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 4, 2000

TC/TG/TRG TITLE: Energy Calculations

DATE OF MEETING: June 27, 2000 LOCATION: Minneapolis

MEMBERS PRESENT	YEAR APPTD	MEMBERS ABSENT	YEAR APPTD	EX-OFFICIO MEMBERS & ADDIT'L ATTENDANCE
Bill Bahnfleth	1998	Fred Winkelmann	1996	
Chip Barnaby	1999	Carol Gardner	1998	
Dru Crawley (SEC)	1999	Jean LeBrun (INTL)	1996	
Dan Fisher	1998	Michael Witte	1998	
Jeff Haberl	1999			
Moncef Krarti	1999			
Les Norford	1998			
Agami Reddy	1999			
Klaus Sommer (INTL)	1999			
Robert Sonderegger (CHM)	1999			
Jeff Spitler (VC)	1999			
George Walton	1996			

DISTRIBUTION

ALL MEMBERS OF THE TC/TG/TRG

TAC CHAIR	Dennis O'Neal
TAC SECTION HEAD	Byron Jones
SPECIAL PUBLICATIONS LIAISON	Ramon Pons
STANDARDS LIAISON	David Knebel
JOURNAL/INSIGHTS LIAISON	Steve Taylor
HANDBOOK LIAISON	David Claridge
PROGRAM LIAISON	Emil Friberg
REFRIGERATION LIAISON	Hugh Crowther
RAC RESEARCH LIAISON	Carl Speich
TEGA LIAISON	William Knight
EDUCATION LIAISON	Donald Colliver
ENV HEALTH COMMITTEE LIAISON	William Fisk
STAFF LIAISON (RESEARCH)	William Seaton
STAFF LIAISON (TECH SERVICES)	Martin Weiland
STAFF LIAISON (STANDARDS)	Claire Ramspeck

ASHRAE TC 4.7 Energy Calculations
MINNEAPOLIS MEETING
ACTION ITEMS

4. No-Cost time extension to March 31, 2001 for 1050-RP. Approved 11-0-1, chair not voting.

5. No-cost time extension to March 31, 2001 for 987-RP. Approved 11-0-1, chair not voting.

6. TC 4.7 Research Plan. Approved 11-0-1, chair not voting.

7. WS Incorporation Of Nodal Room Heat Transfer Models Into Energy Calculation Procedures, Approved 11-0-1, chair not voting.

5. Program plan approved 11-0-1, chair not voting.

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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: June 28, 2000

TC/TG/TRG TITLE: Energy Calculations

DATE OF MEETING: June 27, 2000 LOCATION: Minneapolis, MN

TC/TG/TRG MEETING SCHEDULE

LOCATION - past 12 months	**DATE**	**LOCATION - planned next 12 months**	**DATE**
Dallas	2/28/2000	Minneapolis	6/27/2000
Seattle	6/22/1999	Atlanta	1/30/2001

TC/TG/TRG SUBCOMMITTEES

Function	**Chair**
Simulation and Component Models	Dan Fisher
Applications	Joe Huang
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
1.	See Appendix 2.			
2.				
3.				
4.				

HANDBOOK RESPONSIBILITIES

Year & Volume	Chapter Title	**No.**	Deadline	**Handbook Subcom. Chair/Liaison**
2001 Fundamentals	Energy Estimating Methods	30	February 2000 Dallas	Norford/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)

Appendix 3

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

Appendix 4

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

Appendix 5

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

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)
How should ASHRAE Computer Models be Expressed? Boston (6/97)

JOURNAL PUBLICATIONS - Title, when published (past 3 yrs. present & planned)

Additional Attendance*

Present at TC 4.7 Meeting?				Last Name	First Name	E-Mail
Minneapolis June 2000	Dallas February 2000	Seattle June 1999	Chicago January 1999			
	X	X		Abushakra	Bass	b0a7654@unix.tamu.edu
	X			Addison	Marlin	Marlin.Addison@doe2.com
X				Anderson	J R	Anderson@netten.net
			X	Ayres	J Marx	JMAyres@gte.net
X	X	X	X	Bahnfleth	Bill	WPB5@psu.edu
X	X	X	X	Barnaby	Chip	CBarnaby@wrightsoft.com
X		X	X	Beausoleil-Morrison	Ian	IBeausol@nrcan.gc.ca
X		X	X	Black	Al	ABlack@mcclureng.com
		X		Blair	Nathan	Blair@tess-inc.com
X				Blake	Jeff	JBlake@nrcan.gc.ca
X				Bowman	Jim	Jim_Bowman@atandpa.org
X	X	X	X	Brandemuehl	Mike	Michael.Brandemuehl@colorado.edu
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		X		Carpenter	Allen	ACarpenter@nrcan.gc.ca
X				Carpenter	J Patrick	PCarpenter@tklp.com
	X		X	Claridge	David	Claridge@esl.tamu.edu
			X	Clark	Dan	Dan.Clark@carrier.utc.com
X	X	X	X	Crawley	Dru	Drury.Crawley@ee.doe.gov
X	X			Degelman	Larry	Larry@archone.tamu.edu
		X		Desjarlais	Andre	yt7@ornl.gov
X				Dewitte	Jorre	Jorre.Dewitte@ulg.ac.be
X	X			Eldridge	David	eldridd@okstate.edu
X	X	X	X	Fisher	Dan	DFisher@okstate.edu
		X		Flake	Barrett	Barrett.Flake@afit.af.mil
		X		Fraser	Kathleen	KFraser@transalta.com
	X	X		Gardner	Carol	GEMS@teleport.com
X	X			Gu	Lixing	Gu@fsec.ucf.edu
X	X	X		Haberl	Jeff	JHaberl@esl.tamu.edu
X			X	Haddad	Kamel	KHhaddad@nrcan.gc.ca
	X			Hanby	Victor	V.I.Hanby@lboro.ac.uk
X	X	X	X	Haves	Philip	PHaves@lbl.gov
X				Henderson	Hugh	Hugh@cdhenergy.com
		X	X	Hensen	Jan	JaHe@fago.bwk.tue.nl
	X			Henze	Gregor	henze@mit.edu
		X		Holmes	Michael	Michael.Holmes@arup.com
X	X		X	Huang	Joe	YJHuang@lbl.gov
			X	Hydeman	Mark	MHydeman@taylor-engineering.com
			X	Judkoff	Ron	Ron_Judkoff@nrel.gov

* **In order to preserve the e-mail addresses for all attendees, this is a complete list of attendees at this and the prior three meetings. It includes the voting members of the committee listed on the first page. An X in the "Present this meeting?" column indicates presence at this meeting.**

Present at TC 4.7 Meeting?				Last Name	First Name	E-Mail
Minneapolis June 2000	Dallas February 2000	Seattle June 1999	Chicago January 1999			
	X	X	X	Katipamula	Srinivas	S_Katipamula@pnl.gov
X				Kelso	Richard	RKelso1@utk.edu
		X		Kissock	Kelly	JKissock@engr.udayton.edu
	X	X	X	Knappmiller	Kevin	KevinK@kevtec.com
		X	X	Knebel	Dave	DEKnebel@cs.com
X	X			Kosny	Jan	kyo@ornl.gov
X				Kossecka	Elisabeth	Ekossec@ippt.gov.pl
X	X	X		Krarti	Moncef	Krarti@bechtel.colorado.edu
	X	X	X	Kreider	Jan	Kreider@bechtel.colorado.edu
	X			Lamberts	Roberto	Lamberts@ecv.ufsc.br
			X	Lawrie	Linda	L.Lawrie@computer.org
X	X	X	X	Leber	Jon	jahbata@aol.com
	X	X		Lebrun	Jean	J.LeBrun@ulg.ac.be
		X		Levermore	Geoff	Geoff.Levermore@umist.ac.uk
			X	Liesen	Richard	R-Liesen@uiuc.edu
	X			Loomans	Marcel	M.Loomans@bouw.tue.nl
X	X	X	X	McDowell	Tim	Mcdowell@tess-inc.com
		X		McGowan	Alex	Alex@enermodal.com
		X	X	Medina	Mario	MMedina@ukans.edu
X	X	X	X	Morner	Svein	SMorner@dorganai.com
	X			Mottillo	Maria	Mmottilo@nrcan.gc.ca
X	X	X	X	Neymark	Joel	NeymarkJ@sni.net
X	X	X	X	Norford	Les	LNorford@mit.edu
X	X	X	X	Pedersen	Curt	CPederse@uiuc.edu
X		X		Purdy	Julia	JPurdy@nrcan.gc.ca
X	X	X	X	Reddy	T. Agami	ReddyTA@drexel.edu
X	X	X	X	Rees	Simon	SJRees@okstate.edu
	X			Rittelmann	Bill	Brittelmann@ibacos.com
	X			Rock	Brian	barock@ukans.edu
			X	Selkowitz	Steve	SESelkowitz@lbl.gov
X	X	X	X	Smith	Vernon	VSmith@archenergy.com
		X		Somasundaram	Sriram	Sriram.Somasundaram@pnl.gov
X	X	X	X	Sommer	Klaus	Klaus.Sommer@vt.fh-koeln.de
X	X	X	X	Sonderegger	Robert	RCS@src-systems.com
X	X			Sowell	Ed	Sowell@fullerton.edu
X	X		X	Spitler	Jeffrey	Spitler@okstate.edu
X	X	X	X	Strand	Rick	R-Strand@uiuc.edu
X	X	X	X	Walton	George	GWalton@nist.gov
		X		Wetter	Michael	MWetter@lbl.gov
X	X	X	X	Willson	Jim	jimwill@indy.net
		X	X	Winkelmann	Fred	FCWinkelmann@lbl.gov
	X	X	X	Witte	Mike	MJWitte@gard.com
X	X	X	X	Wray	Craig	CPWray@lbl.gov
		X	X	Wright	Jonathan	J.A.Wright@lboro.ac.uk
X				Wyndham-Wheeler	Paul	PWheeler@nrcan.gc.ca
	X	X	X	Yuill	Gren	Yuill@unomaha.edu

Appendix 1

RESEARCH PROJECTS

TC 4.7 Research Projects Status

Active projects

Project	Title	Joint TC	Cognizant Subcommittee/ Contractor	PMS	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: until 2-28-98 (7-1-97) NCE: until 8-31-98 (1-20-98) NCE: until 3-31-99 (6-23-98) NCE: until 3-31-2000 (1-27-99)
987-RP	Preparation of a Toolkit for Building Load Calculations	4.1	Sim/Comp Univ. of Illinois Curt Pedersen	Dru Crawley (chair), Chip Barnaby, George Walton, Dave Knebel; Tom Romine (TC 4.1)	Rec: 1-28-97 (Phil) End: 12-31-99 NCE until 7-31-2000 (6-22-99)
1049-RP	Building System Design and Synthesis	1.5	Sim/Comp Loughborough University	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:
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) End:
1052-RP	Development of an Analytical Verification Test Suite for Whole Building Energy Simulation Programs – Building Fabric		Sim/Comp OSU Jeff Spitler	George Walton (chair), Ron Judkoff, Joel Neymark, Fred Winkelmann	WS: 7-1-97 (Boston) Rec: 6-23-98 (Toronto) Start: 1-1-99 End: 4-30-2000
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 End:
1145-RP	Modeling Two- and Three-Dimensional Heat Transfer Through Composite Wall and Roof Assemblies in Hourly Simulation Programs		Sim/Comp Enermodal Engineering Ltd	Ian Beausoleil-Morrison (chair); George Walton; Fred Winkelmann, Doug Hittle (TC 4.1)	Approved in Toronto (6-23-98) Rec: 6-22-99 (Seattle) End:
1163-TRP	Standard Operating Conditions for North American Residential Buildings		Danny Parker, Joe Huang, Fred Buhl	Craig Wray (chair), Joel Neymark, and Vernon Smith	WS: 6-22-99 (Seattle)

Appendix 2

LONG-TERM RESEARCH PLAN

Technical Committee 4.7 Energy Calculations
2001-2002 Research Plan
1 August 2000

Priority 2001 – 2002	Prior priority	Status	Title	Subcommittee
0		Revision	Procedures for Evaluating Computer Calculated Results Against Measured Energy Data (1051-WS)	Inverse Methods
0	3 (1999-2000)	Cancelled Tech Council 3/00 Reconsideration 10/00	Standard Operating Conditions in North American Residential Buildings (1163-TRP)	Applications
0	1 (2000-2001)	Returned 3/00 Resubmit 9/00	Updated Energy Calculation Models for Residential HVAC Equipment (1197-WS)	Simulation and Component Models
1		Approved by TC; submit 9/00	Incorporation of Nodal Room Heat Transfer Models into Energy and Load Calculation Procedures	Simulation and Component Models
2		Draft WS	Development of Comparative Test Cases for Evaluating Simulation Models of Slab, Crawl Space and Basement Heat Transfer Through Adjacent Ground	Applications
3		Draft WS	Inverse Bin Procedures for Analyzing Energy Savings	Inverse Methods

Appendix 3

TECHNICAL PAPERS FROM SPONSORED RESEARCH

June 1997

664-RP Fisher, D.E., C.O. Pedersen. 1997. Convective Heat Transfer in Building Energy and Thermal Load Calculations. ASHRAE Transactions V 103 n 2.

