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DRAFT

TC/TG/MTG/TRG MINUTES COVER SHEET

(Minutes of all Meetings are to be distributed to all persons listed below within 60 days following the meeting.)

TC/TG/MTG/TRG No. TC 4.01 DATE 01-25-19

TC/TG/MTG/TRG TITLE Load Calculations and Procedures

DATE OF MEETING 06-24-19 LOCATION Kansas City

MEMBERS PRESENT	YEAR APPTD	MEMBERS ABSENT	YEAR APPTD	EX-OFFICIO MEMBERS AND ADDITIONAL ATTENDANCE
Suzzane LeViseur (VM)				Chris Wilkins (CM)
Steve Bruning (VM)				Glenn Friedman (CM)
Jim Pegues (VM)				Russell Taylor (CM)
Jingjuan Dove Feng (VM)				Liam Buckley (PCM)
Rolando Legarreta (VM)				Som Shresta(CM)
Elyse Malherek (VM)				Brian Rock (CM)
Rachel Spittler (VM)				Bob Doeffinger (CM)
Jeff Spitler (VM)				Jason DeGraw (CM)
Chip Barnaby (VM)				Vaisal Shah (Guest)
				Desiree Smith (Guest)
				Scott Hellendrurg (Guest)
				Aksley Bhargava (CM)
				Aredshir Moftakhar (CM)
				Walter Horn (Guest)
				Denis Livchak (Guest)
				Stephen Roth (CM)

DISTRIBUTION: ***All Members of TC/TG/MTG/TRG plus the following:***	
TAC Section Head: Dennis Wessels, PE	SH04@ashrae.net Where x is the section number

All Committee Liaisons As Shown On TC/TG/MTG/TRG Rosters (Research, Standards, ALI, etc.)	See ASHRAE email alias list for needed addresses.
Mike Vaughn, Manager Of Research & Technical Services	MORTS@ashrae.net

Note: These draft minutes have not been approved and not the official, approved record until approved by the TC.

MINUTES

DRAFT

TECHNICAL COMMITTEE
4.1 LOAD CALCULATIONS AND PROCEDURES

2019 Summer Meeting

June 24, 2019

Note: These draft minutes have not been approved and not the official, approved record until approved by the Technical Committee.

1. Call to Order by Chairman - Suzanne LeViseur

2. Roll Call by Rolando Legarreta – 8 of 9 members present at time of roll call; Ellyse Malherek absent at time of roll call, but present during meeting.

3. Introduction of Visitors by Suzanne LeViseur

   Som Shrestha, PhD - Programs

4. Approval and/or Corrections to Previous Meeting Minutes presented by Suzanne LeViseur

   Steve Bruning Move to approve Houston Meeting Minutes correcting listing Som Shrestha, Phd as the Programs Liaison. Chip Barnaby Second the motion. Meeting Minutes approved by TC4.1 8-0-1Absent.

   Atlanta Meeting Minutes – Jim Peques moved to approve meeting minutes. Jeff Spitler second the motion. Atlanta Meeting Minutes approved 8-0-1 Absent. (Ellyse Malherek was present after meeting minute approval).

5. Liaison Comments –

   Section Head - Dennis Wessels, PE

   - TC Re-organization will not be extensive. Some TC's have requested Membership Mergers. Such Changes won't take effect until a year from this meeting (2020). Number of TC's will not reduce to 30 as someone has stated.
   - TC forms are due June 25, 2019. Current Version has been updated.
   - High Tower award is given to members of a TC and is presented during the winter meeting. Any Nominations should be done before September.
   - Individuals can nominate themselves to serve in Tech Council or any other Standing Committee.
   - Roster Updates will take effect July 1, 2019.

   Chapter Technology Transfer - Christopher Adams – not present
   Research - Michael Pouchak, PE – not present
   Handbook - Bass Abushakra, PhD – not present
   Program - Som Shrestha, PhD – At meeting
   Staff, Research/Tech Services - Michael R. Vaughn – not present
   TAC Chairman - Thomas Justice – not present

6. Research Subcommittee Report Som Shrestha, PhD

   1729-RP: Experimental Verification of Cooling Load Calcs for Radiant Systems
   During Sub-Committee Meeting Glen Friedman Mentioned that the Research team had requested a no cost time extension to complete the report. A Draft report has been submitted for review, and the Final Report will be provided to the TC by the Orlando Meeting.
   Motion by Spittler to grant a No Cost Extension – Second by Legarreta, Motion Passes 9-0

   1778-RP Heat and Moisture Loads from Commercial Dish room Appliances and equipment.
   Research is on going and a draft report will be provided prior to the Orlando TC meeting for review and comment by TC members.

