procedures and methods suitable for designing low energy buildings
Goal 10: Significantly increase the understanding of energy efficiency, environmental quality and the design of buildings in engineering and architectural education;

Reasoning for Goals 1, 7, and 10: Building research and forensic investigations in the last two decades have shown that measures to increase energy efficiency in building-envelope assemblies (e.g. walls, roofs) increase the risk of moisture-related failures. Understanding the behavior of asphalt shingle-roof systems in terms of moisture permeance is necessary to evaluate any measure for energy-efficiency improvements in terms of potential moisture problems.

Reasoning for Goal 3: This project is intended to provide accurate and representative material properties leading to realistic estimates of building and system performance, thus enabling better relative comparisons of alternative solutions using simulation tools.

Nearly all designers and contractors involved with new construction and retrofit of buildings with attics will benefit from this research. A better description of the system performance will allow designers to calculate the risk of moisture damage, as these risks become more predictable. In addition, manufacturers and distributors of HVAC system will benefit as this research will

help to clarify those circumstances in which HVAC systems and their interaction with attic air may be involved in elevated moisture contents of the air and the roof deck.

Application of Results:

- ASHRAE Handbook – Fundamentals: Chapter 26 Heat, Air, and Moisture Control in Building Assemblies—Material Properties
- ASHRAE Handbook – Applications: Chapter 44 Building Envelopes
- ASHRAE Standard 160 – Criteria for Moisture-Control Design Analysis in Buildings
- ASHRAE Standard 90.1 – Energy Standard for Buildings Except Low-Rise Residential Buildings
- ASHRAE Standard 90.2 – Energy Efficient Design of Low-Rise Residential Buildings
- ASHRAE Standard 189.1 – Standard for the Design of High-Performance Green Buildings
- Published results in technical papers through ASHRAE Transactions and a scientific paper through the International Journal of HVAC&R research
- Further upgrade of energy simulation and heat, air, moisture simulation tools such as WUFI, Delphine, hygIRC, and EnergyPlus

The current 2013 Handbook of Fundamentals does not contain any moisture related material properties for shingles. This project's goal is intended to deliver material properties for water-vapor permeance of asphalt shingles to complete the material properties for a roof deck.

State-of-the-Art (Background):

The effect of high temperatures and high moisture contents of the roof shingles system (especially between the overlapping of the shingles), which clearly have a major impact on the moisture transport through the shingle system, is not considered in the ASTM E96 Test method at all. The evidence that problems occur comes from recent research carried out by the Oak Ridge National Laboratory [6].

Recent studies have been carried out by Owens Corning Corporation and the Building Science Corporation [1]. They found that the vapor permeance of an individual asphalt shingle was 0.9 perms using the ASTM E96 [2] dry cup measurement method, which can address only homogeneous materials. The dry cup method uses desiccant on one side of the material and 50% relative humidity on the other side. They modified the method to measure vapor transfer through an asphalt roof shingle assembly consisting of overlapping shingles, presumably with the dry cup method at room temperature, and reported a value of 0.65 perms. Although this study made an improvement over the standard method by using a shingle assembly, the effects of high temperature, high relative humidity, and liquid water on the shingle surfaces and between the overlappings were not addressed in this study.

In the last 10 years, many new underlayments have entered the market without any published scientific data on their as-installed performance. Their impact on the overall performance of the roof deck cannot be quantified as long as the moisture transport through the roof shingle system remains unknown.

Recent publications [4], [5] at the 2013 Buildings XII Conference address the moisture problem in attics, but were only partially successful, as both publications were not able to explain the elevated relative humidities measured in unvented attics

The latest research results [6] show that a significant amount of liquid water vapor transport in attics does not happen. This conclusion is only based on a building in a mixed-humid climate, and only disproves that moisture is transmitted by pure liquid transport.

Recent studies from Building Science Corporation [7], [8] claim that moisture transfer through shingles are not significant, but this claim is without any supporting data. Furthermore there remains the question "which realistic moisture transport properties for roof shingles are to be used for design calculations?".

