INVITATION TO SUBMIT A RESEARCH PROPOSAL ON AN ASHRAE RESEARCH PROJECT

1778-TRP, "Heat and Moisture Load from Commercial Dishroom Appliances and Equipment"

Attached is a Request-for-Proposal (RFP) for a project dealing with a subject in which you, or your institution have expressed interest. Should you decide not to submit a proposal, please circulate it to any colleague who might have interest in this subject.

Sponsoring Committee TC: 5.10, Kitchen Ventilation

Budget Range: $199,000 may be more or less as determined by value of proposal and competing proposals.

Scheduled Project Start Date: **September 1, 2018** or later.

All proposals must be received at ASHRAE Headquarters by 8:00 AM, EDT, May 15, 2018. NO EXCEPTIONS, NO EXTENSIONS. Electronic copies must be sent to rpbids@ashrae.org. Electronic signatures must be scanned and added to the file before submitting. The submission title line should read: 1778-TRP, "Heat and Moisture Load from Commercial Dishroom Appliances and Equipment" ***and "Bidding Institutions Name"*** **(electronic pdf format, ASHRAE's server will accept up to 10MB)**

If you have questions concerning the Project, we suggest you contact one of the individuals listed below:

For Technical Matters
Technical Contact
Derek Schrock
Halton Company
103 Industrial Drive
Scottsville, KY 42164-7932
Phone: 270-237-5600
Email: derek.schrock@halton.com

For Administrative or Procedural Matters:
Manager of Research & Technical Services (MORTS)
Michael R. Vaughn
ASHRAE, Inc.
1791 Tullie Circle, NE
Atlanta, GA 30329
Phone: 404-636-8400
Fax: 678-539-2111
E-Mail: MORTS@ashrae.net

Contractors intending to submit a proposal should so notify, by mail or e-mail, the Manager of Research and Technical Services, (MORTS) by May 1, 2018 in order that any late or additional information on the RFP may be furnished to them prior to the bid due date.

All proposals must be submitted electronically. Electronic submissions require a PDF file containing the complete proposal preceded by signed copies of the two forms listed below in the order listed below. **ALL electronic proposals are to be sent to rpbids@ashrae.org.**

All other correspondence must be sent to ddaniel@ashrae.org and mvaughn@ashrae.org. In all cases, the proposal must be submitted to ASHRAE by 8:00 AM, EDT, May 15, 2018. NO EXCEPTIONS, NO EXTENSIONS.

The following forms (Application for Grant of Funds and the Additional Information form have been combined) must accompany the proposal:

(1) ASHRAE Application for Grant of Funds (electronic signature required) and
(2) Additional Information for Contractors (electronic signature required)

ASHRAE reserves the right to reject any or all bids.

State of the Art (Background)

ASHRAE RP1469 Thermal Comfort in Commercial Kitchens (ASHRAE, 2013) found that dishrooms had latent and sensible loads significantly larger than the spaces were designed for and the results led to hot and humid conditions and mold growth.

There are many different types of dishwashing and warewashing equipment used in the foodservice industry. The types vary from powered sink washers to troughs, pre-rinse spray valves, under-counter, door-type, conveyor-type and flight-type warewashers. Each type of equipment operates in a different manner and generates different levels of sensible, latent and moisture loads to the space and whether the appliance is ventilated or not, whether sanitization occurs via hot water or chemicals and the effectiveness of the local ventilation.

The limited database for warewashing equipment is found in the ASHRAE Fundamental's chapter Non-residential Heating and Cooling Load Calculations. In the chapter is Table 5F on warewasher equipment heat gain to space. The original table was added in 2009 as part of a larger ASHRAE research project that revised the kitchen appliance heat gain tables. Since that time, the dishwasher heatgain table has been minimally revised with data from independent testing agencies (FSTC 2016). In the original RP-1362 project, Revised Heat Gain and Capture and Containment Exhaust Rates from Typical Commercial Cooking Appliances (ASHRAE 2008), 83 appliances (2 of which were dishwashers) in 100 test conditions were tested for radiant, sensible convective and latent heat loads to space. The appliance heat gain tables at the time were expanded to incorporate appliances in the modern day commercial kitchen. There was concern about the accuracy of the initial measurements. As a result, the cooling loads previously calculated for commercial kitchen HVAC systems may have been difficult to estimate and potentially undersized. In the same way, today there is concern about the dishroom heat gain and ventilation data in the public domain. The existing dishroom data is very limited and may be inaccurate. Inaccurate load data could account for hot and humid dishrooms with condensation on walls and supply diffusers. The goal is to provide the engineer with a more comprehensive understanding of the overall dishroom design, which will help to accurately calculate cooling loads, design HVAC systems, and specify exhaust hoods.

The International Mechanical Code (International Code Council, 2014) section 507.3 states that “Type II hoods shall be installed above dishwashers and appliances that produce heat or moisture and do not produce grease or smoke as a result of the cooking process, except where the heat and moisture loads from such appliances are incorporated into the HVAC system design or into the design of a separate removal system.” The data for the calculations are not currently available. There is only limited latent and sensible load data available for these dishwashers in Handbook of Fundamentals (HOF) (ASHRAE, 2013). Additionally, it is not known how much ventilation is required to remove the moisture load from the different warewashing systems. If equipment manufacturers supply their own ventilation system it is not known how much of the latent load may still remain in the space.

The California Conference of Directors of Environmental Health's Cooking Equipment Exhaust Ventilation Exemption Guide for the Local Enforcement Agency (CCDEH, 2009) provides a brief list of appliances exempted from hoods. The recommendation is to limit the number of unhooded appliances in a space. The document provides a brief reference to general HVAC, but does not provide guidance to calculate kitchen or dishroom loads, or a source for the heat load values and therefore the minimum cooling capacity requirements. The document does site examples of appliances being sources of hot and humid kitchens.

CIBSE's Energy Efficiency in Commercial Kitchens (CIBSE, 2009) design guide acknowledges the heat recovery design within commercial dishwashers and exhaust air systems. However, it but does not contain or refer to any source for sensible or latent heat rejection values.

Heat gain values provided from manufacturers exist on a very limited basis. Four dishwasher manufacturers have tested 9 models of dishwashers through a third party laboratory (Fisher-Nickel, 2016) that applies ASTM heat gain test methods. Manufacturers have only recently been applying ASTM F2474 (ASTM, 2014) to determine sensible and latent loads from dishwashers. They have not tested equipment in their own laboratories. Underwriters Laboratories is considering listing and labelling heat recovery dishwashers with the sensible and latent loads because

the information is not available elsewhere.

There is limited design guidance available for dishrooms. The design handbook of American Conference of Governmental Industrial Hygienists (ACGIH, 1998) addresses a simplified approach to dishwasher ventilation which provides an inadequate hood design that would result in a poorly performing system. This handbook and other design guides do not address the other sources of dishroom heat and moisture such as booster heaters, pre rinse spray valves, scrappers, pulpers, troffers, disposers, hoses, power wash sinks, and 3-compartment sinks.

In feedback from ASHRAE seminars and forums, designers complain about inadequate design data to calculate the internal loads from dishroom equipment. The results are undersized HVAC equipment and poor air distribution that lead to hot and humid kitchens. The findings of RP-1469 Thermal Comfort in Commercial Kitchens (ASHRAE, 2013) found in a survey of over 100 restaurants nationally that among casual dining, institutional and quick service restaurant dishrooms the operative temperatures were as high as 84.3°F and 71% RH. The average Predicted Mean Vote was above 2. The long term measurements found considerable daily temperature variations in the dishroom from 75°F to 90°F during working hours. If the dishroom was open to the cooking line, the thermal radiation from the hot appliance line raised the operative temperature by an additional 10°F, it was reported as high as 102°F. The relative humidity in the kitchen space was recorded during the working hours in the three different kitchen zones (i.e., cook line, prep line, and dishroom). The relative humidity was up to 55% higher in the dishwashing area than in the other two zones. Long term data at some quick serve restaurants recorded humidity averages in the dishroom of 69% during the summer.

A kitchen comfort zone as a region of the psychrometric chart was developed as part of the study. It included a region with a percent dissatisfied PD<12%. However, nearly 60% of the temperature and humidity data collected in the study was outside the bounds of the comfort zone. The operative temperature was as high as 107°F and the RH was as high as 78%. Such conditions lead to poor working conditions, low productivity, bad morale and mold growth.

The best available source for heat gain from commercial kitchen appliances is ASHRAE's book of Fundamentals chapter on non-residential cooling and heating loads calculations. The heat gain tables that include kitchen cooking appliances are well developed. However, there is limited data for heat gain from dishroom appliances and equipment. There is some information from a limited number of dishwashers manufacturers, but these in no way addresses the breadth of dishwashers available on the market or the other equipment such as pre-rinse spray valves, scrappers/troughs, dishloads and dryers that produce heat and moisture loads in the dishroom space.

Objective

Laboratory research will be conducted to meet the following objectives:

1) Determine the sensible convective, latent and moisture loads to the space when dishroom appliances and equipment are vented, partially vented or unvented. Identify airflows required (if applicable) to fully capture and contain the convective thermal plume and moisture loads from dishroom appliances and equipment. This objective will be accomplished by using flow visualization techniques and standard energy measurement protocols to determine the heat and moisture loads and minimum airflow rates at which all of the convective plume is captured for each commercial kitchen appliance and piece of equipment (if applicable).

