AMERICAN SOCIETY OF HEATING, REFRIGERATION AND AIR-CONDITIONING ENGINEERS, INC.
1791 Tullie Circle, NE / Atlanta, GA 30329
404-636-8400

TC/TG/TRG MINUTES COVER SHEET

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

TC/TG/TRG No. TC 4.7 DATE: December 13, 2001

TC/TG/TRG TITLE: Energy Calculations

DATE OF MEETING: June 26, 2001 LOCATION: Cincinnati

MEMBERS PRESENT	YEAR APPTD	MEMBERS ABSENT	YEAR APPTD	EX-OFFICIO MEMBERS & ADDIT'L ATTENDANCE
Jeff Spitler (CHM)	2000	Bill Bahnfleth (PGM)	1998	
Dru Crawley (VC)	2000	Carol Gardner	1998	
Chip Barnaby (RES)	1999	Moncef Krarti	1999	
Les Norford (SECY)	2000			
Jan Hensen (INTL)	2000			
Klaus Sommer (INTL)	1999			
Ian Beausoleil-Morrison	2000			
Phil Haves	2000			
Joel Neymark	2000			
Agami Reddy	1999			
Vern Smith	2000			
Jim Willson	2000			
Michael Witte	1998			
Craig Wray	2000			
Gren Yuill	2000			

DISTRIBUTION

ALL MEMBERS OF THE TC/TG/TRG

TAC CHAIR	Ed Gut
TAC SECTION HEAD	Byron Jones
SPECIAL PUBLICATIONS LIAISON	Ramon Pons
JOURNAL/INSIGHTS LIAISON	Chad Dorgan
STANDARDS LIAISON	David Knebel
HANDBOOK LIAISON	David Claridge
PROGRAM LIAISON	Emil Friberg
RAC RESEARCH LIAISON	Sheila Hayter
TEGA LIAISON	William Knight
STAFF LIAISON (RESEARCH)	William Seaton
STAFF LIAISON (TECH SERVICES)	Martin Weiland
STAFF LIAISON (STANDARDS)	Claire Ramspeck

ASHRAE TC 4.7 Energy Calculations
CINCINNATI MEETING
ACTION ITEMS

Minutes approved, 11-0-1, chair not voting.

Final report for 1093-RP. Approved 12-0-1, chair not voting.

No-cost extension to March 31, 2002 for 865-RP. Approved 13-0-1, chair not voting.

Work statement 1051-WS. Approved 14-0-0, chair not voting.

Program plan approved 14-0-0, chair not voting.

TC4.7 co-sponsorship of a TC4.1 symposium on European standards for building loads and performance calculation methods. Approved 14-0-0, chair not voting.

ASHRAE co-sponsorship of the Sixth International Conference on System Simulation in Buildings, Liege, Belgium, December, 2002. Approved 14-0-0, chair not voting.

Selection of contractor for 1197-TRP. A contractor was recommended to RAC.

Selection of contractor for 1222-TRP. A contractor was recommended to RAC.

AMERICAN SOCIETY OF HEATING, REFRIGERATION AND AIR-CONDITIONING ENGINEERS, INC.
1791 Tullie Circle, NE / Atlanta, GA 30329
404-636-8400

TC/TG/TRG MINUTES COVER SHEET

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

TC/TG/TRG No. TC 4.7 DATE: December 13, 2001

TC/TG/TRG TITLE: Energy Calculations

DATE OF MEETING: June 26, 2001 LOCATION: Cincinnati

TC/TG/TRG MEETING SCHEDULE

LOCATION - past 12 months	**DATE**	**LOCATION - planned next 12 months**	**DATE**
Atlanta	January 30, 2001	Atlantic City	January 15, 2002
Cincinnati	June 26, 2001	Honolulu	June 22-26, 2002

TC/TG/TRG SUBCOMMITTEES

Function	**Chair**
Simulation and Component Models	Dan Fisher
Applications	Jim Willson
Inverse Methods	Jeff Haberl

RESEARCH PROJECTS – Current		**Monitoring**	**Report Mode**
Project Title	**Contractor**	**Comm.Chm.**	**At Meeting**
Appendix 1			

LONG RANGE RESEARCH PLAN

Rank	Title	W/S Written	Approved	To R & T
	Appendix 2.			

HANDBOOK RESPONSIBILITIES

Year & Volume	Chapter Title	**No.**	Deadline	**Handbook Subcom. Chair/Liaison**
2005 Fundamentals	Energy Estimating Methods	31		Strand/Claridge

STANDARDS ACTIVITIES - List and Describe Subjects

SPC 140P Standard Method of Test for Building Energy Software - Ron Judkoff

TECHNICAL PAPERS from Sponsored Research - Title, when presented (past 3 yrs. present & planned)

none

TC/TC/TRG Sponsored Symposia - Title, when presented (past 3 yrs. present & planned)

Appendix 3

TC/TG/TRG Sponsored Seminars - Title, when presented (past 3 yrs. present & planned)
Appendix 4
TC/TG/TRG Sponsored Forums - Title, when presented (past 3 yrs. present & planned)
Characterizing the Performance of Central Plants for Multi-Building Campuses, Chicago (1/99) Who Needs Moisture Calculations in Building Energy Simulations? What Do You Need?, Toronto (6/98)
JOURNAL PUBLICATIONS - Title, when published (past 3 yrs. present & planned)
none

Additional Attendance

This is a complete listing of attendees at this and the prior three meetings. It includes the voting members of the committee listed on the first page. Email addresses are listed for those who have explicitly authorized their inclusion in the minutes, which are posted on the TC's web site.

Present at TC 4.7 Meeting?					Last Name	First Name	Email
Agree to email on list	Cincinnati June 2001	Atlanta January 2001	Minneapolis June 2000	Dallas February 2000			
				X	Abushakra	Bass	
				X	Addison	Marlin	
X	X	X	X		Anderson	J R	jrhazel@bellsouth.net
			X	X	Bahnfleth	Bill	WPB5@psu.edu
X	X	X	X	X	Barnaby	Chip	CBarnaby@wrightsoft.com
X	X	X	X		Beausoleil-Morrison	Ian	IBeausol@nrcan.gc.ca
		X	X		Black	Al	
			X		Blake	Jeff	
			X		Bowman	Jim	
		X	X	X	Brandemuehl	Mike	
		X			Brau	Jean	
		X	X	X	Buhl	Fred	
			X		Carpenter	J Patrick	
X	X	X		X	Claridge	David	Claridge@esl.tamu.edu
X	X	X	X	X	Crawley	Dru	Drury.Crawley@ee.doe.gov
X	X				Dougherty	Brian	brian.dougherty.nist.gov
			X	X	Degelman	Larry	
		X			Del Porte	Scott	
			X		Dewitte	Jorre	
X	X				Domanski	Piotr	Piotr.domanski@nist.gov
X	X				Dubrous	Francois	fdubrous@nrcan.gc.ca
		X	X	X	Eldridge	David	
X	X		X	X	Fisher	Dan	DFisher@okstate.edu
		X			Garde	Francois	
				X	Gardner	Carol	
		X	X	X	Gu	Lixing	
X	X	X	X	X	Haberl	Jeff	JHaberl@esl.tamu.edu
		X	X		Haddad	Kamel	
				X	Hanby	Victor	
X	X	X	X	X	Haves	Philip	PHaves@lbl.gov
			X		Henderson	Hugh	
X	X	X			Hensen	Jan	JaHe@fago.bwk.tue.nl
				X	Henze	Gregor	
		X			Howell	Jamie	
			X	X	Huang	Joe	

Present at TC 4.7 Meeting?					Last Name	First Name	Email
Agree to email on list	Cincinnati June 2001	Atlanta January 2001	Minneapolis June 2000	Dallas February 2000			
		X			Hydeman	Mark	
				X	Katipamula	Srinivas	
			X		Kelso	Richard	
		X			Kimura	Ken-ichi	
X	X	X			Klaassen	Curtis	curtk@energy.iastate.edu
X	X				Klein	Sandy	klein@engr.wisc.edu
X	X	X		X	Knappmiller	Kevin	KevinK@kevtec.com
	X	X	X	X	Kosny	Jan	
			X		Kossecka	Elisabeth	
			X	X	Krarti	Moncef	
		X		X	Kreider	Jan	
				X	Lamberts	Roberto	
			X	X	Leber	Jon	
				X	Lebrun	Jean	
		X			Liesen	Richard	
X	X				Logee	Terry	terry.logee@ee.doe.gov
				X	Loomans	Marcel	
		X			Lotfi	Nemat	
X	X	X	X	X	McDowell	Tim	Mcdowell@tess-inc.com
					McGowan	Alex	
			X	X	Morner	Svein	
X	X	X		X	Mottillo	Maria	Mmottilo@nrcan.gc.ca
X	X	X	X	X	Neymark	Joel	NeymarkJ@sni.net
X	X				Nichols	Laurier	laurier.nichols@dessausoprin.com
X	X	X	X	X	Norford	Les	lnorford@mit.edu
X	X				Nguyen	Phuong	pnnguyen@pplant.msu.edu
X	X	X	X	X	Pedersen	Curt	
			X		Purdy	Julia	
X	X	X	X	X	Reddy	T. Agami	reddyta@drexel.edu
X	X	X	X	X	Rees	Simon	SJRees@okstate.edu
				X	Rittelmann	Bill	
				X	Rock	Brian	
		X			Scharpf	Dan	
X	X				Schwarz	Walter	wrs@fluent.com
X	X	X	X	X	Smith	Vernon	VSmith@archenergy.com
X	X	X	X	X	Sommer	Klaus	Klaus.Sommer@vt.fh-koeln.de
		X	X	X	Sonderegger	Robert	
			X	X	Sowell	Ed	
X	X	X	X	X	Spitler	Jeffrey	Spitler@okstate.edu
X	X	X	X	X	Strand	Rick	R-Strand@uiuc.edu
X	X	X	X	X	Walton	George	GWalton@nist.gov
X	X	X	X	X	Willson	Jim	jimwill@indy.net

Present at TC 4.7 Meeting?					Last Name	First Name	Email
Agree to email on list	Cincinnati June 2001	Atlanta January 2001	Minneapolis June 2000	Dallas February 2000			
		X			Winkelmann	Fred	FCWinkelmann@lbl.gov
X	X	X		X	Witte	Mike	MJWitte@gard.com
X	X	X	X	X	Wray	Craig	CPWray@lbl.gov
X	X	X			Wright	Jonathan	J.A.Wright@lboro.ac.uk
			X		Wyndham-Wheeler	Paul	
X	X			X	Yuill	Gren	yuill@unomaha.edu
X	X				Zhang	Weiming	wz@gkceme.com

Appendix 1

RESEARCH PROJECTS

TC 4.7 Research Projects Status

Active projects

#	Title	Joint TC	Cognizant Subcommittee/ Contractor	PMSC	Dates / status
865-RP	Accuracy Tests for Mechanical System Simulation		Sim/Comp Penn/TAMU Gren Yuill	George Walton (chair), Ron Judkoff, Robert Sonderegger, Dave Knebel	Rec: 2-20-96 (San Antonio) NCE: 2-28-98 (7-1-97) NCE: 8-31-98 (1-20-98) NCE: 3-31-99 (6-23-98) NCE: 3-31-00 (1-27-99) NCE: 3-31-01 (2-8-00) NCE: 8-31-01 (1-30-01) NCE: 331/02 (6-26-01)
1049-RP	Building System Synthesis and Design	1.5	Sim/Comp Loughborough University Jonathan Wright	Curt Pedersen (chair), Ed Sowell, Dave Knebel, Ron Nelson (TC 1.5), Mike Brandemuehl (TC 4.6), Jan Hensen	WS: 1-20-98 (SF) Rejected all proposals: 6-23-98 (Toronto) Rec: 6-22-99 (Seattle) End: 8-02?
1050-RP	Development of a Toolkit for Calculating Linear, Change-point Linear, and Multiple Linear Inverse Building Energy Analysis Models		Inv U. of Dayton Kelly Kissock	Jan Krieder (chair), Robert Sonderegger, Moncef Krarti, Agami Reddy	WS: 7-1-98 (Boston) Rec: 6-23-98 (Toronto) NCE: 3-31-01 (6-27-00) NCE: 10-1-01 (1-30-00)
1093-RP	Compilation of Diversity Factors and Schedules for Energy and Cooling Load Calculations	4.1	App TAMU (TEES) Jeff Haberl	Agami Reddy (chair), Bill Bahnfleth, Joe Huang, Suzanne LeVisuer (TC 4.1)	WS: 1-20-98 (SF) Start: 2-1-99 NCE: 3-31-2001 (2-8-00) Accept report: 6-26-01
1197-RP	Updated Energy Calculation Models for Residential HVAC Equipment	7.6	Sim/Comp U Colorado Michael Brandemuehl	Chip Barnaby (chair), Craig Wray, Brian Dougherty (TC 7.6)	WS: RAC deferred 3-00 Resubmitted 9-00

Appendix 2

RESEARCH PLAN

Technical Committee 4.7 Energy Calculations
2002-2003 Research Plan
August 1, 2001

TC Priority 2002-2003	Prior TC priority	Society status	TC Status	Title	Subcommittee
0	3 (1998-1999)	No RTAR revised WS to be submitted 9/2001	Revised WS approved 6/2001	Procedures for Reconciling Computer-Calculated Results With Measured Energy Data (1051-WS)	Inverse Methods
0	2 (2001-2002)	RTAR, non-prioritized	WS vote expected 1/2002	Development of Comparative Test Cases for Evaluating Simulation Models of Slab, Crawl Space and Basement Heat Transfer Through Adjacent Ground	Simulation and Component Models
0	3 (2001-2002)	RTAR, non-prioritized		Inverse Bin Procedures for Analyzing Energy Savings	Inverse Methods
1		(new)	Draft WS	Procedures and Data for High-Performance Residential Design	Applications
2		(new)	Draft WS	Development of a Procedure for Base-lining Energy Use at Large Central Plants	Inverse Methods

Appendix 3

TC/TG/TRG SPONSORED SYMPOSIA

PLANNED:

Chicago – January 2003

Integrating Airflow Modeling into Energy Analysis Programs (Chair: Ian Beausoleil-Morrison)

Honolulu – June 2002

Inverse Methods for Calculating Savings from Energy Conservation Retrofits (Chair: Jan Kreider)

Recent Advances in Energy Simulation, Part I (Chair: Ian Beausoleil-Morrison)

Recent Advances in Energy Simulation, Part II (Chair: Jan Hensen)

Atlantic City – January 2002

Applications and Development of Calibrated Models for Chillers and Cooling Towers (TC1.5, 4.6 and 8.6 co-sponsors/Chair: Agami Reddy)

Interoperability and Tool Portability (Chair: Chip Barnaby)

PRESENT:

Cincinnati – June 2001

Better Inputs for Better Outputs (TC9.6 co-sponsor/Chair: Jim Willson)

PAST:

Atlanta – January 2001

Analysis Tools for the Design of Low-Energy Cooling Systems(Chair: Joe Huang)

Minneapolis – June 2000

International Experience with Weather Data for Simulation and Design, Part 1: Simulation, Ventilation and Daylighting (TC 4.2 co-sponsor/Chair: Dru Crawley)

International Experience with Weather Data for Simulation and Design, Part 2: Simulation (TC 4.2 co-sponsor/Chair: Dru Crawley)

Seattle - June 1999

*Applications of Heat and Mass Balance Methods to Energy and Thermal Load Calculations (*Chair: Chip Barnaby)

*Accuracy tests for simulation models (*Chair: Mike Witte)

Chicago - January 1999

*Application of Heat Balance Methods to Energy and Thermal Load Calculation (*Chair: Chip Barnaby)

Toronto - June 1998

Baseline Calculations for Measurement and Verification of Energy and Demand Savings (Chair: Robert Sonderegger)

Appendix 4

TC/TG/TRG SPONSORED SEMINARS

PLANNED:

Atlantic City, June 2001

Commercial Use of Building Energy Simulations (Chair: Kamel Hadad)

Automated Baseline Procedures Using Inverse Methods (Chair: Jeff Haberl)

PRESENT:

Cincinnati, June 2001

A Review of State of the Art in Building Simulation Programs (Chair: Dru Crawley)

PAST:

Atlanta, January 2001

Low-Energy Cooling Case Studies (Chair: Phil Haves)

Dallas - January 2000

ASHRAE's Software Toolkits for Energy Calculations (Chair: Dru Crawley)

Chicago - January 1999

Simulation Tool Interoperability and Component Model Portability (Chair: Phil Haves)

Toronto - June 1998

Neural Nets: What Are They and What Can They Do? (Chair: Moncef Krarti)

ASHRAE TC 4.7 Energy Calculations
Tuesday, June 26, 2001, 6:00-8:30 p.m.
Bronze A Room, Millennium Hotel

1. Roll call and introductions. Chairman Jeff Spitler called the meeting to order at 6:04 p.m. Voting members in attendance were Jeff Spitler, Dru Crawley, Chip Barnaby, Les Norford, Jan Hensen, Ian Beausoleil-Morrison, Phil Haves, Joel Neymark, Agami Reddy, Vern Smith, Klaus Sommer, Jim Willson, Mike Witte, Craig Wray and Gren Yuill. All present introduced themselves.

2. Accept agenda & approve minutes of Atlanta meeting. The agenda for this meeting is shown in Attachment A. Wray moved (Willson second) to approve minutes for the Atlanta meeting. The motion was approved 11-0-1 CNV.

3. Announcements. Jim Wolf, outgoing ASH President, has offered to write thank-you letters to employers of ASHRAE members, to acknowledge time away from the job. ASHRAE has asked TCs to consider distributing seminar presentation material, either via hardcopy at the session or on-line. Sheila Hayter, RAC liaison, stated that she needs updates on four items: contractors for 1197-TRP and 1222-TRP, a resubmittal of 1051-WS or a decision to drop it, and TC.47 review of an unsolicited research proposal, 1148-URP. Hayter, in response to a request from Spitler, will ask Seaton about funds and procedures for high-risk research and will inform research subcommittee chairs and TC chairs.

4. Membership. Spitler announced that Willson is replacing Huang as chair of the Applications Subcommittee, Beausoleil-Morrison will chair the Program Subcommittee, and Neymark the Standards Subcommittee. Witte will roll off.

5. Subcommittee reports.

5.1. Applications Subcommittee. Subcommittee Chair Willson reported on activities of the subcommittee, which met Tuesday, June 26, 2001, 3:30-5:00 p.m. Minutes are found in Attachment B. There was no time to prepare minutes before the full TC meeting but a copy of the agenda was distributed. Emphasis was placed on research products and where efforts should be placed. Smith has headed a group to identify benefits of TC4.7-sponsored research. Willson noted that users are applying our products to make their products better. The TC will look at these secondary effects next. Research and program material will be covered later, in appropriate reports.

1093-RP. Diversity Factors and Schedules for Energy and Loads. Reddy reported on the PMS meeting. In its previous meeting (January 2001) the PMS had concerns about conclusions and asked for more work. The contractor (Texas A&M University) prepared a draft final report in February. The PMS was satisfied, informed Spitler and Seaton and recommends that the TC accept the final report. The contractor is planning four papers. Reddy moved (Barnaby second) that the final report be approved. The motion passed, 12-0-1 CNV.

5.2 Inverse Methods Subcommittee. Subcommittee Chair Haberl reported that the subcommittee met Monday evening, in a session that featured lively discussion and progress. Work statement 1051 was distributed, discussed and voted up to the full TC, with Haberl responsible for addressing comments. A work statement on an inverse bin procedure was felt to be premature and will simmer. The subcommittee discussed a work statement on baselining large central plants, with TC9.1 in favor of co-sponsorship. All have RTARs, forwarded to Barnaby as research chair. Haberl has made little progress on a seminar on automatic baselining procedures using inverse methods. Kreider is scheduled to chair a symposium in Honolulu on inverse methods for calculating retrofit savings. Minutes are shown as Attachment C.