Advancement to the State-of-the-Art:
As the moisture permeance of the asphalt shingle roof systems is unknown at high temperature and high relative humidity or in contact with liquid water, a method of measurement must be developed. This is the intended deliverable of this project to ASHRAE.

Evidence exists according to recent field tests [6] carried out by the Oak Ridge National Laboratory that this permeability may change significantly at high temperatures and relative humidities. The existing ASTM Standard E96 does not cover this effect.

Once reliable values for the moisture permeability of roof shingle systems exist, advanced models to simulate the Heat, Air, and Moisture exchange in residential and light commercial attics and unvented roof assemblies with steep slope roofs can be used to understand the conditions under which moisture damage occurs. Further action can then be taken to design new energy-efficient roof assemblies and better re-roofing strategies of existing buildings to reduce the moisture risk.

Beside this, having realistic moisture transport properties for the shingles will results in realistic calculation of the moisture flow into and out of the attic which has an influence on the air-conditioning latent loads.

Justification and Value to ASHRAE:
The principal justification of this project is to ensure that the hygrothermal material properties in the ASHRAE Handbook – Fundamentals continue to be representative of the materials currently in the market and relevant to the conditions to which they are exposed. Asphalt shingle roof systems are the most commonly used for residential homes. Unfortunately, no hygric properties are given in the current tables of material properties in Chapter 26.

The results of this research project are intended to assist designers to more confidently perform hygrothermal modeling to optimize their buildings, as well as promote the advantages of energy and hygric modeling to their clients. The results of this project will support the requirements in ASHRAE Standard 90.1 and 90.2 as they require that insulation must be protected from moisture, and 189.1, and 160 as no calculation input data for shingles are available now.

Objectives:
The main focus will be to develop a method to measure moisture transfer through an asphalt roof shingle assembly under high temperature conditions and a range of moisture conditions.

- Develop a method for the determination of moisture flow due to combined air, liquid and vapor transmission of roof shingle systems under hot and humid conditions. A combined method out of measurement and hygrothermal simulation is supposed to be successful at this time.
- Validate the measurement method with specimen of known materials.
- Deploy the measurement method on several new roof shingle systems and expand the hygric material properties and assembly properties listed in the ASHRAE Handbook – Fundamentals.

Scope/Technical Approach:

Task 1: Compilation of existing research.

Literature shall be reviewed that deals with moisture transfer measurement methods applied to temperatures higher than ASTM E96 or that have put a material surface in contact with liquid water, and field measurements that have monitored temperatures of asphalt shingles and roof decks for the purpose of establishing realistic boundary conditions for laboratory tests.

Deliverables:

- Compilation report on existing research results

Task 2: Development of the principle for the new measurement method.

The basic principle of the new measurement technique and the apparatus shall be developed in this task. The method shall be able to determine the rate of moisture transfer through a shingle assembly over a range of temperatures (70 °F to 170°F), range of RH conditions (95% to 100%, and in contact with liquid moisture).

Deliverables:

- Description report of the measurement method and apparatus
- A complete list of the measured variables, the way they are measured, measurement error analysis, and evidence of the feasibility of the measurements.
- Evidence that the measurement method is able to measure moisture transport through a roof shingle system at warm and humid conditions.

Task 3: Validation of the measurement method/apparatus.

In this task the validation of the measurement method shall be done using two assemblies: 1) a known material applied at low temperatures according to ASTM E96, and 2) sheet metal, which will serve as an impermeable material to confirm that zero moisture transfer is actually measured.

Deliverables:

- Validation report which compares measurement results of the new method when applied at temperatures with results from ASTM E96 measurements and when a applied to sheet metal.

Task 4: Exemplary measurements of several roof shingle systems.

In this task several roof shingle systems shall be measured and evaluated using the new method. At a minimum, three asphalt roof shingle systems from three different manufacturers shall be included with at least one repeated measurement for each.

Deliverables:

- Result report which contains measurement results of the new measurement method.

An approval by the Project Monitoring Subcommittee (PMS) is required upon completing each task.

