

**AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING  
ENGINEERS, INC.  
1791 Tullie Circle, N.E./Atlanta, GA 30329  
404-636-8400**

**TC/TG/MTG/TRG MINUTES COVER SHEET**

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

TC/TG/MTG/TRG No. 6.1                      DATE July 24, 2015

TC/TG/MTG/TRG TITLE Hydronic and Steam Equipment and Systems  
DATE OF MEETING June 30, 2015                      LOCATION Atlanta, GA

MEMBERS PRESENT	YEAR APPTD	MEMBERS ABSENT	YEAR APPTD	EX-OFFICIO MEMBERS AND ADDITIONAL ATTENDANCE
Jason Atkisson	2011	Ramez Afify	2011	
Tricia Bruenn	2011	Michael McDermott	2009	
Thomas Neill	2011	Frank Myers	2013	
Don Prather	2013	Greg Towsley	2013	
Rex Scare	2011			
Edward Tsui (non-quorum)	2011			

**DISTRIBUTION**

*All Members of TC/TG/MTG/TRG plus the following:*

TAC Section Head:	Mark C. Hegberg
TAC Chair:	Dr. Eric W. Adams
All Committee Liaisons As Shown On TC/TG/MTG/TRG Rosters:	ALI/PDC – Darin W. Nutter Chapter Tech. Transfer – Maggie Moninski Research - Stephen S. Hancock Special Pubs - Standard – Cyrus H. Nasser 2016 HB Systems - Forrest S. Yount 2017 HB Fundamentals – Van D. Baxter
Manager Of Standards Manager Of Research & Technical Services	Stephanie Reiniche Mike Vaughn

**1. Call to Order:**

Chair Bruenn called the meeting to order at 1:04pm. Chair Bruenn welcomed all in attendance and self-introductions were made. An attendance sheet was passed and signed by those in attendance

(attached). A roll call of voting members was conducted and a quorum was present with 5 of the 10 voting members at the start of the meeting. The non-quorum voting member arrived at 1:18pm.

Technical Committee 6.1 is concerned with all aspects of hydronic and steam systems. This includes the application of boilers, chillers, terminal units, and all accessories and controls making up the total system as well as the design of the integrated system. In addition to comfort applications of both heating and cooling, snow melting systems are included. Cooperation with other TCs is recognized in areas such as control, noise and vibration, refrigeration, pumps and hydronic and service water piping.

**2. Setting of the Agenda:**

The Chair passed out an updated Agenda. Motion by Rex Scare, second by Jason Atkisson to approve the meeting agenda. Motion passed 5-0-0.

**3. Approval of Chicago Meeting Minutes:**

Motion by Rex Scare, second by Thomas Neill to approve the past meeting minutes. Motion passed 5-0-0.

**4. Recognition of Liaisons:**

No liaisons were present.

Robert Bean reported on the activities of TC 6.5. An RTAR extension is being requested to further enhance the radiant modeling tool. TC 6.5 also co-sponsored Seminar 54 – Design of Energy Efficient Hydronic Heating Systems at this meeting with TC 6.1.

**5. Chair's Report**

Chair Bruenn summarized the key items from the Section 6 Breakfast.

- (a) Members are asked to follow the new procedure for becoming a corresponding member of a TC. Look for the 'Join the TC' button on the ASHRAE website.
- (b) A new, easier standard website template is being introduced this fall for the TCs. TC 6.1 is actively looking for a new webmaster. Interested members should contact Vice Chair (incoming Chair) Scare.
- (c) 2015-16 RAC will be prioritizing research projects related to the residential sector.
- (d) E-mails will be sent to TC volunteers with a July deadline for requesting thank you letters to employers.
- (e) Hightower Award nominations are due by July 15.
- (f) The CEC is requesting suggestions for the Program Track in Las Vegas.
- (g) Employment discipline has been added to ASHRAE BIO Online Input Form. To date, only 30.6% of the membership has updated their bio with this information. The membership is being asked to update their profiles.
- (h) TC and Subcommittee Meetings now have the option to meet via conference call or web meetings. This will allow members who can't travel to participate.
- (i) Members are asked to review the ASHRAE Code of Ethics (<https://www.ashrae.org/about-ashrae/ashrae-code-of-ethics>).