865-RP. Accuracy Tests for Mechanical System Simulation. PMS Chair Walton reported that the PMSC met Monday, June 25, 2001, with the contractors (Texas A&M and University of Nebraska/Omaha). It was good to have Gren Yuill back. Progress has been made, with all systems and all cases to be done end of summer. A draft final report is due by fall. Two issues are a need for a no-cost extension and the use of a mail ballot if the project is

completed before the winter meeting. Witte moved and Neymark seconded a no-cost extension through March 31, 2002. The motion was approved 13-0-1 CNV. Spitler supports a mail ballot.

1050-RP. Development of a Toolkit for Calculating Linear, Change-Point Linear and Multiple-Linear Inverse Building Energy Analysis Models. There is no schedule for completion and no draft final report from the contractor, the University of Dayton, but Spitler understands that project is on cusp of being finished. The current completion date is October 1, 2001. Voting members should expect an email ballot.

1051-WS. Procedures For Reconciling Computer-Calculated Results With Measured Energy Data. Haberl reviewed the work statement, included in Attachment C. Witte moved (Barnaby second) to resubmit WS-1051 as revised. Barnaby stated that the format for work statements is on ASHRAE's web site and that the work statement, if approved, will go to the TC4.7 research liaison (Hayter) for final review before submittal to RAC. Crawley noted typographical errors. Wray asked about how to define measurement uncertainty and how a model can be calibrated without such a definition, and noted that the information for bidders appeared vague. Reddy was not clear aobut the use of calibrated simulations and asked if there is a criterion to determine when a calibration has been completed. He suggested doing a regression with data and calculate the coefficient of variance (CV), then obtain a CV from the calibrated model, both for hourly data. Haberl replied that the thrust of the work is reconciling results with measured data, not calibrating the model. Witte stated that whoever plays will set yardstick and that the work statement concerns quantifying how close one is. The motion passed 14-0-0 CNV.

5.3 Simulation & Component Models Subcommittee. Subcommittee Chair Fisher reported on the subcommittee's activities. The symposium on interoperability will slip to Chicago. Two other symposia , on advances in simulation methods and on integrating airflow modeling into energy analysis programs, are just getting off the ground. Research ideas are discussed in detail in the minutes of the subcommittee meeting, found in Attachment D.

1049-RP Building System Design and Synthesis. PMS Chair Pedersen reported on work by the contractor, Loughborough University, as described more fully in Attachment E. Pedersen stated that the project is in good shape and very close to schedule.

5.4 Research Subcommittee.

Research Subcommittee Chair Barnaby reviewed the new research plan. TC4.7 had three RTARs last year and is allocated two this year, due to funding shortages. RTARs from the past stay on the plan and TC4.7 should be prepared to write work statements for the new ones over the next year. Only two RTARs were put forward and there was no need for a vote to select from a larger list. The new RTARs concern baselining energy use at central power plants and procedures and data for high-performance residential design. The research plan is shown in Attachment F.

TC4.7 was asked to review an unsolicited research proposal (URP) on automated selection of thermal zones for building simulation. Pedersen (chair), Beausoleil-Morrison, Hensen, McDowell, and Pedersen (chair) will serve as a proposal evaluation subcommittee.

Smith reported on the work of the *ad hoc* subcommittee appointed by Spitler to document results of TC4.7-sponsored research. Smith used a Web-based survey and a standard form to assess research over the last five years, which consists of 12 completed research projects and six underway. The survey, six weeks old, attracted 22 respondents, 16 of whom have made use of research results and 12 of whom use the energy-calculation handbook chapter. Research results are used primarily for software development and to a lesser extent for course notes and textbooks. Survey forms are included in Attachment F.

Haberl encouraged educators to provide lists of classes and theses that use TC4.7-sponsored research. Barnaby noted that software has a very long lead time and that his company uses ASHRAE material that predates recent research. He also noted that it may be difficult for potential users to find ASHRAE-developed models.

Haves reported on the progress of the *ad hoc* subcommittee (Barnaby, Haberl, Haves (chair), Spitler, and Wray) tasked with developing a strategic research plan for TC4.7. A draft of the strategy is in Attachment F. The subcommittee has considered three major actions:

1. Ensure that energy calc procedures are complete
2. Integrate energy calculations with other analysis procedures
3. Develop complete analysis procedures, in general involving considerations other than energy

Points 2 and 3 require working with other TCs. Claridge suggested a TG under two TCs, with a finite life. Haves favored a virtual floating group, to avoid difficulties in establishing fixed meeting times.

Spitler saw an opportunity to work with TCs 4.1 and 4.5, specifically on windows (absorbed and transmitted energy, heat balance at inner surface). Barnaby saw a need for a pilot project to develop an appropriate administrative structure for a three-TC project: who would vote when, for what?

Haves stated that the broader aim is a goal-oriented planning process. He proposed to move forward with an inventory of needed energy calculation procedures that are needed, using the Energy Plus punch list. Propose to move fwd on this. Beyond this, there is a need to identify needs at the highest level; these needs are broader than energy calculations because such calculations are not done in isolation.

Haves will establish a time for a 2-3 hour discussion and found that few would be inconvenienced by starting at 1 p.m. on Saturday, January 12, 2002, in Atlantic City. Pedersen will work on establishing a three-way collaboration with TCs 4.1 and 4.5.

5.5 Handbook. Handbook Chair Strand reported that Chapter 31 of the 2001 Handbook of Fundamentals is in final format. In the future, his subcommittee will overlap with Haves' *ad hoc* committee on research and handbook directions for TC4.7. As noted in Attachment G, the subcommittee meeting addressed issues related to an electronic version of the handbook and how to address complaints that the handbook is too scientific and not sufficiently practical.

5.6 Program. Program Chair Beausoleil-Morrison proposed the program for meetings in Atlantic City, Honolulu and Chicago, shown in final form in Attachment H. Barnaby moved (Haves second) that the program for Atlantic City be approved. The motion passed 14-0-0 CNV. Sommers moved (Barnaby second) that TC4.7 co-sponsor a TC4.1 symposium on European standards activities for building loads, energy usage, and performance-calculation methods. The motion passed 14-0-0 CNV. Barnaby, Smith and Sommers volunteered to serve as paper reviewers for this symposium.

5.7 Standards (SPC-140 SMOT). As detailed in Attachment I, Neymark reported that the galleys for ASHRAE Standard 140 are under review and that ANSI approval is expected soon. After publication of the standard, SPC-140 will become SSPC-140, with Judkoff as chair and Neymark as vice-chair. Neymark noted that U.S. Senate Bill 207 includes tax credits for energy efficiency in buildings and could use Standard 140 for software certification.

6. Reports on related activities.

IBPSA. Barnaby reported that the Cincinnati meeting of IBPSA-USA featured a workshop on education and training, including a panel discussion on teaching simulation. Jon Wright spoke at dinner about genetic algorithms for HVAC optimization. Building Simulation '01 will be in Rio de Janeiro, Brazil, August 13-15.

GPC 14P Measurement of Energy and Demand Savings. No report

International Alliance for Interoperability. Crawley reported that 13 software packages are IAI compliant and provided a pointer to a web site: http://www.blis-project.org

TC 4.1 Load Calculations. Spitler noted possibilities for collaboration, including a TC4.1 RTAR on lighting. Walton will be liaison.

TC 4.2 Weather Information. Crawley reported that TC 4.2 approved international weather files for 227 locations in 62 countries outside North America. The files will be available on CD soon.

TC 4.5 Fenestration. Kosny encouraged exchange with TC 4.5.

TC 4.6 Building Operation Dynamics. Haves noted TC 4.6 RTARs on short-term use of building mass and on-site generation.

TC 4.11 Smart Building Systems. Norford reported that TC 4.11 is working on a research road map and has sponsored detailed work on chiller and air-handler fault detection and diagnosis.

TC 9.6 Systems Energy Utilization. Reddy had nothing to report.

GPC 20 XML. Haves reported that the XML Committee is determining its scope and organization, with an emphasis on data and not performance models.

7. Old business. None.

8. New business. Barnaby moved (Hensen second) that ASHRAE co-sponsor the Sixth International Conference on System Simulation in Buildings, to be held in Liege, Belgium in December, 2002. The motion passed, 14-0-0 CNV.

Spitler is considering restructuring the TC and will provide opportunity for input.

Yuill will chair an *ad hoc* committee re education and will recruit members. The goal is a Professional Development Seminar on energy calculations. Spitler asked Yuill to report to the Applications Subcommittee.

Haberl saw a need to recognize members. Smith will work with Haberl to identify ASHRAE awards and award criteria.

Willson will poll members for a time for the Applications Subcommittee that is more suitable than Tuesday, 3:30-5, which conflicts with the TC4.11 meeting.

9. Executive Session.

An executive session, conducted by Acting Chair Crawley, was held for voting members and PES chairs.

1197-TRP: Updated Energy Calculation Models for Residential HVAC Equipment. A contractor will be recommended to RAC.

1222-TRP: Incorporation of Nodal Room Heat Transfer Models into Energy Calculation Procedures. A contractor will be recommended to RAC.

10. Adjourn. The meeting adjourned at 9:00 p.m.

Attachments
A. Agenda
B. Applications Subcommittee
C. Inverse Methods Subcommittee
D. Simulation and Component Models Subcommittee

E. 1049-RP PMS report
F. Research
G. Handbook
H. Program
I. SPC 140

ASHRAE TC 4.7 Energy Calculations

Agenda

Tuesday, June 26, 2001, 6:00-8:30 p.m.
Bronze A Room, Millennium Hotel

1. Roll call and introductions	Norford
2. Accept agenda & approve minutes of Atlanta meeting	Spitler
3. Announcements	Spitler
4. Membership	Spitler
5. Subcommittee reports	
5.1 Applications	Willson
1093-RP Diversity Factors & Schedules for Egy & Loads (TA&M)	Reddy
5.2 Inverse Methods	Haberl
865-RP Accuracy Tests for Mech System Simulation (PSU/TAMU)	Walton
1050-RP Inverse Toolkit (U Dayton)	Kreider
5.3 Simulation & Component Models	Fisher
1049-RP Building System Design Synthesis (Loughborough U.)	Pedersen
5.4 Research	Barnaby
Ad hoc subcommittee: Research Program Success Documentation	Smith
Ad hoc subcommittee: Strategic Research Plan	Haves
5.5 Handbook	Norford/Strand
5.6 Program	Bahnfleth/Beausoleil-Morrison
5.7 Standards (SPC-140 SMOT)	Judkoff/Neymark
6. Reports on related activities	
IBPSA	Barnaby
GPC 14P Measurement of Energy and Demand Savings	Sonderegger
IAI International Alliance for Interoperability	Crawley
TC 4.1 Load Calculations	Spitler
TC 4.2 Weather Information	Crawley
TC 4.5 Fenestration	Pedersen
TC 4.6 Building Operation Dynamics	Brandemuehl
TC 4.11 Smart Building Systems	Norford
TC 9.6 Systems Energy Utilization	Reddy
XML Committee	Haves/Barnaby
7. Old Business	
8. New business	

9. Executive Session Crawley
1197-TRP: Updated Energy Calculation Models for Residential HVAC Equipment
1222-TRP: Incorporation of Nodal Room Heat Transfer Models into Energy Calculation Procedures

10. Adjourn

Web Site and Mailing List

TC 4.7 Web Site: http://www.mae.okstate.edu/tc47/

TC 4.7 E-mail List: This list is to be used only for communications related to TC 4.7. Do not distribute messages of any commercial nature. To subscribe or unsubscribe to the list, you must send an e-mail command to the address:
MAIL-SERVER@GARD.COM
Leave the subject line blank (if your e-mail software requires a subject, you may use a space). To subscribe to the mailing list, the body of the message should include the following:
SUBSCRIBE TC47-L
To unsubscribe from the mailing list, include the following in the body of the message:
UNSUBSCRIBE TC47-L
To see a list of subscribers, include:
LIST TC47-L
For a list of all available commands, include:
HELP
To send a message to all subscribers to the list, address your message to:
TC47-L@GARD.COM
Note: ASHRAE staff are not involved in the operation of these lists. Please do not ask them for help. If you have any questions, please contact: Mike Witte
mjwitte@gard.com 847-698-5685 FAX 847-698-5600

TC 4.7 Subcommittee Meeting Schedule

(excerpted from http://www.ashrae.org -- Search for TC 4.7)

Room assignment codes.
H = Hyatt Regency (number in parenthesis is floor location of meeting room)
CC= Cincinnati Convention Center - All meeting space is on the 2nd floor
M= Millennium (formerly Regal Hotel. Hotel changed names in April)

Meeting Room Locations:
NUMBER TITLE DAY TIME ROOM #
TC 4.7 Energy Calculations (50) (OVH) Tuesday 6:00-8:30p M/Bronze A (2)
TC 4.7 1197 RP Sunday 8-10a CC/239
TC 4.7 1049-RP (10) (OVH) Sunday 10a-12N M/Portico (4)
TC 4.7 1050-RP (10) Sunday 12N-2:00p M/Portico
TC 4.7 1093-RP (5)(OVH) Monday 7:00-8:00a CC/267
TC 4.7 Handbook (10) Monday 5:00-6:00p M/Grand A (2)
TC 4.7 Simulation and Component Models (30) Monday 6:00-7:30p M/Grand A
TC 4.7 (25) Inverse Methods* Monday 7:30-9:00p M/Grand A
TC 4.7 Applications* (15) Tuesday 3:30-5:00p CC/208

* Note: these two subcommittees have swapped meeting times and locations.

TC 4.7 Programs

Sunday, June 24, 2001 8:00 AM - 10:00 AM, Room: 242

Seminar 1 A: A Review of State of the Art in Building Simulation

Wednesday, June 27, 2001 8:00 AM - 10:00 AM Room: 260/261
Symposium CI-01-10: Better Inputs for Better Outputs

TC 4.7 Applications Subcommittee
Cincinnati Meeting Agenda
Tuesday, June 26, 2001, 3:30-5:00p CC/208
Chair: Jim Willson

Introductions (5 minutes)

Review of Agenda (5 minutes)

Role of the Applications Subcommittee (10 minutes)

USER USE OF EXISTING TC 4.7 DEVELOPMENTS (20 Minutes)

I. Survey Findings

A. To Date – First Level Users, Ad Hoc Committee Report

B. Second Level Users (Incorporate into their own programs/products)

1. Who are the second level users ?

2. Who will get input from them?

II. Expanding Use of Existing TC 4.7 Developments

A. Develop list of Intended and other Potential Users

1. Create a list types of users for each Development

2. Expand the listing for each Development to the names of the organizations (institutions, companies, etc.) who comprise the types of users.

DIRECTION FOR NEW DEVELOPMENTS (20 Minutes)

I. **Prospective energy simulation users**

A. Users who write their own computer code

B. Users who do not write their own computer code.

II. **Needs of prospective energy simulation users**

A. Currently not being meet

B. Could be met better

1. ASHRAE assures objectivity

2. ASHRAE involvement can add a high level of credibility

PROGRAMS (15 minutes)

1. Seminar for Atlanta ?

   - Benefits of using Building Energy Simulations
   - So the client wants an energy simulation ..
   - Energy Simulation without fear
   - Avoiding Energy Simulation landmines

2. Condense a Seminar into a 25 minute program available to local ASHRAE chapters?

3. Create a Professional Development Seminar (PDS) on the Use of Building Energy Simulations ?

RESEARCH PROJECTS (5 Minutes)

1. 1093-RP Diversity Factors & Schedules for Energy & Loads (TA&M) – Reddy

OLD AND NEW BUSINESS (10 Minutes)

ADJOURN

TC 4.7 Applications Subcommittee
Cincinnati Meeting Minutes
Tuesday, June 26, 2001 3:30-5:00p CC/208

Attendance List

Name	E-mail
Jim Willson	jimwill@indy.net
Vernon Smith	vsmith@archenergy.com
Chip Barnaby	cbarnaby@wrightsoft.com
Jeff Haberl	jhaberl@tamu.edu
Ian Beausoleil-Morrison	ibeausol@nrcan.gc.ca
Dru Crawley	drury.crawley@ee.doe.gov
Kamel Haddad	khaddad@nrcan.gc.ca
Jan Hensen	j.hensen@tue.nl
Jan Kosny	kyo@ornl.gov
Tim McDowell	mcdowell@tess-inc.com
Maria Mottillo	mmottillo@nrcan.gc.ca
George Walton	gwalton@nist.gov
Kevin Knappmiller	kek@fluent.com
Atila Novoselac	aqn102@psu.edu
Damian Ljungquist	jdlbs_actinc@hushmail.com
Michael Witte	mjwitte@gard.com
Klaus Sommer	klaus.sommer@vt.fh-koeln.de

The meeting was called to order by Willson at 3:30 p.m. After introductions, a sign-up sheet was sent around.

The agenda was reviewed. A question was raised of which RTAR's and work statements stay with Applications. This was answered by Jeff Spitler's June 16, 2001 TC 4.7 Announcements.

Role of the Applications Subcommittee – It was discussed that the intended role of the Applications Subcommittee is to be the "marketing arm" of TC 4.7 As such, Applications will focus on the development of programs to promote and expand the use of the tools and knowledge developed by TC 4.7 Applications will also serve as the "market research arm" of TC 4.7 to more proactively identify the energy calculation and simulation needs of our members. At times the needs of different types of members may be contradictory. If this occurs, the main TC 4.7 committee will be asked to provide direction. Applications will initiate research RTAR's only when the research is needed increase the usage or usability of already existing TC 4.7 tools or knowledge.

User use of Existing TC 4.7 Developments – Survey Findings

At the Main TC 4.7 meeting in Atlanta an Ad Hoc Committee was created to gather data which will show how much usage is occurring of the tools and knowledge which has been created by TC 4.7 research during the last 10 years. This committee is chaired by Vern Smith. Vern presented his findings thus far. They show that about half of the direct usage is accounted for by the two toolkits which were developed (HVAC1 Primary Systems - and HVAC2 Secondary Systems). [Vern's report was also presented at the Main TC 4.7 meeting and a copy of his report can be found in the Main Committee

minutes.]

The ensuing discussion provided the following suggestions:

1. For those who use the TC 4.7 material as part of their classroom instruction, get an estimate of the number of students who take those classes
2. Since this material is often used with DOE-2 and Energy Plus, find out how many DOE-2 and Energy Plus users there are.
3. Post the survey form on the TC 4.7 web page so that is readily available for people to locate and fill out.
4. Check with people on IBIPSA and TC 4.10
5. Look into the connection with SP140

Vern has agreed to continue his Ad Hoc committee activities for another six months. He will particularly be looking the benefits created by the incorporation of TC 4.7 work into other simulation tools and other energy related activity. An effort will also b e made to identify uses that private sector software (Trace, Market Manager, HAP, Wrightsoft)have made of TC 4.7 materials. Jim Willson will look into Trane software, Chip Baranby into Wrightsoft, and Vern with contact Robert Sonderegger regarding Market Manager and other of firms software products.

It was agreed that Applications needs assure that appropriate publicity is given to the results, once the Ad Hoc Committee's study is completed.

Jeff Haberl pointed out that it appears ASHRAE Standard 140 may be referenced as a requirement for US Senate Bill 506. If this occurs, it will be a very significant accomplishment for TC 4.7 and ASHRAE and will certainly necessitate suitable publicity.