Appendix 4

TC/TG/TRG SPONSORED SYMPOSIA

PLANNED:

Atlantic City, June 2001

Interoperability and Tool Portability (Chair: Chip Barnaby)
Inverse Method Toolkit and Applications (Chair: Jan Kreider)

Cincinnati, June 2001

Better Inputs for Better Output (Applications, TC 9.6 co-sponsor/Chair: Jim Willson)
Tools and Techniques for Calibration of Component Models (TC1.5 co-sponsor/Chair: Agami Reddy)
The Stories that Utility Records Tell Us about Energy Performance in Commercial Buildings
(TC 9.6 and 4.7/Chair Taghi Alereza)

Atlanta, January 2001

Simulation Models for Low-Energy Cooling (Simulation & Component/Chair: Joe Huang)
Five papers out for review as of June 15, 2000, one more expected

PRESENT:

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)

PAST:

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)

Boston - June 1997

Field Methods for Analyzing Equipment, Building and Facility Energy Use (Chair: Agami Reddy/co-sponsor TC 9.6)

Appendix 5

TC/TG/TRG SPONSORED SEMINARS

PLANNED:

Cincinnati - June 2001

Low Energy Cooling Case Studies (Chair: Phil Haves)

Commercial Use of Building Energy Simulations (Applications/Chair: Hofu Wu)

Atlanta - January 2001

Low Energy Cooling Case Studies (Chair: Phil Haves)

PRESENT:

none

PAST:

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)

Boston - June 1997

Practical Applications of Energy Calculations (Chair: Chip Barnaby)

ASHRAE TC 4.7 Energy Calculations

Tuesday, June 27, 2000, 6:00-8:30 p.m.
Hyatt/Lake Superior A (5th floor)

1. **Roll Call and Introductions.** Chairman Robert Sonderegger called the meeting to order at 6:00 pm. Members in attendance include: Robert Sonderegger, Jeff Spitler, Bill Bahnfleth, Chip Barnaby, Dru Crawley, Dan Fisher, Jeff Haberl, Moncef Krarti, Les Norford, Agami Reddy, Klaus Sommer, and George Walton. See Additional Attendance for other attendance.

   RAC Liaison Carl Speich was introduced. Speich introduced the incoming RAC Liaison Sheila Hayter. Sonderegger then introduced Byron Jones, TAC Section 4 Head. Jones recognized Sonderegger, presenting him with a certificate of appreciation for his service as chairman during 1998-2000.

2. **Accept Agenda and Approve Minutes of Dallas Meeting**. Agenda for the meeting is shown in Attachment A. Fisher moved (Barnaby seconded) to approve the minutes of the Dallas meeting. Approved unanimously by voice vote.

3. **Announcements.**
   - TAC will be giving an annual TA Award for outstanding service over the past year. One per year, nominations to Sonderegger, deadline around 1 September.
   - Sonderegger requested a volunteer to take over the task of nominating awards from within the TC. Hearing none, Sonderegger volunteered.
   - 7th World Conference, CLIMA 2000, September 2001. Abstracts due August 30. www.clima2000.it
   - Program packages due to ASHRAE HQ by August 4th.

4. **Membership**. Sonderegger reported that TC 4.7 would have a 50% turnover in membership with the new year starting July 2000. Two new members were appointed two years ago but had been left off the roster. Roster is now nearly fixed. New members include Jan Hensen (IM), Ian Beausoleil-Morrison, Phil Haves, Joel Neymark, Vernon Smith, Jim Willson, Craig Wray, and Gren Yuill. Rolling off Sonderegger, LeBrun, Winkelmann, Jeff Haberl, and Walton. Incoming chair is Spitler, Crawley is vice chair, and Norford is new Secretary.

5. **Subcommittee Reports.**

5.1 Applications Subcommittee. Subcommittee Chair Joe Huang reported on activities of the subcommittee. Minutes are shown in Attachment B.

> **1093-RP Diversity Factors & Schedules for Energy and Loads.** Agami Reddy reported on the PMS meeting of 1093 (see Attachment C). Contractor (Texas A&M University) turned in a report on phase 2 in draft form in April. and a phase 3 draft report just prior to this meeting. Complete draft final report due in August and final report planned to be complete in October.

5.2 Inverse Methods Subcommittee. Subcommittee Chair Jeff Haberl reported that the subcommittee met today and discussed several work statements and RTARs (see Attachment D for minutes).

> **865-RP Accuracy Tests for Mechanical System Simulation**. PMS Chair George Walton reported that the PMS met on Monday afternoon with the contractor (Pennsylvania State University/Texas A&M University), who reported that the project was moving forward but that due to the illness of Gren Yuill (PI) may be delayed. The fan issue discussed at the last meeting has been resolved and 4 of 7 systems are complete.
>
> **1050-RP Development of a Toolkit for Calculating Linear, Change-Point Linear and Multiple-Linear Inverse Building Energy Analysis Models.** Sonderegger reported that the PMS had a teleconference with the contractor (University of Dayton). Beta version of the toolkit is expected by the end of July with testing completed by end of September. Draft final report expected by the next meeting. PMS recommends a No-Cost time extension to March 31, 2001. Barnaby moved (Krarti second) to request that the contract be

extended to March 31, 20001. Approved 10-0-2, chair not voting. Sonderegger indicated that the PMS needs additional beta testing volunteers. Jeff Blake volunteered.

5.3 Simulation & Component Models Subcommittee. Subcommittee chair Dan Fisher reported on the meeting of the subcommittee (see Attachment E for subcommittee minutes).

987-RP Preparation of a Toolkit for Building Load Calculations. PMS chair Dru Crawley reported on the progress of the loads toolkit. After many delays due to multiple staff moves and changes, the project is now back on track. Contractor (University of Illinois) agreed to provide a final CD of the toolkit for review by October 1 (meeting notes are shown in Attachment F). The PMS has recommended a No-Cost Time Extension to March 31, 2001. Crawley moved (Walton second) that TC 4.7 request a no-cost time extension until March 31, 2001 for the 987-RP contract. Approved 11-0-1, chair not voting.

1049-RP Building System Design and Synthesis. Ed Sowell reported on 1049-RP for the PMS (see Attachment G for minutes of the PMS meeting). Because of an accident, the PI, Vic Hanby, Loughborough University, was not able to make it to the meeting. Progress report from the contractor was the only information available. PMS concerned about progress to date, $5k spent to date (of $181k). PMS chair will ask contractor to provide a plan to get the RP back on track.

1052-RP Development of an Analytical Verification Test Suite for Whole Building Energy Simulation Programs – Building Fabric. PMS Chair George Walton reported on progress on 1052-RP; contractor is Oklahoma State University. The scope of work includes 17 items, of which four are complete. Contractor has added a simple infiltration test and airflow network test. Working on comparing analytic tests to BLAST. Largest remaining task is 3rd party test. Contractor plans to have draft in December/January, final report ready for approval at next meeting.

1145-RP Modeling Two- and Three-Dimensional Heat Transfer Through Composite Wall and Roof Assemblies in Hourly Simulation Programs. PMS Chair Ian Beausoleil-Morrison reported on progress on 1145-RP. The PMS met with the contractor (Enermodal) on Sunday. The project is generally on schedule, going well. Contractor will use 20 building assemblies in project. Enermodal has completed detailed numerical modeling and developed alternate techniques. Next major step is to implement the models in DOE-2. Draft final report due in early January. PMS to review and vote in January.

5.4 Research Subcommittee. Research Subcommittee Chair Chip Barnaby then led the discussion on one previously approved Work Statement and the 2001-2002 Research Plan.

1163-TRP Standard Operating Conditions in North American Residential Buildings. Robert Sonderegger reported that this Work Statement had been previously approved by the TC and sent out for bids. At the Dallas meeting, the TC had reviewed bids and recommended a contractor but Tech Council rejected the project after it was approved by RAC. In the interim, Sonderegger and others have been working to learn more about the issues, including writing a letter replying to the concerns stated by Tech Council. Tech Council will discuss at their meeting on Wednesday. Barnaby circulated a motion for review by the TC:
"TC 4.7 recommends that ASHRAE research procedures be modified such that projects not be cancelled after they are approved for bidding, except:

- When no satisfactory proposals are received after an adequate number of bidding cycles;
- When procedural irregularities compromise the impartiality of work statement preparation or proposal review; or
- Under emergency conditions such as Society financial reversal or national crisis."

Barnaby moved (Crawley second) that TC 4.7 approve this motion. Approved 11-0-1, chair not voting. Sonderegger will forward to the right channels in ASHRAE.

2001-2002 Research Plan. Barnaby presented a list of active Work Statements in development or already reviewed (see Attachment H). Barnaby moved (Spitler second) to accept the plan as presented. Approved 11-0-1, chair not voting. The 3 RTARs are included in Attachment H.

WS Incorporation Of Nodal Room Heat Transfer Models Into Energy Calculation Procedures. Simon Rees presented the Work Statement on Nodal Room Heat Transfer for discussion (see Attachment I). Fisher moved (Barnaby second) that the TC recommend that RAC approve this Work Statement for bidding. Approved 11-0-1, chair not voting. Sonderegger appointed the following as the Project Evaluation Subcommittee: Phil Haves, Chair; George Walton; Agami Reddy; Tim McDowell; and Vernon Smith.

5.5 Handbook. Handbook Chair Les Norford reported on the Handbook Subcommittee meeting (see Attachment J for notes). TC members to review and provide comments on the draft circulated before the meeting by July 31st and vote yes/no for approval. The TC expressed thanks to Norford for his hard work on handbook chapter.

5.6 Program. Program Chair Bill Bahnfleth provided an update of current and future program plans (see Attachment K). Bahnfleth moved (Barnaby second) that TC 4.7 approve the program plan as presented. Approved 11-0-1, chair not voting.

5.7 Standards (SPC-140 SMOT). Joel Neymark reported on SPC 140P (minutes are shown in Attachment L). The public review was completed just prior to this meeting, ending June 6. Received comments from two people for a total of 16 total comments. The SPC is preparing Responses being prepared for review and approval of the SPC.

6. **Reports on related activities.**

IBPSA. Barnaby reported on IBPSA-USA, met on Saturday, discussion and presentation of interoperability issues (Selkowitz, IAI and Kennedy, XML). Next meeting will be in Atlanta, Saturday afternoon. Next international conference. IBPSA BS '01 in Rio, abstract due September 15th.

GPC 14P Measurement of Energy and Demand Savings. Haberl reported on GPC 14P meeting. GPC 14P had a seminar at this meeting, well attended. The draft guideline was out for 60-day public review prior to the Minneapolis meeting, ended June 6. Comments received and GPC reviewing/preparing responses. Hope to have published in the next year or two.

IAI International Alliance for Interoperability. Haves reported on various activities, XML, IAI, need for underlying data model to prevent tower of babble, competing schema. HVAC committee of IAI is working to develop the model and XML. CEC/DOE work to extend current HVAC IFC model major extension to support energy simulation.

TC 4.1 Load Calculations. Spitler reported that TC 4.1 working with 4.5 and 4.2 on updating there load calculation chapter. 2001 Handbook will only have heat balance and RTS as load calculation methods.

TC 4.2 Weather Information. Crawley reported that TC 4.2 had agreed to extend the weather information in the 2001 Handbook to include the more extensive cooling design data requested by TC 4.1.