Deliverables/Where Results Will Be Published:

Progress, Financial and Final Reports, Research or Technical Paper, 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 final report containing the description of the experimental apparatus, the measurement method, and full results for water-vapor permeance of several roof shingle systems. 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 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 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 (1718-RP) at the end of the title in parentheses.

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 the research project;
2. Why the findings are significant; and
3. How the findings benefit ASHRAE membership and the 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.

Note: Bidders should review detailed requirements regarding deliverable format and other requirement posted at www.ashrae.org/research.

Level of Effort:
The project anticipates 5 months for the principal investigator/researcher and 4 months for a research technician and approximately $10,000 material costs. The estimated cost is $160,000 and the project is expected to take 24 months.

Other Information for Bidders (Optional):

Bidders must prove their expertise in laboratory measurement of heat and moisture transport and hygrothermal simulation. Bidder must have significant experience in the application and testing of products using ASTM E96.

Proposal Evaluation Criteria:

1. Contractor's demonstrated understanding of Work Statement as revealed in proposal. (15 points)
2. Quality of methodology proposed for conducting research. (25 points)
3. Contractor's capability in terms of facilities and relevant prior research. (20 points)
4. Qualifications of personnel for this project. (20 points)
5. Student involvement. (5 points)
6. Probability of contractor's research plan meeting the objectives of the Work Statement. (15 points)

References:

[1] Lstiburek J., Karagiozis AN, Gassman, P. 2011. Vapor Permeability provides No Performance Benefit for Roofing Underlayments in Ventilated Attics. Owens Corning Technical Services Bulletin RD-10102011

[2] ASTM E96 / 96M – 15 – Standard Test Method for Water Vapor Transmission of Materials.

[3] Dodge, F.W. 2002. "Construction Outlook Forecast." www.fwdodge.com. F.W. Dodge Market Analysis Group, Lexington, Mass.

[4] Pallin, S.; Kehrer M. .A hygrothermal probabilistic risk analysis applied on residential unvented attics; Proceedings of Conference on Thermal Performance of the Exterior Envelopes of Whole Buildings XII, 2013, Clearwater, FL.

[5] Miller, William et al. Roof and Attic Design Guidelines for New and Retrofit Construction of Homes in Hot and Cold Climates; Proceedings of Conference on Thermal Performance of the Exterior Envelopes of Whole Buildings XII, 2013, Clearwater, FL.

[6] Boudeaux, P., Pallin,S., Jackson, R. Moisture Performance of Sealed Attics in Mixed-Humid Climate, ORNL Report ORNLTM-2013/525.

[7] Lstiburek, J., Cool Hand Luke Meets Attics
http://www.buildingscience.com/documents/insights/bsi-077-cool-hand-luke-meets-attics#F02

[8] Lstiburek, J. , Mea Culpa Roofs, ASHRAE Journal, January 2015.

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Manager Research & Technical Services
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TO: Marcus Bianchi, Chair TC 4.4, Marcus.Bianchi@owenscorning.com
Samuel Glass, Research Subcommittee Chair TC 4.4, svglass@fs.fed.us
Xudong Yang, Research Liaison Section 4.0, xyang@tsinghua.edu.cn

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

DATE: July 23, 2014

SUBJECT: Research Topic Acceptance Request (1718-RTAR), "Development of a method to determine the moisture transport properties through a roof shingle system under real conditions"

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 approval comment(s) below are addressed to the satisfaction of your Research Liaison in a revision.

1. Clean up the grammar, spelling for the Work Statement.
2. Detail lacking on the approach and the deliverables to ASHRAE are not clearly identified.
3. Co-funder's need to be identified.

Please coordinate changes to the RTAR with the help of your Research Liaison, Xudong Yang, xyang@tsinghya.edu.cn or RL4@ashrae.net, in response to the approval comment(s) only so that it 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, 2016** or it will be dropped from display on the Society's Research Implementation Plan. The next likely submission deadline for work statements is **December 15, 2014** for consideration at RAC's 2014 fall meeting. The submission deadline after that for work statements is **May 15, 2015** for consideration at the Society's 2015 Annual meeting.

