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

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TO: Ronald Westbrook, Chair TC 9.6, westbror@upstate.edu
David Thomsen, Research Subcommittee Chair TC9.6, david.thomsen@providence.org
Oscar Cobb, David Thomsen, Work Statement Author(s), david.thomsen@providence.org

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

CC: Jeff Gatlin, Research Liaison 9.0, jeff.gatlin.pe@gmail.com
Paolo Tronville, Incoming Research Liaison 9.0, paolo.tronville@polito.it

DATE: July 9, 2018

SUBJECT: Work Statement (1816-WS), "Reporting the Energy use and Heat Gain form Imaging Equipment"

During their recent annual meeting, the Research Administration Committee (RAC) reviewed the subject Work Statement (WS) and voted 12-0-1 to conditionally accept it for bid provided that the RAC approval conditions below are addressed to the satisfaction of your Research Liaison in either written responses or revisions to the work statement.

See the approval conditions below.

1. Clearly explain why the project is important, in energy and air-flow perspectives.
2. Task breakdown need to be better defined.
3. Required deliverables need to be included.
4. It is not clear how obtaining additional data that may conflict with manufacturer's data can be used in the design of the imaging equipment thermal management systems.

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

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

Please coordinate changes to this Work Statement with your Research Liaison, Jeff Gatlin, jeff.gatlin.pe@gmail.com or Paolo Tronville, paolo.tronville@polito.it RL9@ashrae.net.
Once he is satisfied that the approval conditions have been met, the project will be ready to bid.

The first opportunity that you will have for this project to possibly bid is fall 2018. To be eligible for this bid cycle, a revised work statement that has been approved for bid by your research liaison should be sent (electronically) to Michael Vaughn, Manager of Research and Technical Services, mvaughn@ashrae.org or morts@ashrae.net, by **September 1, 2018**. The next opportunity for bid after that will be spring 2019.

Project ID	**1816**	
Project Title	**REPORTING THE ENERGY USE AND HEAT GAIN FROM IMAGING EQUIPMENT**	
Sponsoring TC	TC 9.6, (Healthcare Facilities)	
Cost / Duration	$150,000 / 18 Months	
Submission History	**1st Submission WS. RTAR Accpted w/comments January 2017**	
Classification: Research or Technology Transfer	Basic/Applied Research	
RAC 2018 Annual 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**		**#11** - The incremental knowledge gained from this project does not justify the requested $150K Manufacturers of such equipment such as GE and Siemens should provide the heat gains and their directions should be followed. It is not clear how obtaining additional data that may conflict with manufacturier's data can be used in the design of the imaging equipment thermal management systems.
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.		**#12** - this project ensures that medical equipment heat load is well accounted for. This is critical for proper design optimization and improved building performance
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.		**#5**- Yes…but…am not aware of their qualification and relationship to the WS authors. **#13** - Bidders list appears to be consulting design firms. Not sure these firms will be equiped for the work. **#11**- 4 identified.
Proposed Project Description Correct? Are there technical errors and/or technical omissions that the WS has that prevents it from correctly describing the project? If there are, than the WS needs major revision.		
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.		**#7** could the information be presented in a form with a id, a milestone name and a duration? #12 - however, not well described or characterized.
Adequate Intermediate Deliverables? The project should include the review of intermediate results by the PMS at logical milestone points during the project. Before project work continues, the PMS must approve the intermediate results.		
Proposed Project Doable? Can the project as described in the WS be accomplished? If difficulties exist in the project's WS that prevent a successful conclusion of the project, then the project is not doable. In this situation, major revision of the WS is needed to resolve the issues that cause the difficulty.		
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.		**#7**- Not sure how the cost estimates were derrived but this could show up as a much lower cost during the bidding.
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.		**#12** - missing relevant elements for the deliverables; the authors should consult other ASRHAE WS to include the standard language.
Decision Options	**Initial Decision**	**Final Approval Conditions**
ACCEPT		**#5** - WS is short and concise. It appears the WS authors are experts in this field and know what they are looking for. #13 - PES has too many members. The scope should include comparison of measured results to data published in manfacturers installation guides. Requires breakdown of tasks. For example, perhaps complete one or two tests as a pilot and review with PMS. Refine the method before completing balance of tests. **#7** - See time and cost estimate comments. **#12** - Please conside inputting the WS in the required form and use the standard ASHRAE deliverable in additional to any project specific deliverables. Also, need a letter of commitment from ASHE! HD - There are relevant schemes, eg NABERS in Australia, that are worth looking at, and might inform the proposed work. There are probably international organisations who could reasonably bid to do this and add value. As I said in the meeting, the project is the easy bit. Exploiting it is the tough
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: May 14, 2018

