

AMERICAN SOCIETY OF HEATING, REFRIGERATION AND
 AIR-CONDITIONING ENGINEERS, INC.
1791 Tullie Circle, NE / Atlanta, GA 30329
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TC/TG/TRG Minutes Cover Sheet

TC/TG/TRG No. TC 2.8 **Date** June 23, 2013
TC/TG/TRG Title Building's Environmental Impact and Sustainability
Date Of Meeting June 23, 2013 **Location** Hotel Sheraton, Denver, CO

Members Present	Year Apptd	Members Absent	Year Apptd	Ex-Officio Members & Addit'l Attendance
Mr Dunstan L Macauley, III	2011	Dr Raymond Man-Hung Yau, PhD	2009	Jim Crawford
Mr Ashish Rakheja	2011	Dr Malcolm Lewis, PE	2009	NG Yong Kong
Mr J Kevin Cross	2010	Mr David L Grumman, P.E.	2009	Gerald Kettler
Ms Janice K Means, PE	2010	Mrs Diotima A Von Kempfski	2008	Harvey Sachs
Michael P Deru, PhD	2009	Mr John M Swift, Jr	2011	Donald Brundage
Mr E Mitchell Swann, PE	2008	Ms Joy Eileen Altwies	2011	Michael Schmeida
Dr Thomas M Lawrence, PhD	2011	Mr David E Ellis, PE	2011	Samir Traboulsi
Mr William L Stanton Stafford, PE	2011			Mark MacCracken
Mr Thomas E Cappellin, PE	2010			Andy Persity
Dr Paul A Torcellini	2009			Vinay Ananthachar
Mr Francis A Mills	2013			Mina Agarabi
Mr Abdel Kader H Darwich, I	2010			Calina Ferraro
Mr Douglas David Fick	2004			James Sweeney
Mr Kevin R Brown	2011			Andres F Alfonso
Mr. Jaap J Hogeling	2009			Dick LeClaire
Mr David L Grumman, P.E.	2011			Mark Pfeifer
				Locke Hutson

Distribution:

All members of the TC/TG/TRG

TAC Chair	Charles Culp
TAC Section Head	Thomas Sobieski
Special Publications Liaison	John A. Clark
Standards Liaison	Hoy Bohanon
Handbook Liaison	Jeff Traylor
RAC Research Liaison	William McCoy
CTTC Liaison	Jean-Gabriel Joannette
ALI Liaison	John Nix
Staff Liaison (Research)	Michael Vaughn
Staff Liaison (Standards)	Stephanie Reinche

Note: *These draft minutes have not been approved and are not the official, approved record until approved by this committee.*

TC/TG/TRG Minutes Cover Sheet

TC/TG/TRG No. TC 2.8 Date: June 23, 2013

TC/TG/TRG Title: Building's Environmental Impact and Sustainability

Date of Meeting: June 23, 2013 LOCATION: Plaza Ballroom, Hotel Sheraton - Denver, CO

TC/TG/TRG Meeting Schedule				
Location – Past 12 months		Date	Location - planned next 12 months	
San Antonio, TX		Jun 2012	New York	
Dallas, TX		Jan 2013	Seattle	
Denver, CO		Jun 2013		
TC/TG/TRG Subcommittees				
Function			Chair	
International			Ashish Rakheja	
Program			Kevin Brown	
Handbook			Dave Grumman	
Research			Joy Altweis	
Green Guide			Tom Lawrence	
Existing Buildings			Dunstan Macauley	
Research Projects – Current			Monitoring	Report Mode
Project Title	Contractor		Comm. Chm.	At Meeting
Longrange Research Plan				
Rank	Title	W/S Written	Approved	To R & T
Handbook Responsibilities				
Year & Volume	Chapter Title	No.	Deadline	Handbook Subcom. Chair/Liaison
2009 Fundamentals	Energy Resources	34		Brundage / Bansal
2009 Fundamentals	Sustainability	35		Grumman / Bansal
Standards Activities - List and Describe Subjects				
Technical Papers from Sponsored Research - Title, when presented (past 3 yrs. present & planned)				

Appendix – 3
TC/TC/TRG Sponsored Conference Papers - Title, when presented (Past 3 yrs. present & planned)
Appendix – 4
TC/TG/TRG Sponsored Seminars - Title, when presented (Past 3 yrs. present & planned)
Appendix – 5
TC/TG/TRG Sponsored Forums -Title, when presented (Past 3 yrs. present & planned)
Appendix – 6
Journal Publications - Title, when published (past 3 yrs. present & planned)
Lawrence, T.M., J. Perry and P. Dempsey, 2010, "Making Every Drop Count: Retrofitting Condensate Collection on HVAC Air Handling Units", <i>ASHRAE Journal</i> 52(1):48-54.
Lawrence, T.M., and J. Perry. 2010, "The Collection of Cooling Coil Condensate in High-Performance Buildings", <i>High Performance Buildings</i> 3(4):56-61.
Lawrence, T.M., J. Perry and P. Dempsey, 2010, "Predicting Condensate from HVAC Air Handling Units", <i>ASHRAE Transactions</i> 116(2):3-15.
Lawrence, T.M., J. Perry and T. Alsen. 2012, "AHU Condensate Collection Economics", <i>ASHRAE Journal</i> 54(5):12-17.
Mills, F., T.M. Lawrence, A. Rakheja, R.M. Yau and A. Darwiche. 2012 "Green Building Practices Around the World". <i>ASHRAE Journal</i> 54(1):48-55.