- (j) A new MTG has been formed (this will be discussed in new business).
- (k) A TAC Presentation template for TC members to use with their local Chapters is available.
- (l) The TC Master Calendar is available through Google.
- (m) A disclosure will be provided with technical papers and conference papers disclosing funding sources for the research.

## 6. Sub-Committee Reports

- A. Programs: David Lee (Interim Chair). Subcommittee meeting minutes of June 29, 2015, and look ahead for proposed programs in Orlando, St. Louis, and Las Vegas are attached.

The TC is sponsoring Seminar 54 Design of Energy Efficient Hydronic Heating Systems at this meeting on Wednesday at 8am. This is co-sponsored with TC 6.5 Radiant Heating and Cooling.

Interim Chair Lee asked for more input for topics that are related to the announced program tracks. He reviewed the upcoming tracks for St. Louis. Conference papers and technical papers are typically approved before seminars.

The commercialism policy was reviewed. Photos of products are OK as long as the logo is covered up. One is allowed to mention a specific installation or project. Afterwards the same installation or project is to be referenced generically, such as a 'large university campus'. Also, sources of funding must be disclosed.

- B. Research: Tom Cappellin (Chair). Subcommittee meeting minutes of January 26, 2015, are attached.

The RTAR proposal for developing a standard for testing pressure independent control valves was discussed. Hooman Daneshmand volunteered to do the initial research for the RTAR.

- C. Handbook: Jason Atkisson (Chair). Subcommittee meeting minutes of January 28, 2015, are attached.

Copies of the chapters had been sent to all voting members for final review.

Motion by Jason Atkisson, second by Don Prather to accept Chapter 11 – Steam Systems. Motion passed 5-0-1 (with the Chair abstaining).

Motion by Jason Atkisson, second by Don Prather to accept Chapter 32 – Boilers. Motion passed 5-0-1 (with the Chair abstaining).

Motion by Jason Atkisson, second by Don Prather to accept Chapter 36 – Hydronic Heat Distribution Units and Radiators. Motion passed 5-0-1 (with the Chair abstaining).

Motion by Jason Atkisson, second by Don Prather to accept Chapter 44 – Centrifugal Pumps. Motion passed 5-0-1 (with the Chair abstaining).

Motion by Jason Atkisson, second by Don Prather to accept Chapter 47 – Valves. Motion passed 5-0-1 (with the Chair abstaining).

- D. Chilled Water Sub Committee: Steve Tredinnick (Chair). Chair Tredinnick was absent. The subcommittee meeting was not held.

The outline for the new Handbook chapter is complete. Volunteers are still needed to participate as authors and reviewers are being solicited. Volunteers should contact Chair Tredinnick ([stredinnick@burnsmcd.com](mailto:stredinnick@burnsmcd.com)). The goal is to review the new chapter at the Winter, 2019, meeting for publishing in the 2020 Handbook.

- E. Membership: Larry Konopacz (Chair). Chair Konopacz reported he sent an e-mail to all members of the committee who had not been present at a meeting in the past 3 years to gauge their interest in remaining on the committee roster. The membership list for TC 6.1 has been updated.

- F. Standards: Mike O'Rourke (Chair). Chair O'Rourke was not in attendance.

Greg Towsley has been serving as the liaison to 90.1. As of this year he has asked not to be renewed in this position. Chair Bruenn asked for a volunteer to take over this position.

- G. Professional Development (ALI). Greg Towsley also asked not to be renewed in this position. Don Prather volunteered to become the ALI liaison for TC 6.1.

- H. Web: David Lee (Webmaster) Webmaster Lee stated the website is up to date. Jessica Mangler volunteered to be the webmaster beginning July 1.