TC 4.3 Ventilation Requirements and Infiltration. Wray reported that TC 4.3 has a work statement on infiltration/exfiltration. The project may start in fall 2000.

TC 4.5 Fenestration. No report on TC 4.5.

TC 4.6 Building Operation Dynamics. Brandemuehl reported that TC 4.6 is developing a WS on HVAC equipment dynamic models. TC 4.6 would like a letter of support from TC 4.7 in pursuit of this work statement. TCs 1.4 and 4.11 have cosponsored and it has implications for energy calculations. Requesting letter from chair of TC 4.7 in support of this WS. Barnaby moved (Spitler second) that the chair will send a letter supporting this work statement. Approved 11-0-1, chair not voting.

TC 4.11 Smart Building Systems. Norford reported that TC 4.11 uses the energy calculations from TC 4.7. May in future request co-operative work.

TC 9.6 Systems Energy Utilization. Reddy reported that TC 9.6 was looking into developing a work statement around reconciling simulated data with observed data.

For future meeting, Crawley volunteered to provide an update on TG 2.BIE Buildings Impact on the Environment; Bahnfleth agreed to be liaison with SSPC 90.1.

7. Old Business. None.

8. New business. None.

9. Adjourn. Motion to adjourn. Adjourned at 8:32 pm. Sonderegger thanked by committee for his work as chair.

ASHRAE TC 4.7 Energy Calculations

Agenda

Tuesday, June 27, 2000, 6:00-8:30 p.m.
Hyatt/Lake Superior A (5th floor)

1. Roll call and introductions		Crawley
2. Accept agenda & approve minutes of Dallas meeting		Sonderegger
3. Announcements		Sonderegger
4. Membership		Sonderegger
5. Subcommittee reports		
5.1 Applications		Huang
1093-RP Diversity Factors & Schedules for Egy & Loads	(TA&M)	Reddy
5.2 Inverse Methods		Haberl
865-RP Accuracy Tests for Mech System Simulation	(Penn/TA&M)	Walton
1050-RP Inverse Toolkit	(U Dayton)	Kreider
5.3 Simulation & Component Models		Fisher
987-RP Loads Toolkit	(UoIll)	Crawley
1049-RP Building System Design Synthesis update		Pedersen
1052-RP Analyt Test Suite Whole Bldg Egy Progs	(OSU)	Walton
1145-RP Modeling 2&3-D Ht Transfer Thru Composite	(Enermodal)	Beausoleil-Morrison
5.4 Research		Barnaby
1163-TRP Standard Operating Conditions in North American…		Sonderegger
2001-2002 Research Plan		Barnaby
5.5 Handbook		Norford
5.6 Program		Bahnfleth
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
SPC 152 MOT Design & Seasonal Eff'cies of Resid Thermal Distr Systems		Walton
TC 4.1 Load Calculations		Spitler
TC 4.2 Weather Information		Crawley
TC 4.5 Fenestration		Volunteer
TC 4.6 Building Operation Dynamics		Brandemuehl
TC 4.11 Smart Building Systems		Norford
TC 9.6 Systems Energy Utilization		Reddy

7. Old Business
8. New business
9. 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

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TC 4.7 Meeting Schedule

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

TC 4.7 Sunday 9:00-10:00a Pearl 2 (H/2) – This room is up for grabs to anyone…
TC 4.7 1049-RP Sunday 10a-12:00p Hyatt/Niccollet D3 (M)
TC 4.7 1050-RP Sunday 12:00-2:00p Hyatt/Niccollet D3 (M) CANCELLED (teleconference 6/15)
TC 4.7 1145-RP Sunday 2:00-3:00p Hyatt/Niccollet D3 (M)
TC 4.7 987-RP Sunday 3:00-4:00p Hyatt/Niccollet D3 (M)

TC 4.7 1093-RP Monday 7:00-8:00a Hyatt/Grant (M)
TC 4.7 1052-RP Monday 11:15-12:15p Hyatt/Greenway H(2)
865-RP Accuracy Tests 1-2:15 MCC/203B (2) – not on ASHRAE schedule!
SPC 140P Standard MOT Monday 2:15-6:15p MCC/203B (2)
TC 4.7 Handbook Monday 5:00-6:00p Hyatt/Nicollet D2 (M)
TC 4.7 Simulation & Component Models Monday 6:00-7:30p Hyatt/Nicollet D2 (M)
TC 4.7 Applications Monday 7:30-9:00p Hyatt/Nicollet D2 (M)

TC 4.7 Inverse Methods Tuesday 3:30-5:00p Hyatt/Lake Harriett (5)
TC 4.7 Energy Calculations (50)(OVH) Tuesday 6:00-8:30p Hyatt/Lake Superior A (5)

Don't miss:

Sunday, 9:00:00 AM - 9:50:00 AM, Forum 3 (Room 101 E)
How to Write a Better Research Work Statement

Sunday 8-10 a.m., Symposium MN-00-01 (Room: 101 AB)
Experience with Weather Data for Simulation and Design, Part 1: Simulation, Ventilation and Daylighting

Sunday 10:15:00 AM - 12:15:00 PM, Symposium MN-00-03 (Room: 101 AB)
Experience with Weather Data for Simulation and Design, Part 2: Simulation

AGENDA
TC 4.7 Subcommittee on Applications
Monday, 26 June, 7:30 - 9:00 p.m.
Hyatt/Nicollet D2
Chair: Joe Huang / Secretary: Jeff Haberl

1. **Introductions (5 minutes)**
2. **Accept agenda & approve minutes of Dallas meeting (5 minutes)**
3. **Announcements (5 minutes)**
4. **Program (10 minutes)**

Minneapolis: International Experience with Weather Data for Simulation and Design (Crawley, TC 4.2 Co-sponsor)

Atlanta: Symposium on "Better Inputs for Better Outputs" (Willson)
Seminar on "Commercial Use of Building Energy Simulations" (Wu/Addison)

Cincinnati: Symposium on "Recent Innovations in HVAC System Modeling" (McDowell)

5. **Research**

- **Ongoing Project (5 minutes)**

1093-RP Diversity Factors & Schedules for Energy and Loads (Reddy, PMS Chair)

- **Rejected Work Statement (5 minutes)**

1163-TRP Standard Operating Conditions in North American Residential Buildings

- **Work Statements in Progress (30 minutes)**

"Development of ground coupling cases for the proposed ASHRAE SMOT 140" (Neymark, Beausoleil)

"Defining performance factors for primary and secondary equipment simulation inputs for Commercial buildings" (Nall, LeBrun)

"Development of standardized computer input files for describing typical residential homes and the most common energy conservation retrofits" (Haberl)

"Characterization of building thermal loads from chiller electric use data" (Sonderegger, Haberl)

"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" (Reddy, Addison)

"Analysis and Testing of Energy Cost Budget Method in ASHRAE Standard 90.1" (Bahnfleth)

- **Long Range Research Plan (10 minutes)**

6. **Old Business (5 minutes)**
7. **New Business (5 minutes)**
8. **Adjourn**

ATTENDANCE LIST

NAME:	EMAIL:
Joe Huang	YJHuang@lbl.gov
Jeff Haberl	JHaberl@tamu.edu
Gregor Heinze	GHenze@unc.edu
Moncef Krarti	Krarti@colorado.edu
Fred Buhl	WFBuhl@lbl.gov
George Walton	GWwalton@nist.gov
Klaus Sommer	Klaus.Sommer@vt.fh-koeln.de
Ian Beausoleil-Morrison	IBeausol@nrcan.gc.ca
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Jeff Blake	JBlake@nrcan.gc.ca
Kamel Haddad	Khaddad@nrcan.gc.ca
Jan Kosny	Kyo@ornl.gov
Phil Haves	Phaves@lbl.gov

Joe Huang called the meeting to order at 7:31.

Material was then passed around, including: agenda, a signup list, minutes and RTARs for discussion. This was then followed by introductions.

Huang then instructed the subcommittee to review the minutes and agenda.

MOTION: Barnaby moved and Krarti 2nd to accept the minutes. Motion carried.

There were no announcements from the subcommittee.

Discussion then moved to Program.

Huang reviewed the planned program activities, which consisted of a seminar in Atlanta on “Commercial Use of Building Energy Simulations”, to be chaired by Hofu Wu and Marlin Addison, and two symposia in Cincinnati, one on "Recent Innovations in HVAC System Modeling”, to be chaired by Tim McDowell, and one on "Better inputs for better outputs”, to be chaired by Jim Willson. These were then discussed in sequential order.

Huang mentioned that he had asked Wu and Addison via e-mail about progress on the Atlanta seminar, but did not receive a clear response. Despite the lack of activity, Huang recalled there was substantial discussion and interest expressed at the Dallas meeting about this seminar, which would present the perspectives of consultants who use computer simulations in the professional world. Sonderegger further explained the topic of the seminar as,"energy simulation for profit”

ACTION: Huang said that he would contact Marlin and Hofu again about his progress and interest in organizing this seminar.

ACTION: Kamal Haddad agreed to work with Marlin to forward this seminar.

As for the two symposia slated for Cincinnati, Tim McDowell said that he had not received much interest or support for the first symposium, and recommended that it be dropped from the program list. Huang noted that symposium had already been postponed for two meetings, and accepted this recommendation

In reference to the second symposium, Huang said that he had been in contact with Jim Willson, who said he couldn't make this meeting due to a schedule conflict, but that symposium is progressing well. Willson also stated that he has 4 committed authors who have submitted abstracts, and is expecting papers in August or September. Willson also requested Huang to ask the subcommittee for person(s) willing to review the papers. Huang handed out a spreadsheet from Willson of the paper titles received, and asked the subcommittee for volunteers for reviewing.

ACTION: Sommer, Walton, Henze, Ian Theaker (not present), McDowell agreed to review papers.

Huang then asked for discussion about other ideas for programs.

The discussion then moved on to research. Huang then asked to discuss the ongoing projects.

1093-RP. "Diversity of Factors & Schedules for Energy and Loads"

Huang reported that a PMS meeting was held at 7:00 a.m. with the contractor. Purpose of the project is to develop a method for calculating diversity factors. Contractor has 37 datasets in hand, and additional data from PNNL from the ELCAP project. Contractor has made good progress towards completing the load shapes for the promised 37 sites.

Load shapes will show weekday, weekend profiles from actual data. Input files for DOE-2, BLAST and EnergyPlus will be produced for insertion into simulations. Contractor will produce paper and electronic deliverables with load shapes and data.

PMS will then need to review the deliverable for acceptance and approval

ACTION: Huang asked for reviewers. Buhl and Sommer are interested in reviewing the final report

Huang then moved on to discuss RP1163 "Standard Operating Conditions in North American Residential Buildings".

Project was approved at Dallas by TC 4.7 and was put out for bid. (2) Bids were received and a PMSC was chosen to review proposals. PMSC recommended a bidder to Tech Council, who then decided to cancel the project.

Sonderegger said that various members of the TC have been looking into this issue with RP 1163, and that negotiations are still underway with ASHRAE headquarters. Robert recommended that further discussion be tabled until the full TC 4.7 committee meeting.

Discussion then moved on to discuss the research idea "Analysis and Testing of Energy Cost Method in ASHRAE Standard 90.1 (Deringer).

Joe Deringer reported that he had reviewed 90.1 and noticed several issues about the compliance paths. At the Dallas meeting it was suggested that perhaps 90.1 had a number of technical issues with the Energy Cost budget that needed testing and analysis.

Deringer has developed a draft WS for investigating the problems. A diskette with the WS was delivered to TC 4.7 Applications Secretary.

Deringer suggested that systematic tests needed to be developed with the current Energy Cost Method to parametrically test 90.1 to see what measures count and which don't. This would allow one to see which "legal" requirements have some sort of verifiable basis.

Deringer said that the new Energy Cost method was extremely efficient at naming rules for conserving energy. Deringer proposed that some innovative buildings be proposed and simulated to see if 90.1 was actually tracking the value of the ECDM. The test would see if 90.1 discourages innovative buildings.

Deringer said another possible test would test for the compliance procedures.

Deringer said that another possible test would test for "gaming" see how well one could produce false results by "gaming" 90.1.

Barnaby commented that this sounded like product testing for 90.1 and was describing what 90.1 should have been done in the first place.