ASHRAE TC 2.8 : BUILDING'S ENVIRONMENTAL IMPACT AND SUSTAINABILITY
Summer 2013 Meeting (Denver)

1. **Roll call and Introductions** by John Swift
 - 1.1 Meeting called to Order with Quorum at 5:00
 - 1.2 Roll Call
 - 1.3 Introduction
2. **Accept Agenda/Approve Minutes of Chicago Meeting by John Swift**

Approval of Minutes:

 - 2.1 Motion by Tom Lawrence
 - 2.2 Seconded by Dunstan Macauley
 - 2.3 Minutes approved unanimously with no amendments (16-0-0).
3. **Announcements/Membership/Listserv by John Swift**
 - 3.1 John recognized the visitors present in the meeting : Harvey (Liasion RAC), Andrew Persley (Incoming Chair 189.1),
 - 3.2 Seminar/Forum proposals being accepted for New York and deadline is August 12, 2013.
4. **Update from Section 2 by John Swift**
 - 4.1 TC Training workshop held in the morning.
 - 4.2 Roster has changed starting summer 2013 and information given out by Swift. Dunstan is incoming Chair.
 - 4.3 TAC has developed new summary sheet that TC members can check their eligibility for nominations. The details are available on H&A webpage.
 - 4.4 MTG on Cold Climate Guidelines has been formed chaired by Frank Mills. It is outcome of Cold Climate Conference held in 2012 at Calgary.
 - 4.5 Employment Discipline category added in ASHRAE bio.
 - 4.6 Electronic Participation Beta testing is on and TC 2.8 Denver meeting had members attending thru it.
 - 4.7 New TC activity form is available.
 - 4.8 Next winter meeting is in New York followed by summer meeting at Seattle.
5. **Standards Sub-Committee Report**
 - 5.1 189.3 covers Healthcare and update given by Doug.
 - 5.2 New Standard 189.2 scope & title is currently under consideration.
 - 5.3 SPC 191 (Proposed Standards for Water Efficiency in Buildings, Site & Mechanical Systems) Update by John Swift. Minor change proposed to Purpose & Title. Second public review is targeted for coming Fall.

6. Standing Committee Liaison Report

- 6.1 TAC
 - No Liaison present
 - Tom Sobieski is the Liaison
- 6.2 Special Publications
 - No Liaison Present
- 6.3 RAC
 - No Liaison present
 - David John is the new liaison

7. Program Sub Committee Report by Kevin Brown

- 7.1 TC 2.8 is participating at five programs at Denver.
- 7.2 Several program ideas were developed in the sub-committee meeting and planned for future ASHRAE Conferences.

8. Research Sub-committee Report (Joy Altwies thru GoTo meeting)

- 8.1 RTAR 1627 Project work statement has been evolved. Members are welcome to be on Proposal evaluation sub-committee. RAC will consider it next.

The research topics considered earlier were discussed and the list was pruned based on confirmation in the meeting.
- 8.2 Following research topic ideas evolved in meeting:
 - 8.2.1 Do buildings built to Standard 189.1 perform as expected.
 - 8.2.2 Comparison of LEED Water usage tool with real performance.
 - 8.2.3 Incorporating Societal benefits into financial ROI calculations.
- 8.3 Research ideas were invited from the audience. Swift listed down the requirements for submission of future ideas and also invited them to look at ASHRAE Strategic plan. Dave to also list down these points on website.

9. Handbook Sub Committee Report by Doug

- 9.1 Next update will be in 2017 Handbook.
- 9.2 Interim work is being considered in Energy renewable sources.
- 9.3 Ideas to update on sustainability chapter were invited.
- 9.4 TC 2.5 has proposed chapter on Global climate change.

10. Green Guide Sub Committee Report by Tom Lawrence

- 10.1 The fourth edition is on track for release during Jan 2014 meeting.
- 10.2 Inputs have been received from various members in last six months.
- 10.3 Every Chapter has been extensively redone. New Chapter created on sustainable sites. Environmental Health Committee has re-written Chapter 9 on IAQ.
- 10.4 Vote for forwarding the draft to submission to Special Publications.
Motion moved by Tom, seconded by Dunstan
Motion approved 16-0-0.

11. International Sub Committee by Ashish Rakheja

- 11.1 Informed that Seminars planned in future on following:
- Green building Practices around the world targeted for Chicago meeting.
 - Green building practices in different Climate Types across world.
 - How to make ASHRAE Standard more International (Forum)
- 11.2 Upcoming Conference in Philippines with focus on Developing Economies focusing on Energy efficiency practices. Will be seeking case studies and articles to contribute to ASHRAE Journal/High performance Buildings magazine.
- 11.3 Upcoming Conference in March 2014 at Qatar focusing on “Hot & Dry Climate”. Will be looking at Design guide and articles.

12. Website Sub-Committee Report by Dunstan

- 12.1 The TC website is up to date.
- 12.2 David Ellis will now be taking over and making extensive changes.

13. Existing Buildings Sub Committee Report by Dunstan

Week of July 15 a conference call has been arranged to discuss potential topics.

14. Related Activities Report

- 14.1 LEED (USGBC – ASHRAE Interaction)
- No presence from USGBC. Liasion need to be established.
 - LEED Ver 4 is out for vote currently.
- 14.2 Advanced Energy Design Guides by Paul Torcellini
- Circulation of half million has been hit.
 - Printed version accounts for 10% circulation volume
 - Plans to do two more 50% guides starting Fall.
- 14.3 Building Performance Metric Steering Committee (MTG) by Paul Torcellini
- Update given by Paul.
 - MTG is now disbanded and can be taken off agenda.

- 14.4 Standard 62.1 update given by Abdel.

Database for Analyzing Sustainable and High Performance Buildings by Michael Deru

- Update by Deru.
- Trying demonstration with Commissioning data.

