AMERICAN SOCIETY OF HEATING, REFRIGERATION AND AIR-CONDITIONING ENGINEERS, INC.
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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, 1996

TC/TG/TRG TITLE: Energy Calculations

DATE OF MEETING: June 25, 1996 LOCATION: San Antonio

MEMBERS PRESENT	**YEAR APPTD**	**MEMBERS ABSENT**	**YEAR APPTD**	**EX-OFFICIO MEMBERS & ADDIT'L ATTENDANCE**
Chip Barnaby	1995	Henry Amistadi	1992	See attached Sheet
Drury Crawley	1993	James Axley	1992	
Dan Fisher	1994	Michael Brandemuehl	1993	
Philip Haves	1994	Carol Gardner	1992	
Joe Huang	1992	George Reeves	1995	
Ron Jarnagin	1992	Ed Sowell	1994	
David E. Knebel	1994	Rich Wruck	1992	
Les Norford	1994			
Robert Sonderegger	1994			
Jeff Spitler	1995			
Michael Witte	1994			

DISTRIBUTION

ALL MEMBERS OF THE TC/TG/TRG

RESEARCH & TECHNICAL COMMITTEE CHAIRMAN: Gordon Reistad

R&T SECTION HEAD: Terry Townsend

LIAISONS:

Program: James H. Norman Journal: John H. Stanley

Handbook: George Reeves

MANAGER OF TECHNICAL SERVICES: B.W. Ward

MANAGER OF RESEARCH: William A. Seaton

ADDITIONAL DISTRIBUTION:

ASHRAE TC/TG/TRG ACTIVITIES SHEET

DATE: June 28, 1996

TC/TG/TRG NO.: TC 4.7 **TC/TG/TRG TITLE:** Energy Calculations

CHAIRMAN Charles Barnaby **VICE CHAIRMAN** Robert Sonderegger **SECRETARY** Jeff Spitler

TC/TG/TRG MEETING SCHEDULE

LOCATION - past 12 months	DATE	LOCATION - planned next 12 months	DATE
Atlanta, GA	2/17/96	Philadelphia, PA	1/28/97
San Antonio, TX	6/25/96	Boston, MA	7/1/97

TC/TG/TRG SUBCOMMITTEES

Function	Chairman
Component Models	Dan Fisher
Simulation	Phil Haves
Applications and 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	Approv	To R & T
1.	See attachment 9			
2.				
3.				
4.				

HANDBOOK RESPONSIBILITIES

Year & Volume	Chapter Title	**No.**	Deadline	**Handbook Subcom. Liaison**
1997	28 Energy Estimating Methods			NONE

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 2

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

Appendix 3

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

Appendix 4

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

Priorities for Near-Term Developments in Building Simulation Programs (San Antonio),
Fast Multizone Models for System Optimization (San Antonio)

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

Additional Attendance*

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X	Bahnfleth	Bill	wpb5@psu.edu
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*** In order to preserve the e-mail addresses for all attendees, this is actually a complete list of attendees and recent attendees. It includes the voting members of the committee listed on page 1. An X in the "Present?" column indicates presence at this meeting.**

Appendix 1

RESEARCH PROJECTS -- CURRENT

Project Title	Contractor	Comm.Chm.	At Meeting
RP-665 Preparation of a Toolkit for Primary HVAC System Energy Calculations - Editing portion	Yuill & Bahnfleth	Mitchell	Yes
RP-669 Ice-On-Pipe Brine Thermal Storage System		Knebel	?
RP-717 Attic Energy Calculation Model	Holometrix, Inc.	Jarnagin	Yes
865-RP Development of Accuracy Tests for Mechanical System Simulation	Penn State/Texas A&M	Walton	Yes

Appendix 2

TECHNICAL PAPERS FROM SPONSORED RESEARCH

January 1994

629-RP Brandemuehl, M.J.; Gabel, S. Development of a toolkit for secondary HVAC system energy calculations ASHRAE Transactions v 100 n 1 1994. p 21-32

June 1994

665-RP Bourdouxhe, Jean-Pascal H.; Lebrun, Jean; Grodent, Marc; Saavedra, Claudio. Toolkit for primary HVAC system energy calculation - part 1: boiler model. ASHRAE Transactions v 100 n 2 1994. p 759-773

665-RP Bourdouxhe, Jean-Pascal H.; Saavedra, Claudio; Grodent, Marc; Silva, Katia L.; Lebrun, Jean J.Toolkit for primary HVAC system energy calculation - part 2: reciprocating chiller models ASHRAE Transactions v 100 n 2 1994. ASHRAE, Atlanta, GA, USA. p 774-786

756-RP Reilly, Susan M.; Ward, Gregory J.; Dunne, Christopher P.; Winkelmann, Frederick C. Modeling the solar heat gain reflected from neighboring structures ASHRAE Transactions v 100 n 2 1994. p 835-842

666-RP Krarti, Moncef; Claridge, David E.; Kreider, Jan F., Foundation heat transfer algorithm for detailed building energy programs. ASHRAE Transactions v 100 n 2 1994. p 843-850

June 1995

741-RP Spitler, J.D., J.D. Ferguson. 1995. Overview of the ASHRAE Annotated Guide to Load Calculation Models and Algorithms ASHRAE Transactions v 101 n 2 1995.

Appendix 3

TC/TG/TRG SPONSORED SYMPOSIA

Title, When Presented

FUTURE:

Philadelphia - January 1997

TC 4.7/9.6 Symposium--"*Energy Inverse Analysis for Field Monitoring*"
Chair: Agami Reddy (409/862-2189, areddy@loanstar.tamu.edu).

TC 4.7 Symposium-- "*User Tools for Building Simulation*"
Chair: Carol Gardner (Status - unknown)

PAST:

San Antonio - June 1996:
Symposium: *External Environmental Impacts*
Chair - S. Reilly.

Symposium: *The Great Energy Predictor Shootout II*
Chair - Haberl

Atlanta - February 1996:
Symposium: *User Tools for Building Energy Simulation*
Chair - C. Gardner; three papers promised

Chicago - January 1995:
Symposium: *More New Algorithms for Computer Energy Analysis*

Orlando - June 1994:
Symposium: *New Algorithms for Building Energy Calculations*

Symposium: *The Great Energy Predictor Shootout*
Chair - Jeff Haberl; one paper from Kreider and Haberl and 4 top winners from Denver.

Symposium: *Differences between Calculated and Measured Loss Coefficients*
Chair - David Claridge; have 4 papers in to ASHRAE --being reviewed.

Symposium: *Energy Calculations for Measured Building Data*
Chair - David Claridge; has 1 paper in to ASHRAE --being reviewed.

Symposium: *Fast Energy Calculations*
Chair - Robert Sonderegger; has 2-3 abstracts may slip to Chicago.

Appendix 4

TC/TG/TRG SPONSORED SEMINARS

FUTURE:

TC 4.7/9.6 Seminar--"Calibration of Computer Simulation for Building Energy Analysis" Taghi Alereza

PAST:

Atlanta - February 1996:

Measurement of Energy and Demand Savings-ASHRAE Guideline 14P
Chair: George Reeves (co-sponsored with TC 9.6, Systems Energy Utilization)

San Diego - June 1995:

Innovative Uses of Building Energy Simulations Programs - C. Barnaby

Jan. 1995 - Innovative Uses of Computer Simulation - C. Gardner
Jan. 1995 - Predictor Shootout II: Measuring Results for Energy Conservation Retrofits - J. Haberl
Jan. 1995 - Energy Calculations for Measure Analysis - ?

Jan. 1994 - User Tools for Computer Energy Analysis - C. Gardner
Jan. 1994 - User Tools for Building Energy Simulation - C. Gardner
Jan. 1994 - Standardizing Formats for HVAC Component Models - How to Avoid Reinventing the Wheel - P. Sahlin

TC 4.7 Energy Calculations

6:00 - 8:30 PM, Tuesday, June *25*, 1996

Salon K / Marriot River Center San Antonio, Texas

AGENDA

I.	Roll Call and Introductions		Spitler
2.	Accept Agenda and Approve Minutes of Atlanta Meeting		Barnaby
3.	Announcements		Barnaby
4.	Membership		Sonderegger
5.	Subcommittee Reports		
	5.1	Component Models	Fisher
		665-RP Primary Toolkit Edit	Mitchell
	5.2	Simulation	Haves
		717-RP Attic Model/Radiant Barrier Systems	Jarnagin
	5.3	Applications and Inverse Methods	Haberl
		865-RP Dev. of Accuracy Tests for Mech. System Simulations	Walton
	5.4	Ad Hoc Neutral Model Format (NMF) (if needed)	Norford
		839-RP Dev. of a Component Model Translator for the NMF	Barnaby
	5.5	Research	Witte
		Approval of Research Plan	
	5.6	Handbook	Spitler
	5.7	Program	Bahnfleth
		San Antonio / Philadelphia / Boston	
	5.8	Standards: SPC-140, SMOT for Energy Software	Judkoff
6	Old Business		
	6.1	IBPSA	Crawley
	6.2	GPC 14P	Sonderegger
	6.3	SPC 152	9
	6.4	Educational efforts	Barnaby
7.	New Business		
	7.1	Philadelphia meeting schedule / rooms	Barnaby
8.	Long Range Vision		All
9.	Adjourn		

TC 4.7 Minutes

June 25, 1996

1. The meeting was called to order at 6:10 p.m. Role was called with 10 out of 18 members present. 1 more would eventually arrive to make the total 11.

2. Phil Haves moved to accept agenda; Robert Sonderegger seconded Motion passed unanimously.

3. Les Norford moved; Joe Huang seconded to approve minutes with correction that Dave Knebel was present.. Motion passed unanimously.