2) Draft design guidance document for the design of HVAC for dishrooms. The results of the laboratory measurements will provide the basis of a design guidance document that will address the space recommendations of RP-1469 Thermal Comfort in Commercial Kitchens and to provide the design engineer with a more comprehensive understanding of overall dishroom design through a complete list of appliance heat load data, examples of cooling load calculations, proper sizing of HVAC systems, specification of exhaust hoods, makeup air rates and distribution strategies necessary to maintain operator comfort and reduce the risk of mold in commercial dishrooms.

Scope:

The scope of the project will include the measurement of the sensible convective loads, latent loads and moisture to the space from dishroom equipment and appliances. It will determine the exhaust airflows rates necessary (if applicable) for capture and containment of the convective and latent heat from dishroom equipment and appliances. The list of equipment to be tested should include the 10 types below. They will produce

approximately 18 different operating conditions. The seven pieces of equipment listed in the Handbook of Fundamentals - Chapter 18 Table 5F Recommended Rates of Radiant and Convective Heat Gain from Warewashing Equipment during Idle (Standby) or Washing Conditions do not need to be re-tested.

The specific tasks of this project include:

- Task 1: Construct and/or instrument laboratory space to obtain heat gain to space and capture and containment exhaust airflow rate results according to ASTM 2474 and ASTM 1704.
- Task 2: Test list of dishroom equipment and processes, analyze data and present a summary to the PMS.
- Task 3: Test dishwashers in test matrix, analyze data and present a summary to the PMS.
- Task 4: Draft design guidance document for the design of HVAC for dishrooms.
- Task 5: Draft Final Report

Task 1: Construct and/or Instrument Laboratory Space:

The purpose of this task is to obtain heat gain to space and capture and containment exhaust airflow rate results according to ASTM 2474 and ASTM 1704.

The heat load calculations can be accomplished by using the procedures outlined in both ASTM F2474 Standard Test Method for Heat Gain to Space Performance of Commercial Kitchen Ventilation/Appliance Systems (ASTM, 2014) and ASHRAE RP-1362 Revised Heat Gain and Capture and Containment Exhaust Rates from Typical Commercial Cooking Appliances.

Precise methods to determine the threshold of capture and containment are described in ASTM F1704 Standard Test Method for Capture and Containment Performance of Commercial Kitchen Exhaust Ventilation Systems (ASTM, 2012).

The test methods used to determine the required ventilation to capture the moisture loads from the appliances and determine the heat gains to space have been developed by ASTM and used successfully for many years to evaluate ventilation and heat loads from equipment in the foodservice industry. ASHRAE Projects RP-1202 and RP-1480 both used ASTM F1704 to successfully complete the project goals to verify ventilation rate requirements for commercial cooking appliances. ASHRAE Projects RP-1362 and RP-1631 both used ASTM F2474 to determine heat gain from hooded and unhooded commercial kitchen appliances. As an example, a suggested laboratory layout that could be adopted by a potential bidder is shown in Figure 1 below.

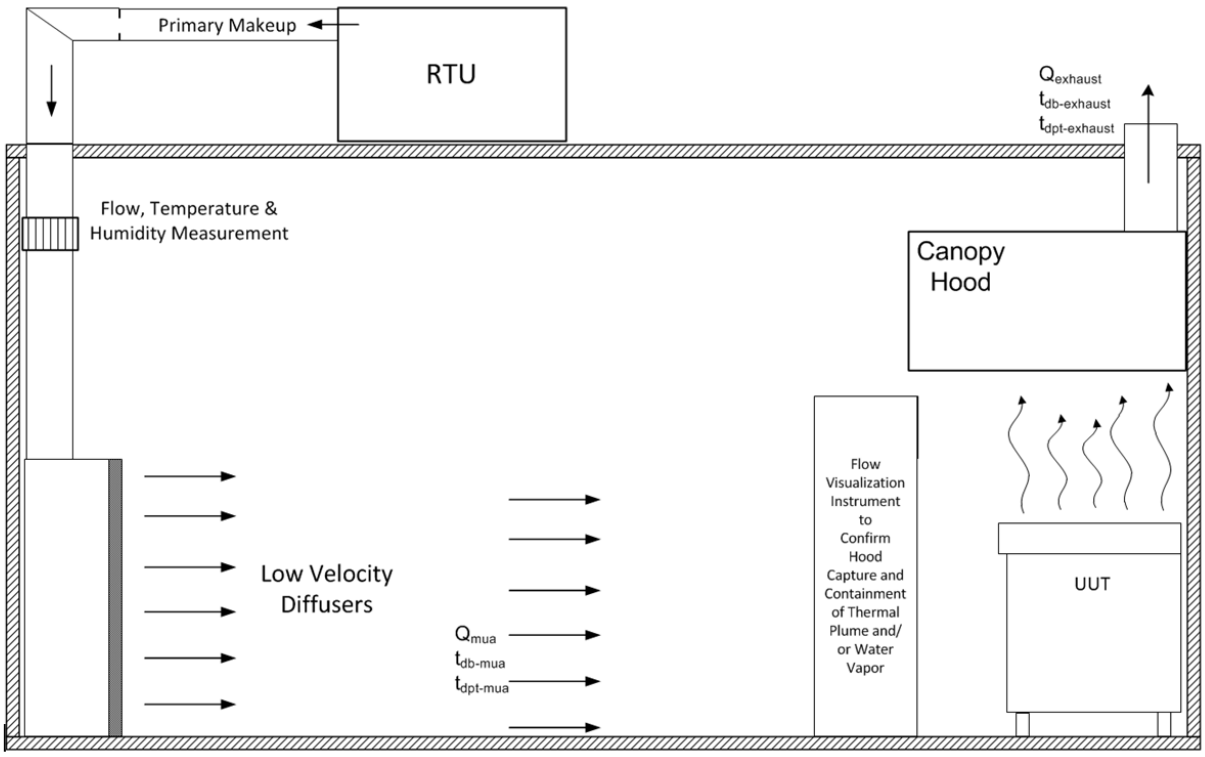

Figure 1 Laboratory Set-Up according to F2474 and F1704

Task 2: Test Equipment for Heat and Moisture Loads

The purpose of this task is to test a specific list of dishroom equipment and processes (approximately 10-items) for total heat and moisture loading, analyze data and present a summary to the PMS. Items to be tested include:

1) Pre-Wash
    a. Pre-rinse spray valves
        i. Non-federal compliant (>1.60 gpm)
        ii. Best in class (0.64 gpm)
    b. Scrappers with Trough
        i. Supplied per manufacturers' specifications with cold water
        ii. Supplied with hot water (typical field operation) Dish conveyors - pre wash
    c. Dish conveyors, pre-wash
2) Wash and Dry - Racks of dishes
3) Clean-Up
    a. Sinks
        i. 3-compartment sink
        ii. Power wash sink
    b. Hoses ~7 gpm

The methods of test for heat and moisture loading are outlined in ASTM F2474 Standard Test Method for Heat Gain to Space Performance of Commercial Kitchen Ventilation/Appliance Systems (ASTM, 2014). The precise methods to determine the threshold of capture and containment are described in ASTM F1704 Standard Test Method for Capture and Containment Performance of Commercial Kitchen Exhaust Ventilation Systems (ASTM, 2012). The apparatus is described in Figure 1 above.

The calculations are governed by:

Heat loads:
q sensible convective load = 1.08 Q std (T db-exh - W db-mua)
q latent load = 4840 Q std (W exh - W mua)

Moisture load:
mw = Q exh (W exh - W mua) / V exh x 60 min/h

where:
q sensible convective load = the convective sensible heat load to the space in Btu/h
q latent load = the convective latent heat load to the space in Btu/h
mw = the moisture load to the space in lbw/h
Q exh = the volumetric flow rate of the exhaust air stream in cfm
Q std = the volumetric flow rate of the air stream at standard conditions in cfm
V exh = specific volume of exhaust air stream ft3/lb dry air
T db-mua = the dry bulb temperature of the makeup air stream in °F
T db-exh = the dry bulb temperature of the exhaust air stream in °F
W mua = the humidity ratio of the makeup air stream in pound of water per pound of dry air
W exh = the humidity ratio of the exhaust air stream in pound of water per pound of dry air

Task 3: Test Dishwashers
The objective of this task is to obtain total head and moisture gain to space from wash and dry dishwashers in the test matrix (approximately 8-9 items), and analyze the data and present to the PMS. Items to be tested include:

1. Wash and Dry Dishwashers: with and without exhaust heat recovery, high temperature and low temperature chemical sanitation and blower dryers on conveyor and flight types
    a. Undercounter (approximately 1 combination)
    b. Door Type (approximately 1 combination)
    c. Rack Conveyor (approximately 3 combinations)
    d. Flight Type* (approximately 3 combinations)

*Due to the physical size of the flight type machines, it could be more practical to evaluate them in the field. The field measurement can be done in accordance with ASTM F2975-12 Standard Test Method for Measuring the Field Performance of Commercial Kitchen Ventilation Systems (ASTM 2016).

The methods of test for heat and moisture loading are outlined in ASTM F2474 Standard Test Method for Heat Gain to Space Performance of Commercial Kitchen Ventilation/Appliance Systems (ASTM, 2014). The precise methods to determine the threshold of capture and containment are described in ASTM F1704 Standard Test Method for Capture and Containment Performance of Commercial Kitchen Exhaust Ventilation Systems (ASTM, 2012).

Task 4: Dishroom HVAC Design Guidance.
The objective of this task is to develop design guidance for engineers for incorporation in the Applications Handbook and Fundamentals Handbooks including items such as: a complete list of appliance heat load data, examples of cooling load calculations, how to properly sizing of HVAC systems, specification of exhaust hoods, makeup air rates and distribution strategies necessary to maintain operator comfort and reduce the risk of mold in commercial dishrooms.