Deringer agreed, but said that unfortunately this had not been done. The current revision of 90.1 has been reviewed and is out. There is also a 200-page supplement that describes all the rules. He said that this whole procedure was the stepchild of the "standards" process…and was ripe for testing with simulation.

Deringer said that there was new membership on 90.1 and that this whole topic of testing sounded like something that needed to go in front of the TCs.

Sonderegger said that this did not fit the "mold" for standard research projects. That this did not sound like an interesting idea.

Huang asked how does the 90.1 committee deal with technical issues that needed to be looked into?

Deringer said that the 90.1 committee has no structure to do research. The closest semblance of research is when a company involved in 90.1 subsidizes some research to resolve a particular issue of interest.

Sonderegger said that this proposal needed to be cast in a way that TC 4.7 could sink its teeth into it. He recalled that the remembered something like this in 1987.

Wray said that this sounded like research still needed to be done on 90.1 and that therefore it should not have been voted out of committee.

Haberl suggested that the WS could be cast as "Research to investigate how simulation could be used to enhance 90.1".

Huang said that many of the 90.1 rules are based not on energy efficiency, but on the need to be neutral in all cases. For example, HVAC selection was taken out of the ECB trade-offs on the argument that it is dependent on building use and client requirements. Huang cautioned that TC 4.7 might not be familiar with the political and other non-energy-related considerations that went into the 90.1 deliberations, while

the 90.1 members know the issues very well but have no institutional means to carry out the needed technical work to understand the ramifications of their decisions.

Deringer said that the ideas he has presented to the subcommittee reflected only his own opinions, and that this needed to be reviewed by 90.1 before coming formally to TC4.7.

Haberl said that TC 9.6 had several RTARs about 90.1 and that discussions had been held into how to marry GP 14 and 90.1, and thus this was a very timely topic.

Deringer reminded the group that the typical way that analysis gets done for 90.1 was that a manufacturer funds analysis that may eventually influence the 90.1 process and that perhaps it was time to formally bring 90.1 into the research agendas of several TCs.

Sonderegger said that TC 4.7 had an ongoing topic for several years about "ongoing research to support 90.1" but that it never got any traction.

ACTION: Deringer promised to go back to 90.1 to report on the comments from TC 4.7.

Huang said that since Bill Bahnfleth is a member of both this subcommittee and 90.1, Bill would be the best person to act as a liaison between the two on this issue. However, as subcommittee chair, Huang would be happy to participate in this discussion and keep the topic on the agenda for future meetings.

Deringer then asked how long it would take for research to be developed to support 90.1. All agreed that this would take several years.

Haberl suggested that it might be worthwhile to have it as an RTAR for a placeholder.

Discussion then moved ahead to discuss RTARs and WS.

Huang asked that discussion moved to discuss "Development of ground coupling cases for the proposed ASHRAE SPC SMOT 140P".

Beausoleil-Morrison then described the WS and said that SPC 140P SMOT does not have a test for ground coupling. This WS would develop tests and then test cases for developing a standard method of test.

A question was then raised to look for historical data sets to test the method.

Haberl offered a residence with ground temperatures.

Beausoleil-Morrison said that this seemed reasonable to add to the scope-of-work to identify and use existing data sets.

Huang asked what the intentions were for this WS. Beausoleil-Morrison said that he intended to edit this and have it ready for vote at Atlanta.

Haves said that RAC has new procedures for WS that tighten the "language" used in the WS, and reminded Beausoleil-Morrison to make this WS compliant with the new "language".

ACTION Beausoleil-Morrison agreed to tighten the WS language.

Haberl suggested that Beausoleil-Morrison might want to see a copy of the original WS for 865 since this was a WS to support SPC 140P.

ACTION: Beausoleil-Morrison agreed to look over this WS.

Wray then clarified the new "rules" for RAC. That RAC would accept (3) RTARs from each TC for the Society Long Range Research plan, but that the TC were welcome to have their own RTARs and WS for future use.

Huang said that the RTAR entitled "Development of standardized computer input files for describing typical residential homes and the most common energy conservation retrofits" (Haberl) was in the form of a WS but needed editing at Dallas.

Huang then discussed the remaining four (4) WS drafts or RTARs. J. Huang noted that several of the RTARs have been sitting in the subcommittee for several meetings, and that they should be deleted unless someone agrees to be their champion and turn them into full WSs.

"Defining performance factors for primary and secondary equipment simulation inputs for commercial buildings" (Nall, LeBrun). This RTAR has been essentially dormant for two years. In Dallas, LeBrun agreed to develop it further. Jean is not at this meeting, but had informed Huang via e-mail several weeks ago that he did intend to work on this WS. Huang concluded that he would keep this RTAR on the agenda for one more meeting in light of this commitment.

"Development of standardized computer input files for describing typical residential homes and the most common energy conservation retrofits" (Haberl). Huang noted that a full WS draft for this topic was presented in Dallas, but that the subsequent discussion raised a number of questions and recommendations that Jeff Haberl agreed to incorporate into the WS.

Haberl said that there has been no work on revising the WS since Dallas, but that he is still interested to push the WS along.

Comment: That this was a very important WS for developing, but that perhaps the title be changed.

ACTION: Jan Kosny agreed to help with the WS. Jeff Blake also agreed to help.

ACTION Haberl agreed to edit the WS…then pass a draft of the WS to Kosny.

"Characterization of building thermal loads from chiller electric use data" (Sonderegger, Haberl) Sonderegger said that this RTAR has not been developed into a WS and recommended a decent burial.

The RTAR entitled "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" (Reddy, Addison) was then discussed

Huang said the topic of this RTAR, which is basically uncertainty analysis of computer simulation results, is of high interest and need, and that the only reason it has not progressed

beyond the RTAR stage is that the RTAR author, Agami Reddy, wanted others in the subcommittee to add their inputs. In Dallas, Addison agreed to work with Agami to develop this RTAR into a WS, but there has been no reported progress since.

ACTION: Kamal Haddad agreed to help with this WS. Wyndham-Wheeler also agreed to help with the WS

The discussion then proceeded to which of the WSs and RTARs to keep on the Research Plan and how they should be ranked.

Barnaby suggested that the #1 WS "Development of ground coupling cases for the proposed ASHRAE SMOT 140" (Neymark, Beausoleil) be the first RTAR.

Huang said that the #2 RTAR should be "Development of standardized computer input files for describing typical residential homes and the most common energy conservation retrofits" (Haberl, Kosny, Blake); 3 to be " 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" (Reddy, Haddad, Wyndham-Wheeler); and #4 to be "Defining performance factors for primary and secondary equipment simulation inputs for commercial buildings" (LeBrun, Nall).

MOTION to adjourn carried.

Meeting was adjourned at 8:55 p.m.

Report by PMS on Progress of ASHRAE 1093-RP

Compilation of Diversity Factors and Schedules for Energy and Cooling Load Calculations

(June 26, 2000)

The PMS and the contractor (Jeff Haberl) met at 7:00 am on Monday, June 26th, to review progress.

During the period from February- June 2000 ASHRAE meetings, the following activities occurred:

(a) On April 14th, the contractors mailed to the PMS a report containing the re-edited preface for the deliverable of Phase 2, along with sample templates of a few sites as required for Phase 3.

(b) The PMS members had a conference call on May 15th to discuss the templates, and to determine whether any changes are required or not. The template info was deemed satisfactory, and the contractor was informed accordingly.

(c) The contractor mailed out a draft report for Phase 3 containing 24 templates. Since the report was received just a few days prior to the Minneapolis meeting, all the PMS members could not read the report in time.

(d) During the PMS review meeting, the following issues and milestones were set:

(i) The PMS would hold a conference within one week of the Minneapolis meeting to discuss the draft Phase 3 report, and recommend changes, if any.
(ii) The contractor would make the necessary changes, if any, complete all the 36 templates, and prepare a draft final report containing additional charts and calculation details, as well as summary profiles. This draft report is to be mailed out to the PMS by end of August.
(iii) The PMS will hold a conference call with the contractor in September to discuss the final draft report and suggest changes, if any.
(iv) The contractor to turn in revised final report soon after.

The overall agreement was that the performance of the contractors was satisfactory.

TC 4.7 SUBCOMMITTEE ON INVERSE METHODS

Tuesday, June 27th, 2000, 3:30 to 5:00 p.m. (90 minutes)
Hyatt, Lake Harriett

Chair: Jeff Haberl

AGENDA

1. Introductions (5 minutes -- all)

2. Discussion of the minutes from the Dallas meeting, February 2000 (10 minutes -- all)

3. Program (15 minutes -- all)
- Jan 2001 meeting (Orlando).
  SEMINAR "Inverse Regression Methods for Simulation" (Addison)
- June 2001 meeting (Cincinnati)
- January 2002 meeting (Atlantic City)
  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)
- June 2002 meeting (Honolulu)
- January 2003 meeting (Chicago)
- June 2003 meeting (Kansas City)

4. Long Range Research Plan (25 minutes - all)

- **WS 1051 "Development of Toolkit for Comparing Results of Hourly Building Energy Simulation Programs against Measured Energy and Internal Environmental Data" (Sonderegger)**
- WS "Development of a procedure for baselining energy use at large central plants." (Krarti)
- WS "Development of procedures for analyzing energy savings from weather dependent and weather independent energy usage using an inverse bin method." (Haberl)
- WS "Methodology Development to Extend ASHRAE Semi-empirical Chiller Models to include Models for Screw Chillers, Package Air-conditioners, and Heat Pumps." (Reddy)
- ONE PAGER Genetic Methods (Nelson)
- ONE PAGER Inverse Methods for Parameter Determination for HVAC01 and HVAC02 Toolkits (LeBrun)

5. Discussion of Work Statements (25 minutes -- all):
- WS 1051 "Toolkit for comparing computer simulation program..." (Sonderegger)
- WS "Development of a procedure for baselining energy use at large central plants." (Krarti)
- WS "Development of procedures for analyzing energy savings from weather dependent and weather independent energy usage using an inverse bin method." (Haberl)
- WS "Methodology Development to Extend ASHRAE Semi-empirical Chiller Models to include Models for Screw Chillers, Package Air-conditioners, and Heat Pumps." (Reddy)
- Other work statements (all)?

6. Old Business (5 minutes -- all)

7. New Business (5 minutes -- all)

8. Adjourn (10 seconds – all)

ATTENDEES:

NAME:	**AFFILIATION:**
Jeff Haberl	Texas A&M
Joe Huang	LBNL
Vernon Smith	AEC
Jim Willson	Honeywell
Ian Beausoleil-Morrison	Natural Resources Canada
Peter Armstrong	PNNL
Chip Barnaby	Wrightsoft
Dru Crawley	USDOE
Ron Nelson	Iowa State University
Larry Degelman	Texas A&M – Retired
Yi Jiang	Tsinghua University
Moncef Krarti	University of Colorado

Haberl called the meeting to order at 3:35 p.m., which was followed by introductions.

Barnaby moved, Vern Seconded, to approve the minutes. Minutes approved from previous ASHRAE meeting.

Haberl said that the agenda will therefore be modified at the request of Barnaby to move the discussion first to the RTARs, and reminded the subcommittee that the RTARs are listed on the long-research research plan.

Haberl said that the first effort at hand was to prioritize the list to be forwarded to the full committee.

Haberl described the existing RTARs/WS:

WS 1051, "Development of Toolkit for Comparing Results of Hourly Building Energy Simulation Programs against Measured Energy and Internal Environment Data", by Sonderegger

RTAR with WS attached on "Development of a procedure for baselining energy use at large central plants", by Krarti.

RTAR with WS attached on "Development of procedures for analyzing energy savings from weather dependent and weather independent energy usage using an inverse bin method", by Haberl

RTAR with partial WS attached on "Methodology Development to Extend ASHRAE Semi-empirical Chiller Models to include Models for Screw Chillers, Package Air-conditioners, and Heat Pumps", by Reddy.

RTAR on "Genetic Methods" by Nelson.

RTAR (title only) on "Inverse Methods for Parameter Determination for HVAC01 and HVAC02 Toolkits" by LeBrun

Discussion then moved to third RTAR on the list, entitled: "Development of procedures for analyzing energy savings from weather-dependent and weather-independent energy usage using an inverse bin method"

Comments: It was suggested that the title be shortened to "Inverse Bin Procedures for Analyzing Energy Savings".