Direction for New Developments

The subject of tools for potential users who write their own computer code vs. potential users who do not write their own code was discussed. Dru Crowley pointed that ASHRAE has a problem with it's software licensing. For example, the published copies of HVAC-1 in the bookstore show a license which only allows the purchaser to personally use the software on his/her own computer. However HVAC-1 was developed and designed to be incorporated into other programs, typically simulation programs. Dru explained that ASHRAE's actual licensing practice is to negotiate on a case by case basis, typically coming up with a one time fee for that particular user on that particular software item. These agreements typically also require the user to acknowledge ASHRAE each time they use the software, but this does not seem to be enforced. The ensuing discussion cited Art Hallstrom and Don Colliver as two individuals who have or should be involved in this issue. The chair will contact them.

Programs

Discussion of programs included three areas:

1. Seminars
    a. Atlanta – Kamel Haddad, Commercial Use of Building Energy Simulations

b. Honolulu – Chip Barnaby, Getting started with Building Simulation

2. Program for local chapter meetings

   At the time they are given, the above seminars will be reviewed for the purpose of trying to develop a 25 minute program which could be presented at local ASHRAE chapter meetings.

3. Create a Professional Development Seminar (PDS) on the Use of Building Energy Simulations

   Time did not allow for discussion of this subject at the Applications committee meeting. [However, during the Main TC 4.7 meeting, Gren Yuill volunteered to develop a proposal for such a PDS.]

Research

In accordance with Jeff Spitler's June 16, 2001 TC 4.7 Announcements, Applications has responsibility for one research project and two RTAR/work statements.

Research Projects:

1. 1093-RP Diversity Factors & Schedules for Energy & Loads (TA&M) – Reddy

   In Agami Reddy's absence, Jeff Herbel reported that the project is proceeding well and that Bill Seaton has asked the contractor to look for ways to expand the value to ASHRAE.

RTAR/Work Statements:

1. Methodology to define bounds of variability in building energy use predictions using detailed simulation models and how it can be incorporated into the design process. (Haddad, Wyndham-Wheeler) No further progress.

2. Defining performance factors for primary and secondary equipment simulation inputs for commercial buildings (LeBrun, Nall) Neither co-author in attendance, it is believed that no work has been done since Atlanta

New idea:

From discussions of possible unmet member needs the following RTAR idea with developed:

1. Procedures and Data for High Performance Residential Design (Witte)

Old and New Business

No old business (other than what was on the agenda) was brought up. No new business was brought up.

The meeting was adjourned at 5:04 p.m.

TC 4.7 SUBCOMMITTEE ON INVERSE METHODS

Monday, June 25, 2001 7:30-9:00 pm
ASHRAE meeting: Cincinnati

Chair: Jeff Haberl
Secretary: Mario Medina

MINUTES

AGENDA

1. Introductions (5 minutes)

2. Discussion of the minutes from the Atlanta meeting, January 2001 (5 minutes)

3. Discussion of Work Statements (30 minutes)

- WS 1051 "Procedures for reconciling computer-calculated results with measured energy data" (Haberl/Sonderegger)
- WS "Inverse bin procedures for analyzing energy savings" (Haberl)
- WS "Development of a procedure for baselining energy use at large central plants." (Krarti)

4. Long Range Research Plan (Research Topic Acceptance Request) (30 minutes)

- WS 1051 "Procedures for reconciling computer-calculated results with measured energy data" (Haberl/Sonderegger)
- RTAR "Inverse bin procedures for analyzing energy savings" (Haberl)
- RTAR "Development of a procedure for baselining energy use at large central plants." (Krarti)
- RTAR "Methodology Development to Extend ASHRAE Semi-empirical Chiller Models to include Models for Screw Chillers, Package Air-conditioners, and Heat Pumps." (Reddy)
- RTAR Genetic Methods (Nelson)

5. Program (10 minutes)

- January 2002 meeting (Atlantic City)…Due in August
  SEMINAR "Automated baseline procedures using inverse methods" (Haberl)
- June 2002 meeting (Honolulu)…Due in August
  SYM "Inverse methods for calculating savings from energy conservation retrofits" (Kreider)
  PAPER "RP1050 Inverse methods" (Kissock et al.)
  PAPER "SMTP Method" (Abushakra)
  PAPER "Neural Network Savings Calculation Method" (Krarti)
- January 2003 meeting (Chicago)
- June 2003 meeting (Kansas City)

6. Old Business (5 minutes)

7. New Business (5 minutes)

8. Adjourn

ATTENDANCE

NAME	AFFILIATION	EMAIL
Jeff Haberl	Texas A&M	Jhaberl@tamu.edu
Vern Smith	AEC	Vsmith@archenergy.com
Kamel Haddad	NRC Canada	Khaddad@nrcan.gc.ca
Mario Medina	Univ. of Kansas	Mmedina@ku.edu
Brent Griffith	MIT	Griffith@mit.edu
Jan Kosny	ORNL	Kyo@ornl.gov
Michael Witte	GARD Analytics	Mjwitte@gard.com
Les Norford	MIT	Lnorford@mit.edu
Jeff Spitler	OSU	Spitler@okstate.edu
Damian Ljungquist	N.R.C. Canada	Jdlbs.actinc@hushmail.com
Weiming Zhang	GKX/EME Engineers	Wz@gkzeme.com

The meeting was called to order at 7:50 p.m. by Haberl, followed by introductions.

Haberl reviewed the agenda and the minutes from the January meeting.

MOTION: To approve the minutes by Witte, seconded by Smith, approved.

Smith then discussed the ASHRAE Research Project Database and circulated forms for the Inverse Subcommittee members to fill in and bring to the TC 4.7 main meeting.

Haberl then began the discussion of the work statements, beginning with a discussion of 1051WS "Procedures for reconciling computer-calculated results with measured energy data" (Haberl/Sonderegger). Copies of the WS were handed out to the subcommittee and Haberl asked the members to take a minute and review the WS.

Haberl then reviewed the status of 1051WS for the members.

There was some discussion about the current version, which centered around the fact that it was leaning too much toward Energy Service Companies. Haberl reviewed the history of the WS and reminded the members that this WS had most recently been edited by Robert Sonderegger who specifically added this language to make it more relevant to Energy Service Companies that were ASHRAE members.

Norford mentioned that the WS needed to move forward to the main TC 4.7 for a vote and then onto RAC. He suggested including a cover letter that detailed the chronology of the changes, authorship, etc.

ACTION: Haberl agreed to do this.

MOTION: To approve the 1051 WS with minor modifications and bring it to the TC 4.7 Main Committee meeting for a vote by Smith, seconded by Norford. Approved.

Discussion then moved on to the WS entitled "Inverse bin procedures for analyzing energy savings" (Haberl). Members were first given time to read the WS.

Haberl reminded the subcommittee about the history of this WS and reviewed the discussion at the Atlanta meeting. Haberl was asked to modify the WS to make it more clear that the procedure would only be usable on hourly data, and that it is an enchancement to the 1050RP toolkit. Haberl reported that these modifications had been made.

Kosny asked why the $75,000 cost when the project seems to be more complex that the 1050RP project? Haberl responded that he felt that this project was more focused on a specific topic and could save costs by modifying the 1050RP code, and thereby avoiding coding costs for input and output routines, etc.

Norford mentioned that this proposal seemed too self-serving, since only one person on the subcommittee really understood what this was about and therefore this limited the number of possible bidders on the RFP.

Spitler commented that the references cited in the current proposal are limited to a PhD thesis and two papers in the Hot and Humid conference. He suggested that ASHRAE may not be ready for the proposed "inverse bin method" until there exists a series of ASHRAE papers that can be reviewed and published to make members more aware of the methodology.

Spitler further recommended that the WS was proposing improvements to 1050RP. However, 1050RP was yet complete, and therefore, it might be better to keep this WS in subcommittee and wait until 1050RP has been finished and a substantial ASHRAE paper has been written and presented that will encourage ASHRAE interest and support for funding such a project.

ACTION: Haberl agreed to table this WS until 1050RP is completed and a substantial ASHRAE paper can be written that fully describes the procedure.

Discussion then proceeded to the WS "Development of a procedure for baselining energy use at a large central plant" (Krarti).

Haberl provided the subcommittee with a background discussion of this proposal. Haberl mentioned that Krarti was the primary author of this proposal but that he had not attended the last two ASHRAE Subcommittee meetings to discuss his proposal, and therefore Haberl was looking for someone else to help Krarti with this WS. Haberl mentioned that he had attended TC 9.1 and that they were very interested in this WS.

No volunteers were available.

Norford suggested that the WS needed to strengthen the discussion on baseline procedures

Spitler suggested that the WS needed more information about available "baseline procedures", for example, why can or can't 1050RP be used for this.

ACTION: Haberl agreed to contact Krarti to see if he was still interested in authoring this WS and coming to the TC 4.7 Inverse Subcommittee meetings to discuss the WS.

Discussion then moved on to the prioritization of the RTARs.

After some discussion, the subcommittee agreed to the following RTAR priority to go forward to TC 4.7:

RTAR #1: "Procedure for reconciling computer calculated results with measured energy data" (Haberl).

RTAR #2: "Development of a procedure for baselining energy use at a large central plant" (Krarti).

RTAR #3: "Genetic Methods" (Nelson).

RTAR #4 "Inverse bin procedures for analyzing energy savings" (Haberl).

Copies of the RTARs are attached to the minutes:

Discussion then moved on to program. Haberl reviewed the following program items for TC 4.7 Inverse Methods:

January 2002 meeting (Atlantic City)…Due in August
SEMINAR "Automated baseline procedures using inverse methods" (Haberl)

Limited progress had been made on this Seminar. Haberl had contacted several people that had expressed interest in this at the January meeting with no success. Haberl recommended moving this back a meeting or two.

June 2002 meeting (Honolulu)…Due in August
SYM "Inverse methods for calculating savings from energy conservation retrofits" (Kreider)
PAPER "RP1050 Inverse methods" (Kissock et al.)
PAPER "SMTP Method" (Abushakra)
PAPER "Neural Network Savings Calculation Method" (Krarti)

Haberl reported that Kreider was handling this Symposium, and that he had contacted Kreider about this and that it was supposed to be on track with papers due 9/1/2001.

January 2003 meeting (Chicago) No program planned.

June 2003 meeting (Kansas City) No program planned.

Old business – no old business

New business – Spitler mentioned that Inverse Subcommittee is still a TC 4.7 Subcommittee until further notice.

Meeting adjourned.

RESEARCH TOPIC ACCEPTANCE REQUEST (RTAR)
TC 4.7 Energy Calculations

Title:	**Procedures for Reconciling Computer-Calculated Results with Measured Energy Data (1051-WS)**
Research Category:	Design and O&M Tools
Research Classification:	Basic and Applied
TC/TC Priority:	3 (1998/1999) (pre-RTAR work statement)
Estimated Cost:	$95,000
Other Interested TC/TGs:	Guideline 14P
Possible Co-funding Organizations:	
Handbook Chapters to be Affected By Results of this Project:	Fundamentals, Chapter 31

Background/State-of-the-Art:

U.S. businesses and institutions spend an estimated $175 billion per year for energy. Of that, the fraction under performance contracts and energy service agreements is currently growing, aided by cheaper monitoring technology and integration with EMCS systems. Energy simulation programs are used both for estimating potential savings as well as to help verify savings from retrofits actually installed. The potential accuracy afforded by today's energy simulation programs is high. Yet the reliability of the results is frequently compromised by a lack of certainty that the simulations reflect actual conditions. While it is easy to match simulation results with utility bills, it is considerably harder to match daily or even hourly data. There is little systematic guidance available to the practitioner, neither qualitative nor quantitative.

Comparing simulation program results to measured data has always been recognized as an important factor in substantiating how well the simulation model represents a real building. Reconciling simulation results to measured monthly utility data has been the preferred method. Most of these methods rely on simple comparisons including bar charts, monthly percent difference time-series graphs, and monthly x-y scatter plots. Yet monthly comparisons fall short of the level of comparison that is needed when the simulation is used to evaluate changes that amount to less than 10 to 20% of a building's total energy use.

More recent efforts compare hourly simulations to hourly measured data. Unfortunately, at hourly levels of comparison, many of the traditional statistical and graphical comparison techniques become overwhelmed with too many data points. A few proposed advanced methods include carpet plots, comparative 3-D time-series plots, and weather day type analysis to characterize the observed discrepancies. How-to manuals have been compiled and methods developed to simplify this task.

It is time to cull the best from the existing body of research and develop a coherent methodology for the practicing energy engineers. To help the practitioner substantiate computer simulations of energy savings, ASHRAE seeks to develop a well-documented toolkit of procedures to help the practitioner successfully reconcile computer simulations to measured data from actual buildings.

Recently, ASHRAE has developed Guideline 14P *Measurement of Energy and Demand Savings* for determining the appropriate methods for analyzing energy savings from energy conservation retrofits. Guideline 14P has defined how energy savings are to be measured and characterized, one of which is calibrated simulation. Because of its broader scope, Guideline 14P defines *uncertainty* in estimating savings as the standard of comparison between different energy savings calculations. Simple formulas are proposed, anchored in basic statistics, to quantify such uncertainty. Discrepancy between measured data and simulation results therefore has a direct bearing on uncertainty. The greater the discrepancy, the more uncertain are the savings predictions of the simulation, however accurate and

detailed. Unfortunately, although Guideline 14P provides procedures for using calibrated simulation, it does not provide a methodology to calibrate a simulation to measured conditions.

Justification and Need/Advancement to State-of-the-Art:

To date, no consensus guidelines have been published on how to assess the comparison of the results from a building energy simulation program against measured data from an actual building. Historically, actual comparisons have been an art form that inevitably relies on user knowledge, past experience, statistical expertise, engineering judgment, and an abundance of trial and error.

One major problem with reporting simulation accuracy rests with the calculation procedures, which have been reported in the previous work. Typically, when a model is established as being calibrated (i.e., the user states that the "accuracy" for electricity is approximately "5% per month"), the author does not reveal the techniques used other than stating that the final result is "calibrated" or "validated". Hourly or daily error values are seldom reported. Even in cases when error estimates are presented, the methods and equations used to obtain the comparisons are not. Therefore, because the manifest lack of uniformity and abundance of confusion in calibrating simulations to actual data, Guideline 14p identified as an important task the development of consensus procedures for comparing the results of computer simulations to measured data.

Hence, the purpose of this research is to bring order and clarity to the intersection of simulation and measurement, and at the same time assist the practitioner in reconciling energy calculations to measured data in the most expedient way. Accordingly, there are two thrusts to be emphasized:

1) To define discrepancy between simulation results and measured data, and to relate it to the definition of uncertainty of energy savings estimation in ASHRAE Guideline 14p; this effort should include the development of the most suitable presentation formats to characterize discrepancy with hourly, daily and monthly formats;

2) To develop a set of procedures, and a method for applying them, for the purpose of diagnosing and resolving such discrepancies in the most expedient and cogent manner; this part aims at systematizing and transferring expert energy modeler's know-how to the realm of the practitioner.

The procedures outlined in this work statement will result in an ASHRAE publication that can be widely distributed to ASHRAE members. ASHRAE has already developed and is distributing software toolkits that contain computer-modeling routines of primary (HVAC01) and secondary (HVAC02) systems. Therefore, the final result of this work is intended to be a guide, complete with algorithms, presentation formats, and quantitative references, of how to reconcile the results of simulation programs developed with such toolkits with actual data.

The project will benefit the following:

1. ASHRAE to buttress the credibility of the use of calibrated simulation codes based on ASHRAE methods by the energy engineering community.
2. Software code developers and users to assess how well calibrated computer simulations fit measured data from actual buildings.
3. ASHRAE members as a guide for more effective use of available computer simulation codes in their day-to-day practice.
4. ASHRAE Guideline 14p to strengthen its calibrated simulation approach by providing specific procedures for calibrating a computer simulation to measured conditions.
5. Performance contractors and energy service companies with a consensus calibration method to using calibrated simulations to measure savings from performance contracts.

Objective:

The objective of this work statement is to develop procedures and how-to-instructions to characterize and minimize the discrepancy between the results of building energy simulation programs and measured energy data.

RESEARCH TOPIC ACCEPTANCE REQUEST (RTAR)

Title:

Development of a Procedure for Baselining Energy Use at Large Central Plants

TC/TC:

TC 4.7 Energy Calculations

Research Category:

O&M Tools

Estimated Cost:

Basic and Applied

Background/State-of-theArt:

The commercial sector accounts for approximately 15% of the total US energy consumption. Half of the commercial sector energy use is attributed to multi-building facilities. Several of these multi-building facilities are served by large central plants that produce energy forms directly used in the buildings (such as steam, hot water, chilled water, and electricity) from primary fuel sources (including natural gas, fuel oil, and potable water). Colleges and universities are examples of multi-building facilities with a central plant. It is estimated that 83% of college and university floor-space is located in a multi-facility served by a central plant.

The potential to reduce energy use in multi-building facilities is significant. For instance, energy conservation programs sponsored by some state universities have been able to achieve 30% reduction in energy consumption. If this reduction is extrapolated to all the us college and university facilities, it would provide about $1.3 billion in reduced energy bills or about 10% of total budget of us department of education allocated to post-secondary education.

One important element that ensures the effectiveness and the success of energy conservation programs is a procedure to assess and quantify the energy and/or cost savings attributed to implemented retrofit measures. Recently, several procedures and guidelines for measuring and verifying energy savings for individual buildings have been developed. Among the methods proposed for the measurement of energy savings are those proposed by ASHRAE Guideline 14P, the National Association of Energy Service Companies (NAESCO), the Federal Energy management Program (FEMP), the American Society of Heating Refrigeration and Air Conditioning Engineers (ASHRAE), the Texas LoanSTAR program, and the North American Energy Measurement and Verification Protocol (NEMVP) sponsored by DOE and later updated and renamed the International Performance Measurement and Verification Protocol (IPMVP).

However, none of the existing base-lining procedures are applicable to large central plants serving multiple buildings. One of the main features of large central plants is that they include the relatively complex energy interaction between several equipment used central plants such as boilers, chillers, turbines, pumps, and heat exchangers. In a typical central plant, primary fuel sources (such as natural gas, fuel oil, potable water, and purchased electricity) are used by a utility plant to produce various energy demands (such as steam, hot water, chilled water, and generated electricity) supplied to the buildings. The conversion of the primary fuels to energy demands is accomplished through numerous energy conversion processes performed within the utility plant. Any base-lining procedure for central plants should be capable to account for the various thermal interactions between the

multiple equipment commonly used in the plant.

Justification and Need/Advancement to State-of-the-Art:

In order to improve the energy performance of large central plants, a simplified base-lining procedure is needed to measure the energy savings from retrofits of multi-building facilities. This procedure should have the ability to identify various system effects such as those due to equipment replacement, operational strategies change, weather variation, addition or subtraction of building stock, or equipment degradation. The base-lining procedure would facilitate the comparison of energy savings retrofits between multi-building facilities.

It is expected that the development of an accepted procedure for base-lining energy use at large central plants will complement and widen the applicability of the existing guidelines and standards for measuring savings from energy retrofits in commercial buildings including multi-building facilities (such as ASHRAE 14 GPC-14P and IPMVP). The procedures outlined in this work statement will result in an ASHRAE publication that can be widely distributed to ASHRAE members. ASHRAE has already developed and is distributing software toolkits that contain computer-modeling routines of primary (HVAC01) and secondary (HVAC02) systems. Therefore, the final result of this work is intended to be a guide, complete with algorithms, presentation formats, and quantitative references, of how to reconcile the results of simulation programs developed with such toolkits with actual data.

The project will benefit the following:

6. ASHRAE to buttress the credibility of the use of baseline procedures based on ASHRAE methods by the energy engineering community.
7. Software code developers and users to develop standard baseline procedures fit measured data from actual buildings.
8. ASHRAE members as a guide for more effective baseline procedures for use in their day-to-day practice.
9. ASHRAE Guideline 14p to strengthen its use in large central plants.
10. Performance contractors and energy service companies with a consensus calibration method for baselining large central plants.