Task 5: Draft Final Report.
Final report to include raw data as an Appendix.

Deliverables:

The project deliverables will include:

From Task 1: A detailed overview of the measurement equipment and laboratory setup and test methods used to conduct all of the testing.
From Task 2: Data on the heat moisture loads from the various dishroom equipment.
From Task 3: Heat and moisture loads from specific dishwashing equipment.
From Task 4: Design guidance document for the proper sizing of HVAC systems in dishrooms and which HVAC designs provide the best moisture control.
From Task 5: Draft Final Report

Progress, Financial and Final Reports, Technical Paper(s), and Data shall constitute the 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 report, design guide, or manual, (collectively, "Final Report"), in a form approved by the Society, shall be prepared by the Institution and submitted to the Society's Manager of Research and Technical Services by the end of the Agreement term, containing complete details of all research carried out under this Agreement, including a summary of the control strategy and savings guidelines. Unless otherwise specified, the final draft report shall be furnished, electronically for review by the Society's Project Monitoring Subcommittee (PMS).

Tabulated values for all measurements shall be provided as an appendix to the final report (for measurements which are adjusted by correction factors, also tabulate the corrected results and clearly show the method used for correction).

Following approval by the PMS and the TC/TG, in their sole discretion, final copies of the Final Report will be furnished by the Institution as follows:

-An executive summary in a form suitable for wide distribution to the industry and to the public.
-Two copies; one in PDF format and one in Microsoft Word.

c. *Science & Technology for the Built Environment* or *ASHRAE Transactions* Technical Papers

One or more papers shall be submitted first to the ASHRAE Manager of Research and Technical Services (MORTS) and then to the "ASHRAE Manuscript Central" website-based manuscript review system in a form and containing such information as designated by the Society suitable for publication. Papers specified as deliverables should be submitted as either *Science & Technology for the Built Environment* or *ASHRAE Transactions*. Research papers contain generalized results of long-term archival value, whereas technical papers are appropriate for applied research of shorter-term value, ASHRAE Conference papers are not acceptable as deliverables from ASHRAE research projects. The paper(s) shall conform to the instructions posted in "Manuscript Central" for an *ASHRAE Transactions* Technical or HVAC&R Research papers. The paper title shall contain the research project number (1778-RP) at the end of the title in parentheses, e.g., (1778-RP).

All papers or articles prepared in connection with an ASHRAE research project, which are being submitted for inclusion in any ASHRAE publication, shall be submitted through the Manager of Research and Technical Services first and not to the publication's editor or Program Committee.

d. Data

Data is defined in General Condition VI, “DATA”

e. Project Synopsis

A written synopsis totaling approximately 100 words in length and written for a broad technical audience documenting: (i) the main findings of the research project, (ii) why the findings are significant, and (iii) how the findings benefit ASHRAE membership and/or society in general.

The Society may request the Institution submit a technical article suitable for publication in the Society’s ASHRAE JOURNAL. This is considered a voluntary submission and not a Deliverable. Technical articles shall be prepared using dual units; e.g., rational inch-pound with equivalent SI units shown parenthetically. SI usage shall be in accordance with IEEE/ASTM Standard SI-10.

Level of Effort

It is anticipated that the level of effort for this project will require three man-months of a principal researcher’s time and up to nine man-months for a research engineer. The total project duration is expected to be up to 24 Months with an estimated cost of $199,000. The lab testing is estimated at $180,000 and the design guidance document is $19,000. The largest portion of this project funding is expected to go toward instrumentation and testing in the field.

Proposal Evaluation Criteria

1. Contractor's understanding of Work Statement as revealed in proposal. 15%
   a) Logistical problems associated
   b) Technical problems associated
2. Quality of methodology proposed for conducting research. 25%
   a) Organization of project
   b) Management plan
3. Contractor's capability in terms of facilities. 15%
   a) Managerial support
   b) Data collection
   c) Technical expertise
4. Qualifications of personnel for this project. 20%
   a) Project team 'well rounded' in terms of qualifications and experience in related work
   b) Project manager person directly responsible; experience and corporate position
   c) Team members' qualifications and experience
   d) Time commitment of Principal Investigator
5. Student involvement 5%
   a) Extent of student participation on contractor's team
   b) Likelihood that involvement in project will encourage entry into HVAC&R industry
6. Probability of contractor's research plan meeting the objectives of the Work Statement. 15%
   a) Detailed and logical work plan with major tasks and key milestone
   b) All technical and logistic factors considered
   c) Reasonableness of project schedule
7. Performance of contractor on prior ASHRAE or other projects (No penalty for new contractors.) 5%

No	Major Project Completion Milestone	Deadline Month
1	Test list of dishroom equipment and processes (approximately 10), analyze data and present a summary to the PMS.	8
2	Test dishwashers in test matrix (approximately 8), analyze data and present a summary to the PMS	18
3	Draft design guidance for the design of HVAC for dishrooms	20

References

1. ACGIH. American Conference of Governmental Industrial Hygienists. 1998
   ASHRAE. Applications Chapter 33: Kitchen ventilation. 2015.
2. ASHRAE. Fundamentals Chapter 18: Nonresidential Heating and Cooling Load Calculations. 2013.
   ASHRAE. RP-1469. Thermal Comfort in Commercial Kitchens, 2013
3. ASHRAE. RP-1362 Revised Heat Gain and Capture and Containment Exhaust Rates from Typical Commercial Cooking Appliances, 2008
4. ASHRAE. Standard 154 Ventilation of Commercial Cooking Operations, 2016.
5. ASTM. F1704: Standard Test Method for Capture and Containment Performance of Commercial Kitchen Exhaust Ventilation Systems, 2012.
6. ASTM. F2474: Standard Test Method for Heat Gain to Space Performance of Commercial Kitchen Ventilation/Appliance Systems, 2009.
7. ASTM. F2975-12 Standard Test Method for Measuring the Field Performance of Commercial Kitchen Ventilation Systems, 2016.
8. CCDH. Cooking Equipment Exhaust Ventilation Exemption Guide for the Local Enforcement Agency, California Conference of Directors of Environmental Health, 2009
9. CIBSE. Energy efficiency in commercial kitchens, 2009
10. ICC. International Code Council. International Mechanical Code, 2015.

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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:	Jimmy Sandusky, Chair TC 5.10, jimmy.sandusky@halton.com Derek Schrock, Research Subcommittee Chair TC 5.10, derek.schrock@halton.com
FROM:	Michael Vaughn. MORTS, mvaughn@ashrae.org Manager of Research and Technical Services
DATE:	October 11, 2017
CC:	Dennis Loveday, Research Liaison 5.0, d.l.loveday@lboro.ac.uk
SUBJECT:	Work Statement 1778-WS, "Heat and Moisture Loading from Commercial Dishroom Appliances and Equipment"

During their fall meeting, the Research Administration Committee (RAC) reviewed the subject work statement (WS) and voted 10-0-0 CNV to accept this WS for bid.

1. Need a better understanding of how to perform the test and whether it is in the field or in a dedicated test facility.
2. Provide a better description of the expected deliverable from Task 4 (design guidance for Application Manual).

See the attached WS review summary for additional information.

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

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.

If you have any questions, please contact the ASHRAE Manager of Research and Technical Services, Michael Vaughn, (morts@ashrae.net). The deadline for submitting the above information to Mike Vaughn so that this work statement has an opportunity to possibly bid in the spring **February 15, 2018.**

Project ID		
Project Title	**Heat and Moisture Loading from Commercial Dish room Appliances and Equipment**	
Sponsoring TC	TC 5.10, Kitchen Ventilation	
Cost / Duration	$199,000 / 24 months	
Submission History	**1st WS Submission, RTAR accepted F15**	
Classification: Research or Technology Transfer	Basic/Applied Research	
RAC 2017 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.		**#12** - 3 potential bidders identified. Others should be added.
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.		**#12** - There is an exhaustive description of the SoA. Goal 4 cited in the Applicability to ASHRAE's Strategic Plan is focused on offices, not relevant to kitchens and dishwashing rooms. Goals 2 and 7 are more relevant to this WS. The goals of the project conflate thermal comfort, productivity and health of kitchen workers and with the more specific goal of estimating the heat and humidity loads of dishwashers in dish rooms. How are actual practices in kitchen dishwashing rooms captured for designing the test procedure, especially for the portion of the test to be performed in the field. Many Standards are cited.
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.		**#12** - WBS includes 5 tasks that are described in detail. **#8** - The load and technical calculation in task 2 are reasonable
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.		**#12**- Correct the name of the ASHRAE Research Journal. **#8** - Would like more deliverables between task 2 and task 4
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.		
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.		**#11** - the amount of work required to finished this project is beyond the estimated effort and budget proposed by the WS authors. **EK** - Bidders need to allow for purchase of dishwashers and field instrumentation (for flight type dishwashers). Schedule is provided for a 20 month project abut stated duration is up to 24 months.
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.		**#11** - as it, I was confused whether the experiments would be done in the field or in a test facility that is more controlled! **#12** - With all the details provided, this project is biddable by those who have had previous experience in this type of work.
Decision Options	**Initial Decision**	**Final Approval Conditions**
ACCEPT	**X**	**#11** - Need a better understanding of how to perform the test and whether it is in the field or in a dedicated test facility. Also, reviewing the cost and timeline is important. **#12**- This is a very detailed and thorough statement WS. **#8** - improve intermediate deliverables. **#13** - Suggest providing better description of the expected deliverable from Task 4 (design guidance for Application Manual). **#3** - While WS is well written and shows good understanding of the state of the art and the need for research, one might question whether this research is a high priority for ASHRAE. Undoubtedly however, a great deal of energy is used in kitchens, and since RAC accepted the RTAR, and the TC has provided adequate responses to our questions, acceptance is warranted.
COND. ACCEPT		
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: 7/26/17