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

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

Title:

Reporting the Energy Use and Heat Gain From Imaging Equipment

WS# 1816

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

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

Chapter 18 of ASHRAE Fundamentals, HVAC Design Manual for Hospitals and Clinics, Chapter 8 ASHRAE Applications

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Responsible TC/TG: **9.6**

Date of Vote: **05/11/2018**

For		11
Against	*	0
Abstaining	*	
Absent or not returning Ballot	*	4
Total Voting Members		15

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

TC 4.1 Load Calculation Data and Procedures (7-0-0-3 on 05/04/2018)
TC 4.7 Energy Calculation and Modeling (8-0-0-3 on 05/10/2018)

Has RTAR been submitted? **Yes**
Strategic Plan Theme/Goals

Work Statement Authors: **

Oscar Cobb, David Thomsen

Proposal Evaluation Subcommittee:

Chair: **Oscar Cobb**
Members: **Mike Meteyer, George Augustini, Amit Bhansali Glenn Friedman, Jeff Haberl Jonathan Flannery**

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

Same as Proposal Evaluation Subcommittee

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

Walt Vernon, walterv@mazzetti.com, 415.362.3266, Mazzetti
Dan Koenigshofer, dkoenigshofer@dewberry.com, 919.425.7616, Dewberry
Roger Lautz, rlautz@aeieng.com, 608.236.1110, AEI
Mark Peckover, mark.peckover@stantec.com, 503.273.0094, Stantec

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

ASHE – Jonathan Flannery, 312.422.3825, $10,000

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

	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

WORK STATEMENT# 1816
SPONSOR TC: TC9.6 – Healthcare Facilities
CO-SPONSOR TCs: TC4.1 Load Calculation and Procedure,
TC4.7 Energy Calculation and Modeling

A. TITLE

Reporting the Energy Use and Heat Gain from Imaging Equipment

B. EXECUTIVE SUMMARY

This research will determine heat gain and energy use for large, often multi-component, imaging systems in the field. Results will be used to update and expand current data in multiple ASHRAE publications. It will also provide energy use metrics for energy modeling and medical equipment comparisons in HVAC designs. Estimated budget: $150,000.

C. APPLICABILITY TO THE ASHRAE RESEARCH STRATEGIC PLAN

As ASHRAE strives to meet the strategic goals to both "Educate" and "Adapt", specifically "utilizing science and technology to create practical tools and resources for the designer", this proposed research will improve available resources. This aligns with two primary components of ASHRAE's research strategic plan: (1) maximizing the actual operational energy performance of buildings and facilities and (2) supporting development of tools, procedures and methods suitable for designing low energy buildings.

D. APPLICATION OF THE RESULTS

For an HVAC design engineer, the lack of consistency in manufacturer heat gain data, as well as inconsistencies in the actual installed heat gain, result in inaccuracies from design through operation. These inaccuracies can directly and indirectly impact patient care. Design engineers must rely exclusively on the general component data published by the manufacturers. This leaves the design engineers with uncertainties that can lead to oversizing that result in less-efficient equipment and skewed building energy use values during design. The results of this research will offer additional data (not previously captured) and reasonable ranges for design consideration when using the stated equipment. This will afford designers better opportunity to appropriately design HVAC equipment and improve overall building system efficiencies.

E. STATE-OF-THE-ART (BACKGROUND)

HVAC design engineers rely on ASHRAE resources for designing imaging spaces within healthcare occupancies. For a limited number of imaging rooms, ANSI/ASHRAE/ASHE Standard 170-2013 [1] provides prescriptive air change rates, but does not include all imaging rooms nor all spaces required for imaging (such as equipment rooms). ASHRAE 2013 Fundamentals Handbook [2] notes in Chapter 18: "The data (of Table 6) are presented to provide guidance in only the most general sense. For large equipment, such as MRI, heat gain must be obtained from the manufacturer." However, manufacturers generally provide a table of heat gain (in btu/hr) for components but do not explain their derivation, i.e. average, maximum, procedures per hour, type of procedures, diversity, nor do they indicate reliable data for installed equipment heat gain. As a result, engineers are limited to full load (or sometimes start-up only) design conditions which may not represent normal operating modes.