4. Chip Barnaby made several announcements. R&T has bifurcated; PMSC is the responsible body for the research project and is ASHRAE's representative; Journal/Insights Liaison is Jeff Haberl; ASHRAE Journal would like Back-to-Basics articles - Haberl will try to round up authors; the committee has been asked to review a CIBSE Guide section - Robert Sonderegger will review it since no one else volunteered; Clima 2000 will be held in September 1997 some possibility of travel money exists for TC members to present forums at the conference; the Environmental Health Committee offers to help with any environmental health issues that should come to the committee's attention - contact Andrew Persily (apersily@nist.gov); Gren Yuill received Distinguished Service Award; Don Wolfe, grad. Student on RP-787 received Homer Addams award; Al Black received Distinguished Service Award; Deadlines - research plan must be filed August 1, Handbook draft has to be in July 15; Program plan due tomorrow morning ;

5. Membership. 1997 roster has been sent out; a couple changes will be made Sandy Klein to be on committee; Dru Crawley will take over research subcommittee chair; Les Norford will take over handbook subcommittee;

6. Terry Townsend, section head, addressed the committee on deadlines; also offered to help review work statements, etc.

7. Phil Haves presented the simulation subcommittee minutes. (Attachment 2). The TC sponsored two forums "Fast Zone Models"(Jean Lebrun) and "Priorities for Developments in Simulation Programs" (Haves). The "Priorities" forum was merged with a TC 6.5 forum. One discussion item in the forum led to a one-pager " Modular Simulation of Building Loads". (Attachment 2)

   A draft work statement "Advanced Single Zone Air Flow Models for Practical Building Environmental and Energy Simulation" draft (Attachment 2) written by Kevin Knapmiller was distributed. TC 4.10 will take the lead. Volunteers to review the work statement should contact Knapmiller (kevink@apk.net)

   A one pager on goal-oriented model synthesis was discussed. Haves, Norford and Spitler will try to draft a work statement for the next meeting.

   " Modular Simulation of Building Loads". (Attachment 2) was described. Haves will expand this for the next meeting.

   The 9:00 p.m. start date for the meeting was much too late.

8. Dan Fisher presented the component models subcommittee report, attachment #1 and the work statement for the loads toolkit, attachment #1.

   Fisher moved that the work statement "Preparation of a Toolkit for Building Load Calculations", Sonderegger seconded. Motion passed, 10-0-0, chair voting.

   PMSC appointed by chair: Barnaby (chair) Walton, Knebel, Crawley,

   Mike Witte will send work statement to Terry Townsend.

9. John Mitchell reported on 665-RP Plants Toolkit edit project**. Spitler moved "TC 4.7 accept the final report on RP-665, subject to review and approval by the Project Monitoring Subcommittee, and forward the final document to Special Publications.", seconded by Sonderegger, Motion passed, 9 yes, 0 no, 1 abstentions (chair not voting)**

10. Jeff Haberl presented the Applications and Inverse Methods subcommittee report (Attachment #3) Several one-pagers were presented, along with the subcommittee rankings. Program: Predictor Shootout 2 symposium was given at this meeting. Haberl will recommend to Special Publications that they issue a technical data bulletin with the 4 papers and data diskette.

11. George Walton presented the 865-RP (Development of Accuracy Tests for Mechanical System Simulation) PMSC report. Contractor is a Penn State / Texas A&M team. Substantial progress has been made. Expected completion date is April 1, 1997.

    PMSC Walton (chair), Judkoff, Maeda, Knebel.

12. Ad Hoc NMF subcommittee did not meet New versions of software are available via ftp download. See attachment 4 for download information.

13. Witte presented draft Long Range Research Plan. After some discussion, and finding out that there should only be five research projects on the plan, a revised plan was formulated (Attachment 8). **Witte moved that the TC approve (Joe Huang seconded) the research plan as revised by the committee during the discussion. Motion passed, 9 yes, 0 no, 1 abstentions (chair not voting)**

14. Handbook. Spitler reported that the handbook subcommittee has met, with Spitler substituting for Kreider as chair. See attachment 5.

15. Program: Bill Bahnfleth acting program chair. Subcommittee chairs have covered program as it is. Energy predictor shoot-out, 2 forums, 4 tech papers in progress. Upcoming meetings: Phila meeting: 9.6 wants co-sponsorship: see attachment. Seminar Calibration for Building Simulation Programs.

16. Mike Witte, standing in for Ron Judkoff, reported on SPC 140 P. (Attachment 6)

17. Ron Jarnagin reported on 717-RP. **Jarnagin moves that "TC 4.7 approve a no-cost extension for 717-RP through Feb. 28, 1997." Motion passed, 10 yes, 0 no, 1 abstentions (chair not voting)**

    Chair appoints Fisher to serve on PMSC, in addition to Jarnagin (chair), Mark Kelley, Jan Kreider.

18. Dru Crawley reported on IBPSA. Regionalization process in ongoing. Building Simulation '97 will be held in Prague Czech Republic. Contact Larry Degelman for more info on IBPSA/USA. Or see web

page www.mae.okstate.edu/ibpsa

19. Robert Sonderegger reported on GPC 14P (Guideline for the Measurement of Energy and Demand Savings). Contact George Reeves (73027.3642@compuserve.com) for more information.

20. Jon Leber (jahbata@aol.com)briefly reported on SPC 152. Needs coordination or at least review by some TC 4.7 members. Contact Iain Walker (walker@epb12.lbl.gov) and/or Mark Modera (mpmodera@lbl.gov) The next update is expected in about one month.

21. Education. Some discussion of educational outreach was had, following on Brandemuehl's discussion Some vigorous, wide-ranging discussion followed. The possibility of a three hour seminar was discussed. The chair appointed Hittle (chair), Knebel, Brandemuehl, and Klein to look into giving a three-hour seminar at the next meeting.

22. New business; meeting rooms for Philadelphia. Chip will try to fix Monday night schedule. Program and Handbook rooms will be canceled.

    Yuill reiterated search for suitable awardees and Distinguished Service Award Point Tally is attached as Attachment 7.

23. Further discussion of the TC 4.7 Long Range Vision was led by Robert Sonderegger.

    Knebel moved, Sonderegger seconded that the "TC 4.7 Recommends that the Scope and Goal statement (Attachment 9) presented by Sonderegger be approved by R&T". The motion was approved unanimously!

24. Mike Witte will investigate a TC 4.7 list server.

25. moved, seconded that the meeting be adjourned. It was unanimously approved at 8:30 p.m.

Minutes

TC 4.7 Component Models Subcommittee

June 24, 1996

1. The meeting was called to order at 8:05 p.m. Present were Fisher (chair), Spitler, Witte, Sommer, Walton, Sonderegger, Barnaby, Norford, Smith, Meyer, Al-Houmoud, Buhl, Huang, Yavuzturk, Subbarao, Haves, Lebrun.
2. Barnaby gave a brief report on the "Primary Toolkit" editing project. The PMSC has not met yet.
3. Fisher presented the revised work statement "Preparation of a Toolkit for Building Loads Calculations". He reported that TC 4.1 approved co-sponsorship at their meeting this afternoon. A brief silent review period was held while the entire subcommittee read the work statement. Sonderegger moved that we approve the work statement; Norford seconded. A brief discussion was held; the w. s. does not explicitly state that driver routines must be delivered; nor does it mention how many models of each type must be delivered. A few very minor editorial changes were agreed on by consensus. It was approved unanimously.
4. Les Norford discussed an idea for a research project related to infiltration. The sub-committee decided that the idea had already been pursued successfully.
5. Dan Fisher discussed an idea for researching diversity factors. TC 4.1 had no interest in pursuing this. Some work has been done for Standard 90; some more informal investigation should be done to check on this. Mike Witte and Robert Sonderegger will check and report back to the subcommittee. Les Norford will pass some citations to Sonderegger and Witte. Huang reports that some California utilities have done some studies and LBL has 15 minute aggregate data.
6. Joe Huang presented a work statement draft "Modeling Two-Dimensional Heat Transfer through Walls in Hourly Simulation Programs." After some discussion, Huang will revise for Philadelphia.
7. Witte distributed the existing TC 4.7 Long Range Research Plan. Brief discussion followed.
8. The meeting was adjourned at 9:10 p.m.

Meeting Roster

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Work Statement

From
TC 4.7, Energy Calculations
TC 4.1, Loads Calculations

Preparation of a Toolkit for Building Load Calculations

June 24, 1996

Background

Most engineers now have access to powerful desktop computers and an ever enlarging library of packaged software for performing many types of calculations related to HVAC design and analysis. However, there is a need for a compendium of models for calculation of building heat transfer and loads so that engineers and program developers can efficiently and accurately use the available computer power to solve immediate problems.

In the past, ASHRAE has offered publications devoted to energy calculation techniques [1-2]. These publications are still widely used in spite of their age. Replacement publications are badly needed by engineers and students involved in calculation of building loads and energy use.

TC 4.7 has undertaken research that is improving this situation. First, an Annotated Guide to Models and Algorithms Relating to HVAC Equipment has been prepared under research project 530-RP [3]. This guide provides an annotated list of readily available material that assists in HVAC model development. Second, the research project 629-RP [4] documents actual calculation techniques for representing secondary (air side) HVAC components along with appropriate fundamental methods. Third, a similar project 665-RP [5] has been completed and documents additional methods suitable for primary HVAC components such as chillers and boilers. Fourth, 741-RP (co-sponsored with TC 4.1) produced a thorough annotated guide to models and algorithms relating to building load calculations. The current work statement specifies work to document loads-related models and algorithms. This will result in the publication of a replacement for Energy Calculations 1 [1] and will complete the 10 year documentation effort initiated by T.C. 4.7.

An important goal of this project is to unify where possible the techniques used for sizing calculations and those used for energy calculations. With the sponsorship of 515-RP which may yield improved conduction transfer function models for building elements and the sponsorship of 875-RP, Advanced Methods for Calculating Peak Cooling Loads, TC 4.1 has strongly signaled its intention to move in the direction of fundamentally based cooling load procedures. At the most basic level, the equations used for sizing calculations are the same as those used for energy calculations. Thus, T.C. 4.1 and T.C. 4.7 are in agreement on the need for a library of fundamental procedures.