Objective:

The main objective of this research project is to develop and document a procedure to baseline energy use at large central plants that serve multiple buildings. The procedure would account for different plant component efficiencies, operational strategies, variable weather conditions, and addition or elimination of building stock and/or plant equipment. As an application, the developed procedure would be demonstrated to measure savings from retrofits to equipment in the central plant for a multi-building facility.

Contributors:

Jeff Haberl
Moncef Krarti

RESEARCH TOPIC ACCEPTANCE REQUEST (RTAR)

Title: Use of Evolutionary Computation for Inverse Problems

TC/TC: TC 4.7

Research Category: High Risk, Innovative and Emerging Technologies

Estimated Cost: $150,000

Background/State-of-theArt: Evolutionary Computation (EC) methods excel at inverse problem solving. These methods use the principals of biological evolution to evolve good solutions to problems. EC methods work by first producing a random population of potential forward solutions to the problem. These solutions are evaluated and given a "fitness" according to their ability to solve the problem. The most-fit solutions are kept and used, in combinations with genetic operators, to produce new solutions that replace the less-fit solutions to the problem. By continuing this process, the fitness of the solutions increases and, eventually, a good solution is obtained. The genetic operators are usually mutation of individual solutions and/or crossover of the parts of two more-fit solutions. The solutions to the problems can be represented in various ways, including mixtures of logic variables, integers, real numbers, and/or symbolic programs. The various EC methods include Genetic Algorithms, Evolutionary Strategies, and Genetic Programming. These methods can explore large and complicated search spaces to find good solutions.

Genetic Algorithms are often used to solve integer parameter identification problems and Evolutionary Strategies are used to solve real number parameter problems. Genetic Programming (GP) is the most versatile of the methods for obtaining solutions to inverse problems because it evolves programs that take the input for the problem and produce the desired output (similar to the way artificial neural networks (ANNs) can be used to solve problems). GP is more flexible than ANNs because the programs it evolves can use any programming variables and statements that can be executed on a computer. GP only requires knowledge of the problem to be solved (inputs and outputs) and the variables and statements that it can use. It requires no preconceived knowledge of what the program that obtains the solution should look like. In obtaining the best solution, the potential solution programs are all executed in the forward direction. But, since the solutions are based on the best match between the output and the input, inverse problems are solved as easily as forward problems. The cost is that a large number of candidate solutions must be evaluated. The EC process guides the solutions so that the number of evaluations is orders of magnitude less than random guessing at the solution. This process is similar to finding an optimum solution to a problem, except that for GP, the solution space is all possible programs (up to the maximum length determined by the computer and available memory).

Justification and Need/Advancement to State-of-the-Art: Evolutionary Computation (EC) methods have been shown to be superior at solving complex inverse problems that cannot be solved by other methods. These methods can explore large and complicated search spaces to find good solutions. GP is more flexible than ANNs because the programs it evolves can use any programming variables and statements that can be executed on a computer. GP only requires knowledge of the problem to be solved (inputs and outputs) and the variables and statements that it can use. It is therefore necessary for ASHRAE to explore the use of EC methods to provide ASHRAE members with advanced tools for large-scale inverse problems that are expected in the near future.

Objective: The work for this project would demonstrate the use of three EC methods to solve a variety of inverse problems. Genetic Algorithms could be used to solve integer parameter identification problems, Evolutionary Strategies could be used to solve real number parameter problems, and GP could be used to solve problems where ANNs would typically be used.

Contributors: Ron Nelson

RESEARCH TOPIC ACCEPTANCE REQUEST (RTAR)

Title: Inverse Bin Procedures for Analyzing Energy Savings

TC/TC: TC 4.7

Research Category: Design, Commissioning & O&M Tools

Estimated Cost: $75,000

Background/State-of-theArt: ASHRAE has funded the development of 1050RP "Toolkit for linear, change-point linear & multiple-linear inverse models", and 1093RP "Compilation of diversity factors for energy load calculations" which are intended to produce a toolkit of inverse models that can be used to calculate energy baselines (1050RP) and diversity factor calculation procedures (1093RP) to assist building energy simulations. In addition to the work of 1050RP, ASHRAE research project 1093RP "Compilation of Diversity Factors and Schedules for Energy and Cooling Load Calculations" has identified the most appropriate methods for calculating diversity profiles that describe the 24-hour weekday-weekend profiles of lighting, receptacle and/or occupancy loads for input into computer simulation programs. In addition to the work of 1050RP and 1093RP, an inverse bin method has been developed that has been demonstrated to be as accurate as the most accurate hourly neural network models that dominated the ASHRAE Predictor Shootout I and II. This is an enhancement to the linear and change-point linear models shown in Figure 1 because the inverse bin method has the ability to capture more than two "bends" or points of change in the slope of the regression line through the use of "bins" which correspond to the traditional 5 F (or 2.8 C) ASHRAE bin intervals. Humidity sub-binning and/or a time-lagged analysis can also be applied as appropriate to capture a building's sensitivity to humidity and/or thermal mass effects. Therefore, this WS is intended to expand the capability of the previous projects 1050RP and 1093RP by developing public domain computer code that would be compatible with FORTRAN 90 source code developed for 1050RP that is capable of performing inverse temperature-humidity-lagged binning for weather-dependent loads.

Justification and Need/Advancement to State-of-the-Art: At the current time ASHRAE does not have a well-documented toolkit of inverse bin method calculations and the appropriate uncertainty calculations. Although procedures are being developed for multivariate, linear, change-point linear and variable-based degree day calculations (ASHRAE 1050RP), and for diversity factors for energy calculations (1093RP), no toolkit exists that contains specific computer code for empirically analyzing the weather-dependent, hourly energy use from most buildings using the inverse bin method. It is therefore necessary to document the existing algorithms for calculating inverse bin method models weather dependent loads, and develop a toolkit of computerized inverse bin method procedures that can be used by ASHRAE members to analyze energy use in existing buildings. Development of the appropriate uncertainty analysis for these methods is also needed

Objective: The objective of this research is to develop and document procedures that will analyze interval hourly, weather-dependent data from HVAC system energy use and ambient conditions using the inverse bin method. This method would operate on hourly data (i.e., columnar ASCII data) from on-site measurements of energy use and ambient conditions, and would calculate a bin model that captures weather dependent loads. The deliverable from this project is intended to be a modification to ASHRAE's 1050RP Inverse Method Toolkit (i.e., FORTRAN 90 software source code) for calculating linear, change-point linear and multi-linear regression models.

Contributors:

Jeff Haberl

WORK STATEMENT
TC 47 Energy Calculations

Title:	**Procedures for reconciling computer-calculated results with measured energy data (1051-WS).**
Research Category:	Design and O&M Tools
Research Classification:	Basic and Applied
TC/TG Priority:	3 (1998/1999) (Pre-RTAR work statement)
Estimated Cost:	$95,000
Other Interested TC/TGs:	Guideline 14P
Possible Co-funding Organizations:	
Handbook Chapters to be Affected By Results of This Project:	Fundamentals, Chapter 31

Background/State-Of-The-Art:

U.S. businesses and institutions spend an estimated $175 billion per year for energy. Of that, the fraction under performance contracts and energy service agreements is currently growing, aided by cheaper monitoring technology and integration with EMCS systems. Energy simulation programs are used both for estimating potential savings as well as to help verify savings from retrofits actually installed. The potential accuracy afforded by today's energy simulation programs is high. Yet the reliability of the results is frequently compromised by a lack of certainty that the simulations reflect actual conditions. While it is easy to match simulation results with utility bills, it is considerably harder to match daily or even hourly data. There is little systematic guidance available to the practitioner, neither qualitative nor quantitative.

Comparing simulation program results to measured data has always been recognized as an important factor in substantiating how well the simulation model represents a real building. Reconciling simulation results to measured monthly utility data has been the preferred method. Most of these methods rely on simple comparisons including bar charts, monthly percent difference time-series graphs, and monthly x-y scatter plots. Yet monthly comparisons fall short of the level of comparison that is needed when the simulation is used to evaluate changes that amount to less than 10 to 20% of a building's total energy use.

More recent efforts compare hourly simulations to hourly measured data. Unfortunately, at hourly levels of comparison, many of the traditional statistical and graphical comparison techniques become overwhelmed with too many data points. A few proposed advanced methods include carpet plots, comparative 3-D time-series plots, and weather day-type analysis to characterize the observed discrepancies. How-to manuals have been compiled and methods developed to simplify this task.

It is time to cull the best from the existing body of research and develop a coherent methodology for the practicing energy engineers. To help the practitioner substantiate computer simulations of energy savings, ASHRAE seeks to develop a well-documented toolkit of procedures to help the practitioner successfully reconcile computer simulations to measured data from actual buildings.

Recently, ASHRAE has developed Guideline 14P *Measurement of Energy and Demand Savings* for determining the appropriate methods for analyzing energy savings from energy conservation retrofits. Guideline 14P has defined how energy savings are to be measured and characterized, one of which is calibrated simulation. Because of its broader scope, Guideline 14P defines *uncertainty* in estimating savings as the standard of comparison between different energy savings calculations. Simple formulas are proposed, anchored in basic statistics, to quantify such uncertainty. Discrepancy between measured data and simulation results therefore has a direct bearing on uncertainty. The greater the discrepancy, the more uncertain are the savings predictions of the simulation, however accurate and detailed. Unfortunately, although Guideline 14P provides procedures for using calibrated simulation, it does not provide a methodology to calibrate a simulation to measured conditions.

Justification and Need/Advancement to State-of-the-Art:

Computers have been used extensively during the past three decades as effective heating, ventilating, and air-conditioning (HVAC) design tools to supplement tedious manual energy calculations (Ayers and Stamper 1995; Kusuda 1999). As computing technology has become affordable, engineers and architects have begun to take advantage of hourly simulation programs on desktop personal computers (PCs) that can inexpensively and quickly perform load calculations (ASHRAE 1991).

In recent years measurement technology has become sufficiently inexpensive and ubiquitous to make it practical to monitor energy and environmental data in great detail and over long periods of time. Energy consumption is being measured at sub-hourly intervals by utilities and building owners. Yet, though both the accuracy of simulations and the availability of measured interval data have increased, the integration of the two approaches has so far not kept pace. While both simulations and measurements are performed with considerable resolution in time and space, all that detail is jettisoned when one only compares aggregated monthly simulation results to monthly utility data, an approach that has changed little since the dawn of energy calculations.

Comparing computer models to actual metered data is not a new practice. As early as 1970, recommendations were made to calibrate models based on measured data (Ayers and Stamper 1995;Kusuda 1999). Some researchers and engineers have attempted to compile "how to" manuals and methods in order to simplify this task; however, in almost all cases the end result falls short of a useful toolkit of procedures (Diamond and Hunn 1981; Hsieh 1988; Kaplan et al. 1990; Hinchey 1991; Hunn et al. 1992; Kaplan et al. 1992; Haberl et al. 1993; Clarke et al. 1993; McLain et al. 1993; Bou Saada and Haberl 1995a, 1995b; Haberl et al. 1995; Manke and Hittle 1996).

Recently, ASHRAE has developed Guideline 14p *Measurement of Energy and Demand Savings* for determining the appropriate methods for analyzing energy savings from energy conservation retrofits. Guideline 14p has defined three methods for calculating how energy savings are to be measured and characterized, one of which is calibrated simulation. Unfortunately, because of its broad scope, Guideline 14p defines *uncertainty* in estimating savings as the standard of comparison between different energy savings calculations. Therefore, simple formulas are proposed, anchored in basic statistics, to quantify such uncertainty. Discrepancy between measured data and simulation results therefore has a direct bearing on uncertainty. The greater the discrepancy, the more uncertain are the savings predictions of the simulation, however accurate and detailed. Nonetheless, although Guideline 14p provides procedures for using calibrated simulation, it does not provide a methodology to reconcile computer-calculated results with measured energy and internal environmental data.

To date, no consensus guidelines have been published on how to assess the comparison of the results from a building energy simulation program against measured data from an actual building. Historically, actual comparisons have

been an art form that inevitably relies on user knowledge, past experience, statistical expertise, engineering judgment, and an abundance of trial and error.

One major problem with reporting simulation accuracy rests with the calculation procedures, which have been reported in the previous work. Typically, when a model is established as being calibrated (i.e., the user states that the "accuracy" for electricity is approximately "5% per month"), the author does not reveal the techniques used other than stating that the final result is "calibrated" or "validated". Hourly or daily error values are seldom reported. Even in cases when error estimates are presented, the methods and equations used to obtain the comparisons are not.

Therefore, because the manifest lack of uniformity and abundance of confusion in calibrating simulations to actual data, Guideline 14p identified as an important task the development of consensus procedures for comparing the results of computer simulations to measured data.

Hence, the purpose of this research is to bring order and clarity to the intersection of simulation and measurement, and at the same time assist the practitioner in reconciling energy calculations to measured data in the most expedient way. Accordingly, there are two thrusts to be emphasized:

1. To define discrepancy between simulation results and measured data, and to relate it to the definition of uncertainty of energy savings estimation in ASHRAE Guideline 14p; this effort should include the development of the most suitable presentation formats to characterize discrepancy with hourly, daily and monthly formats;
2. To develop a set of procedures, and a method for applying them, for the purpose of diagnosing and resolving such discrepancies in the most expedient and cogent manner; this part aims at systematizing and transferring expert energy modeler's know-how to the realm of the practitioner.

The procedures outlined in this work statement will result in an ASHRAE publication that can be widely distributed to ASHRAE members. ASHRAE has already developed and is distributing software toolkits that contain computer-modeling routines of primary (HVAC01) and secondary (HVAC02) systems. Therefore, the final result of this work is intended to be a guide, complete with algorithms, presentation formats, and quantitative references, of how to reconcile the results of simulation programs developed with such toolkits with actual data.

The project will benefit the following:

1. ASHRAE to buttress the credibility of the use of calibrated simulation codes based on ASHRAE methods by the energy engineering community.
2. Software code developers and users to assess how well calibrated computer simulations fit measured data from actual buildings.
3. ASHRAE members as a guide for more effective use of available computer simulation codes in their day-to-day practice.
4. ASHRAE Guideline 14p to strengthen its calibrated simulation approach by providing specific procedures for calibrating a computer simulation to measured conditions.
5. Performance contractors and energy service companies with a consensus calibration method to using calibrated simulations to measure savings from performance contracts.

Objective:

The objective of this work statement is to develop procedures and how-to-instructions to characterize and minimize the discrepancy between the results of building energy simulation programs and measured energy data.

Scope:

Task 1. Locate, characterize, and categorize previously developed calibration assessment methods beginning with those listed in the references. Review and provide a brief description and usability of the techniques employed.

Task 2. Based on the results of Task 1 develop procedures and presentation formats for comparing the results of hourly building energy simulation programs against measured energy and internal environmental data. Such procedures should include algorithms necessary to accomplish the task, such as, but not be limited to:

- procedures for the statistical fitting of hourly, daily and monthly simulated energy use data to whole-building electricity data, whole-building heating/cooling data, whole-building lighting & other end-use data,
- procedures for the graphical viewing of the progress of fitting simulated data to whole-building electricity data, whole-building heating/cooling data, whole-building lighting data at different levels of time resolution (i.e., hourly, daily and monthly),
- procedures for fitting simulated data to measured data when comparing system component efficiency (e.g., chillers, pumps, boilers), and
- procedures for statistical fitting of hourly, daily and monthly simulated interior conditions to measured interior conditions.
- procedures for calculating the uncertainty of the how well the simulated data match the measured data that relate to the procedures in ASHRAE Guideline 14p.

The tool kit should also locate, characterize and include methods for using actual measured weather data in the simulation, as opposed to the more habitual typical years.

Task 3. Demonstration examples of the procedure and toolkits using measured hourly, daily or monthly data from an actual building and simulations produced with the current version of at least one publicly available simulation program (e.g., DOE-2, BLAST, TRNSYS, EnergyPlus), including the necessary input files to run the program, the necessary routines for extracting the hourly measured building energy & environmental data extracted from the calibration. Demonstrations should include: comparisons of simulated data to measured data: cooling, heating, electricity, interior temperatures, and systems and plant equipment performance data. This demonstration will also include a successful independent test of the developed procedures.

Task 4. A final report documenting the methods used in conducting the project and identifying areas where additional research is needed.

Task 5. Preparation of an ASHRAE technical paper, ASHRAE Research Journal paper, research note, and/or ASHRAE Journal Article as requested by the PMS.

Deliverables:

1. Progress and financial reports shall be made to the Society through its Manager of Research and quarterly reports.

2. The Principal Investigator shall report in person to the Project Monitoring Sub-Committee (PMSC), (and full TC if deemed appropriate) at the annual and winter ASHRAE meetings, and satisfactorily answer such questions regarding the research as may arise during those meetings.

4. A DRAFT and FINAL report. The DRAFT report covering complete details of all research carried out on the project shall be prepared and submitted to the PMSC prior to the end of the contract period. This DRAFT report shall be reviewed and approved by the PMSC prior to submittal of the FINAL report to the Society for final completion of the contract.

The DRAFT and FINAL report shall include, at a minimum, the following:

- An executive summary suitable for wide distribution to the industry and the public.

- A final report that details the annotated bibliography, including PC-formatted electronic copy of all appropriate material mentioned above.

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 3-1/2" PC-formatted diskette(s), ZIP disk, or CD-ROM; in a suitable word processing format used to produce the report.

All computer code will be documented according to the recommendations of ASHRAE's TC 1.5 -- Computer Applications Technical Committee. All software documentation will be consistent with the previously developed HVAC-01 and HVAC-02 toolkits.

5. One or more ASHRAE technical paper(s) that reports the results of the project to be presented at an ASHRAE meeting. The papers shall conform to Section 5 of the Society's "Author's Manual for Technical and Symposium Papers".

6. A Technical Article suitable for publication in the ASHRAE Journal, or ASHRAE Research Journal if requested by the Society.

Level of Effort:

1. Obtain, review, and categorize the readily available technical literature relevant to calibration methods.

- Labor for researchers and engineers: 20%

2. Prepare toolkit of comparison procedures including examples.

- Labor for researchers and engineers: 50%

3. Produce a final, computer-readable original of the publication in a format satisfactory to both the PMS and to ASHRAE Special Publications.

- Labor for researchers and engineers: 10%

4. Prepare quarterly reports and a brief final report documenting the methods used in conducting the project and identify areas where additional research is needed.

- Labor for researchers and engineers: 5%

5. Prepare a technical paper, and a research note, and/or ASHRAE Journal Article as requested by the project monitoring subcommittee.

- Labor for researchers and engineers: 15%

Total person-months = 12 to 18 person-months, apx. cost $95,000, completed in 18 calendar months or less. PI person-months = 4 person-months.

Other Information For Bidders:

1. Successful contractor will demonstrate their knowledge of calibration procedures and expertise in using publicly available simulation programs in their proposal.

2. The proposed budget should include a reasonable breakdown of the costs of performing the work, including travel, programming, computer supplies, computers, etc. Project responsibilities and project management will also be defined.

3. The proposal should include a detailed timetable including the logistics of accomplishing the major tasks outlined above.

Proposal Evaluation Criteria:

The following proposal evaluation criteria will be used for selection:

(25%) Familiarity with calibration methods of at least one publicly available simulation code, and demonstrated use of such knowledge.

(20%) Familiarity with measured data from HVAC systems, including the ability to obtain such data, and a knowledge of all traditional methods used to statistically analyze such data.

(30%) Demonstrated ability to develop a useful guide for use by practicing engineers, including personnel experience, and demonstrated report writing capabilities.