(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 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)	

Title:
Heat and Moisture Loading from Commercial Dishroom Appliances and Equipment

WS# 1778
(To be assigned by MORTS - Same as RTAR #)

Results of this Project will affect the following Handbook Chapters, Special Publications, etc.:
ASHRAE Applications Handbook Ch 33 Kitchen Ventilation
ASHRAE Fundamentals Handbook Ch 18 Nonresidential Heating and Cooling Load Calculations
ASHRAE Standard 154 Ventilation for Commercial Cooking
ASHRAE Load Calculation Applications Manual
Model Codes (IMC, UMC, Title 24)

Responsible TC/TG: TC 5.10 Kitchen Ventilation

Date of Vote: August 14, 2017

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

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

Has RTAR been submitted?
Strategic Plan
Theme/Goals
Yes

Work Statement Authors: **
Curt Sawan
Don Fisher
Rich Swierczyna

Proposal Evaluation Subcommittee:
Chair: Don Fisher
Members:
Curt Sawan
Rolando Legarreta (TC4.1 representative)
Derek Schrock

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

Recommended Bidders (name, address, e-mail, tel. number): **
1. University of Syracuse, Building Energy and Environmental Systems Laboratory 263 Link Hall, Syracuse University, Syracuse, NY 13244-1240; Jianshun Zhang, Professor http://Beesl.Syr.Edu
2. Frontier Energy, Food Service Technology Center, 12949 Alcosta Blvd., San Ramon, CA dzabrowski@frontierenergy.com 925-866-2844**
3. Andre Salivar CEM, CFSP, CMVP, Manager-Project/Product
SCE Foodservice Technology Center (FTC)
6050 N. Irwindale Avenue, Irwindale, CA 91702
FTC line (626) 812-7666, Direct: (626) 812-7558, Pax: 42558

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

Potential Co-funders (organization, contact person information):
1. Pacific Gas & Electric Company
Rob Bohn, Energy Efficiency Product Management
Tel: 415.973.2588, rob.bohn@pge.com

2. Southern California Gas Company
Melissa Marks

3. Southern California Edison
Brian James, brian.james@sce.com

	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# 1778

Title:

Heat and Moisture Load from Commercial Dishroom Appliances and Equipment

Sponsoring TC/TG/MTG/SSPC:

TC 5.10

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

Executive Summary:

Warewashing and dishwashing cleaning processes in commercial foodservice produce significant heat and moisture loads. The current database on dishroom appliances and equipment is practically non-existent. There are minimal manufacturers' data and no design guidance on how to properly ventilate dishrooms to manage the heat and moisture loads. This project will develop a database on the heat gain to space, moisture loading and ventilation rates for commercial foodservice equipment in dishrooms. The project will measure the loads from typically unhooded and hooded appliances and their relationship to energy consumption, and uses the results to update the Heat Gain from Typical Commercial Warewashing Equipment table in the ASHRAE Fundamentals Handbook. It will include a list of considerations and a design procedure to update the Applications Handbook on Kitchen Ventilation. The results of the laboratory measurements will provide the basis of a design guidance document that will address the space recommendations of RP-1469 Thermal Comfort in Commercial Kitchens. This work will also provide the design engineer with a more comprehensive understanding of overall dishroom design through a complete list of appliance heat load data, examples of cooling load calculations, proper sizing of HVAC systems, specification of exhaust hoods, makeup air rates and distribution strategies necessary to maintain operator comfort and reduce the risk of mold in commercial dishrooms.

Applicability to the ASHRAE Research Strategic Plan:

Three of the Society's goals emphasize the importance of keeping indoor environments comfortable, productive and safe to inhabit. The main goal of this project is to deliver data and procedures to develop and design comfortable dishrooms. The project will develop a database and best-practice design procedure that will appear in the Applications and Fundamentals Handbooks and referenced in numerous Standards on kitchen ventilation and cooling and heating load calculations. The design guidance document will address the recommendations of RP-1469 Thermal Comfort in Commercial Kitchens and provide the design engineer with a more comprehensive understanding of overall dishroom design through a complete list of appliance heat load data, which will help to accurately calculate cooling loads, design HVAC systems, and specify exhaust hoods necessary to maintain IEQ, operator comfort and reduce the risk of mold in commercial dishrooms. These objectives address Goals 4, 2 and 7 and are described below.

Goal 4: Significantly advance our understanding of the impact of indoor environmental quality (IEQ) on work performance, health symptoms and perceived environmental quality in offices, providing a basis for improvements in ASHRAE standards, guidelines, HVAC&R designs and operation practices. 1) 1st priority - must address: Quantify the impact of outdoor air (OA) ventilation rates and thermal comfort parameters (air temperature and velocity, radiant temperature, humidity) on the following outcomes: high level cognitive, performance (highest priority); perceived indoor environmental quality (PIEQ), and acute building-related health symptoms.

Goal 2: Progress toward Advanced Energy Design Guides (AEDG) and cost-effective net-zero-energy (NZE) buildings. 1) Variability in building loads is not well characterized, which leads to variability of performance for any one (fixed) design; passive or adaptive management of building load variability is a challenge, but would improve overall energy performance.

Goal 7: Support development of tools, procedures and methods suitable for designing low-energy buildings. 2) With many innovative designs, there may be significant implications for the indoor environment that require analysis of thermal comfort, indoor air quality, etc.

Application of Results:

The results of the laboratory measurements will provide the basis of a design guidance document that will address the space recommendations of RP-1469 Thermal Comfort in Commercial Kitchens and to provide the design engineer with a more comprehensive understanding of overall dishroom design through a complete list of appliance heat load data, examples of cooling load calculations, proper sizing of HVAC systems, specification of exhaust hoods, makeup air rates and distribution strategies necessary to maintain operator comfort and reduce the risk of mold in commercial dishrooms

State-of-the-Art (Background):

ASHRAE RP1469 Thermal Comfort in Commercial Kitchens (ASHRAE, 2013) found that dishrooms had latent and sensible loads significantly larger than the spaces were designed for and the results led to hot and humid conditions and mold growth.
There are many different types of dishwashing and warewashing equipment used in the foodservice industry. The types vary from powered sink washers to troughs, pre-rinse spray valves, under-counter, door-type, conveyor-type and flight-type warewashers. Each type of equipment operates in a different manner and generates different levels of sensible, latent and moisture loads to the space and whether the appliance is ventilated or not, whether sanitization occurs via hot water or chemicals and the effectiveness of the local ventilation.

The limited database for warewashing equipment is found in the ASHRAE Fundamental's chapter Non-residential Heating and Cooling Load Calculations. In the chapter is Table 5F on warewasher equipment heat gain to space. The original table was added in 2009 as part of a larger ASHRAE research project that revised the kitchen appliance heat gain tables. Since that time, the dishwasher heatgain table has been minimally revised with data from independent testing agencies (FSTC 2016). In the original RP-1362 project, Revised Heat Gain and Capture and Containment Exhaust Rates from Typical Commercial Cooking Appliances (ASHRAE 2008), 83 appliances (2 of which were dishwashers) in 100 test conditions were tested for radiant, sensible convective and latent heat loads to space. The appliance heat gain tables at the time were expanded to incorporate appliances in the modern day commercial kitchen. There was concern about the accuracy of the initial measurements. As a result, the cooling loads previously calculated for commercial kitchen HVAC systems may have been difficult to estimate and potentially undersized. In the same way, today there is concern about the dishroom heat gain and ventilation data in the public domain. The existing dishroom data is very limited and may be inaccurate. Inaccurate load data could account for hot and humid dishrooms with condensation on walls and supply diffusers. The goal is to provide the engineer with a more comprehensive understanding of the overall dishroom design, which will help to accurately calculate cooling loads, design HVAC systems, and specify exhaust hoods.

The International Mechanical Code (International Code Council, 2014) section 507.3 states that “Type II hoods shall be installed above dishwashers and appliances that produce heat or moisture and do not produce grease or smoke as a result of the cooking process, except where the heat and moisture loads from such appliances are incorporated into the HVAC system design or into the design of a separate removal system.” The data for the calculations are not currently available. There is only limited latent and sensible load data available for these dishwashers in Handbook of Fundamentals (HOF) (ASHRAE, 2013). Additionally, it is not known how much ventilation is required to remove the moisture load from the different warewashing systems. If equipment manufacturers supply their own ventilation system it is not known how much of the latent load may still remain in the space.

The California Conference of Directors of Environmental Health's Cooking Equipment Exhaust Ventilation Exemption Guide for the Local Enforcement Agency (CCDEH, 2009) provides a brief list of appliances exempted from hoods. The recommendation is to limit the number of unhooded appliances in a space. The document provides a brief reference to general HVAC, but does not provide guidance to calculate kitchen or dishroom loads, or a source for the heat load values and therefore the minimum cooling capacity requirements. The document does site examples of appliances being sources of hot and humid kitchens.

CIBSE's Energy Efficiency in Commercial Kitchens (CIBSE, 2009) design guide acknowledges the heat recovery design within commercial dishwashers and exhaust air systems. However, it but does not contain or refer to any source for sensible or latent heat rejection values.