   New RTAR to revise the Load Calculation Applications Manual; last revision was done in 2009. Can be submitted for publication and submit work statement. It was recommended to submit the work statement for Next deadline (WS 1616 attached to meeting minutes). Jim Pegues to distribute via email to committee members and Voting Members to follow up with an email ballot.

Dennis Livchak (TC 5.10) is proposing and RTAR for TC4.1 to sponsor with TC 5.10 for Heat loads of Commercial refrigeration Equipment. Rolando Legarreta to work with Dennis and draft the RTAR for this project.

David Claridge will be the new Research Liaison (RL4@ashrae.net) and should be included in the meeting minutes distribution.

7. Programs Subcommittee Report by Rachel Spittler
   TC 4.1 did not have any programs for KC.
   Reference Attached Sub-Committee Report

8. Standards Subcommittee Report by Glenn Friedman

   ANSI/ASHRAE/ACCA Standard 183-2007
   ANSI/ASHRAE Standard 203-2015

   No actions needed on Standards at this time.

9. Handbook Subcommittee Report by Jim Pegues (Chapter 18 Non-Residential)
   Sub-Committee is working on updating data as it becomes available for the 2021 edition.
   Voting approval should be done in January or June 2020.
   Deadlines for submission is July 2020. Results from RP-1729 to be incorporated.
   Reference attached Handbook Sub-committee Report.

   ASHRAE Publications requested to define what to do with some previous publications.
   Calculation Models and algorithms annotated by Jeff Spittler – Bruning recommended to have it updated. Jeff Spittler recommends posting it for free.

10. ASHRAE Website for TC4.1 by Jim Pegues
    Website is current.

11. Old Business by Suzanne LeViseur
    None

12. New Business by Suzanne LeViseur
    At TC Chairs Breakfast, letters will be sent out regarding TC mergers as mentioned above.
    Remote meetings can be setup for TC's that don't reach quorum.
    Mike Vaugh will be moving to New ASHRAE Building.
    Steve Hemerlanin will be taking over Mort's (Mike Vaughn's place).
    Sundays in the afternoon is the YEA Mixer/Party; this function can be an excellent opportunity to recruit new members.
    Traditionally TC4.1 VC is responsible to welcome new members (Dove offered to take care of it while VC).

    RP-1816 Heat Gain for Medical Equipment – Glenn Friedman is of the PES. Is currently being evaluated, has not gone for approval; PES made the recommendation. The project duration is anticipated to be 18 months.

13. Adjournment
    Jeff Spittler Motioned to Adjourn the meeting.
    Jim Pegues Second the motion.
    Meeting adjourned at 3:44 PM

ASHRAE Technical Committee 4.1

TC 4.1 Programs Subcommittee Meeting

5-6 PM, Sunday, June 23, 2019

Room 2102B, First Floor of the Kansas City Convention Center

Minutes prepared by chair, Rachel Spitler (rspitler@cyntergy.com)

1. Meeting convened at 5:13 PM. The chair and seven others were present.
2. No sessions or seminars at Kansas City.
3. Discussion on future seminars ensued.
4. The question was raised if there was a way to help young engineers approach load calculations holistically? Things to know BEFORE starting loads: weather data, zoning, block loads vs. room loads, etc. Part of the problem is that brand new engineers are not necessarily at the conference. But, assuming they are or some other means of dissemination was available, a "Fundamentals of Load Calculations" seminar would be useful. The idea was also discussed about collaborating with YEA for a Fundamentals of Load Calculations seminar. A suggestion was made to contact YEA about a kind of resource or publication that is available for new engineers; this could be a form of outreach.
5. On a larger scale, a comment was made that ASHRAE should look into disseminating some Fundamental seminars to new engineers freely. This could help entice YEA members and employers to send new engineers to ASHRAE, plus possibly promote membership.
6. Discussion occurred over a program RP 1729 and RP 1778 – can we see if they are available for a seminar can do something for Orlando, especially radiant system applications for practicing engineers? Working title "Ongoing Research for Load Calculations". Rolando Legarreta will check with RP 1778 members and Chris Wilkins with RP 1729 members about availability and interest in presenting at Orlando.
7. The meeting adjourned at 5:40 PM.