ACTION Haberl will incorporate new title and make editorial changes of text, accordingly.

Haberl then read through all the RTARs sequentially. No comments on the others.

The first WS is already in the works, and thus does not have to be on the Research Plan.

Barnaby asked what is the status of the WS (which ones are completed).

Haberl said there are 2 in addition to WS-1051. The last two are not ready as WS.

Nelson gave a short explanation of what evolutionary methods are. These include genetic algorithms, genetic programming.

ACTION: Nelson agreed to produce a Work Statement for this RTAR (last RTAR).

Haberl asked for a vote on which RTARs to give the highest priority.

A count of the votes is as follows (i.e., the most = first):

"baseline power plant" 1
"inverse binned methods " 6
"evolutionary methods " 2

Ask for vote on the second priority
"semi-empirical chiller model" 1
"evolutionary methods" many

As for the vote on the third priority
"baselining central power plant" 6
"semi-empirical chiller" 4

Therefore, the priority of the RTARS is:

1. "Inverse Bin Procedures for Analyzing Energy Savings" (Haberl).

2. "Genetic methods" (Nelson).

3. "Development of a procedure for baselining energy use at large central plants." (Krarti)

4. "Methodology Development to Extend ASHRAE Semi-empirical Chiller Models to include Models for Screw Chillers, Package Air-conditioners, and Heat Pumps." (Reddy)

Haberl then moved to the next item on the original agenda:

Haberl now discussed the program. In Dallas, the following items were proposed:

SEMINAR "Inverse regression methods for simulation", to be chaired by Addison.

Haberl asked if there are others willing to chair this seminar. Haberl gave a brief overview of the discussion from Dallas and the objective of this seminar. There were no volunteers. Therefore, Haberl has scratched this program.

There is no program for Cincinnati

A SYMPOSIUM is planned for Atlantic City chaired by Jan Kreider. Haberl has contacted Jan, who has expressed approval of this planned Symposium. Haberl then summarized 3 potential papers for this symposium that are listed in the agenda by Kissock (report on 1050-RP work), Abushakra (report on 1093-RP work), and Krarti (Neural Net paper). Therefore, the symposium is on track for Atlantic City. Ron Nelson said he may have a paper for this symposium on "Testing the validity of before-after energy savings methodology".

ACTION Haberl will notify Kreider to proceed with the Symposium.

Jeff asked if anyone had any idea for program for Honolulu, Chicago, or Kansas City. There was done.

The discussion then moved to a draft work statement on "Inverse bin methods for analyzing energy savings" (revised title).

Degelman suggested that the project title include the term "toolkit" in its title.

Huang suggested that the WS include a paragraph to explain the inverse bin method.

Crawley said that the WS must include a section on criteria for evaluation, and follow the mandatory WS format.

Petersen asked for clarification on what constitutes an inverse bin method?

Crawley thought that the second and third paragraphs are redundant, and hard to follow. Crawley also thought the relationship of the toolkit to the work of 1050-RP is vague, and needs to be better defined.

Haberl said that the output of this project is meant to be a new module in the 1050-RP toolkit being developed.

ACTION Smith, Nelson, agreed to review the revised work statement.

ACTION Haberl will incorporate those Comments and complete a modified WS by the Atlanta meeting.

Discussion now moved to the WS "Development of a Procedure for Baselining Energy Use at Large Central Plants", led by the WS author Moncef Krarti. The discussion was hampered by the copies being incomplete due to photocopying mistakes.

Haberl mentioned that he had discussed this topic with John Riley at Black and Veach, who said that such a procedure is needed.

ACTION Haberl will get Krarti in touch with Mr. Riley.

Petersen suggested that Krarti contact TC 4.6 as a potential co-sponsor.

ACTION Vern Smith agreed to review the Work Statement.

Discussion now moved to the Work Statement 1051, "Procedure for reconciling computer-calculated with measured energy data ". The authors are Jeff Haberl and Robert Sonderegger, with Robert working on a latest revision.

ACTION Since Robert is not here, Jeff Haberl will get the last version from Robert and circulate it with the minutes for review.

It was then moved by J Huang, and seconded by Chip Barnaby, for the meeting to adjourn at 5:01.

TC 4.7 Simulation and Component Models Subcommittee

Minneapolis Meeting Minutes
6/26/2000

Introductions

The meeting was called to order at 6:01 pm with 27 in attendance as shown on the attached roster.

Additions or corrections to agenda

None

Program Updates

Atlantic city symposium – Interoperability and Portability

Chip Barnaby: No papers yet, but plenty of time… will put out call for papers.
Fred Buhl will assist in contacting possible LBNL contributors

Atlanta: seminar and symposium: Low Energy Cooling: Models and Case Studies

Joe Huang and Phil Haves reported that both the symposium and seminar are in good shape with five papers currently under review for the symposium. One of the five is quite short; Joe will discuss with the paper's author the possibility of moving this paper to the seminar.

Down the road…

Mike Brandemuehl mentioned a Cincinnati TC 4.6 Symposium, "Applications of Dynamic Models for HVAC Systems", that 4.7 members might like to participate in.

Jeff Spitler and George Walton noted that we should keep current research projects in mind as we plan the program (Loads Toolkit, 2-D and 3-D Conduction in Walls, Analytical Verification of Load Calculation Procedures)

Work Statements in Progress

Incorporation of Nodal Room Heat Transfer Models into Energy and Load Calculation Procedures (Rees)

The subcommittee recommended submitting the work statement to the full committee for approval. The following changes were recommended:

1. Add rooftop daylighting systems to the bulleted list of systems in the Background section.
2. Add radiant coupling between surfaces to the first bulleted list in the Scope section.
3. Change project duration to 22 months, PI man-months to 4.5, research assistant man-months to 11, and total estimated cost to $120,000 under the Duration and Level of Effort section.

The subcommittee will recommend a first place ranking for this work statement on the research plan.

Development of Detailed Descriptions of HVAC Systems (Templates) for Simulation Programs

This work statement, which was rejected by RAC will be critically reviewed by Les Norford, Fred Buhl, Moncef Krarti and Vernon Smith. The review will result in a recommendation to proceed with a revised work statement that will meet RAC criteria. Chip Barnaby will forward notes to the ad-hoc sub-sub-committee.

Updated Energy Calculation Models for Residential HVAC Equipment.

This work statement, which was deferred by RAC, will be resubmitted. A letter explaining the negative votes from TC 7.6 will accompany the resubmittal.

Research Projects

987-RP: Loads Toolkit

Chip Barnaby reported that the toolkit was about 90% done, one good round of comments submitted, a few identified loose ends and adjustments to format (fewer duplicate methods). Will be reviewed piecemeal ASAP, and October 1 for a new CD. Extension to March 2001 was requested and agreed to by PMS.

1145-RP: Modeling Two- and Three-dimensional Heat Transfer Through Composite Wall and Roof Assemblies in Hourly Energy Simulation Programs.

Ian Beausoleil-Morrison reported that work is in progress for 20 cases/assemblies, soon to be implemented in DOE-2 to show implementation. 70 to 80% done, on schedules, PMS should get final draft for approval soon. Craig Wray, Moncef Krarti, Joe Huang, and Rick Strand volunteered to review the final report.

1049-RP Building Design Synthesis

Mike Brandemuehl reported that the PI, Vic Hanby, wasn't able to attend due to bicycle accident. The PMSC is concerned that things are progressing too slowly. Curt Pedersen will communicate this concern to PI.

1052-RP Analytic Test Suite for Whole Building Energy Programs

George Walton reported that the project is progressing well--still one major task left: the sky, but there isn't a good model available to start with. Tests involving BLAST are proceeding, automatic generation of files is almost done, and a final report will be ready for the next meeting.

New Business

Mike Brandemuehl, reported that TC 4.6 would be resubmitting a work statement called Dynamic Models of Cooling Coils, which was previously rejected by RAC. TC 4.6 is seeking a letter of endorsement supporting this work from TC 4.7. The subcommittee recommended that 4.7 submit such a letter.

Phil Haves apprised the committee of a discussion in TC1.5 and TC 4.12 on the development of data exchange formats (IAI, XML, etc.). Both committees are proposing to set up subcommittees and/or task forces to oversee this work. Phil solicited suggestions on resolving the oversight issue.

Adjourn

The meeting was adjourned at 7:22pm

ATTACHMENT 1: Attendance

Minn.	Dallas	Seattle	Last Name	First Name	E-Mail
	X		Abushakra	Bass	B0a7654@unix.tamu.edu
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		X	Axley	Jim	James.axley@yale.edu
X	X	X	Barnaby	Chip	cbarnaby@wrightsoft.com
X		X	Beausoleil-Morrison	Ian	ibeausol@nrcan.gc.ca
		X	Blair	Nathan	Blair@tess-inc.com
X			Blake	Jeff	jblake@nrcan.gc.ca
X	X	X	Brandemuehl	Mike	michael.brandemuehl@colorado.edu
X	X		Buhl	Fred	wfbuhl@lbl.gov
		X	Carpenter	Allen	Acarpent@nrcan.gc.ca
	X		Cho	Donngwoo	dwcho@kict.re.kr
	X	X	Claridge	David	claridge@esl.tamu.edu
	X	X	Crawley	Dru	drury.crawley@ee.doe.gov
	X		Dongyi	Xiao	xiaodongyi@hotmail.com
X	X		Eldridge	David	eldridd@okstate.edu
X	X	X	Fisher	Dan	d-fisher@uiuc.edu
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X		X	Huang	Joe	YJHuang@lbl.gov
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X			Kosny	Jan	kyo@ornl.gov
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		X	Winkelmann	Fred	fcwinkelmann@lbl.gov
		X	Witte	Mike	mjwitte@gard.com
X	X		Wray	Craig	cpwray@lbl.gov
			Wright	Jonathan	J.A.Wright@lboro.ac.uk
	X		Wu	Hofu	hwu@csupomona.edu

Minutes of the 987-RP Loads Toolkit PMS Meeting
Minneapolis, June 25th, 3:00 PM

Since the last meeting of the PMS:

- Navigator and presentation schemes have been developed and tested.
- Most of the components have been written and tested.
- Major revision of windows module since Dallas based on the new TC 4.5 Fenestration chapter on Solar Heat Gain Coefficients.
- Reviewed comments received.

Remaining to be completed:

- Address the review comments (contractor handed out side-by-side comments and draft responses)
- Expand text in document
- Test revised window module.
- Develop detached shading module.
- Develop RTS module
- Major editing throughout document.

What Next:

- Personnel relocations that have contributed to delays are now over.
- Scope of toolkit will be frozen—additional models have been added continually throughout project.
- Coordinate the completion of the loads toolkit with EnergyPlus schedule.
- Contractor requests an 8-month no-cost time extension to March 31, 2001.
- Contractor to provide current revision of the CD to all reviewers by July 7.
- Final CD for review by the PMS and other reviewers to be provided by the contractor by October 1.

1049-RP PMS

Jan 25, 2000

Monitoring Committee:

Curt 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

Because of an accident, the PI, Vic Hanby could not travel to the meeting. He submitted a report that was discussed by the PMS during the scheduled meeting on Sunday. The subcommittee agreed on several issues:

1. The contractor's addition of a *degree of feasibility* (DoF) attribute to the configuration generator is a good idea. However, the PMS suggests changing the name to Feasibility Index (FI) or some other term that cannot be confused with Degree of Freedom.
2. It was felt that the contractor should consider using a generic graph package to represent the configuration and then produce the adjacency matrix from that.
3. The PMS wants to make sure that the adjacency matrix being developed is capable of representing all current systems such as VAV, etc. This would appear to be a good check on the process.
4. The contractor's concern about treating control-related components was shared by the subcommittee. The improvement for greater flexibility mentioned in the report is definitely necessary.
5. The subcommittee is somewhat concerned with the level of effort directed toward the project. They would like the contractor to articulate specific goals to be accomplished between now and the next meeting, and relate them to the time line for the project.