- 14.5 Inter Agency Sustainability Working Group by Kinga Porst

No discussions

- 14.6 Green Globes/GBI (Harvey J. Bryan/Coad)

No discussions

- 14.7 ASHRAE Climate Change Program
 - No discussions
- 14.8 Design towards NZEB Short Course (Frank Mills / Dunstan Macauley)
 - No discussions.
- 14.9 ASHRAE Building Energy Quotient
 - Several cities in US have passed regulations to declare building energy consumption.
- 14.10 MTG on Green Life Cycle Analysis (Tom Lawrence)
 - No discussions
- 14.11 Proposal Standard on Energy Modeling (Glaser)
 - Being done by TC 2.09

15. New Business

- Dunstan proposed interim Conference calls with Sub-committee Chairs prior to meeting in New York

16. Adjourn

- 16.1 Motion by Tom
- 16.2 Seconded by Abdel
- 16.3 Motion passed unanimously (16-0-0).

TC 2.8 Web Site www.tc28.ashraetcs.org

TC 2.8 E-mail List

This list is only for communications related to ASHRAE TC 2.8 Building Environmental Impacts and Sustainability. Do not distribute messages of any commercial nature.

To subscribe or unsubscribe to the list, you can go to the TC 2.8 list web site:
<http://lists.onebuilding.org/listinfo.cg/tc28-l-onebuilding.org>

To send a message to all subscribers to the list, address your message to:

tc28-l@lists.onebuilding.org

Note: ASHRAE does not operate this list. Please do not ask them for help.

ASHRAE Annual Meeting
June 23, 2013
12:45 – 1:45 PM

Attendees:

John Swift	Cannon Design	jswift@cannondesign.com
Tom Lawrence	UGA	lawrence@engr.uga.edu
Kevin Cross	Honeywell International	kevin.cross@honeywell.com
Janice Means	Lawrence Tech. Univ.	jmeans@ltu.edu
Abdel Darwich	Guttman and Blaevoet	adarwiche@gb-eng.com
Tom Cappellin	E.L. Pruitt Co.	tcappellin@msn.com
Dunstan Macauley	TAI	dmacauley@taiengineering.com
Ashish Rakheja	AECOM	ashish.rakheja@aecom.com
Dick LeClaire	SPX Cooling Technologies	dick.LeClaire@spx.com
Dave Grumman	Grumman/Butkas Assoc.	dlgrumman@sbcglobal.net
Sonia Punjabi	DOE	Sonia.punjabi@ee.doe.gov
Ng Yong Kong	NYK Engineering	nyy@nyk.com.my

- The 4th edition is on track for publication in January 2014.
- The document is now ~99% done, with only minor editorial changes and tweaks needed.
- All voting members of TC 2.8 have been invited to the Dropbox folder and have the chance to review the documents during the past few weeks.
- Dave Grumman will handle the assembly of the contributors; Janice and Abdel will need to help solicit.
- Items for clarification from ASHRAE staff include how to get who created the figures from older versions that are carried through, how to handle the Index and Table of Contents (will it be developed “automatically”).
- Will renumber the GreenTips by chapter, such as GreenTip 2-1, etc.
- Will submit to the main TC the vote to approve for publication.

ASHRAE Annual Meeting
June 23, 2013
4:30 PM – 4:50 PM

TC 2.8 - Existing Buildings Subcommittee

- Looking at the operational energy use, we can reduce building emissions by demolishing existing infrastructure and rebuilding a new more efficient facility.
- If we look at the embodied energy of a building and its contribution global warming, retrofitting/reusing an existing infrastructure versus building new facility may result in lower total emissions.
- As part of our task, we need to determine what the deliverable is as we look at the total emissions off buildings. We originally discussed writing a journal article to start the discussion on the topic followed by a forum to discuss.
- The following recommendations were made as examples/resources:
 - The Athena Institute- Living Building Challenge
 - Look at buildings from cradle to grave and how to properly account for the total emissions.
 - New York City Mayor's Office Building Resiliency Task Force Report (see NY USCBC website)
 - Look into the impact IAQ has on human behavior
 - Look at lessons from around the globe
 - Frank Mills will provide examples from the UK
 - Ashish Rakheja will provide examples from India including a study of a building in a highly populated area
 - State of California has 400 million dollars earmarked for existing schools to improve energy efficiency / IAQ?
 -

TC2.8 Research Subcommittee Project Listing
June 23, 2013

Active Research Projects:

Priority	Title	Authors & TCs	Related Documents	Current Status
1	1627 - An Evaluation of the Actual Energy Performance of Small Office and K-12 School Buildings Designed in Accordance with the 30% ASHRAE <i>Advanced Energy Design Guides</i>	Kevin Cross, Mitchell Swann TC 2.8	WS-1627	<p>June 2013: Meeting held with Section 2 RL to determine next steps; needs PES members from TC2.8 before resubmitting to RAC for 8-15 deadline</p> <p><i>May 2013: WS was <u>Returned with Comments</u></i></p> <p><i>March 2013: WS-1627 was submitted to RAC</i></p> <p><i>January 2013: received approval from Section 2 liaison (David John) to proceed to a TC vote on the work statement</i></p> <p><i>June 2012: awaiting response from RAC</i></p> <p><i>May 2012: resubmitted with revisions to MORTS by May deadline, for review at RAC's June meeting</i></p> <p><i>November 2011: received comments from RAC</i></p>

Discussion of current research project status:

1627-WS An Evaluation of the Actual Energy Performance of Small Office and K-12 School Buildings Designed in Accordance with the 30% ASHRAE *Advanced Energy Design Guide*

- We received the WS back from RAC's spring meeting. Its status is Returned with Comments, meaning the RAC needs additional information before approving. The next deadline for resubmission is August 15, 2013.
- We discussed whether the timeline for the next publication of AEDG's makes this research project moot, as the last info we have is 2015 publication. There may not be sufficient time to award and complete the project and provide results for input to the next AEDG's.
- RL2 felt that the project was close to approval at RAC, but that the timing issue is something TC2.8 would have to decide.