State-of-the-Art (Background Continued 1):

Heat gain values provided from manufacturers exist on a very limited basis. Four dishwasher manufacturers have tested 9 models of dishwashers through a third party laboratory (Fisher-Nickel, 2016) that applies ASTM heat gain test methods. Manufacturers have only recently been applying ASTM F2474 (ASTM, 2014) to determine sensible and latent loads from dishwashers. They have not tested equipment in their own laboratories. Underwriters Laboratories is considering listing and labelling heat recovery dishwashers with the sensible and latent loads because the information is not available elsewhere.

There is limited design guidance available for dishrooms. The design handbook of American Conference of Governmental Industrial Hygienists (ACGIH, 1998) addresses a simplified approach to dishwasher ventilation which provides an inadequate hood design that would result in a poorly performing system. This handbook and other design guides do not address the other sources of dishroom heat and moisture such as booster heaters, pre rinse spray valves, scrappers, pulpers, troffers, disposers, hoses, power wash sinks, and 3-compartment sinks.

In feedback from ASHRAE seminars and forums, designers complain about inadequate design data to calculate the internal loads from dishroom equipment. The results are undersized HVAC equipment and poor air distribution that lead to hot and humid kitchens. The findings of RP-1469 Thermal Comfort in Commercial Kitchens (ASHRAE, 2013) found in a survey of over 100 restaurants nationally that among casual dining, institutional and quick service restaurant dishrooms the operative temperatures were as high as 84.3°F and 71% RH. The average Predicted Mean Vote was above 2. The long term measurements found considerable daily temperature variations in the dishroom from 75°F to 90°F during working hours. If the dishroom was open to the cooking line, the thermal radiation from the hot appliance line raised the operative temperature by an additional 10°F, it was reported as high as 102°F. The relative humidity in the kitchen space was recorded during the working hours in the three different kitchen zones (i.e., cook line, prep line, and dishroom). The relative humidity was up to 55% higher in the dishwashing area than in the other two zones. Long term data at some quick serve restaurants recorded humidity averages in the dishroom of 69% during the summer.

A kitchen comfort zone as a region of the psychrometric chart was developed as part of the study. It included a region with a percent dissatisfied PD<12%. However, nearly 60% of the temperature and humidity data collected in the study was outside the bounds of the comfort zone. The operative temperature was as high as 107°F and the RH was as high as 78%. Such conditions lead to poor working conditions, low productivity, bad morale and mold growth.

The best available source for heat gain from commercial kitchen appliances is ASHRAE's book of Fundamentals chapter on non-residential cooling and heating loads calculations. The heat gain tables that include kitchen cooking appliances are well developed. However, there is limited data for heat gain from dishroom appliances and equipment. There is some information from a limited number of dishwashers manufacturers, but these in no way addresses the breadth of dishwashers available on the market or the other equipment such as pre-rinse spray valves, scrappers/troughs, dishloads and dryers that produce heat and moisture loads in the dishroom space.

Advancement to the State-of-the-Art:

This project advances the state of the art by generating and housing the largest database of commercial kitchen heat and moisture load data. It will lead to the eventual comfortable dishroom in the same fashion the heat gain from appliance data had led to better performing commercial kitchen exhaust hoods and a more functional design of kitchen HVAC. The results from this project will facilitate the incorporation of the dishroom into the design of the kitchen space and building HVAC. The integrated design leads to a more comfortable, healthy and energy efficient commercial kitchen (ASHRAE, RP-1362, 2008).

Justification and Value to ASHRAE:

The research need for this project is driven by the needs of the design engineer. ASHRAE consultants and designers complain about inadequate design data to calculate the internal loads from dishroom equipment. The result is undersized HVAC equipment and poor distribution that leads to hot and humid kitchens. The hot and humid kitchens have resulted in poor working conditions, low productivity and bad morale (ASHRAE RP-1469, 2013). The data and procedures developed by this project would provide guidance for a comfortable and healthy dishroom environment, with ASHRAE as the authoritative, 'go to' source, for the necessary information, thereby raising ASHRAE's profile internationally.

Objectives:

Laboratory research will be conducted to meet the following objectives:

1) Determine the sensible convective, latent and moisture loads to the space when dishroom appliances and equipment are vented, partially vented or unvented. Identify airflows required (if applicable) to fully capture and contain the convective thermal plume and moisture loads from dishroom appliances and equipment. This objective will be accomplished by using flow visualization techniques and standard energy measurement protocols to determine the heat and moisture loads and minimum airflow rates at which all of the convective plume is captured for each commercial kitchen appliance and piece of equipment (if applicable).

2) Draft design guidance document for the design of HVAC for dishrooms. The results of the laboratory measurements will provide the basis of a design guidance document that will address the space recommendations of RP-1469 Thermal Comfort in Commercial Kitchens and to provide the design engineer with a more comprehensive understanding of overall dishroom design through a complete list of appliance heat load data, examples of cooling load calculations, proper sizing of HVAC systems, specification of exhaust hoods, makeup air rates and distribution strategies necessary to maintain operator comfort and reduce the risk of mold in commercial dishrooms.

Scope/Technical Approach:

The scope of the project will include the measurement of the sensible convective loads, latent loads and moisture to the space from dishroom equipment and appliances. It will determine the exhaust airflows rates necessary (if applicable) for capture and containment of the convective and latent heat from dishroom equipment and appliances. The list of equipment to be tested should include the 10 types below. They will produce approximately 18 different operating conditions. The seven pieces of equipment listed in the Handbook of Fundamentals - Chapter 18 Table 5F Recommended Rates of Radiant and Convective Heat Gain from Warewashing Equipment during Idle (Standby) or Washing Conditions do not need to be re-tested.

The specific tasks of this project include:

- Task 1: Construct and/or instrument laboratory space to obtain heat gain to space and capture and containment exhaust airflow rate results according to ASTM 2474 and ASTM 1704.
- Task 2: Test list of dishroom equipment and processes, analyze data and present a summary to the PMS.
- Task 3: Test dishwashers in test matrix, analyze data and present a summary to the PMS.
- Task 4: Draft design guidance document for the design of HVAC for dishrooms.
- Task 5: Draft Final Report

Task 1: Construct and/or Instrument Laboratory Space:

The purpose of this task is to obtain heat gain to space and capture and containment exhaust airflow rate results according to ASTM 2474 and ASTM 1704. • The heat load calculations can be accomplished by using the procedures outlined in both ASTM F2474 Standard Test Method for Heat Gain to Space Performance of Commercial Kitchen Ventilation/Appliance Systems (ASTM, 2014) and ASHRAE RP-1362 Revised Heat Gain and Capture and Containment Exhaust Rates from Typical Commercial Cooking Appliances.• Precise methods to determine the threshold of capture and containment are described in ASTM F1704 Standard Test Method for Capture and Containment Performance of Commercial Kitchen Exhaust Ventilation Systems (ASTM, 2012).• The test methods used to determine the required ventilation to capture the moisture loads from the appliances and determine the heat gains to space have been developed by ASTM and used successfully for many years to evaluate ventilation and heat loads from equipment in the foodservice industry. ASHRAE Projects RP-1202 and RP-1480 both used ASTM F1704 to successfully complete the project goals to verify ventilation rate requirements for commercial cooking appliances. ASHRAE Projects RP-1362 and RP-1631 both used ASTM F2474 to determine heat gain from hooded and unhooded commercial kitchen appliances. As an example, a suggested laboratory layout that could be adopted by a potential bidder is shown in Figure 1 below.

Scope/Technical Approach (Continued 2):

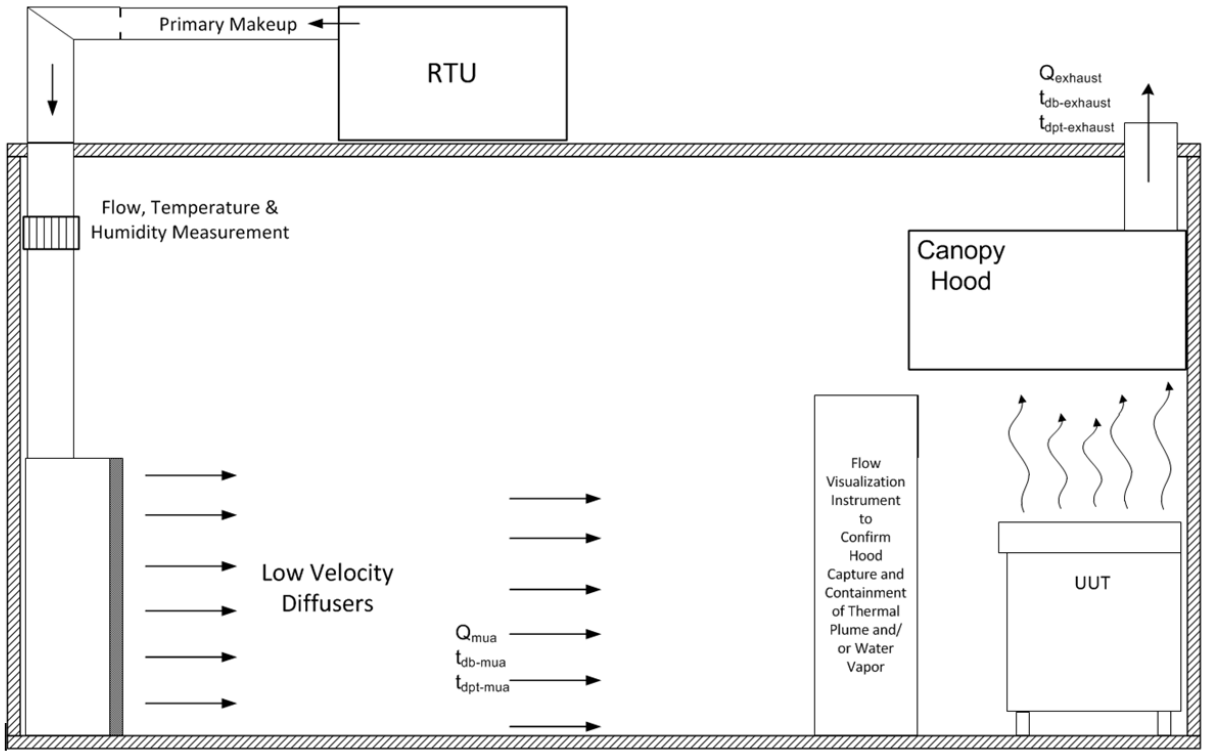

Figure 1 Laboratory Set-Up according to F2474 and F1704

Task 2: Test Equipment for Heat and Moisture Loads

The purpose of this task is to test a specific list of dishroom equipment and processes (approximately 10-items) for total heat and moisture loading, analyze data and present a summary to the PMS. Items to be tested include:

1) Pre-Wash
    a. Pre-rinse spray valves
        i. Non-federal compliant (>1.60 gpm)
        ii. Best in class (0.64 gpm)
    b. Scrappers with Trough
        i. Supplied per manufacturers' specifications with cold water
        ii. Supplied with hot water (typical field operation) Dish conveyors - pre wash
    c. Dish conveyors, pre-wash
2) Wash and Dry - Racks of dishes
3) Clean-Up
    a. Sinks
        i. 3-compartment sink
        ii. Power wash sink
    b. Hoses ~7 gpm

The methods of test for heat and moisture loading are outlined in ASTM F2474 Standard Test Method for Heat Gain to Space Performance of Commercial Kitchen Ventilation/Appliance Systems (ASTM, 2014). The precise methods to determine the threshold of capture and containment are described in ASTM F1704 Standard Test Method for Capture and Containment Performance of Commercial Kitchen Exhaust Ventilation Systems (ASTM, 2012). The apparatus is described in Figure 1 above.

Scope/Technical Approach (Continued 3):

The calculations are governed by:

Heat loads:
q sensible convective load = 1.08 Q std (T db-exh - W db-mua)
q latent load = 4840 Q std (W exh - W mua)

Moisture load:
mw = Q exh (W exh - W mua) / V exh x 60 min/h

where:
q sensible convective load = the convective sensible heat load to the space in Btu/h
q latent load = the convective latent heat load to the space in Btu/h
mw = the moisture load to the space in lbw/h
Q exh = the volumetric flow rate of the exhaust air stream in cfm
Q std = the volumetric flow rate of the air stream at standard conditions in cfm
V exh = specific volume of exhaust air stream ft3/lb dry air
T db-mua = the dry bulb temperature of the makeup air stream in °F
T db-exh = the dry bulb temperature of the exhaust air stream in °F
W mua = the humidity ratio of the makeup air stream in pound of water per pound of dry air
W exh = the humidity ratio of the exhaust air stream in pound of water per pound of dry air

Task 3: Test Dishwashers

The objective of this task is to obtain total head and moisture gain to space from wash and dry dishwashers in the test matrix (approximately 8-9 items), and analyze the data and present to the PMS. Items to be tested include:

1. Wash and Dry Dishwashers: with and without exhaust heat recovery, high temperature and low temperature chemical sanitation and blower dryers on conveyor and flight types
    a. Undercounter (approximately 1 combination)
    b. Door Type (approximately 1 combination)
    c. Rack Conveyor (approximately 3 combinations)
    d. Flight Type* (approximately 3 combinations)

*Due to the physical size of the flight type machines, it could be more practical to evaluate them in the field. The field measurement can be done in accordance with ASTM F2975-12 Standard Test Method for Measuring the Field Performance of Commercial Kitchen Ventilation Systems (ASTM 2016).

The methods of test for heat and moisture loading are outlined in ASTM F2474 Standard Test Method for Heat Gain to Space Performance of Commercial Kitchen Ventilation/Appliance Systems (ASTM, 2014). The precise methods to determine the threshold of capture and containment are described in ASTM F1704 Standard Test Method for Capture and Containment Performance of Commercial Kitchen Exhaust Ventilation Systems (ASTM, 2012).

Task 4: Dishroom HVAC Design Guidance.
The objective of this task is to develop design guidance for engineers for incorporation in the Applications Handbook and Fundamentals Handbooks including items such as: a complete list of appliance heat load data, examples of cooling load calculations, how to properly sizing of HVAC systems, specification of exhaust hoods, makeup air rates and distribution strategies necessary to maintain operator comfort and reduce the risk of mold in commercial dishrooms.

Task 5: Draft Final Report.• Final report to include raw data as an Appendix.

Deliverables/Where Results Will Be Published:

The project deliverables will include:

From Task 1: A detailed overview of the measurement equipment and laboratory setup and test methods used to conduct all of the testing.

From Task 2: Data on the heat moisture loads from the various dishroom equipment.

From Task 3: Heat and moisture loads from specific dishwashing equipment.

From Task 4: Design guidance document for the proper sizing of HVAC systems in dishrooms and which HVAC designs provide the best moisture control.

From Task 5: Draft Final Report

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 report, design guide, or manual, (collectively, "Final Report"), in a form approved by the Society, shall be prepared by the Institution and submitted to the Society's Manager of Research and Technical Services by the end of the Agreement term, containing complete details of all research carried out under this Agreement. Unless otherwise specified, 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.

Deliverables/Where Results Will Be Published (Continued):

The paper title shall contain the research project number 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 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 anticipated that the level of effort for this project will require three man-months of a principal researcher's time and up to nine man-months for a research engineer. The total project duration is expected to be up to 24 Months with an estimated cost of $199,000. The lab testing is estimated at $180,000 and the design guidance document is $19,000. The largest portion of this project funding is expected to go toward instrumentation and testing in the field.

Proposal Evaluation Criteria:

No.	Proposal Review Criterion	Weighting Factor
1	Contractor's understanding of Work Statement as revealed in proposal. a) Logistical problems associated b) Technical problems associated	**15%**
2	Quality of methodology proposed for conducting research. a) Organization of project b) Management plan	**25%**
3	Contractor's capability in terms of facilities. a) Managerial support b) Data collection c) Technical expertise	**15%**
4	Qualifications of personnel for this project. a) Project team 'well rounded' in terms of qualifications and experience in related work b) Project manager person directly responsible; experience and corporate position c) Team members' qualifications and experience d) Time commitment of Principal Investigator•	**20%**
5	Student involvement a) Extent of student participation on contractor's team b) Likelihood that involvement in project will encourage entry into HVAC&R industry	**5%**
6	Probability of contractor's research plan meeting the objectives of the Work Statement. a) Detailed and logical work plan with major tasks and key milestone b) All technical and logistic factors considered c) Reasonableness of project schedule	**15%**
7	Performance of contractor on prior ASHRAE or other projects (No penalty for new contractors.)	**5%**

Project Milestones:

No.	Major Project Completion Milestone	Deadline Month
1	Test list of dishroom equipment and processes (approximately 10), analyze data and present a summary to the PMS.	**8**
2	Test dishwashers in test matrix (approximately 8), analyze data and present a summary to the PMS	**18**
3	Draft design guidance for the design of HVAC for dishrooms	**20**

Authors:

Don Fisher - Fisher Consultants
Curt Sawan - Red Lobster Restaurants
Andre Saldivar - Southern California Edison
Rich Swierczyna - Frontier Energy

References:

ACGIH. American Conference of Governmental Industrial Hygienists. 1998
ASHRAE. Applications Chapter 33: Kitchen ventilation. 2015.
ASHRAE. Fundamentals Chapter 18: Nonresidential Heating and Cooling Load Calculations. 2013.
ASHRAE. RP-1469. Thermal Comfort in Commercial Kitchens, 2013
ASHRAE. RP-1362 Revised Heat Gain and Capture and Containment Exhaust Rates from Typical Commercial Cooking Appliances, 2008
ASHRAE. Standard 154 Ventilation of Commercial Cooking Operations, 2016.
ASTM. F1704: Standard Test Method for Capture and Containment Performance of Commercial Kitchen Exhaust Ventilation Systems, 2012.
ASTM. F2474: Standard Test Method for Heat Gain to Space Performance of Commercial Kitchen Ventilation/Appliance Systems, 2009.
ASTM. F2975-12 Standard Test Method for Measuring the Field Performance of Commercial Kitchen Ventilation Systems, 2016.
CCDH. Cooking Equipment Exhaust Ventilation Exemption Guide for the Local Enforcement Agency, California Conference of Directors of Environmental Health, 2009
CIBSE. Energy efficiency in commercial kitchens, 2009
ICC. International Code Council. International Mechanical Code, 2015.

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.

1778-RTAR Response to RAC

In their response dated November 20, 2015, RAC had 3 questions for TC 5.10 to address in the future WS. Below are the questions and responses:

1. There is a CIBSE document, TM50, on Energy Efficiency in Commercial Kitchens http://www.cibse.org/knowledge/cibse-tm/tm50-energy-efficiency-in-commercial-kitchens. It covers design guidance on ventilation, and a section on dish rooms. It might be worth looking at it before going further with a work statement on this topic. Are re-inventing the wheel here to some degree?