(25%) Project plan, project timetable, budget detail, and proposal documentation in support of the project methodology.

References:

ASHRAE. 1991. ASHRAE handbook: 1991 HVAC applications volume. American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc., Atlanta, GA.

Ayers, J.M. and E. Stamper. 1995. Historical development of building energy calculations, ASHRAE Transactions Preprint. 101(1).

BLAST. 1993. BLAST users manual. BLAST Support Office, University of Illinois Urbana-Champaign.

Bou Saada, T., Haberl, J. 1995a. "A Weather-daytyping Procedure for Disaggregating Hourly End-use Loads in an Electrically Heated and Cooled Building from Whole-building Hourly Data", Proceedings of the 30th Intersociety Energy Conversion Engineering Conference, July 31, - August 4, 1995, Orlando, Florida.

Bou Saada, T., Haberl, J. 1995b. "An Improved Procedure for Developing Calibrated Hourly Simulation Models", Proceedings of the International Building Performance Simulation Association, August 14-16, 1995, Madison, Wisconsin.

Clarke, J.A, P.A. Strachan and C. Pernot. 1993. An approach to the calibration of building energy simulation models. ASHRAE Transactions. 99(2): 917-927.

Diamond, S.C. and B.D. Hunn. 1981. Comparison of DOE-2 computer program simulations to metered data for seven commercial buildings. ASHRAE Transactions. 87(1) : 1222-1231.

Flake, B.A., J.W., Mitchell and W.A. Beckman. 1997. "Parameter Estimation for Non-linear Chilled Water Plant Models." ASHRAE Transactions.

Haberl, J., Bronson, D., Hinchey, S., O'Neal, D. 1993. "Graphical Tools to help Calibrate the DOE-2 Simulation Program to Non-weather Dependent Measured Loads", 1993 ASHRAE Journal, Vol. 35, No.1, pp. 27-32, (January).

Haberl, J., Bronson, D., O'Neal, D. 1995. "An Evaluation of the Impact of Using Measured Weather Data Versus TMY Weather Data in a DOE-2 Simulation of an Existing Building in Central Texas." ASHRAE Transactions Technical Paper no. 3921,Vol. 101, Pt. 2, (June).

Haberl, J.S., J.D. Bronson, and D.L. O'Neal. 1995. An evaluation of the impact of using measured weather data versus TMY weather data in a DOE-2 simulation of an existing building in central Texas. ESL Report No. ESL-TR-93/09-02. College Station, TX.

Hinchey, S.B. 1991. Influence of thermal zone assumptions on DOE-2 energy use estimations of a commercial building. M.S. Thesis, Energy Systems Report No. ESL-TH-91/09-06, Texas A&M University, College Station, TX.

Hsieh, E.S. 1988. Calibrated computer models of commercial buildings and their role in building design and operation. M.S. Thesis, PU/CEES Report No. 230, Princeton University, Princeton, NJ.

Hunn, B.D., J.A. Banks, and S.N. Reddy. 1992. Energy analysis of the Texas Capitol restoration. The DOE-2 User News. 13(4): 2-10.

Kaplan, M.B., B. Jones, and J. Jansen. 1990a. DOE-2.1C model calibration with monitored end-use data. Proceedings from the ACEEE 1990 Summer Study on Energy Efficiency in Buildings, Vol. 10, pp. 10.115-10.125.

Kaplan, M.B., P. Caner, and G.W. Vincent. 1992. Guidelines for energy simulation of commercial buildings. Proceedings from the ACEEE 1992 Summer Study on Energy Efficiency in Buildings, Vol. 1, pp. 1.137-1.147.

Kusuda, T. 1999. "Early History and Future Prospects of Building Systems Simulation" Proceedings of the Sixth International IBPSA Conference, Kyoto, Japan.

LBL. 1989. DOE-2 Supplement, Ver 2.1D. Lawrence Berkeley Laboratory, LBL Report No. LBL-8706 Rev. 5 Supplement. DOE-2 User Coordination Office, LBL, Berkeley, CA.

Manke, J., and Hittle, D. 1996. "Calibrating Building Energy Analysis Models Using Short Term Test Data", Proceedings of the 1996 ASME International Solar Engineering Conference, ASME Solar Energy Division, pp. 369-378.

McLain, H.A., S.B. Leigh, and J.M. MacDonald. 1993. Analysis of savings due to multiple energy retrofits in a large office building. Oak Ridge National Laboratory, ORNL Report No. ORNL/CON-363, Oak Ridge, TN.

Author(s):

Jeff Haberl, Texas A&M University
Mike Witte, GARD Analytics
Ron Judkoff, NREL

Robert Sonderegger, Silicon Energy Inc.

TC 4.7 Simulation and Component Models Subcommittee
Cincinnati Meeting Minutes
Monday, June 25, 2001, 6:00-7:30p M/Grand A

Introductions/Additions to Agenda

Dan Fisher called the meeting to order at 6:00 pm. Thirty-two people were in attendance as shown in the attached list.

Program

Atlantic City – January 2002

- *Symposium Interoperability and Portability* (Chip Barnaby)

Call for papers has not yet gone out, this will slip to Chicago; still hope to do this though.

Honolulu: (June 2002)

a. *Recent advances in building simulation methods* (Ian Beausoleil-Morrison) –fifteen abstracts have been received. The symposium will be split this into two sessions with Jan Hensen chairing one and Ian chairing the other. This might end up being late in submission so this might get pushed back. Curt Pedersen noted that TC4.1 could co-sponsor. Jeff Spitler and Klaus Sommers (in addition to Ian and Jan) volunteered to review abstracts.

Chicago – January 2003

- *Integrating Airflow Modeling into Energy Analysis Programs* (Ian Beausoleil-Morrison)—call for abstracts not done yet but coming in two-three months.

TC 4.7 Research Review

Jeff Spitler—ASHRAE going through a mid-life crisis about how our research isn't practical enough (as we have heard from Jeff and Vern Smith), preliminary report sent to ASHRAE and handed out at this subcommittee meeting. Jeff would like all attendees to read through the report and note anything that is missing. TC4.7 has done more research than any other TC and thus we need to have strong documentation that our research benefits practicing engineers. Vern put up a web survey through the news lists (TC47, IBPSA-USA, BLDG-SIM), eventually got about 22 responses, though not all of the respondents were very specific or detailed. Looking for specific benefits from all projects, some cases we have nothing other than that the information is in the handbook which isn't necessarily good enough. The following suggestions were made:

- Mike Witte—List everything in handbook that is a result of research JS--*everything* should go in the handbook that can; information should go back 10 years.
- Curt Pedersen—there needs to be feedback to ASHRAE that their restrictive policies are preventing a greater impact (experience of Don Shirey with trying to use toolkit models and ASHRAE hindering that).
- George Walton—sometimes it takes a few years for research to have a measurable impact.
- Jeff Haberl—contact Moncef Krarti about the impact of RP-666 (no information currently).
- Jeff Haberl—some mention of standards and the need to mention the impact as well.

Work Statements in Progress

(discussed after item 3 below) Chip Barnaby—this subcommittee can submit one new RTAR and so the committee should designate a priority. RTARs are needed by August 1.

1. *Development of Detailed Descriptions of HVAC Systems (Templates) for Simulation Programs* (Crawley, Norford)

- Need?...Status?

Les—we have dropped the ball, nothing for today but hope to do better for next time. DEF—do we need to do this or has this been done? (asked last time). Les said "yes". Let's put this on hold for a year and not send it up as an RTAR.

2. *Development of ground coupling cases for the proposed ASHRAE SMOT 140* (Neymark, Beausoleil-Morrison)

- Moved to S&C from Applications
- Background, Status, Discussion

Ian said that this has been in Applications in the past but now this is in S&C; point is pretty much described in the title. Want to get these issues back in by developing new ground coupling tests for whole building energy simulation. Jan Hensen and Moncef Krarti has read through and made minor modifications. This is a full work statement after going up as an RTAR approximately one year ago. DEF—are there enough models out there to warrant the addition of such tests? Ron Judkoff—NREL working on it, E+ will have two, one program up in Canada also working on it, so this is probably enough to justify it. Ian—in response to questions from Jeff Haberl, we could turn this from a comparative test into an empirical test. Ground losses can be fairly important (20-30% of loads) as discussed by Les Norford and Ron Judkoff. This work statement be the top priority from this subcommittee (no objections from those in attendance).

3. *Energy performance simulation model for refrigerated warehouses* (Kosny, Huang)

- Moved to S&C from Applications
- Background, Status, Discussion

This also came over from Applications. None of the authors were in attendance and no one knew anything about this so discussion was delayed until the next meeting. Dru Crawley has a question about what the impact is and how many refrigerated warehouses are actually in existence. There was the sense that if this is a small problem then this won't fly. Mike Witte has volunteered to contact Kosny and Huang to get this in shape and in RTAR format/to ASHRAE by August 1 (Sheila needs it by approximately July 15). Chip Barnaby—why can't existing program simulate these. Answers—product flow at the doors and what happens, phase changes, etc. Cray Wray—DOE probably has numbers on number of warehouses, TC4.3 probably has input that is missing on what the air exchange might be at the doors. Ian—models should go into the toolkits? Mike Witte—concerns that this could be a beast that doesn't fit, perhaps we should evaluate what needs to be done before a model gets developed. Jan Kosny arrived during the discussions—project got interest from TC10.6 and TC10.8 (in participating). Jan sent current version and will get comments back from these TCs and will have something at the next meeting. Hope is that 3 TC involvement will increase chances of getting funding; concerns about mass, schedules, phase change. Jan will work with Mike to get an RTAR by the deadlines noted above. Chip—key to a project is the title; changing titles can get things lost along the way. Jan and Mike tasked to have the final title language by the full committee meeting. Phil Haves—a good title can come into play at certain levels so we need to be sure that the title is solid.

4. *New One Pagers...Research Ideas*

Jeff Haberl has a few ideas:

- develop a combine duct and attic model for comprehensive heat transfer on both the supply and the return side (Craig Wray and George Walton—this should be an aggregation of models not a combination);

- humidity control in residential systems (Craig Wray says that there exists a 400 page document on humidity control);
- ventilated windows is also a simulation need.

Phil Have suggested that we need to assess what we currently have and what models are needed to plug the holes (need a critical review and a plan) especially considering the tightness of research funds; need to look at different types of buildings and controls/building operations and applications of these methods. The committee agreed that this was an excellent idea. The following points were made:

- Mike Witte—three documents could help use to get going: E+ forums/user workshops, ARTI work recently done, E+ punchlist of feature gaps that are also gaps in general.
- Craig Wray—NRCCan also did a similar study for HOT2000.
- Ron Judkoff—also take a look at Dru Crawley's tools directory; Amistadi also put a tools directory and group of articles together on this same topic.
- Volunteers for this committee to put a bulleted list of talking points for the next meeting—Ian Beausoleil-Morrison volunteered (under duress!) to put together a bulleted list of topics for the next meeting Mike Witte also volunteered (under duress!) to seek permission to extract the relevant information from EnergyPlus documents and send that information to Ian.

5. Prioritization for Research Plan

- Chip Barnaby—this subcommittee can submit one new RTAR and so the committee should designate a priority. RTARs are needed by August 1.
- Kosny and Huang is the top RTAR priority from this subcommittee.

Research projects in Progress

1. RP 1049 Design Synthesis (Curt Pedersen)

Curt Pedersen reported that the project is going very well. Some of the progress was shown at the IBPSA-USA meeting via talk by Jonathan Wright (PI). PI has reacted to all of the comments made at the last meeting and the PMSC is very pleased with the current progress. PI was in attendance and is pleased with the project and progress. COP also noted that new personnel was hired and this will help even further. PI noted that concerns about linkage to a particular program (IDA) will be downplayed. Jeff Spitler noted that there is useful synergy with other research projects the PI is working on.

Old and New Business

2. Future of the Toolkits

- Maintenance—The discussion focused on combining the toolkits on a single CD.
  - Dru Crawley—there are substantial differences in the toolkits; if we want to just cram them onto a CD it could be done pretty quickly, but to get everything into the loads toolkit format would take quite an effort.
  - Mike Witte—what about other work like attic models that have been done on other research projects, we ought to pursue those components if ASHRAE has rights to the code.
  - Dan Fisher—should this committee push forward a project to combine and unify the toolkits with the RP-987 look? Dru Crawley had a working version of a work statement about three years ago that might be resurrected. Dru will fax his hard copy of notes to DEF will work to getting this into some proposals for next meeting.

- Education Versions —Dan Fisher stated that he would like to see really cheap versions of the toolkit for classroom use by students.
- Licenses—Chip Barnaby—licensing on all three toolkits is "slightly" different. Hope is that if we get all of the toolkits on one CD we can get one license and perhaps also get an educational version.

3. Other Items...

Jeff Spitler—opportunity to work with TC4.1 on heat gain from lighting work statement (more with data), could be an applications subcommittee thing (George Walton volunteered to get involved, Jeff will get George in contact with Chris Wilkins).

Adjourn

The meeting was adjourned at 7:30 pm.

ATTTACHMENT 1: Attendance

Cinci.	Atlanta	Minn.	Last Name	First Name	E-Mail
	X	X	Armstrong	Peter	pr_armstrong@pnl.gov
X	X	X	Barnaby	Chip	cbarnaby@wrightsoft.com
X	X	X	Beausoleil-Morrison	Ian	ibeausol@nrcan.gc.ca
		X	Blake	Jeff	jblake@nrcan.gc.ca
		X	Brandemuehl	Mike	michael.brandemuehl@colorado.edu
	X	X	Buhl	Fred	wfbuhl@lbl.gov
X	X		Crawley	Dru	drury.crawley@ee.doe.gov
	X	X	Eldridge	David	eldridd@okstate.edu
X		X	Fisher	Dan	d-fisher@uiuc.edu
X			Griffith	Brent	griffith@mit.edu
	X		Gu	Lixing	gu@fsec.ucf.edu
X			Haberl	Jeff	jhaberl@tamu.edu
X	X		Haddad	Kamel	Khaddad@nrcan.gc.ca
X	X		Haves	Philip	phaves@lbl.gov
X	X		Hensen	Jan	j.hensen@tue.nl
	X		Holmes	Mike	Michael.holmes@arup.com
		X	Huang	Joe	YJHuang@lbl.gov
X			Judkoff	R.	Ron_judkoff@nrel.gov
X			Knappmiller	Kevin	kevink@kevtec.com
X	X	X	Kosny	Jan	kyo@ornl.gov
	X	X	Krarti	Moncef	krarti@colorado.edu
	X		Laouadi	Aziz	Aziz.laouadi@nrc.ca
	X		Liesen	Richard	r-liesen@uiuc.edu
X			Lubun	mike	mlubun@nrcan.gc.ca
X	X	X	McDowell	Tim	mcdowell@tess-inc.com
	X		Mottillo	Maria	mmottilo@nrcan.gc.ca
X			Neymark	Joel	neymarkj@sni.net
X			Nguyen	Phuong	pnnguyen@pplant.msu.edu
X	X	X	Norford	Les	lnorford@mit.edu

Cinci.	Atlanta	Minn.	Last Name	First Name	E-Mail
X			Novoselac	Atila	aqn102@psu.edu
X			Pedersen	Curt	cpederse@uiuc.edu
		X	Purdy	Julia	Jpurdy@nrcan.gc.ca
	X		Reddy	T. Agami	Reddyta@drexel.edu
			Ries	Robert	rries@cmu.edu
X	X	X	Rees	Simon	SJRees@okstate.edu
X			Shipley	David	Shipley@marbek.ca
X		X	Shirey	Don	Shirey@fsec.ucf.edu
X	X	X	Smith	Vernon	vsmith@archenergy.com
X		X	Sommer	Klaus	klaus.sommer@vt.fh-koeln.de, Sommer.Roycroft@T-online.De
	X	X	Sonderegger	Robert	rsonder@siliconenergy.com
X	X	X	Spitler	Jeffrey	spitler@okstate.edu
X			Sreedharan	Priya	psreedharan@lbl.gov
X	X	X	Strand	Rick	r-strand@uiuc.edu
		X	Turcio	Wallace	wturcio@embraer.com.br
		X	Ullah	Mohammad	bdgullah@nus.edu.sg
X	X	X	Walton	George	gwalton@nist.gov
	X		Winkelmann	Fred	fcwinkelmann@lbl.gov
X			Witte	Mike	mjwitte@gard.com
X	X	X	Wray	Craig	cpwray@lbl.gov
X			Wright	Jonathan	J.A.Wright@lboro.ac.uk
X			Xu	Peng	pxu@lbl.gov

1049-RP Progress Report June, 2001

Monitoring Committee:

Curtis Pedersen (TC 4.7), chair
Dave Knebel (TC 4.7)
Ron Nelson (TC 1.5)
Ed Sowell(TC 4.7)
Mike Brandemuehl (TC 4.6)

Contractor: University of Loughborough, UK

The new PI, Jon Wright, presented a progress report at the June meeting in Cincinnati. He responded to the three "instructions" given by the monitoring committee at the January meeting. They were:

1. 1. Fans should be included in the mix of components.
2. Review options for making the configuration generation part of the optimization process.
3. Bring the additional researcher on board as soon as possible.

After discussion, the monitoring committee agreed that the inclusion of fans in the mix of components was not realistic since it introduces an infinitely variable situation that depends on the size of the configuration.

Configuration generation has been made a part of the initial optimization process. It is working quite will, and may reduce the need for system simulations.

Dr. Richard Buswell has been appointed to the project, effective from 1 July 2001.

Thus, all of the items of concern by the PMS in January have been addressed.

The project is proceeding very well, and the PMS is pleased with the progress.

The following table summarizes the status of the project.

Task	Comments	Time Allocated (months)	Completion, January 2001 (%)	Completion, June 2001 (%)
1. HVAC Design Inventory	Inventory satisfactory	3	0	85
2. Selection of a Simulation Program	IDA being used	15	100	100
3. Component Model Developmen	Work on this will begin immediately	12	5	5
4. ACG Development	Implementation in progress	30	55	60
5. Optimization-Simulation Interface Editors and Interpreter	Implemented in JAVA	12	25	65
6. Implement Optimization Method	Genetic Algorithm to be used here (JDEAL)	24	40	75
7. Develop Run-time Supervisor	First version complete	9	5	20
8. Design Test Briefs	Will work with Ove Arup and Partners	18	10	15
9. Evaluation of Project and Final Report	Some documents done	9	15	20

ASHRAE
Technical Committee 4.7 Energy Calculations
2002-2003 Research Plan

1 August 2001

TC Priority 2002-2003	Prior TC priority	Society status	TC Status	Title	Sub-com
0	3 (1998-1999)	No RTAR revised WS to be submitted 9/2001	Revised WS approved 6/2001	Procedures for Reconciling Computer-Calculated Results With Measured Energy Data (1051-WS)	IM
0	2 (2001-2002)	RTAR, non-prioritized	WS vote expected 1/2002	Development of Comparative Test Cases for Evaluating Simulation Models of Slab, Crawl Space and Basement Heat Transfer Through Adjacent Ground	SCM
0	3 (2001-2002)	RTAR, non-prioritized		Inverse Bin Procedures for Analyzing Energy Savings	IM
1		(new)	Draft WS	Procedures and Data for High-Performance Residential Design	A
2		(new)	Draft WS	Development of a Procedure for Base-lining Energy Use at Large Central Plants	IM

Additional Work TC 4.7 Work Statements in Process

TC Priority 2002-2003	Prior TC priority	Society status	Status	Title	Sub-com
				Development of a Toolkit of HVAC Models (Algorithms) for Refrigerated Warehouses	SCM
				Development of Standardized Computer Simulation Input Files for Describing Typical Residential Homes and Common Energy Conservation Retrofits	A
				Methodology to Define Bounds of Variability in Building Energy Use Predictions Using Detailed Simulation Models and How it can be Incorporated in the Design Process	A
	2 (2000 – 2001)		No progress	Define Performance Factors for Primary and Secondary Equipment Simulation Inputs for Commercial Buildings	A
				Analysis and Testing of the Energy Cost Budget Method in ASHRAE 90.1	A?
				Use of Evolutionary Computation for Inverse Problems	IM
				Characterization of Building Secondary Thermal Loads from Chiller of Electric Use Data	A?
				Extend and Develop Methodology of 827-RP to Include Models for Air-Conditioners and Heat Pumps	IM
			Cancelled by Tech Council	Standard Operating Conditions in North American Residential Buildings (1163-TRP)	A
	3 (2000 – 2001)		Rejected 3/00	Development of Detailed Descriptions of HVAC Systems (Templates) for Energy Simulation Programs (1198-WS)	SCM

RESEARCH TOPIC ACCEPTANCE REQUEST (RTAR)
TC 4.7 Energy Calculations

Title:	**Development of a Procedure for Base-lining Energy Use at Large Central Plants**
Research Category:	Design and O&M Tools
Research Classification:	Basic and Applied
TC/TC Priority:	2 (2002/2003)
Estimated Cost:	$80,000
Other Interested TC/TGs:	Guideline 14P
Possible Co-funding Organizations:	
Handbook Chapters to be Affected By Results of this Project:	Fundamentals, Chapter 31

Background/State-of-the-Art:

The commercial sector accounts for approximately 15% of the total US energy consumption. Half of the commercial sector energy use is attributed to multi-building facilities. Several of these multi-building facilities are served by large central plants that produce energy forms directly used in the buildings (such as steam, hot water, chilled water, and electricity) from primary fuel sources (including natural gas, fuel oil, and potable water).