ASHRAE Standard 203-2014 [3], Method of Test for Determining Heat Gain of Office Equipment Used in Buildings, is an example of how ASHRAE has facilitated a methodology and improved the available dataset for HVAC design engineers, but nuances of imaging equipment are not addressed.

Therefore, a key knowledge gap exists, as was previously identified and partially addressed in RP-1343 [4]. To determine cooling loads and estimate hourly energy use, RP-1343 developed two Method of Tests (MOT) to measure the heat gain (both airside and waterside) of various medical imaging systems:

- Complete typical system heat gain via field tests during sleep, idle and "in-use" modes.
- Component heat gain via standardized factory tests.

The first MOT, successfully tested, obtained data on energy use on integrated imaging systems and unitary devices. That field data, although limited, was immediately useful for initial equipment sizing and energy modeling. The

second MOT, reviewed with GE Medical Systems, was to standardize manufacturers' testing and reporting of heat rejection data from individual components under the anticipated time intervals of sleep/-idle/-high use for standardized procedures and operation.

The HVAC Design Manual for Hospitals and Clinics [5] incorporates the results of RP-1343 within Table 8.9, and provides significantly more detail of various imaging modalities in Chapter 8, Room Design. However, in reviewing Table 8.9, there is noticeable limited manufacturer representation and a wide variation between the recommendations from the manufacturer and the field-tested data. Additionally, the table states, "It is expected that Phase II of this research project (RP-1343) will result in a much more extensive database for heat gains to air and water for imaging systems."

F. ADVANCEMENT TO THE STATE-OF-THE-ART

RP-1343 sought to collect data in the gap that exists between the medical equipment manufacturers' provided energy-use data and the equipment's actual energy consumption following installation. That research revealed that there was more work to be done. The proposed research will enable designers to take the incredibly complex medical equipment functions and simplify them to the needs of the HVAC designer, in tabular form. The energy consumption data, test protocol and standardized reporting format that will come from this proposed research will have a tremendous impact in advancing the state of the art in healthcare facility HVAC design by ensuring the availability of meaningful, accurate and useable heat gain design data for medical systems and equipment.

G. JUSTIFICATION OF NEED AND VALUE TO ASHRAE

This research will be a valuable addition as it will provide a "more extensive database for heat gains to air and water for imaging systems" by building upon both RP-1343 and Standard 203-2014. Once complete, Table 6 "Recommended Heat Gain from Typical Medical Equipment" in Chapter 18 of the ASHRAE Fundamentals Handbook, Table 4 "Summary of Heat Gain to Air from Imaging Systems" in Chapter 8 of ASHRAE Applications Handbook, and Chapter 8 Section 4 "Imaging Rooms" of the HVAC Design Manual for Hospitals and Clinics can all be updated. Further, the individual equipment test and reporting protocol could evolve into consideration for adoption into an ASHRAE Standard. Without this research, the existing tables and ASHRAE resources remain incomplete and become less valuable because they are unable to provide sufficient guidance to designers, and energy modelers.

H. OBJECTIVES

This research will provide standardized and consistent heat gain data, help engineers calculate cooling loads, model energy use, and make more accurate equipment and system selections. Specifically the research will result in two Data Tables:

- Data Table 1 - will provide heat gain and energy use by complete systems based on field tests of operating systems.
- Data Table 2 - will indicate typical heat gain and energy use by system components under prescribed load conditions (if sufficient manufacturer assistance occurs).

I. SCOPE/TECHNICAL APPROACH

In this research, the researcher shall conduct additional field tests of systems and unitary equipment (first MOT) covering a wider inventory of systems, equipment and their applications. This will produce an immediate influx of data for use by HVAC design engineers and energy modelers. With manufacturer participation, the researcher will also develop a standardized test protocol and reporting format (second MOT) in order to obtain component loads under the anticipated time intervals of sleep/-idle/-high use scenarios.