Response: TC 5.10 reviewed the CIBSE kitchen design guide and it does not provide data on the heat loads from dishwashing or other heat gain loads in the dish washing room.

2. Clarify the machine washing condition further.

Response: More information has been included in the Background section of the Workstatement to expand on the types of conditions encountered during washing cycles.

3. Clarify the need for a design guide (as written, free-standing, publication), as contrasted with other possible tech transfer approaches, ranging from web-based tool to simple Handbook guidance. If design guide is pursued, it should incorporate results from this research and earlier TC 5.10 kitchen design research.

Response: This research project will not directly produce a design guideline. The results of the research will first be used to provide Handbook guidance. If ASHRAE desires at a later date to develop a design guide, the results from this project will be available for that purpose.

Additional Revision Information Incorporated into the Workstatement:

Background Research Need

The work statement authors have revised the work statement for TRP-1778 per the requests of RAC. The scope has been tightened up to concentrate on the generation of sensible and latent load data from dishroom appliances and equipment to more accurately predict cooling capacities. The sensible and latent measurements from all typical equipment and appliances will be included. This project will deliver a guidance document on the design of dishrooms that can be used in the Handbook and Standards. However, the results from this project will form the basis of a formal design guide for dishrooms planned for a future TC project.

Project Objectives

The main objective has been tightened up to include the most common dishroom equipment, but not to duplicate data already published in HOF. The 18 pieces of equipment to be tested will not include the 8 duplicate pieces in Chapter 18 Nonresidential Cooling and Heating Load Calculations Table 5F Recommended Rates of Radiant and Convective Heat Gain from Warewashing Equipment during Idle (Standby) or Washing Conditions. The 25 pieces of equipment are comprehensive regarding the sources of heat and moisture loading from dishroom equipment.

Secondly, the results of the laboratory measurements will provide the basis of a design guidance document that will address the space recommendations of RP-1469 Thermal Comfort in Commercial Kitchens and to provide the design engineer with a more comprehensive understanding of overall

dishroom design through a complete list of appliance heat load data, examples of cooling load calculations, proper sizing of HVAC systems, specification of exhaust hoods, makeup air rates and distribution strategies necessary to maintain operator comfort and reduce the risk of mold in commercial dishrooms.

Dishrooms are a combination of unhooded (e.g., pre-rinse spray valves, sinks, troughs) and hooded (e.g., dishmachines) loads that need to be addressed with both local exhaust and general ventilation. Measuring the loads are the first step to optimizing the design in dishrooms. The current codes for local exhaust are inadequate to remove the thermal plume from the dishmachines. One of the objectives of this project is to determine the correct local exhaust rates for applicable appliances.

The choice between local exhaust and general ventilation was partly addressed in RP-1631 Countertop Commercial Appliance Emissions where appliances were operated either hooded or unhooded within energy simulation models. Based on a life cycle cost analysis for particular climate zones, recommendations were given for local exhaust or general ventilation design. Some of the loading scenarios for kitchens in the project could be applied to dishrooms. However, a life cycle cost analysis for dishrooms and the advantages of local exhaust or general ventilation could be the focus of a more detailed research project that would include a formal Design Guide for Dishrooms.

Additional references have been added to show further literature review. The useful and most current data for internal heat gain from commercial kitchen appliances are available in HOF Chapter 18 Nonresidential Cooling and Heating Load Calculations. One of the objectives of this project is to expand the database in HOF Chapter 18. The manufacturers of the appliances and equipment are requesting third-part testing of heat gain data. They claim the apparatus of ASTM F-2474 Standard Test Method for Heat Gain to Space Performance of Commercial Kitchen Ventilation/Appliance Systems which forms the basis of the test method is too difficult/expensive to set-up. The complexity of the test set-up and field measurement is reflected in the increase in budget. UL is requiring heat gain as a part of listing and labelling heat recovery dishmachines. ACGIH and CIBSE do not tabulate data on the heat loads from kitchen or dishroom equipment.

Benefit to ASHRAE

The main benefit to ASHRAE will be the expansion of the internal heat gain database. It will compile a single source for a comprehensive list of appliance heat gain for kitchens and dishrooms. An additional benefit to ASHRAE will be the promotion of energy efficient heat recovery models by listing the technology and publishing the load data from heat recovery models and non-heat recovery models, thereby showing the advantages of heat recovery technology.

Conclusion

The revised work statement provides measured heat and moisture data for the most common dishroom equipment and appliances. The results of the laboratory measurements will provide the basis of a design guidance document that will address the recommendations of RP-1469 Thermal Comfort in Commercial Kitchens and to provide the design engineer with a more comprehensive understanding of overall dishroom design through a complete list of appliance heat load data, which will help to accurately calculate cooling loads, design HVAC systems, and specify exhaust hoods necessary to maintain operator comfort and reduce the risk of mold in commercial dishrooms.

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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
mvaughn@ashrae.org

TO: Jason Greenberg, Chair TC 5.10, jgreenberg.ashrae@gmail.com
Derek Schrock, Research Subcommittee Chair TC 5.10, derek.schrock@halton.com

CC: David John, Research Liaison 5.0, davidjohntarpon@gmail.com

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

DATE: November 20, 2015

SUBJECT: Research Topic Acceptance Request (1778-RTAR), "Developing Design Guidelines for Dish room Ventilation"

During their annual meeting, the Research Administration Committee (RAC) reviewed the subject Research Topic Acceptance Request (RTAR) and voted to accept with comments it for further development into a work statement (WS) provided that the key comment(s) and question(s) below are addressed to the satisfaction of your Research Liaison, David John, davidjohntarpon@gmail.com, or RL5@ashrae.net in the work statement draft.

1. There is a CIBSE document, TM50, on Energy Efficiency in Commercial Kitchens - http://www.cibse.org/knowledge/cibse-tm/tm50-energy-efficiency-in-commercial-kitchens. It covers design guidance on ventilation, and a section on dish rooms. It might be worth looking at it before going further with a work statement on this topic. Are re-inventing the wheel here to some degree?

2. Explain the machine washing condition further.

3. Clarify the need for a design guide (as written, free-standing, publication), as contrasted with other possible tech transfer approaches, ranging from web-based tool to simple Handbook guidance. If design guide is pursued, it should incorporate results from this research and earlier TC 5.10 kitchen design research.

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, 2017** 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, 2016** for consideration at RAC's 2016 Annual meeting. The submission deadline after that for work statements is **August 15, 2016** for consideration at the RAC's 2016 fall meeting.

Project ID	**1778**	
Project Title	**Developing Design Guidelines for Dish Room Ventilation**	
Sponsoring TC	TC 5.10 (Kitchen Ventilation)	
Cost / Duration	$135,000 / 12M	
Submission History	**1st Submission**	
Classification: Research or Technology Transfer	Technology Transfer	
RAC 2015 Fall Meeting Review		
Essential Criteria	**Voted NO**	**Comments & Suggestions**
Background: The RTAR should describe current state of the art with some level of literature review that documents the importance/magnitude of a problem. References should be provided. If not, then note it in your comments.	**7, 9**	**7** - There are no relevant references. Needs literature review - what has been done in this regard in other countries. **9** - Dishwashing or ware washing is usually conducted with machines. If machine washing is used, there should be the data on how such a machine discharges heat and moisture into a room by the product company. Why such data cannot be used for designing ventilation? **2** - It would be good to describe clearly whether any recommendations for dishwasher rooms do exist and if so how this project will advance them. **10** - Perhaps I'm too optimistic in expecting guidance to be available at least from the health care industry? Given that I'd expect good practice to require capture of this (they refer to type II hoods) and disposal of the latent and chemical odors outside, the problem reduces to air flow requirement per capture efficiency, water temperature, and volume of water consumed in a dishwashing "session" (# of full service meal equivalents, or similar metric). So, it would seem to be a problem defined by how much hood flow is required, and the qualities of the make-up air (dish areas are historically not associated with close control of sensible temperatures, in my scattered episodic experience over 5 decades and 4 (?) states).
Research Need: Based on the background provided is the need for additional research clearly identified? If not, then the RTAR should be rejected.	**9, 10**	**9** - The heat and moisture load will be obtained from the washing machine. The RTAR should explain why such data from product manufacturers cannot be useful nor trusted. **10**- My issue is different. I'm a huge fan of tech transfer, for substantial system issues such as hot-humid climate design, ground source heat pump systems for commercial buildings, etc. I feel real need for this material to have coverage in the Handbook (or, better, as a nice graphics-based web tool), but it doesn't seem to rise to the level of a design guide as ASHRAE has used the term for Publications.
Relevance and Benefits to ASHRAE: Evaluate whether relevance and benefits are clearly explained in terms of: a. Leading to innovations in the field of HVAC & Refrigeration b. Valuable addition to the missing information which will lead to new design guidelines and valuable modifications to handbooks and standards. Is this research topic appropriate for ASHRAE funding? If not, Reject.	**9**	**7** - This RTAR has two projects together: 1. determination of latent loads, and 2. development of design guidelines. These are two separate projects and it is recommended to submit two separate RTARs. **10** - I almost never disagree with Mr. KK, but I do not see this as separate projects. **9** - If washing machine is large and discharges much of heat and moisture, heat and moisture should not be discharged into a room, but directly be discharged outside with duct or so. The impression of the RTAR is that the research content was already explored in the industrial ventilation field. **2** - The project is only 12 months long. Perhaps too short to achieve the expected goals.
IF ABOVE THREE CRITERION ARE NOT ALL SATISFIED - MARK "REJECT" BELOW & CONTINUE REVIEW BELOW		
Other Criteria	**Voted NO**	**Comments & Suggestions**
Project Objectives: Based on the background and need, evaluate whether the project objectives are: 1. Aligned with the need 2. Specific 3. Clear without ambiguity 4. Achievable If not, then appropriate feedback should be provided.		**2** - It is unclear whether the objective is to find ventilation strategy or to determine heat/moisture loads from dishwashers or both. **10** - In my opinion, neither: these are just means to get the data for a design guide. **6** - Overall this is a well written RTAR. Please clarify that it is standard practice that dishwashing equipment manufacturers do not provide load information. Would 20 new tests be sufficient to cover most equipment? Will energy consumption be part of the design guideline?
Expected Approach and Budget: Is there an adequate description of the approach in order for RAC to be able to evaluate the appropriateness of the budget? If not, then the RTAR should be returned for revision. Anticipated funding level and duration:		**2 -** It is unclear whether local exhausts (hoods) are considered for use or general ventilation is proposed for achieving the goals. **10** - Background states that Type 2 hoods are required; presumably they exhaust outdoors when installed properly.
References: Are the references provided?		
Decision Options	**Initial Decision?**	**Final Approval Conditions**
ACCEPT AS-IS		**13** - Suggest that the work statement scope for this work include a design guide that can be published by ASHRAE, incorporating results from this research and earlier TC 5.10 kitchen design research. **9 -** Explain the machine washing condition further. **10** - I need to understand the need for a design guide (as written, free-standing, publication), as contrasted with other possible tech transfer approaches, ranging from web-based tool to simple Handbook guidance.
ACCEPT W/COMMENTS		
REJECT		