ASHRAE Technical Committee 4.1

TC 4.1 Handbook Subcommittee Report

Kansas City, MO
June 23, 2019

1. Work Schedule for 2021 Handbook – Fundamentals – Chapters 17 and 18

Finish Date	Work Phase	Description
thru 1/2020	Construction	Make revisions and additions
1/2020 or 6/2020	Approval	Committee vote to approve revisions
7/12/2020	Submission	Submission deadline for Chapter 17 (Residential)
7/19/2020	Submission	Submission deadline for Chapter 18 (Non-Residential)
5/2021	Publication	Handbook mailed to members.

2. Chapter 18 - Room Load Calculations for Radiant Systems
   a. The research team for RP-1729 gave a summary of project results.
      - Project is finished. Draft final report submitted. PMSC is still reviewing the draft.
      - Integrating project results into Chapter 18: The heat gain and Heat Balance Method sections of the Chapter are unaffected. For Radiant Time Series, a separate set of Conduction Time Series and Radiant Time Series tables will be needed for rooms using radiant cooling. Creation of these tables was not in scope for RP-1729 and needs to be the subject of separate research. Therefore, radiant cooling material for the 2021 Handbook will need to be a qualitative discussion rather than quantitative discussion.
      - Jim Pegues to meet with Chris Wilkins and Dove Feng on Monday at 1pm prior to TC 4.1 Full Committee Meeting to discuss ideas for qualitative material to be added to the chapter.

3. Chapter 18 – Example Problem
   a. Background: Subcommittee is reformulating the example problem to improve focus and maintainability. Another objective is to remove the dependency on the TC 4.2 design weather update project which often is completed late in the Handbook cycle and delays work on the example until just before the submission deadline.
   b. Consensus points from discussion:
      - Overall objectives for the example should be (i) to demonstrate component cooling and heating load calculations in detail for a sample room, (ii) to demonstrate that peak cooling loads can occur at different times of day and times of year due to orientation necessitating calculation for a "design year" (12 design days x 24 hours) to identify true peak load, (iii) to demonstrate that the block load is a diversified peak rather than the sum of individual room peaks. These objectives were formulated with the training needs of practicing engineers (a key audience for Chapter 18) in mind.
      - Retain Section 9.1 – Single room cooling load calculation for the 2nd floor corner office. This effectively demonstrates the calculation procedures for all key load components in detail. Update with latest data and procedures.
      - Retain Section 9.2 – Heating load calculation for the same office.
      - Remove Section 9.3 – This was the block load and detailed room by room load calculation for the entire ASHRAE Headquarters Building.
      - Replace Section 9.3 with smaller scale examples of peak cooling loads for rooms in different parts of

the building (different exterior orientations) to demonstrate how orientation causes peak load to occur at different times of day and year. This might be done by moving the corner office to different corners of the building. Also include a block load calculation to illustrate how the block is a diversified peak.

- Remove references to the ASHRAE Headquarters building. Its OK to continue using the building data, but just refer to it generically.
- Remove references to Atlanta weather data. Instead describe a hypothetical site. Show a complete table of Chapter 14-type weather data for this site and indicate which items in which tables are the source of data for load calculations. Chip Barnaby suggests working with Michael Kummert (principal investigator for RP-1847, Climate Data Update) to generate the table. Embed this table in the Chapter 18 example.

4. Chapter 18 – Data Table Updates
   a. Table 1 – Occupant Heat Gains – Chris Wilkins is making inquiries with Research Activities Committee (RAC) to determine if more recent data is available.
   b. Table 5F – Warewashing Equipment – RP-1778 is updating and expanding heat gain data for warewashing equipment. Project is still scheduled for completion in December 2019. Jim Pegues will provide Rolando Legarreta with a copy of the current Table 5F and the explanatory paragraph from the 2017 Handbook. Rolando will work with the RP-1778 principal investigator to have the table and paragraph updated.
   c. Tables 6 and 7 – Medical and Laboratory Equipment Heat Gains – RP-1816 is working to update and expand this heat gain data. The project has just gone to bid. Bob Doeffinger will check status to determine if any data will be available in time for the 2021 Handbook.