Justification of Need

The techniques for calculation of building loads have evolved significantly since the publication of Energy Calculation 1 in 1976. Several large public domain hourly simulation codes have been implemented since then (e.g. DOE-2, BLAST, and TARP), and many years of experience have been accumulated by users and developers of those codes. In addition, today's practitioners generally have access to vastly more computing power than their counterparts in the late 1970's. Expectations have risen with available computing power, but building load calculation programs have not kept pace with either the available computing power or the expectations of practitioners. The compilation of an up-to-date and coherent set of load calculation component models is an essential step in bringing accurate and user friendly load calculation and energy analysis programs to the workplace. First, a validated set of models will provide a sound theoretical basis for program developers. Second, the models will provide practitioners a means of validating commercial programs. Third, by providing models in a modern language (FORTRAN 90), the toolkit will encourage developers to take advantage of modern interfacing and data structuring techniques.

An additional need addressed by this work statement is the identification, evaluation and collection of the common techniques used for both energy calculations and peak load calculations (equipment sizing). TC 4.1 and TC 4.7 have always promulgated closely related techniques. The joint sponsorship of this work is an explicit effort to capitalize on that commonality.

Objective

The objective of this project is to prepare computer software and associated documentation that implements available models and algorithms for calculating:

1. Space heat gains and losses due to all pertinent sensible and latent modes.

2. The space conditioning load (defined as the rate of heat addition or extraction required to maintain a specified space temperature profile).

3. Surface temperatures and space temperature when it is not specified.

Scope

Collect, implement in FORTRAN 90, document, and verify algorithms for building load calculations. The included algorithms should draw heavily from the sources identified in the 741-RP Annotated Guide. New model development should be undertaken only after explicit approval from the PMSC.

The input requirements of the zone algorithm generally determine the outputs required from the component algorithms. Thus, the zone algorithm "sets the style" for the entire Toolkit. The Toolkit will include only heat balance based zone models. A key aspect of this project is assessing the relationship between the heat balance algorithm (or solution technique) and the fundamental equations required to calculate zone loads and temperatures. The test procedure must evaluate not only the accuracy of a solution technique, but also its stability over the expected range of inputs.

In a Toolkit of this type, clarity should take precedence over efficiency. Both component and room models should be retained in the most basic form possible. Complete variable definitions and model descriptions are essential.

The following areas should be covered in the Toolkit --

1. Fundamentals:

    - Required weather data
    - Sky models.
    - Sun position and solar incident angle.
    - Shading effect of building wings, overhangs, and simple fixed objects.
    - Solar intensity on an arbitrarily oriented surface.
    - Psychrometric routines from A Toolkit for Secondary HVAC System Energy Calculations [5].
    - Outside surface heat transfer coefficients including dependence on orientation, wind speed, and roughness.

2. Load components (sensible and latent, as appropriate):

    - One dimensional wall and roof elements.
    - Ground coupled floor, foundation and basement wall elements including two dimensional and three dimensional models.
    - Glazing losses and gains including angle of incidence dependencies for solar gains.
    - Infiltration and natural ventilation (correlation models and air flow network models).
    - Internal gains (lighting, people, equipment, process gains, etc.).

3. Room model:

    - Short wavelength radiation distribution.

- Long wavelength radiation distribution.
- Convective transfer under still and moving air conditions.
- Internal mass, including both building elements (e.g. partitions) and contents (e.g. furniture).
- Interface with HVAC system (thermostat and control models).
- Moisture balance (first order model).

The specific project tasks are as follows:

1. Develop, with advice from the monitoring committee, a technique for presenting the algorithms, including a listing of the FORTRAN 90 code statements, the test input and output data, and sufficient discussion to allow others to understand the calculation approach. The presentation technique should build on the formats used in the Secondary HVAC Toolkit (629-RP) and the Primary HVAC Toolkit (RP-665). References should be provided for each algorithm.

2. Collect, implement in FORTRAN 90, and verify loads-related algorithms for the areas enumerated above.

3. Develop test data sets that establish correct operation of each algorithm. The test inputs and outputs with software drivers are to be included in the Toolkit publication.

4. Prepare complete draft versions of the Toolkit software and manual.

5. Coordinate third-party testing and review of the Toolkit software and manual. See Other Information for Bidders below.

Deliverables

1. Produce a final, camera-ready original of the publication in a format satisfactory to both the monitoring committee and to ASHRAE Special Publications.

2. Produce a PC compatible diskette containing code, test data and software drivers developed for the project. All software must be presented in the standard ASHRAE format.

3. Prepare a brief final report documenting the methods used in conducting the project and identifying areas where additional research is needed.

4. Prepare a technical paper and research note, as required by ASHRAE research policy.

Level of effort

Project duration: 32 months (spanning 6 ASHRAE meetings). Person months principal investigator: 6 - 12; person months assistants: 24. Estimated value: $150,000

Other Information for Bidders

1. Bidders should include in their proposal an explicit third-party testing plan. Experience in other Toolkit projects indicates that thorough testing can only be accomplished on a funded basis. Masters level graduate students are well qualified to perform testing tasks. An essential aspect of any testing

plan is independence: the testers must have no direct involvement in the development of the Toolkit manual or software.

2. In their proposals, bidders should present their qualifications with respect to software development in addition to those related to engineering and building science.

3, Since the result of this research project will be an ASHRAE publication, bidders should demonstrate a clear and concise writing style as well as a command of the ASHRAE technical vocabulary.

References

1. *Energy Calculations 1 -- Procedures for Determining Heating and Cooling Loads for Computerized Energy Calculations, Algorithms for Building Heat Transfer Subroutines.* ASHRAE, 1976.

2. *Energy Calculations 2 - Procedures for Simulating the Performance of Components and Systems for Energy Calculations.* ASHRAE (out of print).

3. 530-RP Final Report (*An Annotated Guide to Models and Algorithms For Energy Calculations Relating to HVAC Equipment*). ASHRAE.

4. Brandemuehl, M. J., S. Gabel and I. Andresen. 1993. A Toolkit for Secondary HVAC System Energy Calculations. Atlanta, GA: ASHRAE.

5. 875-RP Final Report., to be completed in 1997.

6. 741-RP Annotated Guide and Final Report. ASHRAE.

7. Press, W. H. et al. *Numerical Recipes -- The Art of Scientific Computing.* Cambridge: The Cambridge University Press, 1986.

8. 665-RP, 342-RP, 359-RP, 472-RP, 515-RP, and 626-RP reports.

Work Statement Contributors

TC 4.7: C. Barnaby; TC 4.7 D. Fisher; TC 4.1 C. Pedersen

Minutes

TC 4.7 Simulation Subcommittee

June 24, 1996

1. The meeting was called to order at 9:11 p.m. Present Haves (chair), Spitler, Witte, Sommer, Walton, Sonderegger, Barnaby, Norford, Vern Smith, .Jeff Meyer, Al-Houmoud, Buhl, Huang, Yavuzturk, Subbarao, Fisher, Lebrun.

2. Phil Haves gave a brief report on 717-RP. The PMSC has not yet met, but they will attempt to meet before the meeting.

3. Phil Haves reported on the "fora". (Fast Zone Models and Priorities for Developments in Simulation Programs.) Jean Lebrun distributed a brief summary of the "Fast Zone Models" forum. Phil Haves summarized the discussions in the "Priorities for Developments in Simulation Programs".)

4. Kevin Knappmiller presented a draft work statement (Attachment A) for Work Statement WS-856. The work statement needs some more work and input. A brief discussion followed. Kevin will continue to revise work statement with input from same people. A revised work statement will be distributed within two weeks.

5. Haves discussed the status of the goal-oriented model synthesis work statement - only a one-pager exists at present. Some discussion of the way forward was presented. Haves, Spitler, and Norford agreed to draft something more, with Haves taking the lead.

6. Lebrun discussed a work statement idea for "Fast Multi-Zone Models for System Optimization". He saw for a global simulation. All effort to date has been concentrated at the component level in both the zone, system and plant models. Multi-zone models are needed to capture the integration . Lebrun will draft a one-pager from Philadelphia.

7. Haves presented a one-pager entitled " Modular Simulation of Building Loads." A vigorous discussion followed. George Walton, Jeff Spitler, Chip Barnaby, Fred Buhl, Phil Haves volunteered to move this along.

8. Long-range research plan. A very brief discussion was held. In un-ranked order, the following projects should remain on the plan:
   Goal-oriented model synthesis
   Modular simulation of building loads
   Advanced Single Zone Air Flow Models

8. Program ideas were solicited.

9. Robert Sonderegger discussed some "provocations" for discussion related to TC 4.7's scope.

10. A need for a liaison to TC 6.5 was brought up by Phil Haves. Dan Fisher volunteered.

11. The meeting was adjourned at 10: 37 p.m.

Meeting Roster

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1996-1997 RESEARCH PLAN
TECHNICAL COMMITTEE 4.7
PRIORITY ?

PROJECT TITLE

Modular Simulation of Building Loads

OBJECTIVE

Develop an efficient method of coupling the different algorithms required for building loads simulation that permits flexible reconfiguration.

BENEFITS

The results of the project would bring to building loads calculations the level of flexibility currently available in the simulation of mechanical systems through the use of component-based simulation programs such as TRNSYS and HVACSIM+. This level of flexibility allows component models of differing complexity to be substituted without affecting the rest of the system and without the need for programming. TRNSYS and HVACSIM+ cannot efficiently provide this flexibility in loads calculations because of the much larger number of variables that are typically involved in coupling different elements of a loads calculation model, e.g. long wave radiant exchange, solar distribution.

A simulation methodology that allowed the elements of a load calculation model to be interconnected more easily would provide designers and researchers with the foundation of a tool that would allow them the flexibility to consider and compare different building envelope/room configurations and would allow novel elements to be introduced more easily into building simulation programs.

ESTIMATED COST

$150,000

ESTIMATED DURATION

36 months

METHOD OF PUBLISHING RESULTS

Technical report, technical paper.

Work Statement From TC 4.10 and TC 4.7

Title

Advanced Single Zone Air Flow Models for Practical Building Environmental and Energy Simulation

Background

Increasingly, there is a need to predict the performance of enclosed spaces in which the air is imperfectly mixed. Examples include atria, displacement ventilation, clean rooms and VAV systems at minimum flow rate. All the major whole building energy and environmental simulation programs treat the air in each enclosed space as fully mixed and hence neglect variations in the temperature and contaminant distributions. Computational fluid dynamics (CFD) can be used to study these problems, but is currently too demanding for practical simulation. What is required is a modeling approach that is intermediate in complexity between CFD and the fully mixed zone approximation.