The potential to reduce energy use in multi-building facilities is significant. For instance, energy conservation programs sponsored by some state universities have been able to achieve 30% reduction in energy consumption. If this reduction is extrapolated to all the US college and university facilities, it would provide about $1.3 billion in reduced energy bills or about 10% of total budget of U.S. Department of Education allocated to post-secondary education.

One important element that ensures the effectiveness and the success of energy conservation programs is a procedure to assess and quantify the energy and/or cost savings attributed to implemented retrofit measures. Recently, several procedures and guidelines for measuring and verifying energy savings for individual buildings have been developed. Among the methods proposed for the measurement of energy savings are those proposed by ASHRAE Guideline 14P, the National Association of Energy Service Companies (NAESCO), the Federal Energy management Program (FEMP), the American Society of Heating Refrigeration and Air Conditioning Engineers (ASHRAE), the Texas LoanSTAR program, and the North American Energy Measurement and Verification Protocol (NEMVP) sponsored by DOE and later updated and renamed the International Performance Measurement and Verification Protocol (IPMVP).

However, none of the existing base-lining procedures is applicable to large central plants serving multiple buildings. One of the main features of large central plants is that they include the relatively complex energy interaction between several equipment used central plants such as boilers, chillers, turbines, pumps, and heat exchangers. In a typical central plant, primary fuel sources (such as natural gas, fuel oil, potable water, and purchased electricity) are used by a utility plant to produce various

energy demands (such as steam, hot water, chilled water, and generated electricity) supplied to the buildings. The conversion of the primary fuels to energy demands is accomplished through numerous energy conversion processes performed within the utility plant. Any base-lining procedure for central plants should be capable to account for the various thermal interactions between the multiple equipment commonly used in the plant.

Justification and Need/Advancement to State-of-the-Art:

A simplified base-lining procedure is needed to measure the energy savings from retrofits of multi-building facilities to improve the energy performance of large central plants. This procedure should have the ability to identify various system effects, such as those due to equipment replacement, operational strategies change, weather variation, addition or subtraction of building stock, or equipment degradation. The base-lining procedure would facilitate the comparison of energy savings retrofits between multi-building facilities.

It is expected that the development of an accepted procedure for base-lining energy use at large central plants will complement and widen the applicability of the existing guidelines and standards for measuring savings from energy retrofits in commercial buildings including multi-building facilities (such as ASHRAE 14 GPC-14P and IPMVP). The procedures outlined in this work statement will result in an ASHRAE publication that can be widely distributed to ASHRAE members. ASHRAE has already developed and is distributing software toolkits that contain computer-modeling routines of primary (HVAC01) and secondary (HVAC02) systems. Therefore, the final result of this work is intended to be a guide, complete with algorithms, presentation formats, and quantitative references, of how to reconcile the results of simulation programs developed with such toolkits with actual data.

The project will benefit the following:

11. ASHRAE to buttress the credibility of the use of baseline procedures based on ASHRAE methods by the energy engineering community.
12. Software code developers and users to develop standard baseline procedures fit measured data from actual buildings.
13. ASHRAE members as a guide for more effective baseline procedures for use in their day-to-day practice.
14. ASHRAE Guideline 14P to strengthen its use in large central plants.
15. Performance contractors and energy service companies with a consensus calibration method for base-lining large central plants.

Objective:

The main objective of this research project is to develop and document a procedure to base-line energy use at large central plants that serve multiple buildings. The procedure will account for different plant component efficiencies, operational strategies, variable weather conditions, and addition or elimination of building stock and/or plant equipment. The developed procedure will be demonstrated to measure savings from retrofits to equipment in the central plant for a multi-building facility.

RESEARCH TOPIC ACCEPTANCE REQUEST (RTAR)
TC 4.7 Energy Calculations

Title:	**Procedures for Reconciling Computer-Calculated Results with Measured Energy Data (1051-WS)**
Research Category:	Design and O&M Tools
Research Classification:	Basic and Applied
TC/TC Priority:	3 (1998/1999) (pre-RTAR work statement)
Estimated Cost:	$95,000
Other Interested TC/TGs:	Guideline 14P
Possible Co-funding Organizations:	
Handbook Chapters to be Affected By Results of this Project:	Fundamentals, Chapter 31

Background/State-of-the-Art:

U.S. businesses and institutions spend an estimated $175 billion per year for energy. Of that, the fraction under performance contracts and energy service agreements is currently growing, aided by cheaper monitoring technology and integration with EMCS systems. Energy simulation programs are used both for estimating potential savings as well as to help verify savings from retrofits actually installed. The potential accuracy afforded by today's energy simulation programs is high. Yet the reliability of the results is frequently compromised by a lack of certainty that the simulations reflect actual conditions. While it is easy to match simulation results with utility bills, it is considerably harder to match daily or even hourly data. There is little systematic guidance available to the practitioner, neither qualitative nor quantitative.

Comparing simulation program results to measured data has always been recognized as an important factor in substantiating how well the simulation model represents a real building. Reconciling simulation results to measured monthly utility data has been the preferred method. Most of these methods rely on simple comparisons including bar charts, monthly percent difference time-series graphs, and monthly x-y scatter plots. Yet monthly comparisons fall short of the level of comparison that is needed when the simulation is used to evaluate changes that amount to less than 10 to 20% of a building's total energy use.

More recent efforts compare hourly simulations to hourly measured data. Unfortunately, at hourly levels of comparison, many of the traditional statistical and graphical comparison techniques become overwhelmed with too many data points. A few proposed advanced methods include carpet plots, comparative 3-D time-series plots, and weather day type analysis to characterize the observed discrepancies. How-to manuals have been compiled and methods developed to simplify this task.

It is time to cull the best from the existing body of research and develop a coherent methodology for the practicing energy engineers. To help the practitioner substantiate computer simulations of energy savings, ASHRAE seeks to develop a well-documented toolkit of procedures to help the practitioner successfully reconcile computer simulations to measured data from actual buildings.

Recently, ASHRAE has developed Guideline 14P *Measurement of Energy and Demand Savings* for determining the appropriate methods for analyzing energy savings from energy conservation retrofits. Guideline 14P has defined how energy savings are to be measured and characterized, one of which is calibrated simulation. Because of its broader scope, Guideline 14P defines *uncertainty* in estimating savings as the standard of comparison between different energy savings calculations. Simple formulas are proposed, anchored in basic statistics, to quantify such uncertainty. Discrepancy between measured data and simulation results therefore has a direct bearing on uncertainty.

The greater the discrepancy, the more uncertain are the savings predictions of the simulation, however accurate and detailed. Unfortunately, although Guideline 14P provides procedures for using calibrated simulation, it does not provide a methodology to calibrate a simulation to measured conditions.

Justification and Need/Advancement to State-of-the-Art:

To date, no consensus guidelines have been published on how to assess the comparison of the results from a building energy simulation program against measured data from an actual building. Historically, actual comparisons have been an art form that inevitably relies on user knowledge, past experience, statistical expertise, engineering judgment, and an abundance of trial and error.

One major problem with reporting simulation accuracy rests with the calculation procedures, which have been reported in the previous work. Typically, when a model is established as being calibrated (i.e., the user states that the "accuracy" for electricity is approximately "5% per month"), the author does not reveal the techniques used other than stating that the final result is "calibrated" or "validated". Hourly or daily error values are seldom reported. Even in cases when error estimates are presented, the methods and equations used to obtain the comparisons are not. Therefore, because the manifest lack of uniformity and abundance of confusion in calibrating simulations to actual data, Guideline 14p identified as an important task the development of consensus procedures for comparing the results of computer simulations to measured data.

Hence, the purpose of this research is to bring order and clarity to the intersection of simulation and measurement, and at the same time assist the practitioner in reconciling energy calculations to measured data in the most expedient way. Accordingly, there are two thrusts to be emphasized:

1) To define discrepancy between simulation results and measured data, and to relate it to the definition of uncertainty of energy savings estimation in ASHRAE Guideline 14p; this effort should include the development of the most suitable presentation formats to characterize discrepancy with hourly, daily and monthly formats;

2) To develop a set of procedures, and a method for applying them, for the purpose of diagnosing and resolving such discrepancies in the most expedient and cogent manner; this part aims at systematizing and transferring expert energy modeler's know-how to the realm of the practitioner.

The procedures outlined in this work statement will result in an ASHRAE publication that can be widely distributed to ASHRAE members. ASHRAE has already developed and is distributing software toolkits that contain computer-modeling routines of primary (HVAC01) and secondary (HVAC02) systems. Therefore, the final result of this work is intended to be a guide, complete with algorithms, presentation formats, and quantitative references, of how to reconcile the results of simulation programs developed with such toolkits with actual data.

The project will benefit the following:

1. ASHRAE to buttress the credibility of the use of calibrated simulation codes based on ASHRAE methods by the energy engineering community.
2. Software code developers and users to assess how well calibrated computer simulations fit measured data from actual buildings.
3. ASHRAE members as a guide for more effective use of available computer simulation codes in their day-to-day practice.
4. ASHRAE Guideline 14p to strengthen its calibrated simulation approach by providing specific procedures for calibrating a computer simulation to measured conditions.
5. Performance contractors and energy service companies with a consensus calibration method to using calibrated simulations to measure savings from performance contracts.

Objective:

The objective of this work statement is to develop procedures and how-to-instructions to characterize and minimize the discrepancy between the results of building energy simulation programs and measured energy data.

RESEARCH TOPIC ACCEPTANCE REQUEST (RTAR)
TC 4.7 Energy Calculations

Title:	**Procedures and Data for High Performance Residential Design**
Research Category:	Design and O&M
Research Classification:	Basic and Applied
TC/TG Priority:	1 (2002/2003)
Estimated Cost:	$115,000
Other Interested TC/TGs:	Possibly 4.1, 4.3, 4.4, 4.5, 4.12, 9.6, TGRSCB
Possible Co-funding Organizations:	NAHB, USDOE, USEPA
Handbook Chapters to be Affected By Results of this Project:	Fundamentals, Chapter 31

State-of-the-Art (Background):
Building energy simulations have proven to be a powerful tool for evaluating energy consumption in residential buildings. Accurate simulations are required to support high-performance design and to evaluate effective energy conservation measures in response to energy shortages and energy price increases. The reliability of such simulations, however, is strongly dependent on realistic inputs. There is considerable uncertainty associated with many of the inputs typically required for simulation. The analyst often does not know either the importance or the accuracy of the many hundreds of assumptions typically required. For residential buildings, areas of input which remain particularly poorly described include: state-of-the-art envelope characteristics such as the impact of plastic house wrap on infiltration rates, thermally complex envelope features such as attics, typical internal loads such as domestic hot water loads when low-flow fixtures are required by code, typical operating conditions such as when occupants will use the HVAC system vs. open windows, HVAC equipment performance data such as duct losses, and the influence of region, vintage, and occupant demographics. As residential building envelopes have improved significantly in recent decades, the importance of internal gains and operating assumptions have become even more important. The characteristics of appliances are also changing rapidly due to environmental and regulatory pressures, so much of the available appliance energy use and water use data is out of date for newer appliances.

Advancement to the State-of-the-Art:
This project seeks to remedy known gaps in knowledge associated with typical constructions and operating conditions for performing hourly energy simulations for residential buildings and to assemble existing knowledge into a single source.

Justification and Value to ASHRAE:
Energy simulations are being used increasingly as the basis for home energy rating systems (HERS), energy-efficient mortgages, energy code development, energy code compliance, and high-performance design. The return of energy shortages and volatile energy prices has increased the need for accurate energy simulations to support energy conservation decisions by utility operators, regulatory agencies, builders, and individual homeowners.

Research is needed to develop and document a comprehensive set of assumptions to assist engineers and designers in performing better building energy simulations for residential buildings. Changes in a wide range of factors including construction techniques, minimum appliance efficiency standards, energy codes, and lifestyle changes have created a need for additional data. For example, how does the use of plastic house wrap impact on infiltration rates? Or what is the range of domestic hot water use in areas with water efficiency codes or in homes with newer water-saving appliances? Given these types of changes, it is no longer adequate to assume typical values for envelope u-values and internal loads. It is necessary to understand the regional, vintage, regulatory, and lifestyle impacts on these assumptions.

Within ASHRAE, this project will assist SSPC 90.2 in better analyzing cost-effective code requirements and provide a reference for assumptions to be used for code compliance analysis. This project will also provide ASHRAE members with improved guidelines for calculating residential energy conservation savings and associated impacts with building energy simulations. Such information will also assist software suppliers to provide better methods, examples, and data libraries for use with building energy analysis software programs. This project would also build upon previous TC4.7 research in the areas of ground coupling, 2D/3D conduction, and attics.

Better documentation of assumptions and guidelines for using simulations will also benefit utilities and regulatory agencies in better estimating peak load and load profile impacts of residential programs. This, in turn, will allow improved analysis of options for residential utility customers, aiding in improvement of utility program benefits, both to customers and utility managers. Improved assumptions and guidance for carrying out building energy simulations will also assist building code agencies and provide a better framework for performing simulation analysis in support of energy codes and home energy rating systems (HERS).

Objective:
The objective of this research is to document, in a single reference, procedures and data required for residential building energy simulations to support high performance residential design, energy conservation assessments, and codes and standards. Subject areas to be addressed should include:

- Envelope characteristics, including detailed descriptions of typically used components and constructions by region, vintage, and site-built vs. factory-built; procedures for modeling complex thermal features including thermal bridging, 2-D/3-D ground heat transfer, attic heat gains, infiltration, interior and exterior shades, and passive solar features.
- Internal loads, including cooking, cleaning, and domestic hot water use, with variations accounting for the impacts of new vs. existing appliance stocks, energy and water-use codes and standards, and occupant demographics.
- Operating conditions, including setpoints, use of HVAC system vs. open windows, schedules, and operation of interior and exterior shading accounting for impacts of occupant demographics.
- Equipment characteristics, including duct and hydronic distribution losses, appropriate use of rated performance values, old and new equipment stock, and the impact of energy codes and standards.

To: Al Woody
Eckhard Groll
Other interested parties

From: Jeff Spitler, TC 4.7 Chair

Date: 29 June 2001

Re: ASHRAE TC 4.7 Research Benefits

Attached is the latest revision to our research benefits documentation. This supercedes the version that we gave to Eckhard earlier. This is the result of a fair amount of work by an *ad hoc* subcommittee that I appointed at the January 2001 ASHRAE meeting. The members of the subcommittee included Vern Smith (chair), Mike Brandemuehl, Jim Willson, Jan Hensen, Mark Hydeman, Dru Crawley, and myself. In addition to making a number of phone calls, the subcommittee put together a web-based survey to collect information. (See: http://www.archenergy.com/ashrae/tc4-7survey.htm)

The information is provided on a project-by-project basis, as requested. In addition to the information specific to each research project, a number of general points were raised by the subcommittee's work. These include the following :

1. Results from a number of the research projects have been incorporated into several different building energy analysis programs. These include EnergyPlus (over 2300 users), DOE 2.x (number of users estimated variously as being over 2500 and over 4000), BLAST (over 1000 users). Although the exact impact on buildings is difficult to estimate, one study done by the Department of Energy estimated the total estimated savings in energy consumption made possible through the use of these programs at $90 billion. In addition, these programs have been used to:
    a. develop ASHRAE Standard 90.1 and ASHRAE Standard 140
    b. support education at the undergraduate and graduate level in mechanical engineering, architectural engineering, and architecture programs. The programs have been used in both classes and in research leading to M.S. and Ph.D. theses.
    c. develop Title 24, California Energy Code
2. Because most of our research involves the development of models and algorithms for building energy analysis, it typically sees the most usage when implemented in building energy analysis programs. However, there is a tendency for there to be a significant lag time between when a research project is finished and when it actually gets implemented in one or more building energy analysis programs. As an example, some of our work finished 3-5 years ago is just now being implemented in the EnergyPlus program.
3. Furthermore, once the work is implemented, it may be used for years to come. One of our TC members pointed out that his company (WrightSoft) sells software that uses earlier ASHRAE research (Simplified Energy Analysis Using the Modified Bin Method). Several thousand copies have been sold, and are routinely being used.
4. We expect that some of our research will become more useful in the future, as available computational power increases. A prime example of this is RP-756, Modeling of Reflected Solar Heat Gain from Neighboring Structures in Building Energy Simulation Programs. Although the project provide interesting results, adding these features to existing building energy simulation programs would require (at the time) excessive computational times. At some point in the near future, this should not be a problem.
5. This has been a useful exercise for the technical committee. In addition to the *ad hoc* subcommittee that worked on preparing the documentation, I have appointed a second subcommittee to work on strategic planning for our research. A draft strategic plan was circulated prior to the meeting, and we plan to have a Saturday afternoon session in Atlantic City to work further on the plan. The goal is to help us to prioritize our future research to maximize its benefit to the society. In addition, I have reorganized the division of

labor among the subcommittees, so that one subcommittee, Applications, will focus on trying to meet user needs by preparing "how to" documents, repackaging (if necessary) our research results, and organizing educational activities, such as an ASHRAE PDS.

6. Finally, it should also be noted that ASHRAE policy has sometimes been detrimental to effective distribution of research results. While this is certainly not the primary constraint on dissemination of research results, the subcommittee felt that it should be mentioned. Specific examples include:
    a. We developed the concept of a toolkit as a replacement for the very popular 1970's Energy Calculations Procedures series. The toolkits (one each for building loads, HVAC systems, and plants) are comprised of a manual that describes the models and algorithms, as well as source code either on a diskette or a CD. The idea was that developers of building energy analysis programs could use parts or all of the toolkit, as needed, in order to be able to incorporate the results of our research into their programs. While the first toolkit (HVAC systems) was published with an appropriate license, the second toolkit went out with a license that forbade any usage of the program on any other machine! This completely negates the purpose of the toolkit. One program developer, aware that the license didn't match the intent of the toolkit called ASHRAE headquarters was told that there was absolutely no way that an exception could be made. The actual text of the license agreement follows below.
    b. Historically, research projects have been available for the cost of copying. This has always seemed reasonable. However, it doesn't seem to make sense that members should be charged to download electronic versions of the research reports off the Internet. In this case, the distribution costs are negligible.
    c. Anecdotal cases have been reported where technical committees had research results that they wished to disseminate as a special publication, but were refused by the Special Publications committee. Understandably, it may not make financial sense to publish everything that any TC wishes to publish. However, it seems that in such a case, there must be an alternative method for publishing the document that will allow its dissemination. Again, allowing the membership to download the document seems like a very low cost alternative method for disseminating the results.