ACCEPT Vote - Topic is ready for development into a work statement (WS).
ACCEPT W/COMMENTS Vote - Minor Revision Required - RL can approve RTAR for development into WS without going back to RAC once TC satisfies RAC's approval condition(s)
REJECT Vote - Topic is not acceptable for the ASHRAE Research Program

Research Topic Acceptance Request Cover Sheet

Date: August 14, 2015

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

A. Title	☑
B. Applicability to ASHRAE Research Strategic Plan	☑
C. Application of the Results	☑
D. State-of-the-Art (background)	☑
E. Advancement to State-of-the-Art	☑
F. Justification and Value to ASHRAE	☑
G. Objective	☑
H. Estimated Duration	☑
I. References	☑

Title:
Developing Design Guidelines for Dishroom Ventilation

RTAR# 1778
(To be assigned by MORTS)

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

Applications Handbook Chapter 33
Fundamentals Handbook Chapter 18
SSPC 154

Responsible TC/TG: 5.10 Kitchen Ventilation

Date of Vote: June 29, 201 (Atlanta)

For		9
Against	*	0
Abstaining	*	0
Absent or not returning Ballot	*	0
Total Voting Members		9

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

TC 4.1 6-0-0-2 June 29, 2015 (Atlanta TC Meeting)

RTAR Lead Author: Derek Schrock

Expected Work Statement Lead Author: Derek Schrock

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

Research Classification:

- ☑ Basic/Applied Research
- ☐ Advanced Concepts
- ☐ Technology Transfer

	Yes	No
Has an electronic copy been furnished to the MORTS?	✔	
Has the Research Liaison reviewed the RTAR?	✔	

* Reasons for negative vote(s) and abstentions

DRAFT RTAR Template

Developing Design Guidelines for Dishroom Ventilation

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)

Dishwashing or warewashing processes in commercial foodservice can produce significant moisture loads. Currently, there is little data and no design guidance on how to properly ventilate dish rooms to manage the moisture loads. This project will obtain data on latent loads and develop a design guide.

Background

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

ASHRAE RP-1469 (ASHRAE, 2013) found that dishrooms had latent and sensible loads signifiganctly larger than the spaces were designed for which lead to hot and humid conditions and mold growth.

There are many different types of dishwashing and warewashing equipment used in the foodservice industry. The types vary from powered sink washers to under-counter, door-type, conveyor-type and flight-type warewashers. Each type of equipment operates in a different manner and generates different levels of latent load to the space such as whether the appliance is ventilated or not, whether sanitization occurs via hot water or chemicals and the effectiveness of the ventilation in the area.

The International Mechanical Code (International Code Council, 2014) section 507.3 states that “Type II hoods shall be installed above dishwashers and appliances that produce heat or moisture and do not produce grease or smoke as a result of the cooking process, except where the heat and moisture loads from such appliances are incorporated into the HVAC system design or into the design of a separate removal system.”

Currently, there is only limited latent and sensible load data available for these appliances. Table 5E in Chapter 18 (ASHRAE, 2013) has some data on latent heat load from warewashing equipment that has a nameplate energy rating of less than 50,000 Btu per hour, but this is for unvented equipment. That data was collected as part of ASHRAE RP-1362 (ASHRAE, 2008).

It is not known how much ventilation is required to remove the moisture load from all of the different warewashing systems. Additionally, if equipment manufacturers supply their own ventilation system it is not known how much of the latent load may still remain in the space.

Research Need

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

The research need for this project is driven by the needs of the design engineer. Some of the key questions that the designer needs to know are:

1. How much sensible and latent load is produced from the different combinations of appliances when they are unvented or partially vented?
2. What airflows would be required to fully ventilate the moisture load from the Dishroom space without requiring addtional tonnage to condition the space?
3. What do the requirements of the Dishroom space relative to the rest of the food preparation area be to eliminate moisture loads propagating from the Dishroom space into the other spaces?
4. What if there is no separate Dishroom space? How are the loads managed?
5. When specifying components of the ventilation system (e.g. supply diffusers, return grilles, ductwork), should certain materials be considered (i.e. aluminum, not steel, to resist corrosion)

In order to answer these questions, the following research is required:

1. Determine the airflows necessary for capture and containment of the door type, conveyor type, flight type warewashers (for both low-temperature and high temperature rinse), power soak, spray nozzles, and under-counter units.

2. Determine the sensible and latent loads to the space when ventilation is provided by the appliance manufacturer and for ventless units.

3. Can the moisture load be contained to a Dishroom if that area is kept under negative pressure relative to the rest of the space?

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)

Laboratory research will be conducted to meet the following objectives:

1) Identify the airflows required to fully capture the moisture loads from the appliances. This objective will be accomplished by using flow visualization and energy measurements to determine the minimum airflow at which all of the moisture is captured for each configuration. Precise methods are described in ASTM F1704 (ASTM, 2012).

2) Determine the sensible and latent loads to the space when these appliances are partially ventilated or ventless units are used. This can be accomplished using the approaches outlined in both ASTM F2474 (ASTM, 2009) and ASHRAE RP-1362.

A comprehensive design guide will be written that provides step by step instructions to design engineers on how to design Dishroom spaces that are separate or integral to the rest of the foodservice establishment and how to properly size the HVAC system for the various warewashing appliances.

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) ( )

The test methods used to determine the required ventilation to capture the moisture loads from the appliances and determine the heat gains to space have been developed by ASTM and used successfully for many years in the foodservice industry. ASHRAE Projects RP-1202 and RP-1480 both used ASTM F1704 to successfully complete the project goals of verify how much ventilation was required to exhaust the heat from appliances. ASHRAE project RP-1362 used ASTM F2474 standard to determine heat gain to space.

The cost of this project is expected to be $135,000. The laboratory testing for the appliances to determine the capture and containment performance and heat gain to space is estimated to be $70,000. The RP-1362 budget for these types of tests was $215,000 for 80 appliances. For this project it is anticipated that there will be approximately 20 tests.

The project duration for testing the 80 appliances in RP-1362 was 24 months for the laboratory testing and reporting. It is expected that to test 20 appliances for this project would take 8 months.

The cost of the guideline preparation itself is anticipated to be an additional $65,000 for a total cost of $135,000. It is expected that it will take 3 months to prepare the design guideline with an overall project duration of 12 months

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)

One of the goals of the Society is to keep indoor environments comfortable, productive and safe to inhabit. The main goal of this project is to deliver a design guideline for Dishrooms that allow engineers to accomplish that goal. By developing a design guideline that ASHRAE can sell, it provides a return on investment to ASHRAE at the same time.

This project lines up with Goal 2 of the Strategic Plan – specifically defining the building loads with regard to Dishroom areas. This project also supports Goal 7 of the Strategic Plan as it helps define the true latent and sensible loads in the space which can then be used to develop optimal energy efficient designs.

This project advances the state of the art in this area because there is little or no design data or design guidance currently available for engineers to reference.

We do not feel that there are other stakeholders that should be approached since the goals of this project directly align with the Societies mission

Anticipated Funding Level and Duration

Funding Amount Range: $135,000

Duration in Months: 12

References

List the key references cited in this RTAR

ASHRAE, 2013. Chapter 18: Nonresidential Heating and Cooling Load Calculations, Table 5E.

International Code Council, 2014. 2015 International Mechanical Code.

ASTM, 2012. ASTM F1704: Standard Test Method for Capture and Containment Performance of Commercial Kitchen Exhaust Ventilation Systems, 2012.

ASTM, 2009. ASTM F2474: Standard Test Method for Heat Gain to Space Performance of Commercial Kitchen Ventilation/Appliance Systems.

ASHRAE, 2008. RP-1362: Revised Heat Gain and Capture and Containment Exhaust Rates from Typical Commercial Cooking Appliances.

ASHRAE, 2013. RP-1469. Comfort in Commercial Kitchens.