## **7. Liaison Reports from other TC's and Organizations.**

- (a) Mehdi Doura reported SPC 155P MOT/Rating Commercial Space Heating Boiler System has been updated to reflect the new test method for jacket loss vs. direct water. It will be released for public review next summer.
- (b) Don Prather stated there was nothing to report from TC 7.7 Testing and Balancing.
- (c) Don Prather said those interested in copies of I=B=R that was developed by the AGA and AHRI as a basic level residential and light commercial design guide for hydronic systems, should contact ACCA.
- (d) Robert Bean reported the Uniform Solar Energy Hydronics Code is in conflict with the Uniform Mechanical Code regarding the use of embedded fittings. A task group is being formed and he stated anyone is welcome to join and participate.

## **8. Old Business:**

- (a) UMC Code Change Proposals are attached with their outcomes (if applicable).

- (b) Don Prather reported he had heard nothing regarding the proposed MTG of TC 7.3 to address the operations and maintenance activities that impact energy efficiency. Mr. Prather is still willing to participate and will report back on any activity of this MTG. Rex Scare will be the primary TC 6.1 participant, Don Prather and Edward Tsui will be the secondary participants.

**9. New Business:**

- (a) The committee discussed the lack of activity for SPC 208 – Method of Test for Determining Hydronic System Balance Valve Capacity. Contact will be made with the SPC Liaison, Adam Hinge, to discuss how to revive this SPC. The committee in discussion agreed there was a need to continue the SPC. Don Prather volunteered to chair the SPC with several members expressing interest in participating. The committee is looking for guidance from Adam Hinge as to how to proceed.
- (b) Chair Bruenn thanked the outgoing subcommittee chairs for their work. She also thanked Vice Chair Scare for filing in at the last two meetings while she was absent.
- (c) Rex Scare will take over as the Chair of TC 6.1 at the next meeting. Bob Walker will continue as Secretary. Subcommittee assignments are 90.1, VACANT; ALL, Don Prather; Chilled Water Plant, Steve Tredinnick; Handbook, Tricia Bruenn; Membership, Larry Konopacz; Programs, David Lee; Research, Tom Cappellin; Standards, Mike O'Rourke; and Webmaster, Jessica Mangler.

**10. Meeting Adjournment:**

Motion by Tricia Bruenn, second by Thomas Neill to adjourn the meeting. Meeting adjourned at 2:50pm.

Submitted by,  
Bob Walker.  
TC 6.1 Secretary





## **TC 6.1 Program Subcommittee Meeting - Minutes:**

June 29, 2015

### **Attendees:**

David Lee, Armstrong Fluid Technology – Interim Program Chair

Jen Leach, Cummins Wagner

Bob Walker, Belimo

Rex Scare, Armstrong International

Hooman Daneshmand

Jason Atkisson, AEI

Niels Bidstrup, Grundfos

Anders Nielsen, Grundfos

Tricia Bruenn, Belimo

Larry Konopacz, Xylem-Bell & Gossett

Ben Bell-Walker, Biomass Thermal Energy Council/USFS

### **Minutes:**

- Upcoming Seminar 54 – Design of Energy Efficient Heating Hydronic Systems on Wednesday July 1, 2015. Sponsored by TC 6.1 and co-sponsored by TC6.5
- 3 Seminars to be submitted for Orlando conference:
  - PICV vs Pressure dependant control valves
    - Chair: Bob Walker
    - Speakers: Hooman Daneshmand, Larry Konopacz
  - ECM motors for distribution pumps
    - Chair: Jason Atkisson
    - Speakers: Niels Bidstrup, Larry Konopacz, Anders Nielsen
  - Biomass heating for residential systems
    - Chair: Ben Bell Walker    Speakers: TBA
- Other programs pushed back to St. Louis, summer 2016
- Discussed best approaches to getting programs approved. Conference papers are given 1<sup>st</sup> priority followed by Technical papers. Seminars are the most competitive due to high number of submissions. If proposed program falls into one of the conference tracks (other than Fundamentals/Applications or Systems/Equipment), likelihood of acceptance is higher.