3. Chapter 17 - Residential Load Calculations Chapter
   a. The chapter has not been revised in 2 or 3 cycles. The material is old in that it does not provide factors for modern construction and energy codes which have highly insulated envelopes.
   b. Options being considered were:
      (i) Leave chapter as is for another cycle
      (ii) Drop the chapter from the handbook since the industry overwhelmingly uses ACCA Manual J
      (iii) Revise the chapter, supplying updated factors representative of modern construction practices and codes. This requires substantial work to develop the new factors.
   c. Action: Chip contacted the Residential Building Committee multiple times between January and June to seek advice on importance to ASHRAE of updating the Residential Load Calculation Chapter. He has not received a reply yet.
   d. Proposal:
      - Do a lightweight update to Chapter 17 for the 2021 Handbook.
      - Initiate a research project like RP-1199 (the project that developed the existing Chapter 17 content and data) to update procedures and data supporting a more significant revision of Chapter 17 for the 2025 Handbook.

Unique Tracking Number Assigned by MORTS 1616

RESEARCH TOPIC ACCEPTANCE REQUEST (RTAR) FORM

Sponsoring TC/TG/SSPC: TC 4.1

Title:

"*Revise Load Calculation Applications Manual* (2009)"

Abstract

This project revises the ASHRAE *Load Calculation Applications Manual* (Spitler, 2009) to incorporate significant advances for peak cooling and heating load estimating data and procedures resulting from recently completed ASHRAE research.

Applicability to ASHRAE Research Strategic Plan:

This project supports goal #10 in the 2010-2015 ASHRAE Research Strategic Plan: "Significantly increase the understanding of energy efficiency, environmental quality and the design of buildings in engineering and architectural education. The proposed project will incorporate the results of four recent ASHRAE-funded research projects (RP-1363, RP-1453, RP-1311, RP-1362) into a new edition of the *Load Calculation Applications Manual*. Each of the four research projects makes significant advances in the art of load estimating which contribute to more accurate and effective building designs. By publishing this information in an application manual, a format likely to be more widely used in engineering and architectural education (and in engineering practice) than the *Handbook - Fundamentals* alone, the research results will reach a wider audience. That in turn will contribute to greater understanding of effective methods of building design through accurate peak load estimating.

Research Classification:

Technology Transfer

TC/TG/SSPC Vote:

10-0-0-0 (5/3/2010)

Reasons for Negative Votes and Abstentions:

(none)

Estimated Cost:

$100,000

Estimated Duration:

18 months

RTAR Lead Author

James Pegues
Carrier Corporation
james.f.pegues@carrier.utc.com

Expected Work Statement Lead Author

James Pegues
Carrier Corporation
james.f.pegues@carrier.utc.com

Co-sponsoring TC/TG/SSPCs and votes:

none

Possible Co-funding Organizations:

none

Application of Results:

This research project will produce an ASHRAE Special Publication: the *Load Calculation Applications Manual, 2nd edition.* Separate versions of the manual using IP units and SI Metric units will be produced.

State-of-the-Art (Background):

ASHRAE research project RP-1326, Load Calculation Applications Manual, produced an application manual representing current state of the art for peak cooling and heating load procedures and data. By publishing this information in an application manual it was hoped the information would reach a wider audience than that reached by the Handbook - Fundamentals alone, thereby increasing the effective use of the information by our industry.

The 2009 edition of the *Load Calculation Applications Manual* utilized information from the *2005 Handbook - Fundamentals* and the decades of ASHRAE and industry research the Handbook is based upon. A few pertinent research projects, among many, contributing to this information were projects dealing with:

- The Heat Balance Method (Pedersen, Fischer and Liesen, 1997).

- The Radiant Time Series Method (Spitler, Fisher, and Pedersen, 1997).
- Design Weather Data (Thevenard and Humphries, 2005).
- Clear Sky Solar Radiation Profiles (Threlkeld, 1963).
- Calculation of solar heat gain for fenestration with shading devices (Klems and Warner, 1997)
- Heat gain from lighting fixtures (Fisher and Chantrasrisalai, 2006).
- Heat gain from commercial cooking equipment (Fisher, 1998).
- Heat gain from office equipment (Wilkins and Hosni, 2000).

Shortly after the first edition of the *Load Calculation Applications Manual* was finished, four ASHRAE research projects were completed which made significant advances in procedures and data for clear sky solar radiation profiles, design weather data, calculation of solar heat gain for fenestration shading devices and heat gain from commercial cooking equipment. This creates an information gap between the first edition of the Applications Manual and the new state of the art. The objective of this proposed project is to close the information gap by incorporating the new research into a second edition of the Applications Manual.