The proposed research will perform the tasks described, by Data Table, below:

Data Table 1 –

- The researcher will identify at least three installations of each of the nine modalities (Cat Scan, Fluoroscopy, Cyber Knife, Linear Accelerator, MRI, Nuclear Camera, PET Scan, Ultrasound, X-ray).
- The researcher will field test each installation per the MOT in RP-1343.

- The researcher will average results while also reporting the range of observed values (utilizing current research and RP-1343).
- The researcher will make specific recommendations concerning results and applicability for future installations.

Data Table 2 –

- The researcher will develop a draft common protocol for testing and reporting manufacturer values for the various modalities, based upon RP-1343 and Standard 203-2014.
- The researcher will solicit, potentially through the assistance of a representative trade association, peer review of a draft common protocol for testing and reporting by imaging equipment manufacturers, particularly if the proposed approach differs from the manufacturer's current evaluation.
- The researcher will seek manufacturer's input to complete the report forms published in RP-1343 (Tables 6.5, 6.6 and 6.7) for each of the models made by that manufacturer, per the approved common protocol for testing and reporting.
- If sufficient manufacturer assistance occurs, the researcher will provide a MOT and reporting forms which will be used by manufacturers in the future.
- The researcher will make specific recommendations concerning results and applicability for future installations.

J. DELIVERABLES

1. Progress and Financial Reports to the PMS must be made at quarterly intervals. All available data must be current as of 2 weeks before the scheduled report time. Data and/or reporting information may be transmitted electronically or on ASHRAE approved digital media.

2. The Principal Investigator shall report in person to the sponsoring TC at the annual and winter meetings, and answer such questions regarding the research as may arise.

3. Memorandum proposing suggested changes to standards and test procedures, as described above, will be created by the Principal Investigator and presented and discussed with the PMS.

The following deliverables are expected at the milestones dates described in Section M below.

4. List of equipment and hospitals to be tested with written agreements
5. List of manufacturer contacts and draft of approach (letter, email, calls, ASHRAE contact, etc.)
6. Preliminary test data
7. Summary document describing results of manufacturer contacts
8. Summary of status of field test and data collection for presentation at meeting
9. Summary document of results of meetings/calls with manufacturers
10. Draft of final report on field test with MOT
11. Signed agreement with at least one manufacturer on MOT
12. Final report

The Final Report shall be prepared and submitted to the Society by the end of the contract period covering complete details of all research carried out on the project. The final report shall include, as a minimum, the following:

- An Executive Summary suitable for wide distribution to the industry and to the public.
- Description of test procedure, locations, and data collected
- Data Table 1 and Data Table 2 for use in the ASHRAE Handbook, Fundamentals Edition
- Standard MOT for testing the heat gain and energy usage of large, often multi-component, imaging systems.
- Unless otherwise specified, the final report shall be furnished in the following manner:
    - Six bound copies
    - One unbound copy, printed on one side only, suitable for reproduction.
    - Two copies on ASHRAE approved digital media; one in ASCII format and one in the latest versions of Microsoft Word format for the report and in Microsoft Excel format for data and approved by the PMS.

13. Publications as discussed and confirmed with PMS

- One or more papers based on the final results of the project 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. The papers should be submitted as either Research Papers for Science and Technology for the Built Environment 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 papers shall conform to the instructions posted in "Manuscript Central" for a technical ASHRAE Transactions Technical or Science and Technology for the Built Environment paper. The technical paper title shall contain the research project number (xxxx-RP) at the end of the title in parentheses, e.g., (9999-RP).
- A Technical Article suitable for publication in the ASHRAE Journal, if requested by the Society.

K. LEVEL OF EFFORT

The level of effort is approximated to require 18 months. A total cost of $150,000 is estimated.