List of previous research topic ideas:

Research Topic Idea	Generated by	Update/Status	Next Step
Research to inform future Green Guide content & green tips	David Ellis	No update	Remove from research topic list
Research on methods to improve building performance and reduce design professional risk, including possible subtopics of: <ul style="list-style-type: none"> • Measurement and verification impacts • ESCO effectiveness (both in energy savings and financial goals) 	Mitchell Swann, David Ellis	No update	Mitchell will take a second look
Research to investigate commercial building energy code enforcement effectiveness	Joy Altwies	Initial investigation into existing literature indicates topic is well-addressed; unlikely to proceed	Remove from research topic list
Comparison of embodied energy in design options/equipment	Kevin Cross	No update	Remove from research topic list
What motivates jurisdictions to adopt/not adopt ASHRAE codes (specifically 189.1 and 90.1)?	Joy Altwies	Initial investigation into existing literature indicates topic is well-addressed; unlikely to proceed	Remove from research topic list
Do buildings built to Standard 189.1 perform as expected?	Kevin Cross, Joy Altwies, Tom Lawrence	Kevin Cross and Brent Stephens developed an early stage RTAR (see attached)	On-hold awaiting further efforts by Kevin on WS-1627
Comparison of LEED water use/plumbing calculator tool with real performance (Long term: develop comprehensive water use tool/simulator)	John Swift	No update	John will keep this topic active and pursue further

Incorporating societal benefits into financial ROI calculations (added at main committee meeting)	David Ellis	David has indicated he cannot pursue the project	TC2.8 members indicated a desire to keep this, but needs a champion to develop the idea
---------------------------------------------------------------------------------------------------	-------------	--------------------------------------------------	-----------------------------------------------------------------------------------------

Anyone interested in pursuing research topics (including those who generated ideas above) are asked to provide the following information:

- The topic description/general idea of the research
- The primary objective or question that will be answered by the research (such as “Have AEDG’s improved the performance of buildings?”)
- A few bullets describing how the research might be conducted (what will the winning bidder do? Will they gather data, perform an analysis, etc.?)

For reference: Current ASHRAE Strategic Research Plan Goals. Ideally, research topics should address one of these goals:

1. Maximize the actual operational energy performance of buildings and facilities
2. Progress toward Advanced Energy Design Guide (AEDG) and cost-effective net-zero-energy (NZE) buildings
3. To reduce significantly the energy consumption for HVAC&R, water heating and lighting in existing homes
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
5. Support the development of ASHRAE energy standards and reduce effort required to demonstrate compliance
6. Building Information Modeling (BIM) of energy efficient, high-performing buildings
7. Support development of tools, procedures and methods suitable for designing low energy buildings
8. Facilitate use of natural and low global warming potential (GWP) synthetic refrigerants and seek methods to reduce refrigerant charge
9. Support the development of improved HVAC&R components ranging from residential through commercial to provide improved system efficiency, affordability, reliability and safety
10. Significantly increase the understanding of energy efficiency, environmental quality and the design of buildings in engineering and architectural education
11. Understand influences of HVAC&R on airborne pathogen transmission in public spaces and develop effective control strategies

The full ASHRAE document explaining these goals in detail can be found here:
http://ashrae.org/File%20Library/docLib/Public/20100621_strategicnavigationbrochure.pdf

Unique Tracking Number Assigned by MORTS _____
RESEARCH TOPIC ACCEPTANCE REQUEST (RTAR) FORM
Sponsoring TC/TG/MTG/SSPC/EHC/REF: _____

Title:

An Evaluation of the Actual Energy Performance of Buildings Designed in Accordance with ASHRAE Standard 189.1

Applicability to ASHRAE Research Strategic Plan:

For those RTAR submitted after July 2010, if the RTAR will contribute to any of the goals of the updated ASHRAE Research Strategic Plan 2010-2015 (Navigation for a Sustainable Future), then indicate which goals the topic addresses and how. Projects are not required to contribute directly to the strategic goals, but those that do will likely be given a higher priority for funding when research funds are limited.)

This project will contribute directly to the first goal outlined in the 2010-2015 ASHRAE Research Strategic Plan, "Maximize the actual energy performance of buildings and facilities," by improving alignment between energy standards, energy models, and actual energy consumption. The research goal will also be addressed by documenting actual energy savings and performance impacts for selected energy measures, identifying design, construction, installation and operational factors that influence savings and performance.

Research Classification:

Basic/Applied Research

TC/TG/MTG/SSPC Vote:

(For –Against-Abstentions-Absent-Total)

Reasons for Negative Votes and Abstentions:

(Negative Votes)

(Abstentions)

Estimated Cost:

(Estimate total dollars)

Estimated Duration:

(Months to complete)

RTAR Lead Author

(Name, e-mail address)

Expected Work Statement Lead Author

(Name, e-mail address)

Co-sponsoring TC/TG/MTG/SSPCs and votes:

(List only those committees that have reviewed this RTAR and voted to support it)

Possible Co-funding Organizations:

(List only those organizations (name, contact information) that have reviewed this RTAR and expressed support)

Application of Results:

(Handbook chapters, special publications etc. to be affected by results of this project)

ASHRAE Standard 189.1 Standard for the Design of High-Performance, Green Buildings
90.1?