Advancement to the State-of-the-Art:

Four ASHRAE research projects completed in 2009 made important advances in the state of the art for estimating peak cooling loads:

- **RP-1453** - Updating ASHRAE Climatic Data for Design and Standards - Provides new procedures for accurately representing design day clear sky solar radiation profiles. These replace existing procedures originally formulated in the late 1950s and early 1960s. This project also provided new climatic design data based on the latest weather observations worldwide.
- **RP-1363** - Generation of Hourly Design Day Weather Data - Provides new procedures for accurately representing design day dry-bulb and wet-bulb temperature profiles.
- **RP-1311** - Improving Load Calculations for Fenestration with Shading Devices - Provides new procedures and data for calculating solar heat gain for fenestration and fenestration shading devices such as blinds, shades, drapes, and screens.
- **RP-1362 -** Revised Heat Gain and Capture and Containment Exhaust Rates for Commercial Cooking Appliances - Provides new data for kitchen equipment heat gains, based on current equipment types and the latest measurement techniques.

Inclusion of results from RP-1453, RP-1363, RP-1311 and RP-1362 will bring the *Load Calculation Applications Manual* up to par with state of the art information in the *2009 Handbook - Fundamentals*.

Ongoing ASHRAE research is also likely to further advance the state of the art and will be worthy of inclusion in a revised Application Manual. Among the ongoing projects worthy of consideration:

- **RP-1482 -** Update to Measurements of Office Equipment Heat Gain Data - Will provide new data for office equipment heat gains, based on current equipment types and the latest measurement techniques (project completed during 2010)
- **RP-1416 -** Development of Internal Surface Convection Correlations for Energy and Load Calculation Methods - Will provide new data and procedures for determining internal surface convection coefficients (project due to be completed in summer 2011).

In addition to documenting state-of-the-art load calculation procedures, the manual also demonstrates the use of the procedures with examples. Because load calculation procedures have undergone significant changes, the example must be updated to incorporate these new calculations. This also provides an opportunity to update the example subject to use the post-renovation ASHRAE HQ building. In this way use of state-of-the-art procedures for a state-of-the-art building can be demonstrated.

Justification and Value to ASHRAE:

The Load Calculation Applications Manual special publication was created with the objective of gathering information related to load calculations from multiple chapters of the ASHRAE Handbook - Fundamentals into a single focused volume. Chapters contributing information to the Applications Manual include:

- Chapter 18 - Non-Residential Cooling and Heating Load Calculations
- Chapter 14 - Climatic Design Information

- Chapter 15 - Fenestration
- Chapter 16 - Ventilation and Infiltration
- Chapter 4 - Heat Transfer
- Chapter 26 - Heat, Air and Moisture Control in Building Assemblies - Material Properties

Publishing this information in an application manual allows it to reach a wider audience and increases the effectiveness of the material, particularly for education, but also for general industry uses.

This Manual has greatest value when it represents the current state-of-the-art in load calculation procedures and data. TC 4.1 believes an update to the Manual is justified each time significant changes to the state-of-the-art occur, but no more frequently than the 4-year Handbook-Fundamentals cycle. Since the publication of the 2009 edition of the Manual, the state-of-the-art has advanced with significant changes to both load calculation procedures and data. Updating the Manual to the new state-of-the-art will preserve its value both to industry and to ASHRAE.

Finally, ASHRAE has a long history of producing special publications focusing on load calculation procedures. The table below lists the previous special publications covering this subject and includes sales figures for the most recent editions.

Publication Title	Publication Date	Units Sold
Load Calculation Applications Manual	2009	1160 (IP), 36 (SI)
Cooling and Heating Load Calculation Principles	1998	3168
Cooling and Heating Load Calculation Manual, 2nd Edition	1992	no data
Cooling and Heating Load Calculation Manual, 1st Edition	1979	no data

Objectives:

The objective of the project is to revise the *Load Calculations Application Manual, 1st edition* to produce a second edition. The second edition will

- Incorporate results from recently completed ASHRAE research projects RP-1453, RP-1363, RP-1311 and RP-1362.
- Update the example problems to utilize floor plan and construction data for the renovated ASHRAE HQ building.
- Update the software spreadsheets included with the manual to incorporate the new load calculation procedures.
- Offer separate IP units and SI Units versions of the manual.