There has already been a significant amount of work on zonal models, i.e. models in which the room air is divided into a moderate number of zones (~10) in order to better approximate the real temperature and contaminant distributions (refs). These models were often developed for specific situations and also differ in the way they combine analytical and empirical elements. There is a need to review and compare these models in order to determine which are suitable for incorporation into whole building energy and environmental simulation programs. The physical meaning of any particular model must be given and the accuracy limitations associated with the simplifying assumptions must be made.

(Note: J. LeBrun recommended that discussion of physical uncertainties and a need for experimental validation be included here, but as I propose that this workstatement be based on developing a model BETWEEN CFD and a mixed room assumption that we leave further validation of CFD for some other project and assume that CFD is “good enough” to provide the basis for evaluating less complex models. It is only through such a cost saving measure that I believe a project like this can be done within the typical ASHRAE budget.)

Justification of Need

Evaluation of thermal comfort and indoor air quality variation within each of the rooms of a building is central to the design of room air distribution systems and the building envelope. However, this is beyond the capabilities of current practical modeling tools.

This project would identify those techniques capable of modeling the variation of these parameters within the rooms of a building and also quantify the practicality of integrating these techniques into whole building simulation models used for the design of building envelope and air distribution systems.

Objectives

The main objective of the project is to identify and evaluate single zone airflow modeling techniques suitable for incorporation in whole building energy and environmental simulation programs.

Scope

1. Identify modeling approaches and techniques capable of predicting the temperature, velocity, and contaminant distributions in rooms with:
   - imperfectly mixed forced ventilation
   - displacement ventilation
   - natural ventilation
   - clean rooms

(Aria and other large spaces would be specifically excluded, since they pose extreme problems. However, modeling techniques developed for aria might well be suitable for adaption to smaller spaces.)

2. Identify and assess sources of experimental and computational data capable of providing full or partial validation of simplified models of imperfectly mixed spaces.
3. Assess the modeling approaches and techniques identified in (1) in terms of:
   - theoretical basis
   - generalizability (different geometries, changes in load ...)
   - availability of validation data
   - input data requirements
   - suitability for incorporation in whole building simulation programs
4. Synthesize and integrate the different models to treat a wide a range of situations as consistently as possible, with respect to both the predictions and the input requirements.
5. Recommend a scope of work for a follow-on project to implement the most suitable technique(s)/approach(es) in an appropriate simulation program.

Deliverables

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

The Principle Investigator shall report in person to the TC at the annual and winter meeting and answer such questions regarding the research as may arise. A Final Report shall be prepared and submitted to the Society by the end of the contract period covering complete details of all research carried out on the project. Unless otherwise specified, six draft copies of the final report shall be furnished for review by the PMS. Following approval by the PMS and TC 4.7 and TC 4.10, the following will be delivered:

- Four bound copies.
- One unbound copy, printed on one side only, suitable for reproduction.
- Two copies on 3 1/2" diskette(s); one in ASCII format and one in Rich Text Format (RTF).

A Technical or Symposium Paper on this research shall be prepared in a form suitable for presentation at a Society meeting. The Paper shall conform to Section 5 of the Society's Author's Manual for Technical and Symposium Papers.

Level of Effort

It is estimated that the project will require 18 person months of effort with the total project to be completed within an 15 month time period based on an estimate of 3 person-months of the Principal Investigator and 15 person months of a research assistant.

References

MINUTES
REVISED 6/26/96

TC 4.7 Subcommittee on Applications and Inverse Methods
Monday, June 24, 1996, 6:30 - 8:00 p.m.
Marriott River Center, Salon D
Chair: Jeff Haberl

REVISED AGENDA

1. Introductions (all)
2. Discussion of the minutes from February 1996 (all)
3. Discussion of the Long Range Research Plan (all)
4. Status report on Work Statements (Haberl, Krarti)
   - WS "Procedures for Inverse Building Energy Analysis Methods..." (Krarti/Haberl)
   - WS "Toolkit for ANNs..."..reject by R&T rewrite (Krarti)
   - WS "Calibrated Computer Models"...rewrite (Haberl).
   - WS "Development of Procedures for Preparing Weather Data...(Haberl/Cumali)
5. Program (Haberl)
6. Old Business (all)
7. New Business (all)
8. Adjourn

ATTENDING THE MEETING:

- Jeff Haberl, Texas A&M
- Robert Sonderegger, SRC Systems
- Agami Reddy, Texas A&M
- Liu Mingsheng, Texas A&M
- David Claridge, Texas A&M
- Chip Barnaby, Wrightsoft
- Michael Witte, GARD Analytics
- Klaus Sommer, University of Cologne
- Joe Huang, LBNL
- Fred Buhle, LBNL
- Ron Judkoff, NREL
- Vernon Smith, AEC, Boulder, CO
- Kris Subbarao, MEI, Golden, CO

GENERAL DISCUSSION

Haberl opened the meeting at 6:40 p.m. followed by introductions of all persons present. The minutes from the February 1996 meeting were then discussed.

MOTION: To approve the minutes from the February 1996 meeting (Judkoff, 2nd by Claridge). Approved.

Haberl then reviewed the agenda for the San Antonio meeting and suggested the Long Range Research Plan be discussed and prioritized and then discussion of the WS, Program, Old Business, New Business, etc. All agreed.

DISCUSSION OF LONG RANGE RESEARCH PLAN (LRRP).

Discussion then began on the LRRP beginning with the #1 through #9. Jeff Haberl added one new One-pager and Ron Judkoff added two new One-pagers from SPC 140P SMOT. A summary of the discussion follows:

Action items to be cleaned up WS authors and circulated at least 1 month before Philadelphia for discussion in Philadelphia:

"Development of Procedures for Inverse Method Building Energy Analysis", (Krarti/Haberl).

1) the objectives of this WS needed to be reworded to more closely match the title,
2) this WS should specifically exclude neural networks and calibrated simulation methods as inverse methods,
3) delivery of licensable source code that can be copyright by ASHRAE is a requirement of this WS not necessarily FORTRAN, other codes O.K.,
4) development of a GUI is not a priority.
5) procedures developed should be applicable to hourly, daily and monthly data, this is not clear in the current WS,
6) wording in "electronic deliverables" should mention that they must conform to ASHRAE guidelines for electronic file distribution.

"Development of Procedures for Predicting Building Thermal and Electricity use From Measured Data Using Artificial Neural Networks" (Krarti/Kreider)

1) the objectives of this WS needed to be reworded to more closely match the title,
2) wording in "electronic deliverables" should mention that they must conform to ASHRAE guidelines for electronic file distribution.
3) WS needs to refocus objectives so that they highlight the development of application procedures that are specific to HVAC analysis with Neural Nets.
4) Add "4. ... Calculations into "inverse" building energy analysis programs. for BENEFIT section.

WS "Development of computerized procedures for calibrating hourly building energy simulation programs to measured thermal electrical and environmental data." (Haberl)

1) No comments from the San Antonio meeting.

2) WS is ready for discussion in Philadelphia.

WS "Development of procedures for preparing weather data for use with building energy analysis programs." (Haberl/Cumali)

1) No comments from the San Antonio meeting.
2) However, a comment was received that this WS will need to be reviewed.
3) WS needs to be forwarded to TC 4.2 for inclusion on their LRRP.

"Development of procedures for analyzing energy savings from HVAC and Lighting Retrofits using an inverse bin method and main meter, before/after data." (Haberl)

1) No comments from the San Antonio meeting.
2) WS not yet written.

Development of a procedure for baselining energy use at large central plants. (Haberl)

1) Several people mentioned that this seemed to be an interesting topic and that perhaps the author could flesh-out a WS so that others could see just what this means.
2) WS not yet written.

"Develop self-describing information exchange methods for computer programs used in HVAC industry for analysis, design and evaluation." (Cumali)

1) Several people commented that this WS was probably being handled in TC 1.5 as another name as an interoperability WS for data exchange among different software packages.
2) WS not yet written.

"Development of a Reference set of Validated Semi-empirical Tests for Primary and Secondary HVAC Equipment Simulations" (Haberl, Judkoff).

1) There was quite a bit of discussion about this work statement. Several people asked why this needed to be done when HVAC-01 and HVAC-02 toolkits were available.
2) Haberl and Judkoff mentioned that the purpose of this WS was to take HVAC-01 and HVAC-02 and make a suite of test cases for testing HVAC simulations primary and secondary equipment. Further, that it would be important for these test suites to be validated (as much as possible) with actual experimental data.
3) WS not yet written

"Development of an Empirical Validation Test Suite for Whole-building Energy Simulation Programs -- Building Fabric" (Judkoff, Huang)

1) There was quite a bit of discussion about this WS. Judkoff reviewed the background of SPC 140P SMOT and mentioned that this was needed to forward the progress of SPC 140P SMOT in the spirit of RP 865. The intention of this WS was to assemble a valid set of experimental data from as many buildings as possible that could be used to test building fabric models.
2) Judkoff has a draft WS.
3) Judkoff and Joe Huang will edit and revise the WS and circulate prior to Philadelphia for comments and bring a final draft to Philadelphia for discussion.

"Development of an Analytical Validation Test Suite for Whole-building Energy Simulation Programs -- Building Fabric" (Judkoff)

1) There was also some discussion of this WS. Judkoff explained what was needed was a valid set of analytical test equations that could be easily used by whole-building energy simulation programs to test their fabric simulations.
2) Judkoff has a draft WS.
3) Judkoff and Chip Barnaby agreed to edit and revise the WS and circulate prior to Philadelphia for comments and bring a final draft to Philadelphia for discussion.