ASHRAE
Technical Committee 4.7 Energy Calculations
2001-2002 Research Plan

1 August 2000

Priority 2001 – 2002	Prior priority	Status	Title	Subcommittee
0		Revision	Procedures for Evaluating Computer Calculated Results Against Measured Energy Data (1051-WS)	Inverse Methods
0	3 (1999-2000)	Cancelled Tech Council 3/00 Reconsideration 10/00	Standard Operating Conditions in North American Residential Buildings (1163-TRP)	Applications
0	1 (2000-2001)	Returned 3/00 Resubmit 9/00	Updated Energy Calculation Models for Residential HVAC Equipment (1197-WS)	Simulation and Component Models
1		Approved by TC; submit 9/00	Incorporation of Nodal Room Heat Transfer Models into Energy and Load Calculation Procedures	Simulation and Component Models
2		Draft WS	Development of Comparative Test Cases for Evaluating Simulation Models of Slab, Crawl Space and Basement Heat Transfer Through Adjacent Ground	Applications
3		Draft WS	Inverse Bin Procedures for Analyzing Energy Savings	Inverse Methods

RESEARCH TOPIC ACCEPTANCE REQUEST (RTAR)

Title: Incorporation Of Nodal Room Heat Transfer Models Into Energy Calculation Procedures

TC/TG: Technical Committee 4.7 – Energy Calculations

Research Category: Design and O&M

Research Classification: Basic and Applied

TC/TG Priority: 1

Estimated Cost: $120,000

Background:

For over thirty years, room models in energy and load calculation procedures have been based on the assumption of a "well-stirred" zone. This single node model, which assumes a uniform zone air temperature at any point in time, is a reasonable approximation for typical forced air system configurations. However, the "well-stirred" zone model is completely inadequate for system designs that either rely explicitly on the non-uniformity of the zone air temperature to achieve increased energy efficiency and indoor air quality, rely on natural convection, or involve tall spaces. These include:

- displacement ventilation
- under-floor air distribution
- atria, auditoria and stairwells
- chilled beams
- natural ventilation
- baseboard and convective heating
- zones with roof daylight systems.

A number of models known as 'nodal' or 'zonal' models have been developed that use on the order of ten air nodes and allow the heat transfer, temperature gradients and comfort conditions in these types of system to be predicted.

Although multi-node zone models have been under development since the early 1970's (Lebrun 1970), remarkably, none of these models have been incorporated in U.S. load calculation or energy analysis procedures. This has largely been due to the fact that the models are currently not available in modular formats that are easily accessible. The ASHRAE Loads Toolkit (987-RP) was developed specifically to address this problem. It was designed to serve as a repository for models required for energy and thermal load calculations. The goal of this research is to develop methods for incorporating nodal models into heat balance based load and energy calculation procedures. This algorithm will be implemented in the ASHRAE Loads Toolkit and demonstrated for specific displacement ventilation and convective heating nodal models

One way of representing the room internal airflow and non-isothermal temperature conditions is to use a coupled CFD and thermal simulation. Such approaches have been tried with CFD models involving a two-equation turbulence model (Clarke *et al.* 1995) or a simplified CFD model with a zero equation turbulence model (Chen *et al.* 1999). Neither of these approaches has however been computationally

efficient enough for annual energy simulation of multi-zone buildings.

A number of models known as 'nodal' or 'zonal' models have been developed that use on the order of ten air nodes to model systems where the room temperature is non-isothermal. These models could be said to be the next step in the development of room heat transfer models beyond the current models involving only one air node. These nodal/zonal models are generally computationally efficient enough for incorporation into annual energy calculations. There has been little progress however, in the incorporation of these types of models into load calculation and energy simulation programs.

Allard and Inard (1992) have reviewed the development of nodal models developed for rooms with convective heat emitters. LeBrun (LeBrun 1970, LeBrun and Ngendakumana 1987) was amongst the first to identify that there was a systematic difference in heat transfer between results predicted by isothermal models of such systems and experimental results. A number of authors have developed this idea, notably Howarth (1983) who used a two zone model and Inard and Buty (1991) who used a five zone model and a twelve zone dynamic model of rooms with radiator heat emitters (baseboard heating).

Dalicieux and Bouia (1983) have developed a general nodal model for heating applications by introducing pressure as a state variable and solving the energy and mass balance equations. Similar approaches have been used to model the macroscopic movement of air within large spaces such as atria (Togari, Arai and Miura 1993, Arai, Togari and Miura 1994).

Displacement ventilation has been installed in many buildings in Western Europe since the 1980's. These systems inherently produce thermal stratification within the room and strong radiant coupling between the floor and the ceiling. The supply air temperature of these systems is only a few degrees below the comfort temperature. This means that refrigeration plant can operate at higher efficiencies and the possibility of using alternative low energy plant. Calculation of the room heat transfer in these systems therefore requires a room model that can deal with non-isothermal conditions. A number of nodal models have been developed in an attempt to meet this need. These have included models with as little as three air nodes (Mundt 1996) and up to ten air nodes (Li *et al.* 1993, Rees and Haves 1999).

Justification of Need:

A significant fraction of modern, energy efficient system designs rely on temperature gradients within the zone to achieve high efficiencies. Displacement ventilation, under-floor air distribution, task cooling, and hybrid radiant/convective systems are all based on the concept of a thermally stratified zone. Other systems, including natural ventilation, in space convective heating, chilled beam, and perimeter baseboard systems, result in non-uniform zone temperatures that must be accounted for in the design procedure. In addition, the design of systems serving large spaces, such as atria, auditoria and other high-ceiling rooms, requires some resolution of the non-uniform air temperature within the space in order to determine comfort conditions in the occupied zone. For each of these cases, some type of nodal zone model is required in the calculation procedure in order to capture the essential physics of the intended design.

The current generation of North American load and energy calculation programs, based as they are on the "well-stirred" zone model, cannot be used to design these systems. Although a number of suitable nodal zone models have been developed over the years, these models have never been implemented in North American procedures. This lapse in the transfer of technology has left the ASHRAE design community at a serious disadvantage in the assessment and design of energy efficient systems and systems serving large spaces. The proposed work will redress this deficiency by developing a framework for nodal zone models that can be readily incorporated in heat balance based thermal load and energy calculation

programs.

The existence of the new ASHRAE Loads Toolkit makes it possible to cost-effectively undertake the proposed work. The Loads toolkit was specifically designed to facilitate development and dissemination of heat balance based procedures and will be used as the vehicle to distribute existing nodal zone models to program developers.

Objective:

The maximum advantage can be gained from the use of nodal/zonal models if a suitably generalized way can be developed for their incorporation into heat balance based load calculations. The primary objectives of this work are twofold:

- Development of a generalized framework for incorporation of nodal models into heat balance based load and energy calculation procedures;
- Implementation of displacement ventilation and convective heating nodal models.

This framework will consist of the necessary data structures, heat balance solution algorithms and associated documentation. Such a framework can most usefully be accomplished as an extension to the ASHRAE Loads Toolkit (987-RP), which implements the heat balance procedure. Such an extension to the Loads Toolkit would allow engineers to implement a variety of nodal models and examine their suitability when combined with different types of central plant. It also provides a path for further implementation in other heat balance based loads and energy calculation programs.

The models of displacement ventilation and convective heating are to be provided for testing purposes and to serve as an example for engineers who wish to implement other nodal models.

RESEARCH TOPIC ACCEPTANCE REQUEST (RTAR)

TITLE: **Development of Comparative Test Cases for Evaluating Simulation Models of Slab, Crawl Space and Basement Heat Transfer Through Adjacent Ground**

TC/TG: TC 4.7 Energy Calculations

Research Category: Design and O&M

Research Classification: Basic and Applied

TC/TG Priority: 2

Estimated Cost: $120k

Background / State-of-the-Art:

Proposed ASHRAE Standard 140P – Standard Method of Test for the Evaluation of Building Energy Analysis Computer Programs – specifies test procedures for evaluating the technical capabilities and ranges of applicability of computer programs that calculate the thermal performance of buildings and their mechanical systems. (BSR/ASHRAE 2000) While these test procedures cannot test all algorithms within a building energy computer program, they can be used to indicate major flaws or limitations in capabilities.

The Standard 140P test procedures, developed for analyzing and diagnosing building energy simulation software, use software-to-software comparisons. These are comparative tests that allow different building energy simulation programs, representing different degrees of modeling complexity, to be tested by:

(a) comparing the predictions from other building energy programs to the example results provided in its informational Annex, and/or to other results that were generated using Standard 140P;
(b) checking a program against a previous version of itself after internal code modifications to ensure that only the intended changes actually resulted;
(c) checking a program against itself after a single algorithmic change to understand the sensitivity between algorithms;
(d) diagnosing the algorithmic sources of prediction differences.

Experience with comparative tests indicate that differences among results often indicate problems with the software or its usage, including but not limited to:

(a) user input error, where the user misinterpreted or miss-entered one or more program inputs;
(b) a problem with a particular algorithm in the program;
(c) one or more program algorithms used outside their intended range.

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

Proposed Standard 140P is based on the IEA BESTEST methodology (Judkoff and Neymark 1995). During its work on Standard 140P, SPC 140 decided the ground coupling case and associated example results in the IEA BESTEST were inadequate for use with Standard 140P, and recommended that further research be conducted to develop such cases. (ASHRAE SPC 140, 1997)

Objective:

The objective is to develop comparative test cases for evaluating simulation models of slab, crawl space, and basement heat transfer through related floors and the adjacent ground. These tests could eventually be added to proposed ASHRAE Standard 140P – "Standard Method of Test (SMOT) for the Evaluation of Building Energy Analysis Computer Programs."

References:

ASHRAE Special Project Committee 140 (SPC 140). (1997). Meeting Minutes, June 30, 1997, Boston, MA.

BSR/ASHRAE Standard 140P. *Standard Method of Test for the Evaluation of Building Energy Analysis Computer Programs.* First Public Review draft. April 2000.

Judkoff, R., and J. Neymark. (1995). *International Energy Agency Building Energy Simulation Test (BESTEST) and Diagnostic Method.* NREL/TP-472-6231. Golden, CO: National Renewable Energy Laboratory.

RESEARCH TOPIC ACCEPTANCE REQUEST (RTAR)

TITLE: **Inverse bin procedures for analyzing energy savings**

TC/TG: TC 4.7 Energy Calculations

RESEARCH CATEGORY: Design and O&M

RESEARCH CLASSSIFICATION: Basic and Applied

TC/TG PRIORITY: 3

ESTIMATED COST: $75,000

BACKGROUND

ASHRAE has funded the development of 1050-RP "Toolkit for linear, change-point linear & multiple-linear inverse models", and 1093-RP "Compilation of diversity factors for energy load calculations" which are intended to produce a toolkit of inverse models (1050-RP) and diversity factor calculation procedures (1093-RP) to assist ASHRAE Engineers with building energy simulations.

1050-RP (Kissock et al. 1999) has identified linear, change-point linear, variable based degree-day models and multivariate models as being appropriate models for base lining the weather dependent energy use from most commercial and residential buildings. The final deliverable for 1050RP will be public domain FORTRAN code (source and executable) for calculating the identified models. These inverse methods have been shown to be useful for calculating savings in buildings in the Texas LoanSTAR program (Haberl et al. 1998).

In addition to the work of 1050-RP, 1093-RP "Compilation of Diversity Factors and Schedules for Energy and Cooling Load Calculations" (Abushakra et al. 1999) has identified the most useful 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. The final deliverables for 1093RP consists of a toolkit (a spreadsheet) and about several dozen profiles that have been created with the toolkit for representative office buildings.

In addition to the work of 1050-RP and 1093-RP, an inverse bin method has been developed by Thamilseran (1999) that has been developed demonstrated that is more accurate than the 1050-RP methods and almost as accurate as the most accurate hourly neural network models (Thamilseran and Haberl 1995; Haberl and Thamilseran 1996, 1998). In this method an hourly baseline model of a building is developed by calculating the average temperature-dependent energy use for each temperature bin for the appropriate weekday, weekend grouping.

This differs from 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) 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. Unfortunately, ASHRAE has yet to develop a toolkit for an inverse-bin method analysis that would further enhance the library of inverse analysis methods.

Therefore, this WS is intended modify the 1050-RP FORTRAN code by developing public domain computer code that is capable of performing inverse temperature-humidity-lagged binning for weather-dependent loads, and 24-hour day type binning (weekday, weekend/holiday) for non-weather dependent loads.