State-of-the-Art (Background):

(Briefly describe the amount and quality of past research, and quantify existing gaps)

ASHRAE Standard 189.1 was created to address the potentially significant energy and environmental impacts of building design, construction, and operation. Standard 189.1 specifically addresses site sustainability, water use efficiency, energy use efficiency, indoor environmental quality, and the building's impact on the atmosphere, materials, and resources. Of particular importance to this proposed project is to address the actual energy performance in buildings that have been design and constructed to meet Standard 189.1. The need is motivated by recent work that has shown discrepancies in measured versus modeled energy use in buildings built to particular green design standards.

For example, an early report of actual energy use in LEED New Construction (NC) buildings claimed significant energy savings, albeit only when compared to existing commercial buildings across the U.S., which includes a mixture of mostly much older buildings as well as some newer more comparable buildings (Turner and Frankel, 2008). A reanalysis of these same data revealed that although LEED buildings on average used 18-39% less energy per floor area than their conventional counterparts, approximately 1/3 of LEED buildings actually used *more* energy than their conventional counterparts (Newsham et al., 2009). Measured energy performance also had little association with earned energy performance credits. A further reanalysis of the same data later showed that there was actually no statistically significant

difference in either site or source energy use between LEED office buildings and conventional counterparts (Scofield, 2009).

More recently, a survey of energy performance in 25 LEED NC buildings in Arizona found that while, on average, most of the surveyed medium-use buildings performed better than the national average, they performed worse than other buildings located in similar climates (Oates and Sullivan, 2012). The sample also underperformed relative to both design and baseline energy use simulations.

These previous studies highlight a variety of discrepancies in actual building performance when built to green design standards. And although construction to the LEED-NC rating system does not provide a direct comparison to construction to the 189.1 Standard, both utilize ANSI/ASHRAE/IES Standard 90.1 as a basis for energy performance, which raises questions about the actual performance of 189.1 buildings. Therefore, this is a need for ongoing evaluation of the actual energy performance of buildings built to Standard 189.1 in order to accurately inform this continuing maintenance standard.

Advancement to the State-of-the-Art:

(Provide an estimate – as quantitative as possible – of the improvement expected from this research [i.e. x% energy reduction in product y or building type z, x% increase in heat transfer coefficient between y and z, or x% reduction in design time to do y, etc.])

Justification and Value to ASHRAE:

(Identify by number, profession, or industry the ASHRAE members affected. State the likelihood and how the improvement would be adopted by industry. Estimate the timeframe over which x% of society in total would be affected. Indicate the likelihood of ASHRAE's obtaining any intellectual property rights from this project.)

Objectives:

(List the project goals and succinctly state how this project will accomplish its intended advancement to the state-of-the-art [i.e. a computer simulation will be used to do x, a computer simulation will be developed for x and verified using laboratory data from tests y and z, field test data will be obtained from x and used to do y])

The objective of this project is to determine whether buildings designed in accordance with ASHRAE Standard 189.1 actually use the expected/predicted amount of site energy on an annual basis. Results will also for an explanation for why some buildings perform better than expected and why others perform worse.

The successful bidder will:

- Identify a representative sample of buildings designed in accordance with ASHRAE Standard 189.1 (2009 or 2011 versions).
- Gather energy utility data for these buildings and determine energy utilization indices (EUIs) for same, normalized based on standard hours of operation.
- Model similar buildings designed in accordance with ASHRAE Standard 90.1-2007 and determine the corresponding EUIs.
- Compare normalized actual EUIs of building designed in accordance with ASHRAE Standard 189.1 to the modeled EUIs. We would anticipate the former to be 30% to 40% lower than the latter – depending on the version of Standard 189.1 used.
- Survey a subset of the first building sample to understand why some buildings do not meet the energy performance goal, and why some exceed it.

Note that this research topic is similar to Work Statement 1627, which focuses on the 30% Advanced Energy Design Guides for K-12 Schools and Small Office Buildings.

*Need to identify sample sizes

Key References:

Newsham, G.R., Mancini, S., Birt, B.J., 2009. Do LEED-certified buildings save energy? Yes, but.... Energy and Buildings 41, 897–905.
Oates, D., Sullivan, K.T., 2012. Postoccupancy Energy Consumption Survey of Arizona's LEED New Construction Population. Journal of Construction Engineering and Management 138, 742–750.

Scofield, J.H., 2009. Do LEED-certified buildings save energy? Not really.... *Energy and Buildings* 41, 1386–1390.

Turner, C., Frankel, M., 2008. *Energy Performance of LEED® for New Construction Buildings*. New Buildings Institute, Vancouver, WA.

WORK STATEMENT COVER SHEET

Date: **March 14, 2013**

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

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

Title: **An Evaluation of the Actual Energy Performance of Small Office and K-12 School Buildings Designed in Accordance with the 30% ASHRAE Advanced Energy Design Guides**

WS# **1627**
(To be assigned by MORTS - Same as RTAR #)

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

70% Advanced Energy Design Guide for K-12 School Buildings
70% Advanced Energy Design Guide for Small to Medium Office Buildings

Responsible TC/TG: **2.8 Bldg Env Impacts and Sustainability**

Date of Vote: **March 12, 2013**

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

This W/S has been coordinated with TC/TG/SSPC (give vote and date):
AEDG Steering Committee on March 12, 2013

Has RTAR been submitted ? **Yes**
Strategic Plan **Goals 1, 2, and 7**
Theme/Goals

Work Statement Authors:

Kevin Cross
E. Mitchell Swann

Proposal Evaluation Subcommittee:

Chair:
Members:

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

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

Farnsworth Group, Inc., Ian McIntosh, 3175 Satellite Blvd., Bldg. 600, Suite 105, Duluth, GA 30096, e-address: imcintosh@f-w.com, ph. 770-814-9041
Stephen Turner, Inc., Stephen Turner, P.O. Box 2523, Providence RI 02906, e-address: stephen@sturnerinc.com, ph. 401-273-1935
The Energy Center of Wisconsin, Scott Schuetter, 455 Science Drive, Suite 200, Madison, WI 53711, e-address: sschuetter@ecw.org, ph. 608-210-7149
University of Wisconsin Solar Energy Laboratory, Dr. S.A. Klein, 1343 Engineering Research Building, 1500 Engineering Drive, Madison, WI 53706, e-address: klein@engr.wisc.edu, ph. 608-263-5626

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

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

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

Yes	No	How Long (weeks)
X	X	
	X	
X		

* Reasons for negative vote(s) and abstentions

Use additional sheet if needed.

Work Statement #1627

Sponsoring TC: 2.8 Building Environmental Impacts and Sustainability

Co-sponsoring TC/TG/MTG/SSPCs: Advanced Energy Design Guide Steering Committee

Title: An Evaluation of the Actual Energy Performance of Small Office and K-12 School Buildings Designed in Accordance with the 30% ASHRAE Advanced Energy Design Guides

Executive Summary:

An Energy Center of Wisconsin study recently estimated that the use of ASHRAE's *30% Advanced Energy Design Guides* (AEDGs) for K-12 schools and small office buildings has resulted in energy savings of approximately 25% with respect to ASHRAE Standard 90.1-1999. That estimate is based on the number and types of measures implemented, as reported by building designers. This project will quantify energy savings based on actual utility data, and will investigate whether above-average energy performance compromises indoor environmental quality through building surveys. This study will support the development of the 70% AEDG series and guides for achieving cost-effective net-zero-energy buildings.

Applicability to the ASHRAE Research Strategic Plan:

This project will support the following goals outlined in the ASHRAE Research Strategic Plan 2010 – 2015: Navigation for a Sustainable Future:

Goal No. 1: Maximize the actual operational energy performance of buildings and facilities.

By documenting the actual performance of a representative sample of buildings designed in accordance with two AEDGs, we will gain an understanding of how well the real world results measure up to the AEDG goal of achieving 30% less energy consumption than buildings designed to meet ASHRAE Standard 90.1-1999. This project will also investigate success factors for well-performing buildings and why some buildings fall short of the goal. This knowledge will help ASHRAE determine ways to guide building designers and operators toward achieving improved energy performance in future AEDGs.

Goal No. 2: Progress toward Advanced Energy Design Guides (AEDG) and cost-effective net-zero-energy (NZE) buildings.

Documenting the actual energy performance of buildings designed in accordance with two of the first AEDGs, determining critical success factors, and determining why some buildings fall short will help ASHRAE develop future, more aggressive AEDGs that will enable designers and operators to achieve stringent energy performance goals. As stated in the current Research Strategic Plan, the AEDGs are laying the groundwork for achieving cost-effective NZE buildings after 2015.

Goal No. 7: Support development of tools, procedures and methods suitable for designing low-energy buildings.

As stated previously, this research project will support the development of future, more aggressive AEDGs, leading up to guides for achieving cost-effective NZE buildings.

Application of Results:

The results of this project will relate directly to the following two special publications:

1. *30% Advanced Energy Design Guide for K-12 School Buildings*
2. *30% Advanced Energy Design Guide for Small Office Buildings*

The results of this project will relate indirectly to the following two special publications:

1. *50% Advanced Energy Design Guide for K-12 School Buildings*
2. *50% Advanced Energy Design Guide for Small to Medium Office Buildings*

The above four guides have already been published. The results of this project are expected to directly affect and strengthen the content of the following two special publications, which are slated to appear by 2015:

1. *70% Advanced Energy Design Guide for K-12 School Buildings*
2. *70% Advanced Energy Design Guide for Small to Medium Office Buildings*

Additionally, the results of this project will indirectly affect and strengthen the content of 70% AEDGs for other building types.

Results will be disseminated through a technical paper to be submitted for peer review and publication in *ASHRAE Transactions*. Additionally, TC 2.8 intends to sponsor a conference paper session at a national ASHRAE meeting based on the results of this project. The intended benefits of this research are a) more effective use by ASHRAE members and others of the already-published AEDGs, and b) more effectively developed and written 70% AEDGs.

State-of-the-Art (Background):

As a leader in the realm of building energy and sustainability in the built environment, ASHRAE took the initiative to develop the *30% Advanced Energy Design Guide* series for several typical building types that typically don't get the amount of attention in the design phase received by "mega-projects", such as large office buildings and large hospitals. These smaller buildings represent the bulk of the projects built today. These projects are constructed on tight budgets and even tighter schedules. As a result, they often do not get the type of advanced energy modeling that is typical of larger scale or more complex projects. The AEDGs attempt to take some of the findings of analysis programs employed on the mega-projects and scale them to reasonable applications on smaller projects. This is a vital and important contribution.

Practitioners in the industry have come to depend upon ASHRAE for leadership and guidance in the design and selection of building systems and the AEDGs have taken a lead position in the industry. Documenting the effectiveness of those recommendations and determining how to improve them are both important to maintaining that leadership role.

A 2010 report published by the Energy Center of Wisconsin estimated energy use by small offices and K-12 schools designed in accordance with the AEDGs to be 24% and 26% lower, respectively, than would be expected if the buildings had been designed in accordance with ASHRAE Standard 90.1-1999. These estimates were based on the number and type of building improvements adopted by design professionals responding to a survey.