L. PROPOSAL EVALUATION CRITERIA AND WEIGHTING FACTORS

- Contractor's understanding of Work Statement as revealed in proposal. 10%
- Quality of methodology proposed for conducting field research and obtaining manufacturer assistance. 15%
- Contractor's capability in terms of facilities. 15%
- Qualifications of personnel for this project. 15%
- Student involvement. 5%
- Probability of contractor's research plan meeting the objectives of the Work Statement. 10%
- Performance of contractor on prior ASHRAE projects or other energy projects. (No penalty for new contractors.) 5%
- Contractor's access to proposed facilities to be tested. 25%

M. CRITICAL PROJECT MILESTONES

Generally the schedule is expected to be:

- Month 2 – list of equipment and hospitals to be tested with written agreements
- Month 2 – list of manufacturer contacts and draft of approach (letter, email, calls, ASHRAE contact, etc.)
- Month 6 – preliminary test data
- Month 6 – results of manufacturer contacts
- Month 12 – all field test complete and data collated, present data at meeting
- Month 12 – results of meetings/calls with manufacturers
- Month 14 – draft of final report on field test with MOT
- Month 14 – agreement with at least one manufacturer on MOT
- Month 18 – final report

N. WORK STATEMENT AUTHORS

1. Oscar Cobb Jr
2. David Thomsen

O. REFERENCES

[1] ANSI/ASHRAE/ASHE Standard 170, Ventilation of Healthcare Facilities, 2013.

[2] 2013 Fundamentals Handbook, Chapter 18, "Nonresidential Cooling and Heating Load Calculations," ASHRAE, 2013.

[3] ASHRAE Standard 203-2014, Method of Test for Determining Heat Gain of Office Equipment Used in Buildings

[4] ASHRAE Research Project 1343 RP, Method of Testing and Reporting of Energy Use by Medical Equipment. D. Koenigshofer, IES Engineers-Dewberry, Principal Investigator, 2009.

[5] HVAC Design Manual for Hospitals and Clinics, Second Edition, ASHRAE, 2013.

P. OTHER INFORMATION FOR BIDDERS

Proposal should provide a list of proposed hospitals where field research will take place, ideally with a list of specific equipment that will be made available. Strong consideration will be given if a written agreement with proposed hospital is provided in the proposal.

Proposal should also include a list of manufactures and local contacts.

If bidder has test equipment already available, provide list.

List of relevant publications and/or unpublished research.

After project develops second MOT, TC9.6 may use MOT document to form an SPC and the MOT into an ASHRAE/ANSI standard

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

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TO: Michael S Meteyer, Chair TC 9.6, mmeteyer@erdman.com
Kenneth R Mead, Research Subcommittee Chair TC 9.6, kcm3@cdc.gov
Jeff Gatlin, Research Liaison Section 9.0, jeff.gatlin.pe@gmail.com

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

DATE: February 10, 2017

SUBJECT: Research Topic Acceptance Request (1816-RTAR), "Reporting the Energy Use and Heat Gain from Imaging Equipment"

At their winter meeting, the Research Administration Committee (RAC) reviewed the subject Research Topic Acceptance Request (RTAR) and voted to conditionally accept it for further development into a work statement (WS) provided that the RAC approval condition(s) below are addressed to the satisfaction of your Research Liaison and incorporated into the WS and/or in a revision to the RTAR.

The following list summarizes the mandatory comments and questions that need to be fully addressed in the updated RTAR and work statement submission:

1. Make sure working with manufacturers is being done in context of field testing, protocol with manufacturer but, testing should be done in field, not labs.
2. The RTAR should state how the heat generation from equipment is measured and how the operating schedules are.
3. Criteria for the selection of equipment should be mandated in WS. There are 9 modalities and 3 installations (apparatus but would size be different? Would selection be on the data provided by manufacturers (e.g. selection can be made based on loads claimed by manufacturers including installations with the low/moderate and high loads).
4. There are no descriptions how the researchers measure the heat generation from equipment. Does the RTAR only expect measuring the supplied power for the equipment?

Please coordinate changes to the RTAR with the help of your Research Liaison, Jeff Gatlin, jeff.gatlin.pe@gmail.com or RL9@ashrae.net. After coordination with your RL send the revised RTAR and/or letter/email of confirmation regarding the modifications agreed on with the RL to MORTS. This response to the approval condition(s) with the RTAR will be posted by ASHRAE as part of the Society's Research Implementation Plan.

After agreement has been reached and the information forwarded to MORTS, develop a work statement with the help of your Research Liaison prior to submitting it to the Manager of Research and Technical Services for consideration by RAC. The work statement must include a cover letter to RAC, detailing how the comments/conditions from the RTAR were addressed. The work statement must be approved by the Research Liaison prior to submitting it to RAC.