Specific portions of the manual that will be updated to achieve these objectives are shown in the following table:

Component	Description of Work
Chapter 3 - Thermal Property Data	Update thermal property tables to match data in the *2009 Handbook - Fundamentals*. Preliminary survey indicates this mainly involves 5-10 pages of indoor attenuation coefficient data for internal shading of windows.
Chapter 4 - Environmental Design Conditions	(1) Revise explanation of derivation of hourly design-day outdoor dry-bulb and wet-bulb profiles and associated examples, (2) Udpate all weather data tables to use data from the *2009 Handbook - Fundamentals*.
Chapter 6 - Internal heat Gain	(1) Update Table 6.2 to use lighting power density data from *ASHRAE Standard 90.1-2010*, (2) Update Tables 6.5, 6.6 and 6.7 to use new kitchen appliance data from the *2009 Handbook - Fundamentals* Chapter 15 tables 5A, 5B, 5C.
Chapter 7 - Fundamentals of RTSM	(1) Replace data in Tables 7.1 and 7.2 with data generated using the new ASHRAE solar radiation algorithms documented in the *2009 Handbook - Fundamentals*, (2) Revise section 7.5 item 4 to document the new procedures for calculating solar heat gain for fenestration with internal shades, (3) Revise examples 7.1 and 7.2 to use outputs from updated spreadsheets using revised algorithms for solar flux and heat gain.
Chapter 8 - Application of the RTSM - Detailed	The general format of this chapter can be preserved, but all specific data used in the example must be revised. This includes (1) updating all building diagrams and descriptions of input data to use data for the renovated ASHRAE HQ building, (2) replacing all data in tables and graphs to use new outputs

Example	from the updated spreadsheets using both the new input data and the revised calculation algorithms.
Appendix B - Spreadsheet Implementation of RTSM	Revisions in this Appendix flow from changes to the load calculation spreadsheets (see *CD-ROM Contents* below). Screen images of spreadsheet tables and VBA code require revision. Discussion of contents of input and results tables also require revision.
Appendix D	Basic format of the appendix can be reused, but the content must be completely revised and enlarged to document the *2009 Handbook - Fundamentals* procedures for calculating clear sky solar flux, solar heat gain and heat gain for fenestration with internal shades.
Appendix G	Graph results in Figures G.1 and G.2 require revision based on use of 2009 Handbook - Fundamentals calculation results for solar heat gain.
CD-ROM Contents	A CD-ROM is included with this manual. It contains ASHRAE design weather data and load calculation spreadsheets. This software is a very important component of the manual since methods discussed in the manual are only efficient when performed by computer calculation. Thus the spreadsheets are critical to the use and understanding of principles explained in the manual. Revisions needed to the CD-ROM include: (1) Replacing all data in the Stations folder with weather station data, IP index and SI index tables from the *2009 Handbook - Fundamentals.* (2) Updating the load calculation spreadsheets. There are 17 spreadsheets on the CD. These spreadsheets include Visual Basic for Applications (VBA) programming to implement the ASHRAE load calculation algorithms. Many of these algorithms are extensive and as a result the spreadsheets are complex. An initial survey indicates that 2 spreadsheets require significant revision to the VBA algorithms, 10 spreadsheets require moderate revision to update data tables, algorithms and results, and 5 spreadsheets require only minimal or no change to content. These revisions constitute software development and as a result formal software principles for design, development and testing must be used to ensure product quality. This task will therefore require significant effort.
SI Metric Edition	Upon completion of the Inch-Pound (IP) edition, make a copy and produce a second edition with the same technical content which displays all numerical results using SI Metric Units. The time consuming challenge here is the large quantity of tabular data and graphs which will have to be reproduced in SI Metric Units.

Finally, it should be noted TC 4.1's longer term goal is to place the *Load Calculation Applications Manual* on continuous maintenance, synchronizing its revision with the publication of the *Handbook - Fundamentals* so that both publications continually represent state of the art for cooling and heating load estimating procedures and data. This proposed project is the first step in establishing a continuous maintenance regime.

Key References:

ASHRAE Research Completed Prior to 2009

Fisher, D.R. 1998. New recommended heat gains for commercial cooking equipment. *ASHRAE Transactions* 104(2):953-60.