Haberl then called for a vote to prioritize the LRRP. The results are as follows:

LONG RANGE RESEARCH PLAN FOR TC 4.7 APPLICATIONS & INVERSE METHODS: FEBRUARY 1996 (IN ORDER OF A&IM PRIORITY)

A&IM RANK	TC 4.7 RANK	TITLE AND STATUS AS OF SAN ANTONIO WITH ACTION TO BE TAKEN.
#1	#1	Development of procedures for inverse method building energy analysis (Krarti). *STATUS: WS by Krarti discussed in Atlanta. Krarti revised. Needs to be revised and brought to Philadelphia.*
#2	#3	Development of an Analytical Validation Test Suite for Whole-building Energy Simulation Programs -- Building Fabric (Judkoff) *STATUS: New WS by Judkoff...will have WS in Philadelphia.*
#3	#7	Development of an Empirical Validation Test Suite for Whole-building Energy Simulation Programs -- Building Fabric (Judkoff, Huang) *STATUS: New WS by Judkoff...will have WS in Philadelphia.*
#4	#2	Development of procedures for assessing how well hourly whole-building energy simulation programs are calibrated to measured energy and internal environmental data. (Haberl). *STATUS: WS rejected by 4.7. Haberl Revised. WS needs to be discussed in Philadelphia.*
#5 WS 930	#8	Development of a procedures for predicting building thermal and electricity use from measured data with artificial neural networks (Krarti/Kreider). *STATUS: WS Rejected by R&T. Krarti revised. WS discussed in Atlanta. Krarti revised. WS discussed in San Antonio. WS to be revised and discussed in Philadelphia.*
#6	NONE	Development of procedures for baselining energy use at large central plants (Haberl). *STATUS: One Pager. WS needs to be written.*
#7	NONE	Development of a reference set of validated semi-empirical tests for primary and secondary HVAC equipment simulations. (Haberl, Judkoff) *STATUS: New one pager. WS needs to be written.*
#8	NONE	Development of a procedures for preparing weather data for use with building energy analysis programs (Haberl). *STATUS: Draft WS delivered at San Antonio. Needs discussion. Haberl will forward WS to TC 4.2 for joint consideration.*
#9	NONE	Development of procedures for analyzing energy savings from HVAC and Lighting Retrofits using an inverse bin method and main meter, before/after data (Haberl). *STATUS: One Pager only. WS needs to be written.*
#10	NONE	Develop self-describing information exchange methods for computer programs used in HVAC industry for analysis, design and evaluation (Cumali). *STATUS: One pager.*

ASHRAE ONE PAGE WORK STATEMENT
FROM TC 4.7 APPLICATIONS AND INVERSE METHODS SUBCOMMITTEE

TITLE: A&IM RANK: #1
Development of procedures for inverse method building energy analysis.

OBJECTIVE:
The objective of this research is to develop procedures for inverse method building energy analysis. Such procedures would result in a toolkit which would be similar to ASHRAE's HVAC-01 and HVAC-02 toolkits in format and would contain algorithms and documented computer code for performing inverse method calculations. These procedures would exclude artificial neural networks and calibrated simulation models, and would be applicable to hourly, daily and monthly building energy use data.

SCOPE:
This research includes: (1) Thorough literature search into the current methods that are used to empirically analyze building energy use, (2) development of computer code for that performs inverse method calculations, and (3) assembly of such code into an ASHRAE Toolkit including the appropriate documentation.

BENEFIT:
The project will benefit ASHRAE membership as well as the general public as follows:
1. ASHRAE to develop a standard toolkit of inverse methods software.
2. Software suppliers as an aid for incorporating standard inverse building energy analysis programs.
3. Text book publishers for documenting inverse methods.
4. ASHRAE for developing more effective training programs for teaching engineers how to apply inverse calculation software.
5. Improving indoor air quality by providing ASHRAE members with software for performing inverse calculation software for analyzing IAQ.
6. Improving energy efficiency by providing ASHRAE members with inverse calculation software for calculating energy conservation savings.

ESTIMATED COSTS: DURATION:
$95,000 18 calendar months

CONTRIBUTORS:
Moncef Krarti,
Jeff Haberl

ASHRAE ONE PAGE WORK STATEMENT
FROM TC 4.7 APPLICATIONS AND INVERSE METHODS SUBCOMMITTEE

TITLE: A&IM RANK: #4

Development of computerized procedures for calibrating hourly building energy simulation programs to measured thermal electrical and environmental data.

OBJECTIVE:

The objective of this research is to develop procedures that will assist ASHRAE engineers in calibrating hourly simulation programs such as DOE-2 and BLAST to measured data from actual buildings. Such procedures could then eventually be developed into toolkits that are similar to ASHRAE's HVAC-01 and HVAC-02 toolkits in format and would contain algorithms and documented computer code for assessing how well computer simulations are calibrated to measured building energy data.

SCOPE:

This research includes: (1) performing a literature search to determine the different methods that are currently being used to calibrate hourly simulation programs, (2) development of standard procedures for performing the calibrations, and (3) documenting the procedures.

BENEFIT:

The project will benefit ASHRAE membership as well as the general public as follows:
1. ASHRAE to develop standard procedures for assessing how well computer simulations are calibrated to measured building energy data.
2. Software suppliers as an aid for incorporating ASHRAE's calibration assessment procedures into their building energy analysis programs.
3. Text book publishers for documenting calibration assessment procedures.
4. ASHRAE for developing more effective training programs for teaching engineers how to calibrate computer simulation programs.
5. Improving indoor air quality by providing ASHRAE members with improved procedures for calibrating building energy simulation programs.
6. Improving energy efficiency by providing ASHRAE members with improved procedures for calibrating building simulation programs.

ESTIMATED COSTS: DURATION:
$95,000 18 calendar months

CONTRIBUTORS:
Jeff Haberl

ASHRAE ONE PAGE WORK STATEMENT
FROM TC 4.7 APPLICATIONS AND INVERSE METHODS SUBCOMMITTEE

TITLE: A&IM RANK: #5

Development of procedures for predicting building thermal and electricity use from measured data using artificial neural networks.

OBJECTIVE:

The objective of this research is to develop and document procedures for predicting building thermal and electricity use which utilizes artificial neural networks, or connectionist methods. Such procedures would results in a toolkit would be similar to ASHRAE's HVAC-01 and HVAC-02 toolkits in format and would contain algorithms and documented computer code for performing artificial neural network predictions of building energy use.

SCOPE:

This research includes: (1) Development of computer code for that performing artificial neural network calculations, (2) assembly of such code into an ASHRAE Toolkit including the appropriate documentation.

BENEFIT:

The project will benefit ASHRAE membership as well as the general public as follows:
1. ASHRAE to develop a standard toolkit for artificial neural network calculations.
2. Software suppliers as an aid for incorporating artificial neural network calculations into building energy analysis programs.
3. Text book publishers for documenting artificial neural network methods.
4. ASHRAE for developing more effective training programs for teaching engineers how to apply artificial neural network calculations.
5. Improving indoor air quality by providing ASHRAE members with neural network software for analyzing IAQ.
6. Improving energy efficiency by providing ASHRAE members with neural network software for calculating energy conservation savings.

ESTIMATED COSTS: DURATION:
$95,000 18 calendar months

CONTRIBUTORS:
Moncef Krarti,
Jan Kreider

ASHRAE ONE PAGE WORK STATEMENT
FROM TC 4.7 APPLICATIONS AND INVERSE METHODS SUBCOMMITTEE

TITLE: A&IM RANK: #6

Development of a procedure for baselining energy use at large central plants.

OBJECTIVE:
The objective of this research is to develop and document a procedure that will baseline the energy use at large central plants. This would include the capability of developing a baseline at large central plants that serve many buildings and that contain multiple interconnected chillers, boilers, heat exchangers, electrical generation equipment, etc. This system would be capable for normalizing for different operational strategies, addition or subtraction of building stock, weather conditions and other variables such as equipment loading, etc. This type of baseline procedure is intended to be used to measure savings from retrofits to equipment in central plants. Such a procedure could then lead to a toolkit that would be similar to ASHRAE's HVAC-01 and HVAC-02 toolkits in format and would contain algorithms and documented computer code for preparing weather data for use by the most widely used building analysis programs.

SCOPE:
This research includes: (1) performing a literature search to determine the previous work that has been accomplished in this area, (2) developing an baseline calculation procedure, and (3) validating the procedure with measured data from an actual central plant, and (3) documenting the procedure in the appropriate ASHRAE report.

BENEFIT:
The project will benefit ASHRAE membership as well as the general public as follows:
1. ASHRAE to develop a standard procedure for baselining large central plants.
2. Software suppliers as an aid for incorporating ASHRAE's baseline procedure into their building energy analysis programs.
3. Text book publishers for documenting ASHRAE's baseline procedure.
4. ASHRAE for developing more effective training programs for teaching engineers how to baseline large central plants.
5. Improved energy efficiency by providing ASHRAE members with a procedure to baseline large central plants.

ESTIMATED COSTS: DURATION:
$95,000 18 calendar months

CONTRIBUTORS:

Jeff Haberl

ASHRAE ONE PAGE WORK STATEMENT
FROM TC 4.7 APPLICATIONS AND INVERSE METHODS SUBCOMMITTEE

TITLE: A&IM RANK: #7

Development of a reference set of validated semi-empirical tests for primary and secondary HVAC equipment simulations.

BACKGROUND
ASHRAE research project RP865 is developing a reference set of analytical tests for air-side HVAC simulations. To complete the validation of a general purpose HVAC simulation program a reference set of test is now needed for the primary and secondary HVAC equipment simulations, including: pumps, coils, chillers, air-conditioners, boilers, furnaces, etc.

OBJECTIVE:
Using the previously developed work including the results from RP865, and the HVAC 01 and HVAC 02 toolkits as a guide develop a reference set of semi-empirical tests for primary and secondary HVAC equipment simulations.

SCOPE:
This research includes: (1) documenting relevant publications regarding semi-empirical models for primary and secondary HVAC systems (i.e., pumps, blowers, chillers, boilers, etc.), (2) locate a set of valid experimental data for validating the semi-empirical models and validate the models, (3) develop a set of procedures that can be used to use the semi-empirical models to perform an accuracy test on the commonly used primary and secondary HVAC systems.