We hope that you find this information useful. We are continuing to review our research results, and anticipate that this document will be updated in the future. In the meantime, if we can provide any additional information, please feel free to contact me.

Full text of HVAC 1 LICENSE AGREEMENT:

Using this CD-ROM package indicates your acceptance of the terms and conditions of this agreement. If you do not agree with them, you should promptly return the package, and your money will be refunded. The title and all copyrights and ownership rights of the program and data are retained by ASHRAE or its supplier. You assume responsibility for the selection of the program and data to achieve your results and for the installation, use, and results obtained from the program and data.

You may use the program and data on a single machine. You may also copy the program and data into any machine-readable form for backup purposes in support of your use of the program on a single machine. You may not copy or transfer the program or data except as expressly provided for in this license. Specifically, you may not copy or transfer the program or data onto a machine other than your own unless the person to whom you are copying or transferring the program or data also has a license to use them. However, selected portions of data my be reproduced in paper form for distribution to third parties with the written permission of ASHRAE. Distribution to third parties without ASHRAE's permission is expressly forbidden.

ASHRAE RESEARCH PROJECT DATABASE

Project Number	529	Title	Assessment and Modification of Standard Hourly Energy Calculation Methods for Predicting Performance of Ventilative Cooling
Sponsor	TC 4.7		U. of Illinois
			Pedersen, C. O.
			S87.09 C90.09
		Handbook Chapter Where Used	Fundamentals, Chapter 31, 2001 HOF

Papers & Publications	Please Offer a Few Notes on the Useful Impact of this Project.
NY-91-05 #1 Vol. 97 Pt. 1 Spitler, J., C. Pedersen, D. Fisher, P. Menne, J. Cantillo. 1991. *An Experimental Facility for Investigation of Interior Convective Heat Transfer*, ASHRAE Transactions, Vol. 97, Pt. 1., pp. 497-504. NY-91-05 #2 Vol. 97 Pt. 1 Spitler, J., C. Pedersen, D. Fisher. 1991. *Interior Convective Heat Transfer in Buildings with Large Ventilative Flow Rates*, ASHRAE Transactions, Vol. 97, Pt. 1, pp. 505-515.	1. The models from this research were incorporated into the BLAST energy simulation program. 2. Used by Morris, et al. (1994) in study of nighttime ventilative cooling. 3. Provided facility and data for 664-RP. 4. The control algorithms developed by Morris, Braun, and Treado will be field tested in a demonstration project in southern California beginning in September 2001 under a PIER Building Research Program sponsored by the California Energy Commission. The system will be modeled using TRNSYS for California climate zones. 5. These correlations will be used in an empirical validation experiment for building energy simulation software for Electricité de France. 6. Data from 529-RP was used to generate correction correlations for EnergyPlus, which currently has over 2,300 registered users. Reference: Morris F B., J.E. Braun, S.J. Treado.1994. Experimental and simulated performance of optimal control of building thermal performance. ASHRAE Transactions. 100(1):402-414.

Reviewer: _____

ASHRAE RESEARCH PROJECT DATABASE

Project Number	564	Title	Development of Improvements to the TC 4.7 Simplified Energy Analysis Procedure
Sponsor	TC 4.7		Texas A&M University
			Claridge, David
			S88.04 C90.12
		Handbook Chapter Where Used	Chapter 31, 2001 HOF

Papers & Publications	Please Offer a Few Notes on the Useful Impact of this Project.
#3510 Vol 97 Pt. 2 (1991) A thermal mass treatment for the TC 4.7 simplified energy analysis procedure, Claridge D E., Norford L K., Balasubramanya R., ASHRAE Trans. 1992, vol.98, Part 1, Paper number 3575 (RP-564), 320-327 #3574 Vol. 98 Pt. 1 (1992) A multiclimate comparison of the improved TC 4.7 simplified energy analysis procedure with DOE-2, Balasubramanya R., Claridge D E., Norford L K., Kreider J F. ASHRAE Trans. 1992, vol.98, Part 1, Paper number 3574 (RP-564), 305-319, 10 figs., tabs., refs. #3575 Vol. 98 Pt 1 (1992) Improvement of the solar calculations in the modified bin method Vadon M., Kreider J F., Norford L K. ASHRAE Trans. 1991, vol.97, Part 2, Paper number 3510 (RP-564), 204-211	1. Results from this research project were incorporated into the TC 4.7 Simplified Energy Analysis Procedure, Special Publication 90140 2. Sales of Special Publication 90140, Simplified Energy Analysis Using the Modified Bin Method: Total sales to date: 652; sales year to date: 32. 3. Some of these models were incorporated into the HOT2000 simulation software (Natural Resources Canada). Tens of thousands of houses have been simulated with this software. It has also been used to establish code requirements in Canada.

Reviewer: _____

ASHRAE RESEARCH PROJECT DATABASE

Project Number	629	Title	Preparation of a Toolkit for Secondary HVAC System Energy Calculations
Sponsor	TC 4.7		Colorado, U. of
			Brandemuehl, Mike
			S89.09 C93.01
		Handbook Chapter Where Used	Chapter 31, 2001 HOF

Papers & Publications	Please Offer a Few Notes on the Useful Impact of this Project.
#3737 Vol. 100 Pt. 1 (1994) Development of a toolkit for secondary HVAC system energy calculations Brandemuehl M J. ,ASHRAE Trans., 1994, vol.100, part 1, paper no.3737, 21-32 Spec. Pub. #90358 (CD-ROM) HVAC2 Toolkit Algorithms and Subroutines for Secondary HVAC Systems Energy Calculations	1. University de Liege has integrated the models from the Secondary Toolkit in to TRNSYS. 2. The algorithms from the toolkit have been used for education of graduate students at a number of universities in the U.S. and Europe. 3. Several models from the toolkit were used in the development of EnergyPlus, which currently has over 2,300 registered users. 4. Some of the algorithms from the toolkit have been implemented in later versions of DOE-2.x and its derivatives ((such as EnergyPro, Visual DOE, PowerDOE, eQUEST, Perform98, SMECCA, and many others). There are about 4,000 known users of DOE-2.x, and there are likely 1,000 to 2,000 more. 5. The algorithms have been translated into Neutral Model Format (NMF) and are available in IDA, a Swedish building simulation program. 6. Some of these algorithms will be used in the SUNREL simulation program. Special Publication 90358: Total sales to date: 618; sales this year: 31. Reference: Several toolkit models are referenced by Neymark & Judkoff in "International Energy Agency Building Energy Simulation Test & Diagnostic Method for HVAC Equipment (HVAC BESTEST)". Work by National Renewable Energy Lab. HVAC-02 cited in US DOE 1996 NEMVP HVAC-02 cited in US DOE 1997 IPMVP HVAC-02 cited in US DOE 2001 IPMVP HVAC-02 cited in ASHRAE Guideline 14 Algorithms from HVAC-02 used in 865-RP

Reviewer: _____

ASHRAE RESEARCH PROJECT DATABASE

Project Number	664	Title	Energy Estimating Methods for Predicting Ventilative Cooling Performance for Mixed Convection
Sponsor	TC 4.7		Illinois, U. of
			Pedersen, C. O.
			S91.06 C96.02
		Handbook Chapter Where Used	Chapter 31, 2001 HOF

Papers & Publications	Please Offer a Few Notes on the Useful Impact of this Project.
#4065 Vol. 103 Pt. 2 (1997) Convective heat transfer in building energy and thermal load calculations ,Fisher D E, Pedersen C O. ASHRAE Trans., 1997, vol.103, part 2, paper no.4065(RP-664), 137-148	1. The models from this research were incorporated into BLAST for testing. 2. Models from this research have been implemented into EnergyPlus. 3. Data from this project was used, along with RP-529 to develop models of convective heat transfer in rooms. These models were incorporated into a general room convective heat transfer model by Beausoleil-Morrison (2000), See also Beausoleil-Morrison and Strachan (1999) and Beausoleil-Morrison (2001). 4. Models incorporated into ESP-r and HOT3000 simulation programs. 5. These correlations/algorithms will be used in interpreting data from an empirical validation experiment for building energy simulation software for Electricité de France. References Beausoleil-Morrison, I and P. Strachan . 1999. On the significance of modeling internal surface convection in dynamic whole-building simulation programs to local flow conditions. ASHRAE Transactions. 105(2):929-940. Beausoleil-Morrison I, 2000. The Adaptive Coupling of Heat and Air Flow Modelling Within Dynamic Whole-Building Simulation, PhD Thesis, University of Strathclyde. Available online at: ftp://ftp.strath.ac.uk/Esru_public/documents/IB-M_thesis.pdf Beausoleil-Morrison I, 2001. An Algorithm for Calculating Convection Coefficients for Internal Building Surfaces for the Case of Mixed Flow in Rooms. Energy and Buildings. 33 (4) 351-361.

Reviewer: _____

ASHRAE RESEARCH PROJECT DATABASE

Project Number	665	Title	Preparation of a Toolkit for Primary HVAC System Energy Calculations
Sponsor	TC 4.7		U. de Liege
			Lebrun, J.
			S90.09 C94.01
		Handbook Chapter Where Used	Chapter 31, 2001 HOF

Papers & Publications	Please Offer a Few Notes on the Useful Impact of this Project.
OR-94-9-1 #1 Vol. 100 Pt. 2 A toolkit for primary HVAC system energy calculation. Part 1 - boiler model. Bourdouxhe J-P H., Grodent M., Lebrun J., Saavedra C. ASHRAE Trans. 1994, Vol.100, Part 2, Paper number OR-94-9-1 (RP-665), 759-773, OR-94-09 #2 Vol. 100 Pt. 2 A toolkit for primary HVAC system energy calculation. Part 2 - reciprocating chiller models. Bourdouxhe J-P H., Grodent M., Lebrun J J., Saavedra C., Silva K L, ASHRAE Trans. 1994, Vol.100, Part 2, Paper number OR-94-9-2 (RP-665) 774-786 Spec. Pub. 92050 (CD-ROM) HVAC 1 Toolkit: A Toolkit for Primary HVAC System Energy Calculation	1. University de Liege has integrated the models from the Primary Toolkit into TRNSYS. 2. The algorithms from the toolkit have been used for education of graduate students at a number of universities in the U.S. and Europe. 3. Some of the algorithms from the toolkit have been implemented in later versions of DOE-2.x and its derivatives ((such as EnergyPro, Visual DOE, PowerDOE, eQUEST, Perform98, SMECCA, and many others). There are about 4,000 known users of DOE-2.x, and there are likely 1,000 to 2,000 more. 4. Some of the algorithms from the toolkit have been implemented in ESP-r simulation program. 5. While copyright issues precluded the easiest implementation path of directly using the source code, the cooling tower algorithms have been implemented in EnergyPlus, which currently has over 2,300 registered users. Special Publication 92050: Total sales to date: 171; sales this year: 51. Reference: HVAC-01 cited in US DOE 1996 NEMVP HVAC-01 cited in US DOE 1997 IPMVP HVAC-01 cited in US DOE 2001 IPMVP HVAC-01 cited in ASHRAE Guideline 14

Reviewer: _____

ASHRAE RESEARCH PROJECT DATABASE

Project Number	666	Title	Energy Calculations for Basements, Slabs and Crawl Spaces
Sponsor	TC 4.7		Steven Winter Associates
			Claridge, David
			S91.04 C93.06
		Handbook Chapter Where Used	Chapter 31, 2001 HOF

Papers & Publications	Please Offer a Few Notes on the Useful Impact of this Project.
#3847 Vol. 101 Pt. 1 (1995) Comparison of energy prediction of three ground-coupling heat transfer calculation methods. Krarti M., Nicoulin C V., Claridge D E., Kreider J F. ASHRAE Trans. 1995, Vol.101, Part 1, Paper number 3847, 158-172. A foundation heat transfer algorithm for detailed building energy programs. Krarti M., Claridge D E., Kreider J F., ASHRAE Trans. 1994, Vol.100, Part 2, Paper number OR-94-11-2, 843-850	1. Results from 666-RP influenced new ground coupling model in California ACM 2000. 2. Current plans are to implement these algorithms in EnergyPlus. 3. Examples of energy calculations for basements and slabs are included in Chapter 31, 2001 HOF.

Reviewer: _____

ASHRAE RESEARCH PROJECT DATABASE

Project Number	717	Title	An Energy Calculation Model for Attics, Including Radiant Barriers
Sponsor	TC 4.7		Ober
			Holometrix
		Handbook Chapter Where Used	Fundamentals, Chapter 30

Papers & Publications	Please Offer a Few Notes on the Useful Impact of this Project.
Paper??	

Reviewer: _____

ASHRAE RESEARCH PROJECT DATABASE

Project Number	741	Title	Preparation of an Annotated Guide to Models and Algorithms Relating to Building Load Calculations
Sponsor	TC 4.7		Oklahoma State U.
			Spitler, J. D.
			S92.04 C94.06
		Handbook Chapter Where Used	Chapter 31, 2001 HOF

Papers & Publications	Please Offer a Few Notes on the Useful Impact of this Project.
#3903 Vol. 101 Pt. 2 (1995) Spitler, J.D., J.D. Ferguson. 1995. Overview of the ASHRAE Annotated Guide to Load Calculation Models and Algorithms. ASHRAE Transactions Vol. 101, No. 2, pp. 260-264. Spec. Pub. 90390 Spitler, J.D *Annotated Guide to Load Calculation Models and Algorithms.* ASHRAE 1996. (ISBN 883413-33-8).	1. Was used as the background in preparation for development of the Loads Toolkit (RP-987) 2. Contributed significant information to Chapter 30 of the 1997 Handbook of Fundamentals. 3. The Guide is being used for education of graduate students in some European universities. Special Publication 90390: Total Sales to date: 188; total sales this year: 29.

Reviewer: _____

ASHRAE RESEARCH PROJECT DATABASE

Project Number	756	Title	Modeling of Reflected Solar Heat Gain from Neighboring Structures in Building Energy Simulation Programs
Sponsor	TC 4.7		Enermodal Engineering
			Reilly, Susan
			S92.09 C94.07
		Handbook Chapter Where Used	Chapter 31, 2001 HOF

Papers & Publications	Please Offer a Few Notes on the Useful Impact of this Project.
Algorithms for modelling secondary solar heat gain. Dunne C., Reilly S., Ward G. et al ASHRAE Trans., 1995, Vol.101, Part 2, Paper number 3883, 43-49, OR-94-11-1 #1 Vol. 100 Pt. 2 Modelling the solar heat gain reflected from neighbouring structures Reilly S M., Dunne C P., Ward G J. et al ASHRAE Trans., 1994, vol.100, part 2, paper number OR-94-11-1 (RP-756), 835-842,	Enermodal received about 5 inquires concerning the results, i.e. software, and have been disappointed in the interest shown. The year following the completion of the project Enermodal promoted the tool with little success and then moved on. The work was nevertheless valuable. Enermodal found that the existing solar radiation exchange models are lacking --- which is why the research was undertaken. There are details such as view factors to the ground and sky and self-shading that are not handled properly in existing software. The result is that the existing software tends to over predict solar gain. Enermodal did not pursue making the software available as a package rather than as the results of a research project. This would have made the work more accessible.

Reviewer: _____

ASHRAE RESEARCH PROJECT DATABASE

Project Number	787	Title	A Sensitivity Study to Determine Parameters for Floor and Ceiling Plenum Energy Models
Sponsor	TC 4.7		Rock, B. A.
			U. Kansas
		Handbook Chapter Where Used	Chapter 31, 2001 HOF

Papers & Publications	Please Offer a Few Notes on the Useful Impact of this Project.
A sensitivity study of floor and ceiling plenum energy model parameters. Rock B A., Wolfe D J., ASHRAE Trans. 1997, Vol.103, Part 1, Paper number 4012 (RP-787), 16-30.	1. Project showed that further experimental research (originally considered by the TC) was not needed.

Reviewer: _____

second draft – 6/14/01

Towards a Strategy for TC 4.7

Scope of TC4.7

"ASHRAE Technical Committee 4.7 is concerned with identifying, evaluating, developing, and recommending procedures for calculating energy performance of buildings."

- design and operation of individual buildings (including analysis of retrofit options)
- generic assessments for policy purposes, including codes and standards development
- implementation in tools – should be "useable" or "easy to use"
- ensure that calculation procedures are available for systems that are potentially more energy-efficient than conventional systems.

Action Plan

The considerations discussed above suggest that we do the following:

1. Ensure that available energy calculation procedures are complete with respect to:
   a. Different environmental control systems (active/HVAC and passive/envelope)
   b. Different applications (operations, policy … as well as design)
2. Work to integrate energy calculation procedures with other analysis procedures used in different aspects of building procurement and operation.
3. Work to develop complete, end-to-end analysis procedures (emphasis on complete) and ensure that we have working implementations of the core calculations of each step of the selected procedures (leaving interfaces to others). These procedures will generally involve other considerations as well as energy.

The first is largely (though by no means completely) internal to TC4.7 and the current subcommittee structure seems reasonably well matched to fulfilling this aim. This would provide a focus and a filter. For a research topic to be adopted, we should be able to justify the statement that it represents (one of) the highest priorities within our scope. We need a process that involves the whole TC in the assessment of the completeness of existing energy calculation procedures and the prioritization of the gaps to be filled.

The second and third, by their very nature, cut across the scope of many other TCs, mostly in Section 4, some in Section 9.

There is currently no mechanism in ASHRAE to support this level of cross-cutting. We should resist the temptation to spawn Task Groups; there are already too many TC/TGs and setting up separate groups/committees does not necessarily promote integration, which is the underlying need.

We need to identify/invent a way for existing TCs to work together that goes beyond cosponsorship of research projects and program but doesn't create all the bureaucratic baggage of a new TG/TC. Aims of such a collaboration might include:

1. Identification of research needs in a broad technical area, e.g. procedures for the calculation of building/HVAC performance (this would be very helpful to RAC, particularly if carried out across the range of broad topic areas covered by the whole Society)
2. Identification of changes to the structure and content of the Handbook that would make it more useful to the designer.

One partial way to advance this idea would be to hold a series of forums. This vehicle would make it easier to solicit a range of views and also to transcend TC boundaries and allegiances. Another, complementary, approach is to work at the Section level to set goals and define a set of projects that would fill the gaps that prevent those goals being met using current knowledge. A possible way of working would be to create a (set of?) 'virtual' TG(s) on the web, each with a list server for exchanging ideas and an ftp site for developing work statements.

One major goal would be to provide a procedure or process for each of the major tasks in the design, commissioning and operation of buildings that involves (or should involve) energy calculations, e.g.:

- system selection
- system sizing
- performance verification
- retrofit analysis

The aim would be produce a Handbook chapter or group of chapters for each task, linked to a self-consistent and comprehensive set of (interoperable!) computer-based analysis tools and sources of data. These chapters could replace current chapters or form a new Procedures volume. A starting point would be for RAC to commission a set of case-study solutions of some typical design problems using Handbook methods. This would be a relatively short-term project that would rapidly reveal how poorly the current Handbook structure serves the member who "just wants to do <whatever>."

More generally, to get started, we should identify a few problems where:

1. Cross-cutting research is likely to be highly useful
2. The other interested TCs are likely to be cooperative
3. The number of other interested TCs is relatively small, say one to three.