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

areas of the RTAR and subsequent WS where readers require additional information or rewording for clarification.

The first draft of the work statement should be submitted to RAC no later than December 15, 2018 or it will be dropped from display on the Society's Research Implementation Plan. The topic must be approved for bid by RAC by February 1, 2021 or it will be dropped permanently from plan after four years on plan. The next submission deadline for work statements is May 15, 2017 for consideration at the Society's 2017 annual meeting. The submission deadline after that for work statements is August 15, 2017 for consideration at RAC's 2017 fall meeting.

Project ID	**1816**	
Project Title	**Reporting the Energy Use and Heat Gain from Imaging Equipment**	
Sponsoring TC	TC 9.6 (Healthcare Facilities)	
Cost / Duration	$150,000-200,000 - 12 to 18M	
Submission History	**1st Submission**	
Classification: Research or Technology Transfer	Basic/Applied Research	
RAC 2017 Winter 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.	**34**	***#3*** - Thorough background information provided. ***#4*** - There's no information that illustrates that the heat gain from this equipment is a significant issue.
Research Need: Based on the background provided is the need for additional research clearly identified? If not, then the RTAR should be rejected.	**#12**	***#13*** - Consulting engineers need this data. Data plate power input isn't sufficient. It leads to over-cooling the spaces. We need realistic heat gain from imagining devices. ***#12*** - Why did 3 of the 13 voting members of TC 4.7 vote against the RTAR? ***#3*** - There would seem to be a definite need for this information for the efficient design of HVAC systems in clinics and hospitals.
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.	**#12, #4**	***#13*** - Same comment as above. ***#12*** - RP-1343 developed a MOT for manufacturers of imaging equipment to measure heat gain of their systems/components. Yet, half of the funding for this proposed project appears to be committed to convicting manufacturers to test and rate their products according to this MOT. This is not an appropriate use of ASHRAE research funds. Developing the protocol for testing and rating of manufacturer's equipment should be left to the manufacturer's association or the manufacturers themselves. The other half of the funding appears to be committed to field testing of imaging equipment in installed conditions. This is an appropriate use of ASHRAE funds. Restructure the RTAR to perform field testing of installed systems and components. ***#3*** - Will provide information that is currently absent from the handbook and design guides. ***#4*** - The RTAR doesn't give much of an indication of how valuable this information would be.
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.	**#6, #12**	***#6*** - Criteria for the selection of equipment should be mandated in WS. There are 9 modalities and 3 installations (apparatus. But would size be different? Would selection be on the data provided by manufacturers (e.g. selection can be made based on loads claimed by manufacturers including installations with the low/moderate and high loads). ***#12*** - See comments above. ***#4*** - But not sure whether examining 3 technologies would relate to the rest.
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:	**#6, #12, #5**	***#6*** - The budget is the range of costs and the duration is also the range. One number should be provided. **#12**- See comments above. **#5--** There are no descriptions how the researchers measure the heat generation from equipment. Does the RTAR only expect measuring the supplied power for the equipment? ***#3*** - My only concern is that there seems to be rapid technological development in this field, and numbers could be outdated very quickly.
References: Are the references provided?		
Decision Options	**Initial Decision?**	**Final Approval Conditions**
ACCEPT AS-IS	**#13, #3, #8**	***#5***- The RTAR should state how the heat generation from equipment is measured and how the operating schedules are.
ACCEPT W/COMMENTS	**#6, #5**	
REJECT	**#12, #4**	

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: December 12, 2016

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

Title: Reporting the Energy Use and Heat Gain from Imaging Equipment

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

RTAR # 1816
(To be assigned by MORTS)

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

Chapter 18 of ASHRAE Fundamentals
HVAC Design Manual for Hospitals and Clinics
Chapter 8 ASHRAE Applications

Research Classification:

Basic/Applied Research	x
Advanced Concepts	
Technology Transfer	

Responsible Committee: ASHRAE TC 9.6

Date of Vote: October 21, 2016

For		11
Against	*	0
Abstaining	*	1
Absent or not returning Ballot	*	0
Total Voting Members		12