BENEFIT:
The project will benefit ASHRAE membership as well as the general public as follows:
1. ASHRAE to develop a standard method of applying inverse bin method calculations that include latent cooling, thermal mass, and solar effects.
2. Software suppliers as an aid for developing inverse bin method calculations that are capable of measuring latent cooling, thermal mass and solar effects.
3. Text book publishers for developing more accurate inverse methods for evaluating actual building performance data.
4. ASHRAE for developing more effective training programs for teaching engineers how to apply inverse bin methods.

ESTIMATED COSTS:	DURATION:
$75,000	18 calendar months

CONTRIBUTORS:
Jeff Haberl
Ron Judkoff

ASHRAE ONE PAGE WORK STATEMENT
FROM TC 4.7 APPLICATIONS AND INVERSE METHODS SUBCOMMITTEE

TITLE: A&IM RANK: #8

Development of procedures for preparing weather data for use with building energy analysis programs.

OBJECTIVE:

The objective of this research is to develop and document a toolkit that will prepare weather data from varying sources (i.e., NWS, local measured data, etc.) for use by building energy analysis programs such as DOE-2, BLAST, ASEAM, etc. Such a toolkit would be similar to ASHRAE's HVAC-01 and HVAC-02 toolkits in format and would contain algorithms and documented computer code for preparing weather data for use by the most widely used building analysis programs.

SCOPE:

This research includes: (1) performing a literature search to determine the different sources, format, methods of electronic transfer, and quality of weather information (e.g., NWS, solar, and other weather data bases), (2) performing a literature search to determine the different methods that are in use for preprocessing weather data for use by DOE-2, BLAST, ASEAM, PRISM and other programs and/or packing into TRY, TMY, WYEC-2, or BIN format, (2) development of computer codes for performing the weather data preprocessing, and (3) assembly of such code into an ASHRAE Toolkit including the appropriate documentation.

BENEFIT:

The project will benefit ASHRAE membership as well as the general public as follows:
1. ASHRAE to develop a standard toolkit for processing weather data into a format that is useful for building energy analysis programs.
2. Software suppliers as an aid for incorporating ASHRAE's processed weather data into their building energy analysis programs.
3. Text book publishers for documenting weather data processing routines.
4. ASHRAE for developing more effective training programs for teaching engineers how to preprocess weather data for building energy analysis programs.
5. Improved energy efficiency by providing ASHRAE members with improved weather data for analyzing existing buildings.

ESTIMATED COSTS:	DURATION:
$95,000	18 calendar months

POTENTIAL CO-SPONSORS	CONTRIBUTORS:
TC 4.2	Jeff Haberl

ASHRAE ONE PAGE WORK STATEMENT
FROM TC 4.7 APPLICATIONS AND INVERSE METHODS SUBCOMMITTEE

TITLE: A&IM RANK: #9

Development of procedures for analyzing energy savings from HVAC and Lighting Retrofits using an inverse bin method and main meter, before/after data.

OBJECTIVE:

The objective of this research is to develop and document procedures that will analyze measured data from HVAC and lighting retrofits using an inverse bin method. This method would accept hourly columnar data from on-site measurements of energy use and ambient conditions, and would calculate a bin model that captures weather dependent and non-weather dependent (i.e., schedule dependent loads). Such procedures could then be used to produce a toolkit that is similar to ASHRAE's HVAC-01 and HVAC-02 toolkits in format and would contain algorithms and documented computer code for preparing weather data for use by the most widely used building analysis programs.

SCOPE:

This research includes: (1) performing a literature search to determine the previous work that has been accomplished toward performing inverse bin method calculations on measured data (versus bin method design calculations), (2) develop an inverse bin method procedures that will calculate the average hourly weather-dependent energy use per bin, and (3) documenting the procedures in an ASHRAE report.

BENEFIT:

The project will benefit ASHRAE membership as well as the general public as follows:
1. ASHRAE to develop a standard procedure for analyzing retrofit energy savings using an inverse bin method.
2. Software suppliers as an aid for incorporating ASHRAE's inverse bin method into their building energy analysis programs.
3. Text book publishers for documenting the inverse bin method.
4. ASHRAE for developing more effective training programs for teaching engineers how to use an inverse bin method for analyzing building energy retrofits.
5. Improved energy efficiency by providing ASHRAE members with an inverse bin method toolkit for measuring retrofits savings.

ESTIMATED COSTS: DURATION:
$95,000 18 calendar months

CONTRIBUTORS:
Jeff Haberl

ASHRAE ONE PAGE WORK STATEMENT
FROM TC 4.7 APPLICATIONS AND INVERSE METHODS SUBCOMMITTEE

TITLE: A&IM RANK: #10

Develop self-describing information exchange methods for computer programs used in HVAC industry for analysis, design and evaluation.

OBJECTIVE:

The objective of this research is to develop methods of self description for input and output from computer programs to enable unhindered communication among them.

SCOPE:

The scope of thir research will focus on two selected areas: a) Hydronic Systems.
b) Energy Analysis.

This research includes: 1) Classification of input and output data, 2) definition of data models, 3) development/selection of methods of self description, 4) test of the developed methodology, 5) code that permits the data exchange for the two selected areas, 6) description of the methodology and code so that it can be applied to computer programs of interest by ASHRAE members.

BENEFIT:

The project will benefit ASHRAE membership as well as the general public as follows:
1) Help solve the data incompatibility problem among computer programs.
2) Facilitate computer aided design work done by ASHRAE members.
3) Make translation of data from detailed to simple computer programs.
4) Permit use of a variety of programs from the same input/output.
5) Save significant amounts of time in design, analysis, and evaluation of projects requiring use of multiple programs,
6) Improve energy efficiency and cost by permitting use of many different programs in design work from different vendors,
7) Permit greater flexibility of data representation without imposing constraints of standards on data format or content.

ESTIMATED COSTS: DURATION:
$75,000 18 calendar months

CONTRIBUTORS:

Zulfi Cumali,
Jeff Haberl

The Neutral Model Format

a Simulation Model Source Language for Tool Developers

Per Sahlin, KTH, Stockholm
plurre@engserv.kth.se

The calculation engines of the most widely spread building simulation tools were, almost without exception, developed during the seventies. The challenge then was to perform a multizone hourly simulation over a year within acceptable execution times. These programs are therefore highly optimized to perform well on a selected class of problems. If you want to do something slightly different, you are often out of luck. Changing the built-in models is generally beyond reach for anybody but the code developers. Today, person-time rather than machine-time is the limiting factor, and the flexibility of truly modular programs, such as TRNSYS, has proved to be invaluable. Consequently, significant research efforts are invested in model development for TRNSYS and for more recently developed modular simulation environments. Unfortunately, moving models between different environments or solvers, such as TRNSYS, HVACSIM+, ALLAN.Simulation, CLIM 2000, ESACAP, IDA, SPARK, EKS etc., is still a tedious and error prone handicraft.

NMF is a suggested standard for a component model source format, aiming at complete automation of model implementation in several target environments. A translator parses NMF model descriptions and generates environment code, e.g. TRNSYS TYPE subroutines.

An NMF model is essentially a strictly structured way of stating equations, variables and component model boundaries. An equation based language facilitates - given current numerical and computer algebra techniques - automatic generation of algorithmic model descriptions as required by, e.g., TRNSYS. Reverse translation, i.e. from algorithmic to equation based code, is not generally feasible.

As of today, research translators have been written for SPARK and ESACAP. A production quality translator for TRNSYS, HVACSIM+, and IDA has been developed at KTH in Stockholm, mainly based on ASHRAE funding. Several component model libraries have been directly developed in NMF. Others have been manually translated into NMF, e.g. the IEA Annex 10 & 17 group of models. An ASHRAE subcommittee of Technical Committee 4.7 has assumed responsibility for the NMF definition, pending further standardisation efforts.

A beta version for Windows of the ASHRAE translator can be downloaded as a self-extracting file

ftp://urd.ce.kth.se/pub/rp839/nmfwin.exe (remember to transfer as binary)

With the translator delivery comes also the NMF reference report and handbook (in rtf and postscript) as well as a large number of sample NMF component models. The translator is a 32-bit application. To run it under Windows 3.x, a 32 bit extension from Microsoft must be installed. A copy of this Win32s extension is also, for convenience, located in the same directory (file pw1118.exe.)

An e-mail list for NMF has been established on the U.K. mailbase facility. To join the IBPSA-NMF list send an e-mail message to

mailbase@mailbase.ac.uk

The Subject line is irrelevant, but the body of the message should read

join ibpsa-nmf <Yourfirstname> <Yourlastname>

MINUTES - TC 4.7 HANDBOOK SUBCOMMITTEE MEETING

The TC 4.7 Handbook subcommittee met briefly at the appointed time. Present were Spitler, substituting for Kreider as chair, Sondereggor, Pegues, and Yavuzturk. There was no business to transact, so the meeting was adjourned.

_____

Jeff Spitler, for Jan F. Kreider, Handbook Subcommittee Chair

NATIONAL RENEWABLE ENERGY LABORATORY (NREL) **PHONE: 303-384-7520**
1617 COLE BLVD
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GOLDEN CO 80401
USA
DATE: 6/25/96
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CHAIRMAN'S SUMMARY MINUTES
SPC-140 SMOT FOR BUILDING ENERGY SOFTWARE
SAN ANTONIO 6/24/96
R. Judkoff

Correspondence Since Last Meeting

- Use of BESTEST by Canada Department of Natural Resources to test HOT2000 has resulted in some comments on the Ground Coupling case (990) (Frazer/Ian Beausoleil-Morrisson).
- Questions on Empirical Validation one-page work statement from Doug Dale of Alberta U (Mark Ackerman.)
- Bruce Wilcox to replace Chip Barnaby on SPC-140 as Producer.

GENERAL

- Dru Crawley suggested that we become a Standing Committee. He agreed to explore this with appropriate ASHRAE authorities.
- Jeff Haberl agreed to explore the policy about importing "approved" whole reports into standards with Ken Gillespie Jr..

MEMBERSHIP

Following letter will be sent to Sally Hooks concerning membership on SPC-140.