Overall, what we are proposing is a radical change in the way the Society conducts research and produces the Handbooks.

TC4.7 Handbook Subcommittee Meeting Notes
ASHRAE 2001 Annual Meeting in Cincinnati
June 25, 2001

Attendees: Rick Strand (chair), Jim Willson, Klaus Sommer, Curt Pedersen, Vern Smith, Les Norford, Jeff Spitler, Dan Fisher, Ron Judkoff

Announcements: Chapter 31 (previously chapter 30) has been submitted to ASHRAE in its final form by Les Norford (previous chair) and the other members of the handbook subcommittee. Rick Strand noted that he has read the new chapter and that it is in excellent shape—Les Norford and the other members of the subcommittee are to be commended for their hard work. The main purpose of this meeting is to "regroup" and begin the discussion of where to go with the next version of the chapter since this is extremely early within the next cycle. Also for discussion is the role of the new ASHRAE ebook and how this will impact the future of Chapter 31.

Discussion: Future Direction of Handbook Chapter 31/Special Publications
Items: Comments on recently submitted Chapter 31
Holes or needs in future editions of the chapter
Academic/scientific information vs. practical engineering information
Related special publications already in existence from ASHRAE
Efforts by other organizations (CIBSE's "Building energy and environmental modeling")
Additions to Chapter 31 vs. additional handbooks vs. special publications
ASHRAE ebook: impact on Chapter 31 material and other publications
Collaboration with other groups such as TC4.1

Synopsis of discussion: Jim Willson reported that at the membership promotion meeting that it was reported that the handbook is "too scientific and not practical enough" and that ASHRAE is concerned about the impact of research and handbook on the average engineer. Klaus Sommer noted that in Germany there is a 2000 page HVAC manual that is split into more practical information and then more technical research. The practical information summarizes the fundamentals briefly so that there is some background information.

In the discussion of moving to an electronic format, there were concerns about an all electronic format (no printed version). Rick Strand demonstrated the possibilities with the new ebook by showing the demo CD produced as a part of RP-1017, complete with links, color drawings, and animations and asked if the attendees saw any possibilities for producing such items for use in an electronic version of Chapter 31. Klaus Sommer noted that air movement within spaces (such as results from a program like Phoenix, or Fluent as noted by Vern Smith) could be potentially visualized as animations or more static items such as annual fuel consumption graphs. Klaus also noted that it might be helpful to have spreadsheets or tables that were "hidden" behind equations so that the user could gain a better understanding of the physics being the mathematics.

There were questions about whether we have covered all areas, whether we can or need to come up with additional material, and what the concerns are about keeping up with a possibly more rapid schedule. Les Norford responded that changes and keeping up with changes can be a time intensive process. Overall the handbook is in good shape and many of the references have been fixed. Les also noted that the handbook chapter needs to be something that the entire TC is aware of, that a handbook "plan" needs to be constructed by the TC, and that the handbook committee needs more resources. In addition, there could be more interaction with the handbook subcommittees on other TCs. Jeff Spitler mentioned that there is a natural overlap with the new focus of the Applications subcommittee and the handbook subcommittee and that TC4.7 could publish some technical bulletins. Les noted that perhaps we should have a forum (email or actual) on the topic of handbook.

Other ideas about publications—another publication for consulting engineers, an expanded overview for the current chapter or for a version of the chapter for practicing engineers, information on Standard 140 (BESTEST) which will be informally released in about one month.

Action Items: Report to full committee and obtain more feedback on the direction of the handbook and ebook (Rick Strand); consult with Chip Barnaby about efforts by CIBSE to publish practical guidebooks (Rick Strand); review minutes and keep thinking about ideas for the future direction of the toolkit (everyone).

The meeting was adjourned at 5:55

TC 4.7 Program Plan
Following June 2001 meeting

Atlantic City / January 2002

1) Symposium
   Applications and development of calibrated models for chillers and cooling towers.
   Organized by TC 1.5; co-sponsored by TC 4.7 and TC 8.6.
   Chaired by Agami Reddy.

2) Seminar
   Commercial use of building energy simulations
   Organized by TC 4.7 (Applications)
   Chaired by Kamel Haddad

Honolulu / June 2002

1) Symposium
   Inverse methods for calculating savings from energy conservation retrofits.
   Organized by TC 4.7 (Inverse methods).
   Chaired by Jan Kreider.

2) Symposium
   Recent advances in energy simulation: Part 1.
   Organized by TC 4.7 (Sim and comp models); co-sponsored by TC 4.1.
   Chaired by Ian Beausoleil-Morrison

3) Seminar
   Getting started in building simulation.
   Organized by TC 4.7 (Applications).
   Chaired by Chip Barnaby.

4) Seminar
   Automated baselining procedures using inverse methods.
   Organized by TC 4.7 (Inverse methods).
   Chaired by Jeff Haberl.

Chicago / January 2003

1) Symposium
   Interoperability and tool portability.
   Organized by TC 4.7 (Sim and comp models).
   Chaired by Chip Barnaby.

2) Symposium

   Recent advances in energy simulation: Part 2.

   Organized by TC 4.7 (Sim and comp models).

   Chaired by Jan Hensen.

3) Symposium

   Integrating air flow modelling into energy analysis programs.

   Organized by TC 4.7 (Sim and comp models).

   Chaired by Ian Beausoleil-Morrison.

MINUTES
SPC-140 SMOT FOR BUILDING ENERGY SOFTWARE
Cincinnati, June 25, 2001
Chair: R. Judkoff (submitted Jun, 26 2001)

ATTACHMENTS

A. Agenda for June 25, 2001 meeting
B. Mailing List

CORRESPONDANCE SINCE LAST MEETING

ASHRAE Staff is working towards publication of Standard 140. According to Ron Anderson, the galleys for Standard 140 have been completed and should arrive at NREL very soon. ASHRAE anticipates that ANSI review should take about 2 weeks, and that publication within a month is possible.

The following roster recommendation was submitted to the MOS by Judkoff in May.

Name	Type of Member	Interest Category	Initial Term (years)
Beausoleil-Morrison, Ian	PCVM	Producer	5
Crawley, Dru	PCVM	Gen Int	4
Fairey, Philip	PCVM	Gen Int	6
Haberl, Jeff	PCVM	User	3
Judkoff, Ron	PCVM, Chair	Gen Int	4
Neymark, Joel	NVM, Vice Chair	Gen Int	4
Rees, Simon	PCVM	User	3
Walton, George	PCVM	Gen Int	5
Wilcox, Bruce	PCVM	Producer	3
Winkelmann, Fred	PCVM	Producer	6
Witte, Michael	PCVM	User	4

GENERAL

None

DIAGNOSTIC TESTS

The primary purpose of the meeting was to discuss test cases that could be added to Standard 140.

Attendees (see mailing list for full names, etc)

Note: Members of the future SSPC 140 group were in attendence, however, SPC 140 does not officially become SSPC 140 until Standard 140 is actually published by ASHRAE.

Voting Members
Crawley
Haberl
Judkoff (chair)
Walton
Wilcox
Witte

Non-Voting Members
Neymark (vice chair)

Other
Baxter (SPLS Liason)
Beausoleil-Morrison
Deru
Griffith
Henderson
Rees
Shirey
Torcellini

Committee Discussion

Approval of Prior Minutes

SSPC 140 would have had a quorum at this meeting, but does not officially exist until Std 140 is published. There was not a quorum of SPC 140 members at the beginning of the meeting so that no official actions could be taken.

Motion (): Accept Minutes of Jan 2001 meeting (Atlanta).
2nd ():

Vote: Yes = , No =
Absent = ()
Motion = passed/failed.

Discussion regarding Standards Committee Approvals (Baxter)

The following actions were taken regarding the SSPC 140 roster:

22 June 2001: SPLS approved the SSPC 140 Chair's roster recommendation.
23 June 2001: Standards Committee ratified SPLS's SSPC 140 roster approval.

We will have a new SPLS liason next year.

Update on activities regarding federal Senate Bill 207 that includes tax credit legislation for energy efficiency in buildings, and could reference Std 140 (Fairey)

There are 3 bills on tax credit legislation in the U.S. Senate; each bill has a very similar companion bill in the House. All 3 bills reference International Energy Conservation Code (IECC 2000 formerly Model Energy Code [MEC]) and mention certification of software. Of these, Fairey primarily discussed the bi-partisan bill (SB 207 – Smith/Feinstein) – that covers residential, commercial, and public/municipal new buildings and retrofit of existing buildings. SB 207 has a clause requiring certification of software that would be used to estimate energy savings related to tax credit evaluation.

SB 207 currently references the California ACM 98. Fairey's criticisms of using ACM 98 (acronym = ?) for this are that it is too complex and too constrained – some specifics are:

- ACM requires a minimum of 300 simulations for compliance.
- In some cases the state of the art in modeling is limited because some specific algorithms are required, e.g. for:
    - Ground modeling
    - Duct modeling
- ACM needs a range of acceptability rather than a single number.

Update on IECC citing of Std 140 (Fairey)

IECC 2000 currently uses HERS BESTEST as method of test for certification, but they would prefer to use a referencable document. They plan to reference Standard 140 when it gets an ANSI/ASHRAE designation.

Discussion of Test Cases that could be added to Standard 140

Presentations were given on test cases included in the following procedures that could be added to Standard 140:

- HERS BESTEST (Neymark)
- HVAC BESTEST (Neymark)
- RP-1052 Envelope Analytical Tests (Rees)
- RP-865 Air-Side Mechanical Analytical Tests (Haberl)

The sense of the future-SSPC 140 members present was that RP-1052 and RP-865 both need more field trials before those test cases could be considered for Standard 140.

Unofficial motion (Fairey): Incorporate HVAC BESTEST E100-Series test cases into Standard 140 as soon as possible.
Unofficial 2nd (Witte):

Discussion points in favor of motion included:

- Fairey: Energy consumption is the primary metric, therefore testing of mechanical systems models is essential.
- Witte: For a given software, the results (good or bad) of the specific performance map-based tests of HVAC BESTEST can be used as a general measure of the quality of other performance-map based models that exist in that given tool. Any fixes to a given software that were applied in specific cases are likely to be needed throughout its other performance-map related models.

Discussion point against motion included:

- Beausoleil-Morrison: Space cooling is a low priority in Canada

Unofficial Vote: Yes = 6 , No = 0, Abstain = 1 (Chair)
SSPC future members Absent = (Crawley, Wilcox, Winkelmann)
Motion = unofficially passed.

Later discussion of whether to prioritize HVAC BESTEST inclusion above HERS BESTEST inclusion resulted in

For HVAC BESTEST: Haberl, Rees, Fairey
For HERS BESTEST: Beausoleil-Morrison

Based on discussion, the following actions will be taken:

- VC: Send out copies of HERS BESTEST and HVAC BESTEST to SSPC 140.

- VC: Set up a conference call to discuss prioritization of HVAC BESTEST versus HERS BESTEST.

- Chair: Discuss feasibility of supporting work statements related to RP-1052/RP-865 field trials with ASHRAE R&T Committee

- VC: Modify framework of Chapter 4 to include new tests (after SSPC 140 formally decides which new tests are going in)

Meeting Adjourned.

References

ASHRAE. BSR/ASHRAE Standard 140P, *Method of Test for the Evaluation of Building Energy Analysis Computer Programs*. March 2001. ASHRAE, Atlanta, GA.

.

Attachment A – Agenda

SPC 140 Preliminary Agenda

Date: Monday, 25 June 2001
Time: 2:15P - 6:15P
Location: Room CC/234 (2nd level, of Cincinnati Convention Center)

0) Introductions

1) Approval of Previous Minutes (29 January 2001, Atlanta), attached

2) Update on publication status of Std 140 (Judkoff/Neymark)

3) Report on approval of SSPC 140 roster. (Baxter/Judkoff)

4a) Update on activities regarding federal Senate Bill 207 that includes tax credit legislation for energy efficiency in buildings, and could reference Std 140 (Fairey)

4b) Update on IECC citing of Std 140 (Fairey)

5) Discussion regarding mission for SSPC 140 including

- Incorporate more test cases (HERS BESTEST, HVAC BESTEST, 1052-RP, 865-RP)
- Update the current reference results
- Assist with development of compliance criteria that could be called out by other Standards
- Render official interpretations of the Standard
- Identify areas for additional research.

This discussion will include review/refresher presentations on:

5a) HERS BESTEST (Neymark, 15 minutes)
5b) HVAC BESTEST (Neymark, 15 minutes)
5c) RP-1052 Envelope Analytical Tests (Rees, 15 minutes)
5d) RP-865 Air-Side Mechanical Analytical Tests (Haberl, 15 minutes)

5e) Committee discussion to obtain a sense of preferred direction of activities.

6) Other

Attachment B - SPC 140 ADDRESS LIST 12 December 2000

(note: in general email attachments should go out as both *.DOC, *.RTF and *.WP5)

VOTING MEMBERS

Dru Crawley (User)
U.S. Department of Energy
EE-41
1000 Independence Avenue SW
Washington, DC 20585
Ph: (202) 586-2344
Fax: (202) 586-1628
email: drury.crawley@hq.doe.gov

Kathleen Fraser (Producer)
General Services, Transalta
Box 1900, Station "M"
110 - 12th Avenue S.W.
Calgary, Alberta, T2P 2M1
Ph: (403) 267-4784
Fax: (403) 267-2131
email: kathleen_fraser@transalta.com

Jeff S. Haberl, Ph.D., P.E. (User)
Department of Architecture
Texas A&M University
College Station, Texas 77843-3581
Ph: (979) 845-6065 -6507
Fax: (979) 862-2457
email: jhaberl@loanstar.tamu.edu
(note: send email attachments as *.RTF using MIME)

Ron Judkoff (General, Chair)
NREL
1617 Cole Blvd
Golden CO 80401
ph: 303 384 7520
fax: 303 384 7540
email: ron_judkoff@nrel.gov

Bruce Maeda (General)
California Energy Commission
1516 Ninth St MS42
Sacramento CA 95814
ph: 916 654 4077
fax: 916 654 4304
email: bmaeda@energy.state.ca.us

Robert C. Sonderegger (Producer)
Silicon Energy Corp.
1250 Marina Village Pkwy.
Alameda, CA 94501
Ph: (510) 848-8400
Fax: (510) 848-0788
email: Rsonder@siliconenergy.com

George Walton (General)
NISTAdmin
343 Route 270
South Quincy @ Orchard Road
Gaithersburg, MD 20899
Ph: (301) 975-6421
Fax: (301) 975-4032
email: gwalton@nist.gov

Bruce Wilcox (Producer)
BSG
1327 Grand Ave.
Piedmont, CA 94610
Ph: (510) 601-7475
Fax: (510) 601-7415
email: bwilcox@b-s-g.com.

Fred Winkelmann (Producer)
LBNL
One Cyclotron Road
MS 90-3149
Berkeley, CA 94720
Ph: (510) 486-4925
Fax: (510) 486-4089
email: fcw@gundog.lbl.gov

Michael J. Witte (User)
GARD Analytics, Inc.
1028 Busse Hwy.
Park Ridge, IL 60068
Ph: (847) 698-5685
Fax: (847) 698-5600
email: mjwitte@gard.com

SPC 140 NON-VOTING MEMBERS

Charles S Barnaby
Wrightsoft
394 Lowell St.
Lexington MA 02173
ph: 781 862 8719
fax: 781 861 2058
cbarnaby@wrightsoft.com

Joel Neymark (Vice Chair)
J. Neymark & Associates
2140 Ellis Street
Golden, CO 80401
Ph: (303) 384-3672
Fax: (303) 384-9427
email: neymarkj@csn.net

Jeffrey D Spitler
Oklahoma State University
School of Mechanical & Aerospace Engineering
Engineering North 218
Stillwater, OK 74078
ph: 405 744 5900
fax: 405 744 7873
email: spitler@osuunx.ucc.okstate.edu

Gren Yuill
University of Nebraska
Department of Architectural Engineering
Room 123E, Engg
6001 Dodge St.
Omaha, NE 68182-0176
ph: 402 554 3859
fax: 402 554 3860
email: Grenville_Yuill/CET/UNO/UNEBR@
unomail.unomaha.edu

SPC 140 RECENT PRIOR MEETING ATTENDEES (NON-VOTING)

Peter Armstrong
Battelle
pr_armstrong@pnl.gov

Ian Beausoleil-Morrison
Natural Resources Canada
CANMET Energy Technology Centre
580 Booth St., 13th Floor
Ottawa, Ontario
K1A0E4 Canada
Ph: 613 943 2262
Fax: 613 996 9909
email: ibeausol@nrcan.gc.ca

Jeff Blake
Natural Resources Canada
jblake@nrcan.gc.ca

Fred Buhl
LBNL
One Cyclotron Road
Berkeley, CA 94720
Ph: (510) 486-4912
Fax: (510) 486-4089
email: buhl@gronk.lbl.gov

Robert Calla
Natural Resouces Canada
rcalla@nrcan.gc.ca

Gale Corson
1333 Broadway Ste 1015
Oakland, CA 94612
Ph: 510 444 6500, x27
email: galec@schiller.com

Mike Deru
NREL
Michael_deru@nrel.gov

Philip Fairey
FSEC
pfairey@fsec.ucf.edu

Jason Glazer
GARD Analytics, Inc.
1028 Busse Hwy.
Park Ridge, IL 60068
Ph: 847 698 5686
Fax: (847) 698-5600
jglazer@gard.com

Brent Griffith
MIT
griffith@mit.edu

Jim Lutz
Lawrence Berkeley National Lab
1 Cyclotron Rd
MS 90-4000
Berkeley CA 94720
Ph: 510 486 7302
Fax: 510 486 6996
jdlutz@lbl.gov

Simon Rees
Oklahoma State University
Email: sjrees@okstate.edu

Lawrence R. Schaefer
Carrier Corporation
P.O. Box 4808
Carrier Parkway. TR-1
Syracuse, New York 13221
Ph: 315 432 6838
Fax: 315 432 6844
email: larry.schaefer@carrier.utc.com

Don Shirey
Florida Solar Energy Center
shirey@fsec.ucf.edu

Klaus Sommer
Fachhoch-Schule Koeln
klaus.sommer@vt.fh-koeln.de

Paul Torcellini
NREL
Paul_torcellini@nrel.gov

Dongyi Xiao
xiaodongyi@hotmail.com

SPC 140 ASHRAE Liasons & Cognizant ASHRAE Staff

SPLS LIASON
Van Baxter
Oak Ridge National Laboratory
(USPS address)
PO Box 2008, Bldg 3147, MS6070
Oak Ridge, TN 37831-6070
(Shipping address - Fedex, etc)
1 Bethel Valley Rd.
Bldg 3147, MS6070
Oak Ridge, TN 37831-6070
Ph: 540 248 9508, Fax: 540 248 9671
email: vdb@ornl.gov

STAFF LIASON
Claire Ramspeck
Manager of Standards
ASHRAE
1791 Tullie Circle NE
Atlanta GA 30329-2305
ph: 404 636 8400
fax: 404 321 5478
email: cramspeck@ashrae.org

Sandra Armstrong
Standards Administrator
ASHRAE
1791 Tullie Circle NE
Atlanta GA 30329-2305
ph: 404 636 8400 ext. 508
fax: 404 321 5478
email: sarmstrong@ashrae.org

Ron Anderson
Standards Analyst
ASHRAE
1791 Tullie Circle NE
Atlanta GA 30329-2305
ph: 404 636 8400
fax: 404 321 5478
email: randerson@ashrae.org

Mark Weber
Assistant Manager of Standards - American
ASHRAE
1791 Tullie Circle NE
Atlanta GA 30329-2305
ph: 404 636 8400
fax: 404 321 5478
email:mweber@ashrae.org