It appears that no research has been conducted to date that attempts to evaluate the effectiveness of the 30% AEDGs based on utility data and building surveys. This project will address that gap.

Advancement to State-of-the-Art:

According to the second goal of the current ASHRAE Research Strategic Plan, the next step in developing AEDGs is a 70% reduction in annual energy consumption relative to Standard 90.1-2007 (or other baseline). Beyond that, ASHRAE intends to work toward developing design guidelines for “cost-effective net-zero-energy buildings.” In order to accomplish these two goals, it is critical for engineers, designers, and contractors to understand how effective earlier efforts to achieve significant reductions in building energy consumption have been, and to derive lessons from those earlier experiences.

Justification and Value to ASHRAE:

As described above, this project is in good alignment with goals #1, 2, and 7 in ASHRAE’s Research Strategic Plan 2010 – 2015. The project will help ASHRAE maintain its leadership position in the effort to help engineers, designers, and contractors build progressively more energy-efficient buildings that deliver acceptable indoor environmental quality.

Objectives

The three objectives of this research project are to:

1. Compare Energy Utilization Indices (EUIs; site energy use per unit area per year), normalized based on standard hours of operation and plug load energy use, for a sampling of small office and K-12 school buildings designed in accordance with the first (30%) ASHRAE AEDGs to the modeled EUIs of small office and K-12 school buildings in the same climate zone that meet the requirements of ASHRAE Standard 90.1-1999.
2. Determine the factors common to relatively well-performing buildings, as well as the factors common to relatively poorly-performing buildings, based on building surveys.
3. Provide recommendations for how future AEDGs for small office and K-12 school buildings could be made more effective in achieving better energy performance than required by ASHRAE Standard 90.1 while providing acceptable indoor environmental quality.

Scope/Technical Approach

In support of Objective 1 described above, the research team will:

1. Determine the number of K-12 and small office buildings that have been constructed in accordance with the applicable 30% AEDG. The Project Monitoring Subcommittee (PMS) will work with the research team to determine how many AEDG recommendations must have been implemented for a building to qualify. The work statement authors recommend starting with the 2010 Energy Center of Wisconsin Study referenced above. The U.S. Green Building Council may also have data on LEED certified buildings designed in accordance with the AEDGs. We believe the number of buildings to be somewhere between approximately 50 and 100. The research team, in consultation with the PMS, shall then select a statistically valid representative sample of that group of buildings. This representative sample will be known as “Study Group 1.”

2. Gather a limited amount of information, including utility data, gross square footages, operating hour data, and plug load data for a period of at least 12 months for the buildings in Study Group 1. It should not be necessary to conduct site visits to gather these data.
3. Determine the “raw” EUIs for each Study Group 1 building by dividing site energy use in BTUs by gross square footage. Then determine the normalized EUI for each building by adjusting the raw EUIs based on the relationship between actual and standard operating hours to be used in energy modeling, and the relationship between actual and standard plug load power densities to be used in energy modeling. The normalization methodology shall be submitted to the PMS for approval in advance.
4. Develop whole building energy models using eQUEST, EnergyPlus, or a similar modeling program for representative small office and K-12 school buildings designed to meet ASHRAE Standard 90.1-1999 requirements located in at least four of the major climate zones defined by the Department of Energy in which Study Group 1 buildings are located. These will be known as the reference building energy models. Given that there are eight major climate zones and two building types, the maximum number of reference building energy models that will need to be developed is sixteen. The actual number of reference building models needed shall be determined in consultation with the PMS.
5. Determine the EUI for each reference building model.
6. Compare the normalized EUIs for Study Group 1 to the reference building EUIs in a table to determine how many buildings meet the AEDG goal of 30% lower energy use than a building designed to meet the requirements of ASHRAE Standard 90.1-1999. This table shall be submitted to the PMS.

In support of Objective 2 described above, the research team will:

1. Select at least five of the buildings with the best energy performance (i.e. those with the lowest normalized EUIs relative to those of the reference building models) and at least five of the buildings with the worst energy performance in Study Group 1 on which to perform building surveys. This set of at least ten buildings will be known as “Study Group 2.” Study Group 2 shall be selected in consultation with the PMS. The work statement authors hope to see a mix of schools and small office buildings in both the best- and worst-performing subgroups.
2. Interview members of the construction team for each Study Group 2 building to determine the contracting method used during the construction process (e.g. design/bid/build, design/build, etc.), and the level of commissioning performed during or immediately after the construction process.
3. Perform ASHRAE Level I energy audits on the Study Group 2 buildings. The Level I audits are intended to provide insights into the success of design strategies employed to reduce energy consumption with respect to buildings designed to meet ASHRAE Standard 90.1-1999 requirements only. These audits should include qualitative evaluations of the impact of O&M procedures and occupant behaviors on building energy performance. ASHRAE Level I energy audits are described in Chapter 36 of the *2011 ASHRAE Handbook* and in *Procedures for Commercial Building Energy Audits* published in 2011 (see “Key References”).
4. Acquire “basic level” performance data in the areas of indoor air quality, thermal comfort, and lighting for the Study Group 2 buildings at the same time the ASHRAE Level 1 energy audits are conducted. Researchers will follow the methodologies outlined in *Performance Measurement Protocols for Commercial Buildings* published in 2010 and the accompanying *Best Practices Guide* published in 2012 (see “Key References”). Site visits will be required for all Study Group 2 buildings.