RTAR Authors

Lead: Oscar Cobb, David Thomsen

Others: Ken Mead, Dan Koenigshofer,

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

TC 4.1 Load Calculation Data and Procedures (6-0-0-4 on 12/09/2016)
TC 4.7 Energy Calculation and Modeling (10-3-0-0 on 12/07/16)

Expected Work Statement Authors

Lead: Oscar Cobb, David Thomsen

Others: Ken Mead, David Eldridge

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

GE Healthcare, Daniel Nemeck

Siemens Medical Systems, Volker Westphal

Toshiba America Medical Systems, Bill Pue

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

* Reasons for negative vote(s) and abstentions

Abstention due to confusion regarding Phase 1/Phase II, which has since been clarified.

RTAR # _1816_

Title:

Reporting the Energy Use and Heat Gain from Imaging Equipment

Executive Summary

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

This research will determine heat gain and energy use for large, often multi-component, diagnostic medical equipment. Results will be used to update and expand current data in multiple ASHRAE publications. It will also provide energy use metrics for energy modeling and medical equipment comparisons in HVAC designs.

Background

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

HVAC design engineers rely on ASHRAE resources for designing imaging spaces within healthcare occupancies. For a limited number of imaging rooms, ANSI/ASHRAE/ASHE Standard 170 (4) provides prescriptive air change rates, but does not include all imaging rooms nor all spaces required for imaging (such as equipment rooms). ASHRAE 2013 Fundamentals Handbook (2) notes in Chapter 18: "The data (of Table 6) are presented to provide guidance in only the most general sense. For large equipment, such as MRI, heat gain must be obtained from the manufacturer." However, manufacturers generally provide a table of heat gain (in btu/hr) for components but do not explain their derivation, i.e. average, maximum, procedures per hour, type of procedures, nor do they indicate reliable data for installed equipment heat gain.

Therefore a key knowledge gap exists, which was previously identified and partially addressed in RP-1343. To determine cooling loads and estimating hourly energy use, RP-1343 developed two Method of Tests (MOT) for various medical imaging systems:

1. Complete typical system heat gain via field tests.
2. Component heat gain via factory tests.

The first MOT, successfully tested, obtained data on energy use on integrated imaging systems and unitary devices. That field data, although limited, was immediately useful for initial equipment sizing and energy modeling. The second MOT, reviewed with GE Medical Systems, was to standardize manufacturers' testing and reporting of heat rejection data from individual components (as opposed to the integrated systems of the first MOT) of the imaging systems.

Standard 203-2014, Method of Test for Determining Heat Gain of Office Equipment Used in Buildings, is an example of how ASHRAE has facilitated a methodology and improved the available dataset for HVAC design engineers, but nuances of imaging equipment are not addressed.

Research Need

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

For an HVAC design engineer, the lack of consistency in manufacturer data, as well as inconsistencies in the actual installed heat gain, result in inaccuracies from design through operation. Design engineers must rely exclusively on the general component data published by the manufacturers. This leaves the design engineers with uncertainties that can lead to excessive safety factors and less-efficient, oversized equipment and skewed building energy use values during design.

The HVAC Design Manual for Hospitals and Clinics (3) incorporates the results of RP-1343 within Table 8.9, and provides significantly more detail of various imaging modalities in Chapter 8, Room Design. However, in reviewing Table 8.9, there is noticeable limited manufacturer representation and a wide variation between the recommendations from the manufacturer and the field tested data. Additionally, the table states, “It is expected that Phase II of this research project (RP-1343) will result in a much more extensive database for heat gains to air and water for imaging systems.”

This research will be a valuable addition as it will provide a “more extensive database for heat gains to air and water for imaging systems” by building upon both RP-1343 and Standard 203-2014. Once complete, Table 6 “Recommended Heat Gain from Typical Medical Equipment” in Chapter 18 of the ASHRAE Fundamentals Handbook, Table 4 “Summary of Heat Gain to Air from Imaging Systems” in Chapter 8 of ASHRAE Applications Handbook, and Chapter 8 Section 4 “Imaging Rooms” of the HVAC Design Manual for Hospitals and Clinics can all be updated.