JUSTIFICATION

At the current time ASHRAE does not have a well-documented public domain toolkit of inverse bin method calculations. Although procedures are being developed for linear, change-point linear and variable-based degree day calculations (ASHRAE 1050-RP), and for diversity factors for energy calculations (1093-RP), no toolkit exists that contains specific computer code for analyzing the energy use from buildings using the inverse bin method. Inverse bin methods can provide more accurate baseline models for a special class of buildings that are not well modeled by linear, change-point linear, or variable-based degree-days.

Inverse bin methods also have the advantage over linear, change-point linear, variable-based degree-day calculations and combined multiple linear regression methods because the results from inverse bin method calculations can be directly compared to ASHRAE bin method calculations of annual building loads (Thamilseran 1999).

It is therefore necessary to document the existing algorithms for calculating inverse bin method models weather dependent and weather independent loads, and to modify the 1050-RP toolkit to include 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.

ASHRAE has already initiated several previous efforts to develop similar toolkits for simulating Primary (HVAC01), Secondary (HVAC02) systems, and the Load Toolkit. ASHRAE has also constituted GPC-14P for determining the appropriate methods for analyzing energy savings from energy conservation retrofits that can utilize the results of the proposed research. Furthermore, the 1997 ASHRAE Handbook and an initial draft of GPC-14P acknowledged inverse bin methods calculations as important, special purpose, before-after retrofit savings analysis model. Therefore, the development of an ASHRAE Toolkit for inverse bin method calculations will be an important enhancement to the current linear, change-point linear and variable-based degree day methods in 1050RP and in ASHRAE's GPC-14P.

The project will benefit the following:

1. ASHRAE to widen the acceptance and applicability of inverse bin methods in the analysis of data from building mechanical systems.
2. Software code developers/users as an aid for developing inverse bin methods for analyzing measured data from mechanical systems.
3. HVAC building energy analysis book publishers as an aid for developing more effective inverse bin method texts and courses.
4. ASHRAE for use in developing effective training programs for users of inverse bin methods, and as a means of improving inverse bin method documentation.
5. ASHRAE members as an aid for better understanding of how inverse bin methods can be used in their day-to-day practice.

6. ASHRAE member software developers as an aid to producing more effective inverse bin method code and documentation.
7. ASHRAE for use in a better understanding of why and how building energy software programs can be used to improve HVAC performance and indoor air quality.

OBJECTIVE:

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

REFERENCES:

Abushakra, B., Haberl, J., Claridge D. 1999. "Progress report for RP1093: Compilation of diversity factors for energy load calculations", ASHRAE Research Project 1093, Energy Systems Laboratory, Texas A&M University (December).

Haberl, J., Thamilseran, S., Reddy, A., Claridge, D., O'Neal, D., Turner, D. 1998. "Baseline Calculations for Measuring and Verification of Energy and Demand Savings in a Revolving Loan Program in Texas", *ASHRAE Transactions,* Vol. 104, Pt. 2, (June).

Haberl, J., Thamilseran, S. 1998. "Predicting Hourly Building Energy Use: The Great Energy Predictor Shootout II: Measuring Retrofit Savings", *ASHRAE Journal*, (January).

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TECHNICAL COMMITTEE 4.7 – ENERGY CALCULATIONS

WORKSTATEMENT

TITLE

Incorporation Of Nodal Room Heat Transfer Models Into Energy Calculation Procedures

BACKGROUND

For over thirty years, room models in energy and load calculation procedures have been based on the assumption of a "well-stirred" zone. This single node model, which assumes a uniform zone air temperature at any point in time, is a reasonable approximation for typical forced air system configurations. However, the "well-stirred" zone model is completely inadequate for system designs that either rely explicitly on the non-uniformity of the zone air temperature to achieve increased energy efficiency and indoor air quality, rely on natural convection, or involve tall spaces. These include:

- displacement ventilation
- under-floor air distribution
- atria, auditoria and stairwells
- chilled beams
- natural ventilation
- baseboard and convective heating
- zones with roof daylight systems.

A number of models known as 'nodal' or 'zonal' models have been developed that use on the order of ten air nodes and allow the heat transfer, temperature gradients and comfort conditions in these types of system to be predicted.

Although multi-node zone models have been under development since the early 1970's (LeBrun 1970), remarkably, none of these models have been incorporated in U.S. load calculation or energy analysis procedures. This has largely been due to the fact that the models are currently not available in modular formats that are easily accessible. The ASHRAE Loads Toolkit (987-RP) was developed specifically to address this problem. It was designed to serve as a repository for models required for energy and thermal load calculations. The goal of this research is to develop methods for incorporating nodal models into heat balance based load and energy calculation procedures. This algorithm will be implemented in the ASHRAE Loads Toolkit and demonstrated for specific displacement ventilation and convective heating nodal models

One way of representing the room internal airflow and non-isothermal temperature conditions is to use a coupled CFD and thermal simulation. Such approaches have been tried with CFD models involving a two-equation turbulence model (Clarke *et al.* 1995) or a simplified CFD model with a zero equation turbulence model (Chen *et al.* 1999). Neither of these approaches has however been computationally efficient enough for annual energy simulation of multi-zone buildings.

A number of models known as 'nodal' or 'zonal' models have been developed that use on the order of ten air nodes to model systems where the room temperature is non-isothermal. These models could be said to be the next step in the development of room heat transfer models beyond the current models involving only one air node. These nodal/zonal models are generally computationally efficient enough for incorporation into annual energy calculations. There has been little progress however, in the incorporation of these types of models into load calculation and energy simulation programs.

Allard and Inard (1992) have reviewed the development of nodal models developed for rooms with convective heat emitters. LeBrun (LeBrun 1970, LeBrun and Ngendakumana 1987) was amongst the first to identify that there was a systematic difference in heat transfer between results predicted by isothermal models of such systems and experimental results. A number of authors have developed this idea, notably Howarth (1983) who used a two zone model and Inard and Buty (1991) who used a five zone model and a twelve zone dynamic model of rooms with radiator heat emitters (baseboard heating).

Dalicieux and Bouia (1983) have developed a general nodal model for heating applications by introducing pressure as a state variable and solving the energy and mass balance equations. Similar approaches have been used to model the macroscopic movement of air within large spaces such as atria (Togari, Arai and Miura 1993, Arai, Togari and Miura 1994).

Displacement ventilation has been installed in many buildings in Western Europe since the 1980's. These systems inherently produce thermal stratification within the room and strong radiant coupling between the floor and the ceiling. The supply air temperature of these systems is only a few degrees below the comfort temperature. This means that refrigeration plant can operate at higher efficiencies and the possibility of using alternative low energy plant. Calculation of the room heat transfer in these systems therefore requires a room model that can deal with non-isothermal conditions. A number of nodal models have been developed in an attempt to meet this need. These have included models with as little as three air nodes (Mundt 1996) and up to ten air nodes (Li *et al.* 1993, Rees and Haves 1999).

JUSTIFICATION

A significant fraction of modern, energy efficient system designs rely on temperature gradients within the zone to achieve high efficiencies. Displacement ventilation, under-floor air distribution, task cooling, and hybrid radiant/convective systems are all based on the concept of a thermally stratified zone. Other systems, including natural ventilation, in space convective heating, chilled beam, and perimeter baseboard systems, result in non-uniform zone temperatures that must be accounted for in the design procedure. In addition, the design of systems serving large spaces, such as atria, auditoria and other high-ceiling rooms, requires some resolution of the non-uniform air temperature within the space in order to determine comfort conditions in the occupied zone. For each of these cases, some type of nodal zone model is required in the calculation procedure in order to capture the essential physics of the intended design.

The current generation of North American load and energy calculation programs, based as they are on the "well-stirred" zone model, cannot be used to design these systems. Although a number of suitable nodal zone models have been developed over the years, these models have never been implemented in North American procedures. This lapse in the transfer of technology has left the ASHRAE design community at a serious disadvantage in the assessment and design of energy efficient systems and systems serving large spaces. The proposed work will redress this deficiency by developing a framework for nodal zone models that can be readily incorporated in heat balance based thermal load and energy calculation programs.

The existence of the new ASHRAE Loads Toolkit makes it possible to cost-effectively undertake the proposed work. The Loads toolkit was specifically designed to facilitate development and dissemination of heat balance based procedures and will be used as the vehicle to distribute existing nodal zone models to program developers.

OBJECTIVE

The maximum advantage can be gained from the use of nodal/zonal models if a suitably generalized way can be developed for their incorporation into heat balance based load calculations. The primary objectives of this work are twofold:

- Development of a generalized framework for incorporation of nodal models into heat balance based load and energy calculation procedures;
- Implementation of displacement ventilation and convective heating nodal models.

This framework will consist of the necessary data structures, heat balance solution algorithms and associated documentation. Such a framework can most usefully be accomplished as an extension to the ASHRAE Loads Toolkit (987-RP), which implements the heat balance procedure. Such an extension to the Loads Toolkit would allow engineers to implement a variety of nodal models and examine their suitability when combined with different types of central plant. It also provides a path for further implementation in other heat balance based loads and energy calculation programs.

The models of displacement ventilation and convective heating are to be provided for testing purposes and to serve as an example for engineers who wish to implement other nodal models.

SCOPE

A generalized framework for the implementation of nodal models is to be developed as an extension of the ASHRAE Loads Toolkit. The framework is to allow the implementation of the following features found in nodal models:

- Multiple air nodes (of order ten)
- Sub-divided room surfaces
- Inter-nodal airflow that may merge or divide at each node
- Convective conductance between surface elements and air nodes

- Radiant coupling between room surfaces

Conductance in the airflow network may be pre-determined (at a given time step) by semi-empirical equations, or may be dependent on other state variables. Convection and mass airflow conductance may in general involve non-linear relationships with other nodal state variables.

Task 1: Classification of existing models

Complete a literature survey of existing nodal/zonal models and classify them according to:

- Type of systems represented
- Equations that are required to be solved
- Calculation methods used in the solution of the model equations

Task 2: Identification of possible generalized calculation methods

Identify possible numerical calculation procedures that would allow solution of the model equations for intra-zone heat and mass transfer along with the surface heat balance equations.

Identify suitable data structures and input methods or coding procedures that would be necessary to represent the various nodal models identified within the Loads Toolkit.

Task 3: Implementation of the selected calculation methods

Develop an implementation of the proposed data structures and calculation method as an extension of the ASHRAE Loads Toolkit.

Implementation in software is to be done in the Fortran 90 programming language using the coding standards developed in the Loads Toolkit project (987-RP).

Implementation is to be sufficiently modular so that implementation of the calculation procedure is to be kept separate from the implementation of specific nodal/zonal models. Users should be able to implement given nodal models by either adapting ‘user defined’ or ‘custom’ code modules and/or input files that allow definition of the model equations. It should not be necessary to change the heat balance calculation module to implement specific models.

Existing code modules of the Loads Toolkit are to be used wherever possible. In particular existing models of wall conduction are to be used. Modification of existing modules is to be kept to an absolute minimum. Backwards compatibility with the existing toolkit is to be maintained. Execution of conventional zone models using a single air node is to remain possible using the existing toolkit modules.

Task 4: Testing

Select at least two nodal models for testing of the extended Loads Toolkit. These should

include at least one model of convective heating (e.g. LeBrun 1970) and one of displacement ventilation (e.g. Mundt 1996). The models should be in the public domain and have published sample results. The final selection of the models to be used for testing shall be made after consultation with the PMS.

Successful implementation and operation of the test models using the new calculation procedure is to be demonstrated under a range of conditions. The parameters to be varied in tests shall include, but are not limited to:

- Size and number of internal sources
- Fabric thermal mass
- Supply air conditions
- Room geometry
- Surface emissivity

The contractor shall demonstrate the ability of their implementation of the models to successfully reproduce the published sample results.

Success of the tests is to be based on consideration of the following:

- Sufficiently accurate solution of the model equations
- Computational efficiency
- Numerical stability under the full range of parameter variations

The model implementations are to be provided as example nodal models in the extended toolkit documentation.

Task 5: Documentation

The contractor shall provide documentation of the following:

- Description of the calculation method
- Description of the source code
- Description of the example model implementations
- General instructions for implementation of other models

The PMS will supply the contractor with the original Loads Toolkit electronic source documentation. Documentation developed by the contractor shall be integrated with the existing Toolkit documents to form an extended document that is accessible from the toolkit documentation navigation pages. The source code shall be documented in accordance with the guidelines laid down for the Loads Toolkit (987-RP).