Dear Ms Hooks:
Here are my recommendations for changes to SPC-140. These changes are necessitated by several resignations and changes of job status among the committee members.

RECONSTITUTION OF SPC-140

-	Kathleen Fraser:	Change from “Producer” to “User.”
-	Charles Barnaby:	voting to non-voting
-	Bruce Wilcox:	appoint as “Producer”
-	Jeff Spitler	voting to non-voting
-	Carol Gardiner	resigned
-	Mike Witte:	Change from non-voting to voting “User”
-	Dru Crawley	Change from “User” to “General Interest”
-	George Walton	Change from “General Interest” to “Producer”

- Fred Buhl Appoint as non-voting "Producer"

The current recommended constitution of the voting committee is:

GENERAL INTEREST	USER	PRODUCER
Judkoff	Fraser	Wilcox
Maeda	Haberl	Sondreggor
Crawley	Witte	Walton

Please advise me if additional action on this matter is required.

Sincerely,

R. Judkoff, Chair SPC-140

cc:
Tammy Kennedy, Sara Deppen, Jim Heldenbrand, Mike Witte

INTERMODEL COMPARISON BASED TESTS

NREL produced a second draft of the Standard Method of Test. This draft identifies where each applicable section of the IEA BESTEST would fit into the Standards format developed by Dru Crawley for the last meeting. NREL will distribute this draft for review, once the cut and paste mechanics are completed.

- Publication of HERS BESTEST.
- HERS BESTEST cited as the basis for software certification in DOE NOPR 10CFR-437, "Residential Energy Efficiency Ratings.
- Adoption by New Zealand of BESTEST as the basis for certifying code compliance software.
- Use of BESTEST by Canada Department of Natural Resources to test HOT2000.

ANALYTICAL TESTS (HVAC SYSTEMS)

After three rejections, R&T approved 865-WS, "Development of a Reference Set of Analytical Solutions for Mechanical

Systems Simulation Test Cases." George Walton chaired the 865-TRP contractor selection committee, and Pennsylvania State University (Gren Yuill), and Texas A&M (Jeff Haberl) were selected as the contractors.

George Walton, R Judkoff, and Rob Sondreggor agreed to serve on the Project Monitoring Subcommittee (PMS). The subcommittee met at 1:15, monday, 6/24/96 for the first review. PSU was ahead of schedule, and Texas A&M was on schedule.The work is limited to the "air side" of the mechanical equipment problem. SPC-140 discussed this and decided that another research work statement would be needed to address the "wet side" portion of the problem. Jeff Haberl agreed to compose a one-pager for the next meeting.

EMPIRICAL DATA SETS (Building Fabric)

- R. Judkoff wrote a one page Work Statement on the topic of Analytical Solutions (Building Fabric) for the TC-4.7 Research Work Statements, as requested by SPC-140 at the Atlanta meeting. The one pager was reviewed by the "Applications and Inverse Methods Subcommittee, and given high priority ranking. The one pager is attached.

ANALYTICAL TESTS (BUILDING FABRIC)

- R. Judkoff wrote a one page Work Statement on the topic of Analytical Solutions (Building Fabric) for the TC-4.7 Research Work Statements, as requested by SPC-140 at the last meeting.

The WS was reviewed by the "Applications and Inverse Methods Subcommittee, and given a high priority ranking. Chip Barnaby agree to work with Judkoff to develop this into a full WS for the Philadelphia meeting. The one pager is attached.

ATTENDEES
VOTING

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Fred Buhl
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510-486-4089

Klaus Sommer
U Cologne, Germany
klaus.sommer@vt.fh-koeln.de

ATTACHMENT I

NREL **PH: 303-384-7520**
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GOLDEN CO 80401 **EMAIL:**
ron_judkoff@nrel.gov
USA **DATE:** 2/20/96

PRELIMINARY RESEARCH WORK STATEMENT

DEVELOPMENT OF AN ANALYTIC TEST SUITE FOR WHOLE BUILDING ENERGY SIMULATION PROGRAMS

Analytical Verification is defined as a process in which the output from a program, subroutine, or algorithm is compared to the result from a known analytical solution, or a universally accepted numerical solution, for isolated heat transfer mechanisms under simplified and constrained boundary conditions. Analytical verification tests the mathematical solution algorithm for a specific heat transfer mechanism within a program. It does not test how well the algorithm models physical reality. Analytical verification is one part of a three part validation approach which forms the basis for the Standard Method of Test for Building Energy Software being developed under SPC-140. The other two parts of the validation methodology include:

- Empirical Validation in which the calculated results from a program, subroutine, or algorithm are compared to monitored data from a real structure, test cell, or laboratory experiment.

- Comparative Testing in which a program is compared to itself or to other programs. The comparative approach includes "sensitivity testing" and "intermodel comparisons."

The purpose of this project is to produce a suite of analytical tests that can be easily implemented by program users, and producers. In previous work a number of analytical tests were derived and implemented at NREL (Wortman, Burch, Judkoff) including: wall conduction under steady state conditions, mass charging and decay due to a step change in temperature, glazing heat transfer, mass charging and decay due to solar radiation, and infiltration heat transfer. Several other researchers have also proposed analytical solutions (Bland, Bloomfield, Stefanizzi, Van de Perre, and Verstreit). Although many such analytical tests are possible in theory, the utility of a test depends on how easily it can actually be implemented in the context of the typical input capabilities associated with a variety of whole building simulation models. In this project the contractor would review the existing literature on analytical verification of whole building energy simulation computer programs. The contractor would then create a suite of easily implemented tests. The contractor would document the tests by producing a detailed set of modeling specifications for each test, and by producing the target results for each test. The

contractor would also be required to prove that the tests can be implemented by testing several whole building energy simulation programs with time steps of one hour or less. The contractor would adhere to the following format for documenting the tests.

Description: a brief description of the test and its purpose.

Input: Building description and weather data. Common building designs and weather sequenc

Output: Identifies modeling results that are to be produced. These will generally be zone or component loads, heat flows and/or temperatures at hourly, daily, monthly and/or annual intervals.

Quantitative

Results: Tabulated numerical results. Variants may be presented as required to cover common modeling differences, such as combined vs separate calculation of radiant and convective surface heat transfer.

Qualitative

Results: The expected output behaviour described in non-numerical fashion where applicable.

Derivation: Full documentation of how the target results are obtained in sufficient detail to allow verification, extension, and modification.

The contractor will develop the most parsimonious suite of tests that covers as many of the heat transfer mechanisms associated with the building fabric. These can be comprised of existing tests in the literature, or new tests developed by the contractor.

ATTACHMENT II

NREL **PH: 303-384-7520**
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ron_judkoff@nrel.gov
USA **DATE:** 2/20/96

PRELIMINARY RESEARCH WORK STATEMENT

DEVELOPMENT OF AN EMPIRICAL VALIDATION TEST SUITE FOR WHOLE BUILDING ENERGY SIMULATION PROGRAMS

Empirical Validation is defined as a process in which the calculated results from a program, subroutine, or algorithm are compared to monitored data from a real structure, test cell, or laboratory experiment. Empirical Validation provides a bottom line test of a model and its solution algorithms against an approximate truth standard within experimental uncertainty. Empirical Validation allows only a limited sampling of the parameter space because of the expense of gathering high quality and complete data sets. Empirical Validation is one part of a three part validation approach which forms the basis for the Standard Method of Test for Building Energy Software being developed under SPC-140. The other two parts of the validation methodology include:

- Analytical Verification in which the output from a program, subroutine, or algorithm is compared to the result from a known analytical solution, or a universally accepted numerical solution, for isolated heat transfer mechanisms under simplified and constrained boundary conditions. Analytical verification tests the mathematical solution algorithm for a specific heat transfer mechanism within a program. It does not test how well the algorithm models physical reality.

- Comparative Testing in which a program is compared to itself or to other programs. The comparative approach includes "sensitivity testing" and "intermodel comparisons." Comparative testing allows extensive sampling of the parameter space.

Together these three techniques comprise a powerful validation method.

The purpose of this project is to a) evaluate the literature on existing data sets that have been produced specifically for validating whole building energy simulation programs, and b) to assemble at least one data set into an empirical validation test package that can be easily used by software users and producers. The evaluation would involve the following criteria:

SUITABILITY OF THE TEST OBJECT: The data must be from a single zone test cell or

building that was unoccupied and operated as a controlled experiment during the period of data collection. The test object should be de-coupled from the ground, have no attic, have a convective heating system and a relatively well mixed air volume. The test object must have a minimum internal heat capacitance of_____, and be strongly solar driven with a south glass area at least 15% of the floor area. The thermal and optical characteristics of the object must be well defined with no unknown heat transfer paths. The infiltration air exchange must have been measured with a well calibrated continuous tracer gas monitoring system. The test object must have been run in at least a heating temperature controlled mode using electric heaters and a distribution system entirely contained within the insulated envelope. Additionally, a period in which the object was run in a free-floating temperature mode would be considered advantageous.

Minimum required measurements:

- Outdoor ambient dry-bulb hourly integrated temperature (properly shaded and ir shielded aspirated sensor).
- Outdoor hourly integrated wind speed measured 6ft above the roof of the building.
- Hourly integrated global horizontal solar radiation, hourly integrated direct normal solar radiation measured with a properly calibrated pyrheliometer or hourly integrated diffuse radiation measured with a properly calibrated shadow band pyranometer.
- The ground reflectivity around the building.
- The solar albedo of all surfaces.
- The ir emittance of all surfaces.
- The zonal indoor spatially averaged and hourly integrated dry-bulb temperature.
- The hourly integrated electric power usage for heating, indoor lighting, and fans (lights and fans to be completely contained within the insulated envelope of the building).
- Hourly integrated infiltration rate.
- Hourly integrated outdoor barometric pressure.
- Hourly integrated outdoor wet-bulb temperature.
- Hourly integrated indoor wet-bulb temperature.

Other desireable measurements

- Global solar incident radiation in the plane of all windows.
- Global solar transmitted radiation in the plane of all windows.
- Surface temperatures, and temperature rakes through building elements.
- Heat flux transducer measurements through building elements.