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) –

In this research, the researcher shall conduct additional field tests of systems and unitary equipment (first MOT) covering a wider inventory of systems, equipment and their applications. This will produce an immediate influx of data for use by HVAC design engineers and energy modelers. With manufacturer participation, the researcher will also develop a standardized test protocol and reporting format (second MOT) in order to obtain component loads under the anticipated time intervals of sleep/-idle/-high use scenarios.

This research will provide standardized and consistent heat gain data, help engineers calculate cooling loads, model energy use, and make more accurate equipment and system selections, specifically:

- Data Table 1 - will provide heat gain and energy use by complete systems based on field tests of operating systems.
- Data Table 2 - will indicate typical heat gain and energy use by system components under prescribed load conditions (if sufficient manufacturer assistance occurs).

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) (see below)

Cost is approximated at $150k, and duration anticipated at 18 months. The following approach is proposed:

Data Table 1 –

1. The researcher will identify at least three installations of each of the nine modalities (Cat Scan, Fluoroscopy, Cyber Knife, Linear Accelerator, MRI, Nuclear Camera, PET Scan, Ultrasound, X-ray)
2. The researcher will field test each installation.
3. The researcher will average results while also reporting the range of observed values (utilizing current research and RP-1343).

Data Table 2 –

1. The researcher will develop a draft common protocol for testing and reporting manufacturer values for the various modalities, based upon RP-1343 and Standard 203-2014.
2. The researcher will solicit, potentially through the assistance of a representative trade association, peer review by imaging equipment manufacturers of draft common protocol for testing and reporting (if the proposed approach differs from the manufacturer's current evaluation).
3. The researcher will seek manufacturer's input to complete report forms in RP-1343 (Tables 6.5, 6.6 and 6.7) for each of the models made by that manufacturer, per the approved common protocol for testing and reporting.
4. If sufficient manufacturer assistance occurs, the researcher will compile results into single data table.

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)

As ASHRAE strives to meet the strategic goals to both "Educate" and "Adapt", specifically "utilizing science and technology to create practical tools and resources for the designer", this proposed research is an excellent example of the resources ASHRAE seeks to create, and coincides with the ASHRAE 2020 vision of creating tools for the building industry to produce net zero energy buildings. But the information within said tools and resources must be current in order to be valuable to the user. The data referenced in the ASHRAE Handbook is dated 1999, and results from RP-1343 were published in 2009.

As noted above, RP-1343 sought to collect data in the gap that exists between the medical equipment manufacturers' provided energy-use data and the equipment's actual energy consumption following installation. That research revealed that there was more work to be done. The proposed research will enable designers to take the incredibly complex medical equipment functions and simplify them to the needs of the HVAC designer, in tabular form. These will result in better HVAC equipment selection and design, more cost effective solutions, and better building performance by reducing energy usage in health care facilities.

All of these goals fit cleanly within the ASHRAE strategic plan. Further, the design decisions an engineer is faced with during healthcare HVAC design sometimes result in over-designing or under-designing, and subsequently can have an impact directly or indirectly on patient care. From a sustainability perspective, the ability to specify accurate equipment sizing will impact the energy efficiency in the facility's operation, which can be a lengthy life span for medical facilities. The energy consumption data, test protocol and standardized reporting format that will come from this proposed research will have a tremendous impact in advancing the state of the art in healthcare facility HVAC design.

Following completion of this proposed research, the individual equipment test and reporting protocol could potentially evolve into consideration for adoption into an ASHRAE Standard. Such an evolution will help to ensure the availability of meaningful, accurate and useable heat gain design data for medical systems and equipment for many years to come.

Anticipated Funding Level and Duration

Funding Amount Range:

$150,000-200,000

Duration in Months: 12-18

References

[1] ASHRAE Research Project 1343 RP, Method of Testing and Reporting of Energy Use by Medical Equipment. D. Koenigshofer, IEW Engineers-Dewberry, Principal Investigator, 2009.

[2] 2013 Fundamentals Handbook, Chapter 18, "Nonresidential Cooling and Heating Load Calculations," ASHRAE, 2013.

[3] HVAC Design Manual for Hospitals and Clinics, Second Edition, ASHRAE, 2013.

[4] ANSI/ASHRAE/ASHE Standard 170, Ventilation of Healthcare Facilities, 2013.

Feedback to RAC and Suggested Improvements to RTAR Process

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