DELIVERABLES

Progress and Financial Reports shall be made to the Society through its Manager of Research at quarterly intervals.

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

A report summarizing the findings of Tasks 1 and 2 shall be presented to the PMS for review before proceeding to Task 3.

The contractor shall deliver an extended version of the 987-RP Loads Toolkit with additional documentation and source code in portable document format (PDF) on CD-ROM.

A *Final Report* shall be prepared and submitted to the Manager of Research by the end of the contract period covering complete details of all research carried out on the project. Unless otherwise specified, six draft copies of the final report shall be furnished for review by the Project Monitoring Subcommittee (PMS).

Following approval by the PMS and the TC/TG, final copies of the final report will be furnished as follows:
- An Executive Summary suitable for wide distribution to the industry and to the public.
- Six bound copies
- One unbound copy, printed on one side only, suitable for reproduction.
- Two copies on diskette(s); one in ASCII format and one in Microsoft Word format.

One or more *Technical Paper(s)* shall be submitted in a form suitable for presentation at a Society meeting. The Paper(s) shall conform to the Society's "Submitting Manuscripts for ASHRAE Transactions" which may be obtained from the Special Publications Section. **(On the ASHRAE Home Page, these guidelines are titled "Meeting Paper Preparation" and can be found under "How to Participate.")**

All papers or articles submitted for inclusion in any ASHRAE publication shall be made through the Manager of Research and not to the publication's editor.

A Technical Article suitable for publication in the *ASHRAE JOURNAL* **may** be requested by the Society. This is considered a voluntary submission and not a deliverable.

DURATION AND LEVEL OF EFFORT

The project shall be completed within 22 months of Authority to Proceed. The expected level of effort is anticipated to be on the order of 4.5 man-months of principal investigators time and 11 man months of research assistant/engineers time. The estimated cost is $120,000.

OTHER INFORMATION FOR BIDDERS

Project activities shall proceed in close coordination with the PMS of TC 4.7, and timely results shall be transmitted to this subcommittee as available.

The contractor will be provided with the Loads Toolkit source code and documentation in electronic form. Preliminary copies of the Loads Toolkit documentation and source code will be made available to bidders upon request.

Bidders must be prepared to provide a license for the software developed in the project that allows royalty free use and distribution rights for ASHRAE and Toolkit end users.

CRITERIA FOR CONTRACTOR SELECTION

The contractor will be selected based on the following criteria with the weighting given in parentheses:

Contractor's understanding of Work Statement as revealed in proposal. (15%)

Quality of methodology proposed for conducting research.(25%)

Contractor's capability in terms of facilities. (5%)

Qualifications of personnel for this project. (20%)

Student Involvement (5%)

Probability of contractor's research plan meeting the objectives of the Work Statement. (25%)

Performance of contractor on prior ASHRAE projects or related projects – no penalty for new contractors. (5%)

REFERENCES

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Rees, S.J. and Haves, P. 1999. *A Nodal Model for Displacement Ventilation and Chilled Ceiling Systems*. Proc. of 'Building Simulation-99', Kyoto, Japan, September 13-15. Vol. 1, pp.433-440.

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AUTHORS

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TC 4.7 Energy Calculations
Handbook Subcommittee Meeting

Monday, June 26, 2000
5:00-6:00 PM

Attendees:

Les Norford, Subcommittee Chair
David Eldridge
Vern Smith
George Walton
Jim Willson

Norford opened the meeting by asking for comments on the new handbook chapter, chapter 30 of the Handbook of Fundamentals, Energy Estimating and Modeling Methods. He emailed this chapter to TC 4.7 members on June 22, 2000. Willson provided an editorial comment on p. 63, in the inverse-modeling section. Smith, now reading chapter, noted an editorial mistake on p. 2, in the introduction. Willson considered the new chapter to be comprehensive and well written, and ready for a TC vote.

Norford noted that the full TC will need to vote at its meeting on Tuesday, June 28, or conduct a letter ballot over the summer if members require more time to review the chapter. ASHRAE Headquarters staff has a schedule for the 2001 Handbook of Fundamentals that requires Chapter 30 to be approved and submitted by September.

The meeting adjourned at 5:55 p.m.

SUMMARY OF PROGRAMS/PROGRAM PLAN

Minneapolis, June 2000

Symposium — International Experience with Weather Data for Simulation and Design, Part 1: Simulation, Ventilation and Daylighting, Part 2: Simulation. (TC 4.2 co-sponsor/ Dru Crawley drury.crawley@ee.doe.gov)

Atlanta, January 2001 (April 7 Tech Paper submit/August 4, 2000 package to ASHRAE)

1. Symposium: Simulation Models for Low-Energy Cooling (Sim-Comp/Joe Huang YJHuang@lbl.gov)--Five papers out for review, one pending.

2. Seminar: Low Energy Cooling Case Studies (Sim-Comp/Phil Haves phaves@lbl.gov)

3. Seminar: Pathways to Wider Use of Building Simulation Programs (Dru Crawley -- drury.crawley@ee.doe.gov)--Commitment for three presentations (CDH, AEC, LBL)

Cincinnati, June 2001 (September 29, 2000/February 9, 2001)

1. Symposium: Better Inputs for Better Output (Applications, TC 9.6 co-sponsor/Chair: Jim Willson jimwill@indy.net)--commitment for 2 papers, call for papers published 1/00

2. Seminar: Commercial Use of Building Energy Simulations (Applications/Hofu Wu hwu@csupomona.edu)

3. Symposium: Tools and Techniques for Calibration of Component Models (TC1.5&4.7/Agami Reddy reddyta@drexel.edu)--"in limbo" outlook unclear

4. Symposium: The Stories that Utility Records Tell Us about Energy Performance in Commercial Buildings (TC 9.6 and 4.7/Chair Taghi Alereza TAlereza@adm-energy.com)--call for papers published, none received.

Atlantic City, January 2002 (April 2, 2001/August 3, 2001)

1. Symposium: Inverse Method Toolkit and Applications (Inverse/Jan Kreider jfk@well.com) Four papers promised

2. Symposium: Interoperability and Tool Portability (Sim. Comp./Chip Barnaby cbarnaby@wrightsoft.com)

MINUTES
SPC-140 SMOT FOR BUILDING ENERGY SOFTWARE
Minneapolis, June 26, 2000
Chair: R. Judkoff (submitted June, 27 2000)

ATTACHMENTS

A. Agenda for June 26, 2000 meeting
B. Mailing List

CORRESPONDANCE SINCE LAST MEETING

Standard 140P went out for public review on April 8, 2000; the review period ended June 6, 2000. Public review comments were received from ASHRAE on 20 June 2000. (ASHRAE) There were 16 comments from two commenters: 6 from Jim Lutz of Lawrence Berkeley National Laboratory, and 10 from Jason Glazer of Gard Analytics. The Chair to the full committee distributed the comments on June 20, 2000. ASHRAE Staff also distributed copies of the comments to the committee at the Minneapolis meeting.

Also just after receiving the comments, the Chair invited the commenters to attend the SPC 140 meeting.

GENERAL

None

INTERMODEL COMPARISON BASED TESTS

The purpose of the meeting was to address the Public Review comments.

Attendees (see mailing list for full names, etc)

Voting Members
Crawley
Fraser
Haberl
Judkoff (chair)
Sonderegger
Walton

Non-Voting Members
Neymark

Other
Beausoleil-Morrison
Buhl
Lutz (commentor)

Committee Discussion

Approval of Prior Minutes

Motion (Sonderegger): Accept Minutes of February 2000 meeting (Dallas).
2nd (Haberl):

Vote: Yes = 6, No = 0
Absent = (Maeda, Wilcox, Winkelmann, Witte)
Motion passed.

Discussion regarding Public Review Comments

Lutz's Comments

The committee achieved verbal agreement with Jim Lutz regarding the following responses to his comments (using reference numbering provided by ASHRAE Staff):

0001/001

Discussion:

Crawley indicated the following issues regarding use of WYEC2 weather data.

- ASHRAE does not intend to support WYEC2 in the long term. ASHRAE has adopted IWEC data as the new recommended format for weather data. However, the IWEC data is not yet ready for distribution.
- TMY data contains more information than WYEC2 data.

Other issues regarding selection of TMY data are:

- Some parts of the test specification are based on the specific TMY data file.
- TMY2 data (an improvement to TMY data) did not exist when the original research underlying Standard 140 was performed.

Therefore, the committee proposes to include the following response to the comment:

- SPC 140 will include in an informative appendix to Standard 140 why the TMY weather data format was used. Proposed language for this appendix will be attached to the comment response.
- In the future, after publication of this version, SPC 140 will strive to use more current weather data formats in Standard 140 as they become available.

Regarding Annex B12 listed in the comment, Annex B12 relates to binning hourly output zone temperature data from the free float cases, not to weather data, so there will be no change to Annex B12 as a result of this comment.

0001/002

SPC 140 will include the proposed equations in informational Annex B7 pending confirmation that the provided equations give the same results indicated in Figures B7-1 and B7-2.

0001/003

Add the proposed diagram in addition to the current Table 14. This change to normative Section 5.2.3 does not change the requirements of the SMOT, but rather provides an alternate format for understanding the information of Table 14 and is therefore considered to be an editorial change.

0001/004

Editorial comment accepted as proposed.

0001/005

Revision of typographical errors accepted as proposed. Changes are editorial.

0001/006

See response to 0001/002.

GENERAL

The proposed changes described above are to informational annexes or otherwise are editorial in nature, and therefore are not expected to generate a need for a second public review.

Glazer's Comments

Glazer did not attend the meeting. The following responses are the committee's consensus of what to propose as responses. They are organized in order of their potential significance. A conference call with Glazer and a few members of the committee will be scheduled in the near future to identify the commenter's "intent/resolution potential" based on the proposed responses.

0002/001

No change. In a Standard Method of Test (SMOT) there are no formal criteria for when results agree or disagree.

0002/002

No change. Activities discussed by the commenter are appropriate for a regulatory body, but not for a SMOT. A single figure of merit negates the diagnostic capability of the SMOT.

0002/009

No change. The SMOT does include selected mechanical system tests: Case 320 tests deadband control versus Case 270. Cases 640, 650, 650FF, 940, 950, and 950FF test thermostat setback and ventilation control systems.

We believe the meaning of the scope is the same with or without the word "many". The second sentence of the scope states: "While these standard test procedures cannot test all algorithms within a building energy computer program, they can be used to indicate major flaws or limitations in capabilities." SPC 140 feels the first clause of that sentence has already stated that the tests do not cover every possible flaw that could occur in a program.

0002/0010

No change. See first paragraph of response to 0002/009.

0002/008

No change. This is a SMOT and hence the data in Appendix B are strictly informative, as they are not a normative part of the test procedure.

0002/005

The committee agrees that latent heat gains are an important part of internal heat gains. However, the diagnostic nature of the SMOT requires suppression of certain physical phenomena in specific test cases. For clarity, the committee will change the title of 5.2.1.7 to "Internally Generated Sensible Heat". This is an editorial change.

0002/003

No change. Example results (of Annex B8) are informational, so that any user of the Standard can develop results for any program including Trace and HAP.

0002/004

No change. Example results (of Annex B8) are informational, so that any user of the Standard can develop results for any program including EnergyPlus.

0002/006

No response yet. [Discuss this with Dru Crawley.]

0002/007

No change. There are errors and ambiguities in other sources that Annex B2 corrects.

Meeting Adjourned.

References

ASHRAE. 19 June 2000. Comments on the 1st Public Review Draft of BSR/ASHRAE Standard 140P, *Method of Test for the Evaluation of Building Energy Analysis Computer Programs*. ASHRAE, Atlanta, GA. For copies contact: Sandra Armstrong, 404 636 8400, sarmstrong@ashrae.org

AGENDA - SPC 140,
Standard Method of Test for the Evaluation of
Building Energy Analysis Computer Programs

June 26, 2000, Minneapolis Conference Center, Minneapolis, MN
2:15P - 6:15P, Room 203B

- Approval of prior meeting minutes (February 7, 2000, Dallas)
- Public Review Comments
- Other?

Attachment B - SPC 140 ADDRESS LIST 20 June 2000

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

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