Fisher, D.E. and C. Chantrasrisalai. 2006. Lighting heat gain distribution in buildings. ASHRAE RP-1282, *Final Report.*

Klems, J.H. and J.L. Warner. 1997. Solar heat gain coefficient of complex fenestrations with a venetian blind for differing slat angles. *ASHRAE Transactions* 103(1):1026-1034

Pedersen, C.O., D.E. Fisher, and R.J. Liesen. 1997. Development of a heat balance procedure for calculating cooling loads. *ASHRAE Transactions* 103(2):459-468.

Spitler, J.D., D.E. Fisher, and C.O. Pedersen, 1997. The radiant time series cooling load calculation procedure. *ASHRAE Transactions* 103(2).

Spitler, J.D. 2009. *Load Calculation Applications Manual*. ASHRAE Research Project 1326.

Thevenard, D. and R. Humphries. 2005. The calculation of climatic design conditions in the 2005 ASHRAE Handbook - Fundamentals. *ASHRAE Transactions* 111(1):457-466.

Threlkeld, J.L. 1963. Solar irradiation of surfaces on clear days. *ASHRAE Transactions* 69:24.

Wilkins, C.K. and M.H. Hosni. Heat gain from office equipment. *ASHRAE Journal* 42(6):33-44.

New ASHRAE Research Completed During 2009

Hedrick, R. 2009. Generation of hourly design-day weather data (RP-1363). ASHRAE Research Project, *Final Report*.

Swierczyna, R., P.A. Sobiski, and D. Fisher. 2009. Revised heat gain and capture and containment exhaust rates from typical commercial cooking appliances (RP-1362). ASHRAE Research Project, *Final Report*.

Thevenard, D. 2009. Updating the ASHRAE climatic data for design and standards (RP-1453). ASHRAE Research Project, *Final Report*.

Wright, J.L., C. Barnaby, M.R. Collins and N.A. Kotey. 2009. Improving load calculations for fenestrations with shading devices. ASHRAE Research Project RP-1311, *Final Report.*

Research Topic Acceptance Request Cover Sheet

Date: 12/19/2018

(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:
Refrigeration Heatgain Loads

RTAR#
(To be assigned by MORTS)

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

Fundamentals Chapter 18: 18.8 Table 5A
Refrigeration Chapter 16

Responsible TC/TG: 4.1

Date of Vote:

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

Co-sponsoring TC/TG/MTG/SSPCs (give vote and date):
5.10

RTAR Lead Author: Denis Livchak
Expected Work Statement Lead Author:

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

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

Refrigeration Heatgain Loads

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)

This research project will measure heatgain loads of popular commercial self-contained refrigeration equipment. These loads will be published in the ASHRAE handbooks and will be used to perform internal heatgain calculations for commercial buildings that include food-service facilities. This published data will allow designers to size HVAC systems correctly.

Background

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

Commercial kitchens usually have several pieces of refrigeration equipment including refrigerators and freezers. Only walk in coolers are often remotely condensed, and the rest of the equipment is self-contained. Self-contained refrigeration equipment has the condenser integrated into the cooling unit itself, which means that the heat from the refrigerated compartment is rejected directly into the space and the HVAC system needs to be able to condition it.

Commercial refrigeration equipment varies greatly by compartment and compressor size, temperature setpoint, and door material. All these properties affect the heatgain generated by the equipment. The maximum input of the equipment is shown on spec sheets which correlates to the maximum heatgain generated, however duty cycles may vary greatly and directly affect the heatloads. Designers may misinterpret the maximum and average input rate (not published) of refrigeration equipment which would lead to oversizing of the kitchen HVAC systems.

The goal of the project is to conduct laboratory heatgain testing on a variety of self contained refrigeration equipment to provide ASHRAE average heatgain values for each equipment type.

Research Need

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

Currently, there is almost no public information regarding refrigeration heat loads. The ASHRAE refrigeration handbook does not have any information of that type and the ASHRAE Handbook Chapter 18 has only a single line in table 5A showing heat-gain of a small freezer. There is more heat load information on laser printers than refrigeration equipment in the ASHRAE handbooks.

With over a million food-service facilities in the US alone, there is a need to generate heat-gain data for self-contained commercial refrigeration equipment. This data would include equipment input rating, average input with the compressor duty cycle (usage factor) and the sensible radiant heat-gain. The heat load generated by refrigeration equipment has a direct impact on the kitchen comfort and the HVAC load.