The contractor would be responsible for processing weather data into standard electronic TMY format readable by most hourly simulation programs. The contractor would be responsible for assembling a complete description of the test object and its various test modes in a form suitable for unambiguous input to most hourly simulation programs. The contractor would be responsible for formatting the hourly and summed energy consumptions, and indoor temperatures in a convenient form for easy comparison of modeled results to measured results.

ATTACHMENT III

NREL **PH: 303-384-7520**
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GOLDEN CO 80401 **EMAIL:**
ron_judkoff@nrel.gov
USA **DATE:** 6/24/96

SPC-140 SMOT FOR BUILDING ENERGY SOFTWARE: Judkoff
AGENDA: SAN ANTONIO, 6/24/96

SIGN-UP SHEET
MINUTES FROM ATLANTA MEETING
ANNOUNCEMENTS
- Appointment of Kathleen Frazer to SPC-140 (Producer).
- PSU (Yuill) and Texas A&M (Haberl) were selected at FebTC-4.7 meeting.
- SPC-140 now has an FTP site.
- What is the procedure for the SPC-140 minutes?

CORRESPONDENCE SINCE LAST MEETING
- Use of BESTEST by Canada Department of Natural Resources to test HOT2000 has resulted in some comments on the Ground Coupling case (990) (Frazer/Ian Beausoleil-Morrisson).
- Questions on Empirical Validation one-page work statement from Doug Dale of Alberta U (Mark Ackerman.
- Bruce Wilcox to replace Chip Barnaby on SPC-140 as Producer.

ISSUES FROM LAST MEETING
- Dru Crawley's suggestion that we become a Standing Committee (Progress?)
- Jeff Haberl's suggestion to explore the policy about importing "approved" whole reports into standards with Ken Gillespie Jr..
- R. Judkoff wrote a one page Work Statement on the topic of Analytical Solutions (Building Fabric) for the TC-4.7 Research Work Statements.
- R. Judkoff wrote a one page Work Statement on the topic of Empirical Validation (Building Fabric) for TC-4.7 research list (TC-4.9 Bob Brown).
- Review by Project Monitoring Subcommittee (PMS) of 865-TRP "Development of a Reference Set of Analytical Solutions for Mechanical System Simulation Test Cases."

SUBCOMMITTEE REPORTS
- HVAC CALC SUBCOMMITTEE: George Walton

- ANALYTIC SOLUTIONS SUBCOMMITTEE: G.Walton
- INTERMODEL COMPARISON SUBCOMMITTEE: RON JUDKOFF

BREAK INTO SUBCOMMITTEE MEETINGS OR STAY IN PLENARY
SUBCOMMITTEE MEETING REPORTS
ACTIONS
ADJOURN

DISTINGUISHED SERVICE AWARD POINT TALLY
15 POINT MINIMUM REQUIRED

NAME: _____ REGION: _____CHAPTER:

DSA POINT SCORE ITEM	POINTS	TOTAL
A. SOCIETY OFFICES/BOARD OF DIRECTORS		
1. SOCIETY PRESIDENT	5	
2. SOCIETY PRESIDENT ELECT	4	
3. SOCIETY VICE PRESIDE~ & TREASURER	3	
4. REGIONAL DIRECTOR/CHAIRMAN	3 PER YEAR	
5. DIRECTOR AT LARGE	2 PER YEAR	
B. CHAPTER OFFICERS/BOARD OF DIRECTORS		
1. CHAPTER PRESIDENT	1 PER YEAR	
2. CHAPTER OFFICERS	1/2 PER YEAR	
3. BOARD OF GOVERNORS	1/4 PER YEAR	
NOTE: MAX 4 POINTS FOR ALL CHAPTER OFFICERS PER CHAPTER		
C. SOCIETY STANDING COMMITTEES (SEE LIST AT END OF PAGE)		
1. COUNCILS: EDUCATION, MEMBER, PUBLISHING, REGIONS, TECHNOLOGY (voting members only) no points for Officers/Bod	1 PER YEAR	
2. STANDING COMMITTEE CHAIRMAN (BOD&OFFICERS-NO POINTS		
3. STANDING COMMITTEE MEMBER	1 PER YEAR	
4. NOMINATING COMMITTEE ALTERNATE	1/2 PER YEAR	
5. CONSULTANT (UNPAID)	1/2 PER YEAR	
D. SPECIAL SOCIETY COMMITTEES		
1. SOCIETY PROJECT COMMITTEE (MAX 7 POINTS)		
a. CHAIRMAN	3 PER PROJECT	
b. MEMBER	1/2 PER PROJECT	
2. TASK GROUP (MAX 7 POINTS)		
a. CHAIRMAN	1 PER YEAR	
b. MEMBER	1/2 PER YEAR	
3. PRESIDENTIAL AD-HOC (MAX 7 POINTS)		
a. CHAIRMAN	2 PER PROJECT	
b. MEMBER	1/2 PER PROJECT	
4. HANDBOOK (MAX 7 POINTS)		
a. CHAIRMAN	2 PER YEAR	
b. CHAPTER AUTHOR	2 PER CHAPTER	
C. REVISOR	1/2 PER CHAPTER	
d. VOLUME CHAIRMAN	2 PER VOLUME	
e. VOLUME MEMBER	1 1/2 PER VOLUME	
E. GENERAL ACTIVITIES		
1. SYMPOSIUM CHAIRMAN	1 PER SYMPOSIUM	
2. SEMINAR CHAIRMAN	1/2 PER SEMINAR	
3. FORUM MODERATOR	1/4 PER FORUM	
4. ANNUAL/WINTER MEETING		
a. GENERAL CHAIRMAN	2/PER MEETING	
b. GENERAL CO-CHAIRMAN	1 PER MEETING	
C. SUBCOMMITTEE CHAIRMAN	1 PER MEETING	
5. CRC OR OTHER ASH RAE SPONSORED CONFERENCES		
a. GENERAL CHAIRMAN	1 PER MEETING	
b. VICE CHAIRMAN	1 PER MEETING	
C. SUBCOMMITTEE CHAIRMAN	1 PER MEETING	
6. PRESIDENTIAL APPOINTMENT-INTERSOCIETY ASSIGNMENT	1/2 PER ASSIGN	
7. INTERNATIONAL SERVICES (MAX 4 POINTS FOR a, b, & CI		
a. CHAIRMAN OR CO-CHAIRMAN OF ASHRAE INTL CO-SPONSORED CONF	1 PER CONF	
b. TECHNICAL PAPER PRESENTED AT ASHRAE CO-SPONSORED CONF	1/2 PER YEAR	
C. ASHRAE-APPOINTED LIAISON WITH INTL ASSOCIATE	1/2 PER YEAR	
F TECHNICAL COMMITTEE (MAX 3 PER COMMITTEE OR 10 POINT TOTALI		
1. CHAIRMAN	1 PER YEAR	
2. MEMBER	1/2 PER YEAR	
3. CORRESPONDING MEMBER	1/4 PER YEAR	
G. SPEAKERS / AUTHORS - ASH RAE ONLY		
ANNUAL / WINTER MEETING OR ASHRAE SPONSORED CONFERENCES		
a. TECHNICAL PAPER AUTHOR	1 PER PAPER	
b. SYMPOSIUM PAPER AUTHOR	1 PER PAPER	
C. SEMINAR SPEAKER	1/2 PER SEMINAR	
H. ASHRAE PUBLISHED PAPERS		
JOURNAL ARTICLE	1/2 PER ARTICLE	
TOTAL POINTS		

NOTE: STANDING COMMITTEES-ACCREDITATION ACTIVITIES CONTINUING EDUCATION, EDUCATIONAL ACTIVITIES, REFRIGERATION.

ADMISSIONS & ADVANCEMENT, CHARTER & BYLAWS, HONORS & AWARDS, MEETINGS & ARRANGEMENTS, MEMBERSHIP PROMOTION,
ASHRAE PROGRAM, HANDBOOK, JOURNAL/INSIGHTS, SPECIAL PUBLICATIONS, CHAPTERS REGIONAL RESEARCH PROMOTIONAL
ENVIRONMENTAL, HEALTH STANDARDS RESEARCH &TECHNICAL, TECHNICAL ENERGY & GOVERNMENT ACTIVITIES ITEGA) HISTORICAL
FINANCE INTERNATIONAL NOMINATING REGIONAL VICE-CHAIRMEN ARE MEMBERS OF THEIR RESPECTIVE STANDING COMMITTEES

Disclaimer from the secretary:

This document was scanned in and not carefully proofread. Questions, contact Gren Yuill gkyarc@engr.psu.edu

ASHRAE TC 4.7 1997-98 Long Range Research Plan

Approved by TC 4.7 in San Antonio

June 25, 1996

TC Priority	Title	Status	Subcommittee/ Principal Author
1.	Development of Procedures for Inverse Method Building Energy Analysis	WS in Phila.	A&IM/Krarti
2.	Development of Computerized Procedures for Calibrating Hourly Building Energy Simulation Programs to Measured Energy Use and Internal Environmental Data	WS in Phila.	A&IM/Haberl
3.	Development of Analytical Tests for Building Envelope Algorithms	Draft for Phila.	A&IM/Judkoff (SPC 140)
4.	Modeling Two-Dimensional Heat Transfer through Walls in Hourly Simulation Programs	Draft for Phila.	CM/Huang
5.	Modular Simulation of Building Loads	Draft for Phila.	Simulation/Haves
6.	Fast Multizone Models for System Optimization	Draft for Phila.	Simulation/Lebrun
7.	Development of an Empirical Validation Test Suite for Building Envelope Algorithms	Draft for Phila.	A&IM/Judkoff
8.	Development of Procedures for Predicting Building Thermal and Electricity Use Using Artificial Neural Networks	WS in Phila. 930-WS	A&IM/Krarti & Kreider
9. HR	Goal Oriented Model Synthesis for Simulations and Design	*HIGH RISK*	Simulation/Cumali & Haves

TC 4.7 Energy Calculations
Proposed Mission

Scope

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

Goal

Accurate energy models at every engineer's fingertips.