5. Prepare combined Level I energy audit and indoor environmental quality reports for each Study Group 2 building based on audits. These reports should include information concerning contracting method and commissioning. The audit reports shall be delivered to the PMS.
6. Analyze the combined Level I energy audit and indoor environmental quality reports to determine factors common to relatively well-performing buildings, as well as the factors common to relatively poorly-performing buildings. These factors shall be summarized and delivered to the PMS.

In support of Objective 3 described above, the research team will:

1. Evaluate the factors common to relatively well-performing buildings and the factors common to relatively poorly performing buildings, in order to develop recommendations for how the AEDGs for small office and K-12 school buildings might be made more effective in achieving better energy performance than required by ASHRAE Standard 90.1 while providing acceptable indoor environmental quality. These recommendations shall be summarized and delivered to the PMS.

Deliverables/Where Results Will be Published:

1. Progress and Financial Reports must be sent to the PMS at quarterly intervals, no later than January 1st, April 1st, June 10th, and October 1st of the contract period. Reports may be transmitted electronically or on ASHRAE-approved electronic media.
2. The Principal Investigator shall report in person to TC 2.8 at the annual (summer) and winter meetings, and be prepared to answer any questions regarding the research that may arise.
3. Methodology for determining normalized EUIs for Study Group 1 buildings, as described under Task 3 in support of Objective 1.
4. Table comparing the normalized EUIs for Study Group 1 to the reference building EUIs, as described under Task 6 in support of Objective 1.
5. Audit reports for Study Group 2 buildings, as described under Task 5 in support of Objective 2.
6. Summary report or table of factors common to relatively well-performing buildings, as well as the factors common to relatively poorly-performing buildings, as described under Task 6 in support of Objective 2.
7. List of recommendations for how the AEDGs for small office and K-12 school buildings might be improved, as described under Task 1 in support of Objective 3.
8. A Final Report shall be prepared and submitted to ASHRAE by the end of the contract period covering complete details of all research carried out on the project. The Final Report shall include, at a minimum:
 - a. An executive summary suitable for wide distribution to the industry and to the public
 - b. A table comparing the normalized EUIs for Study Group 1 to the reference building EUIs
 - c. A discussion of what factors contribute to the success of relatively well-performing buildings and what factors contribute to the failure of relatively poorly-performing buildings, based on the data obtained via the Level I energy audits and application of the performance measurement protocols
 - d. Recommendations for how the AEDGs for small office and K-12 school buildings can be made more effective in reducing energy consumption while providing acceptable indoor environmental quality
 - e. An appendix containing:

- i. Actual utility data and other information used to determine normalized EUIs for the buildings in Study Group 1
 - ii. Reference building energy models
 - iii. Audit reports for Study Group 2 buildings
 - f. The Final Report shall be furnished in the following manner:
 - i. Two bound copies
 - ii. One unbound copy, printed on one side only, suitable for reproduction
 - iii. Two copies on ASHRAE-approved digital media; one in PDF format and one in Microsoft Word.
9. One or more papers based on the research project. These shall be submitted 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 Paper(s) for HVAC&R Research or Technical Paper(s) for ASHRAE Transactions. Research papers contain generalized results of long-term archival value, whereas technical papers are appropriate for applied research of shorter-term value. ASHRAE Conference papers are not acceptable as deliverables from ASHRAE research projects. The paper(s) shall conform to the instructions posted in “Manuscript Central” for an ASHRAE Transactions Technical or HVAC&R Research paper. The paper title shall contain the research project number (XXXX-RP) at the end of the title in parentheses, e.g., (XXXX-RP).
 - a. Note: A research or technical paper describing the research project must be submitted after TC 2.8 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.

Level of Effort:

The level of effort is expected to include approximately 160 hours (one full-time month) for the principal investigator and 1,370 hours (eight full-time months) for a research assistant or assistants. The estimated cost is \$170,000, and the project is expected to take one year to complete. Note that these estimates are based on the “worst case scenario” of needing to develop 16 reference building energy models.

Other Information for Bidders:

None.

Proposal Evaluation Criteria and Weighting Factors

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|--------------------------------------------------------------------------------|-----|
| 1. Contractor's understanding of work statement as expressed in proposal | 20% |
| a. Technical issues | |
| b. Logistical issues | |
| 2. Qualifications of personnel included in proposal | 30% |
| a. Principal investigator | |
| b. Research assistant(s)/junior engineer(s) | |
| 3. Institutional or corporate capabilities | 30% |
| a. Performance on prior, similar projects demonstrated via references | |
| b. Administrative support capabilities | |
| 4. Probability that proposed research plan will meet work statement objectives | 20% |
| a. Detailed and logical work plan with major tasks and key milestones | |
| b. All technical and logistical factors considered | |
| c. Reasonableness of project schedule | |

References

ASHRAE. 2012. *Performance Measurement Protocols for Commercial Buildings: Best Practices Guide*

ASHRAE. 2011. 2011 ASHRAE Handbook: Heating, Ventilating, and Air Conditioning Applications, Chapter 36: Energy Use and Management.

ASHRAE. 2010. *Performance Measurement Protocols for Commercial Buildings*.

ASHRAE. 2007. *Advanced Energy Design Guide for K-12 School Buildings Achieving 30% Energy Savings Toward a Net Zero Energy Building*.

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ASHRAE. 2011. *Procedures for Commercial Energy Building Audits*, Second Edition.

ASHRAE. 2000. ANSI/ASHRAE/IESNA Standard 90.1-1999: Energy Standard for Buildings Except Low-Rise Residential Buildings.

Energy Center of Wisconsin, 2010. Evaluation of the Market Impact of the ASHRAE Advanced Energy Design Guides (Final Report).

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