HVAC systems need to be designed with all internal kitchen heatgain loads in mind which include, hooded cooking equipment, un-hooded cooking equipment, refrigeration and ware-washing equipment. Extensive ASHRAE research projects have been conducted to document cooking equipment and a project (1778-TRP) is currently being conducted to document ware-washing equipment heatgain. A research project needs to be conducted to document refrigeration heat loads to complete the reference information on commercial kitchen heatgain calculations.

Project Objectives

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

The main project objective is to document commercial self-contained refrigeration heatgain. Self contained refrigeration equipment should be divided in popular type categories which include: reach in refrigeration, chef bases, prep tables, ice machines, soft serve machines and blast chillers. Reach in refrigeration can be broken down into more categories which include: solid door refrigerator, solid door freezer, glass door refrigerator, under-counter refrigerator, refrigerated grab and go cases and glass door chest freezers.

ASHRAE 72 test method defines test conditions for most of these appliance categories and will be used as the appliance test method. ASTM F2474 test method defines how a heat gain test should be conducted in a lab environment and will be used as the method of quantifying heat gain for appliances under test. Generated data would include equipment input rating, average input with the compressor duty cycle (usage factor) and the sensible radiant heat-gain.

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 laboratory project is scheduled to run for 24 months to perform heatgain testing on a variety of self-contained refrigeration equipment types. The goal of the project is to test at least 15 different pieces of self-contained refrigeration equipment to generate heatgain and duty cycle data. With some refrigeration equipment costing over $10k, project costs can be reduced by asking manufacturers to donate refrigeration pieces of equipment for testing. In return, manufacturers will receive heatgain data on their specific equipment and may add that to their specification sheets. It is estimated that this project will require over $50k in equipment under test which could be provided by refrigeration manufacturers. The laboratory capable of ASTM F2474 testing must have over $50k in ventilation and data acquisition equipment to conduct this research, if an existing lab with those capabilities is used, the setup costs would be minimized. Using an existing heatgain testing lab and working with refrigeration manufacturers to donate equipment will avoid over $100k in project costs. Possible co-funding from a electric utility companies may allow to test more refrigeration types extending the number of appliances under test from 15 to 25. The total project cost to ASHRAE would be $195,000.

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)

TThis effort is of interest to ASHRAE because this provides crucial information for HVAC designers on equipment sizing. HVAC designers consistently use ASHRAE handbooks and comprise a majority of ASHRAE members. The refrigeration heatgain information generated through this project will add value to the handbooks by providing a more complete list of commercial kitchen appliance heatgain. Kitchen designers will see more value in specifying energy efficient refrigeration equipment since energy savings at the appliance result in reduced heatgain and HVAC savings. Refrigeration manufacturers would also be able to provide their customers more accurate data on heat load generated by their equipment.

This project aligns with the ASHRAE strategic plan by maximizing the actual operational energy performance of buildings and facilities through providing complete refrigeration heat load information to properly size commercial HVAC systems. Most Specifically: Goal #1: Design Construction Factors: 5. Lack of sufficient site-specific documentation and training to communicate the design intent to building operators. Difficulty for decision-makers to quantify the value of such documentation and training. And: Develop more accurate methods to relate building energy simulation models to actual building energy use.

This project also aligns with ASHRAE strategic plan goal #7 “Support development of tools, procedures and methods suitable for designing low-energy buildings.” The refrigeration heatgain data generated by this project will be used as internal inputs to model low energy buildings. The heat generated by refrigeration equipment can also be reused for heating process loads in ZNE buildings. This project aligns with ASRHAE strategic plan goal #4. Commercial kitchens are very hot and have some of the worst IEQ out of any commercial space. Refrigeration loads add to that heat, this project will advance our understanding of the impact of indoor environmental quality (IEQ) on perceived environmental quality in commercial spaces, providing a basis for improvements in ASHRAE standards, guidelines, HVAC&R designs and operation practices.

The following ASHRAE committees would be interested in the generated data from this project: 4.1, 5.10, 10.7

Anticipated Funding Level and Duration

Funding Amount Range: $195,000

Duration in Months: 24

References

List the key references cited in this RTAR

ASHRAE 72 Method of Testing Open and Closed Commercial Refrigerators and Freezers
ASTM F2474-17 Standard Test Method for Heat Gain to Space Performance of Commercial Kitchen Ventilation/Appliance Systems
1778 TRP ASHRAE funded research project to quantify moisture and heat generated in a commercial dishroom
ASHRAE Refrigeration Handbook
ASHRAE Handbook