Project ID	**1718**	
Project Title	**Development of a method to determine the moisture transport properties through a roof shingle system under real conditions**	
Sponsoring TC	TC 4.4, Building Materials and Building Envelope Performance	
Cost / Duration	$160,000 /24M	
Submission History	**RTAR 2nd Submission. 1st Submission of RTAR Returned 13.11**	
Classification: Research or Technology Transfer	Basic/Applied Research	
RAC 2014 Annual Meeting Review		
Check List Criteria	**VOTED NO**	**Comments & Suggestions**
Is there a well-established need? The RTAR should include some level of literature review that documents the importance/magnitude of a problem. If not, then the RTAR should be returned for revision.		**#10** - Justification for this research is not well stated. Only one study at Oak Ridge Nat#7**CH** - The research is intended to fill the current void in available information for designers. **#2** - ASHRAE strategically is moving into the residential area to provide its expertise to this sector to improve energy performance. **#4** - Good enough. Who would have surveyed the frequency of attic damage?
Is this appropriate for ASHRAE funding? If not, then the RTAR should be rejected. Examples of projects that are not appropriate for ASHRAE funding would include: 1) research that is more appropriately performed by industry, 2) topics outside the scope of ASHRAE activities.		**#10** - This should be cofounded by companies like Owens Corning as stated in the RTAR. **#14** - But the work results will affect other organizations and they should be approached for collaboration. **#7** - Aligns with ASHRAE focus on Residential Buildings. **#2** - Should work with others to be sure work adds knowledge and is used by industry including ASTM. **HS** - If ASHRAE is serious about the residential universe, then this project has strategic importance: impacts on modeling, nailing down ASHRAE turf, focus on attic systems, etc. Are there no roofing groups or NAHB that should/could provide matching funds? "Relevance" (p4) stretches to reach attic-based HVAC, which is already a problem for so many other reasons
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.		**#7**- Detail lacking on the approach and the deliverables to ASHRAE are not clearly identified. **#8** - If this RTAR is approved, the approach (e.g., lab test, site measurements, modeling) and the level of efforts should be clearly stated in WS. Would this benefit building energy simulation as well? #4 - Proposals still sketchy, but they rationalize by putting this into the WS.
Is the budget reasonable for the project scope? If not, then RTAR could be returned for revision or conditionally accepted with a note that the budget should be revised for the WS.		**#7** - Co-funder's are not identified. It would seem logical that building materials supplier/roofing industry would be interested in this research. There should be a long list of potential co-funders. **#8** - Budget seems reasonable considering large number of measurements and new data to be obtained. **#4** - Budget may be large, but large may be needed for definitive work. Besides, proposers who come in low have a real big advantage with our scoring system, as long as they are responsive. This protects ASHRAE
Have the proper administrative procedures been followed? This includes recording of the TC vote, coordination with other TCs, proper citing of the Research Strategic Plan, etc. If not, then the RTAR could be returned for revision or possibly conditionally accepted based on adequately resolving these issues.		

Decision Options	**Initial Decision**	**Approval Conditions**
ACCEPT W/CONDITIONS		**#10** - The second submission is similar to the first submission. Author does not clearly indicate how the comments were addressed in the new submission. **#14-** This RTAR states that it is necessary because the "accepted TC4.4 RTAR" 1670 isn't comprehensive enough to address this. 1670-RTAR was not accepted by RAC and if it were this could still be rolled together if appropriate. Please examine whether this can be done. **#7**- Recommend proceeding to work statement with noted refinements. **#2** - Clean up the grammar, spelling for the WS. **#4** - I'm still concerned that we see little effort to find co-funding, in part to begin developing strategic relationships
COND. ACCEPT		
RETURN		
REJECT		

ACCEPT Vote - Topic is ready for development into a work statement (WS).
COND. ACCEPT 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)
RETURN Vote - Topic is probably acceptable for ASHRAE research, but RTAR is not quite ready.
REJECT Vote - Topic is not acceptable for the ASHRAE Research Program