## TC -6.1 Programs Look Ahead

<b>Year</b>	<b>Date</b>	<b>City</b>
	<b>2015</b>	
	Jan 24-28	Chicago
<b>Tracks</b>	<a href="http://www.ashare.org/chicago/">www.ashare.org/chicago/</a>	
1	HVAC & R Systems and Equipment	
2	HVAC & R Fundamentals and Applications	
3	Industrial Facilities	
4	Large Buildings: Mission Critical Facilities and Applications	
5	Energy Efficiency	
6	Life Safety	
7	Design of Energy and Water Efficient Systems	
8	Hospital Design and Codes	
9		
<b>Technical Paper</b>	Paper: April 14, 2014	
<b>Conference Paper</b>	Abstract: March 24, 2014; Paper: July 9, 2014	
<b>Seminar</b>	Proposal: June 1 to August 11, 2014	
	Hydronics 101: Design Basics for Young Engineers and Complying with Std 90 (Jason Atkison Chair, Julia Keen and Jeff Boldt) 200+	
<b>Forum</b>	Proposal: June 1 to August 11, 2014	

## TC -6.1 Programs Look Ahead

**Year** 2015  
**Date** June 27 to 31  
**City** Atlanta

**Tracks** [www.ashare.org/atlanta/](http://www.ashare.org/atlanta/)

- 1 HVAC & R Systems and Equipment
- 2 HVAC & R Fundamentals and Applications
- 3 Research Summit
- 4 Refrigeration
- 5 Building Operation, Maintenance and Optimization/Commissioning
- 6 Indoor Air Quality
- 7 Modeling Throughout The Building Life Cycle
- 8 High Performance Building
- 9 Moving Advanced Energy Design Guidance to the Mainstream

**Technical Paper** Paper: September 22, 2014

**Conference Paper** Abstract: September 22, 2014; Paper: January 5, 2015

**Seminar** Proposal: February 9, 2015

Design of Energy Efficient Hydronic Systems - David Lee and Robert Bean  
Control Valve Authority Science or Fiction - Mark Hegberg

**Forum** Proposal: February 9, 2015

## TC -6.1 Programs Look Ahead

**Year** Winter 2016  
**Date** January 23 - 27, 2016  
**City** Orlando

### Tracks

[www.ashare.org/orlando/](http://www.ashare.org/orlando/)

- 1 HVAC & R Systems and Equipment
- 2 HVAC & R Fundamentals and Applications
- 3 Design Build
- 4 International Design
- 5 Standards, Guidelines and Codes
- 6 Cutting-Edge Technologies
- 7 The Great Debate
- 8 Modern Residential Systems

**Technical Paper** Paper: August 21, 2015

**Conference Paper** Abstract: July 10, 2015; Paper: August 21, 2015

**Seminar** Proposal: August 10, 2015

- PICV vs Pressure dependant control valves      Chair: Bob Walker      Speakers: Hooman Daneshmand, Larry Konopacz
- ECM motors for distribution pumps              Chair: Jason Atkisson      Speakers: Niels Bidstrup, Larry Konopacz, Anders Nielsen
- Biomass heating for residential systems        Chair: Ben Bell Walker      Speakers: TBA

**Forum** Proposal: August 10, 2015

## TC -6.1 Programs Look Ahead

<b>Year</b>	<b>Summer 2016</b>
<b>Date</b>	June 25 - June 29, 2016
<b>City</b>	St. Louis
<b>Tracks</b>	<a href="http://www.ashare.org/stlouis/">www.ashare.org/stlouis/</a>
1	Advances in Refrigeration Systems and Alternative Refrigerants
2	Research Summit
3	Fundamentals and Applications
4	Systems and Equipment
5	Smart Building Systems/Remote Monitoring and Diagnostics
6	Indoor Environment: Health, Comfort, Productivity
7	Professional Skills Beyond Engineering
8	Renewable Energy Systems and Net Zero Buildings
<b>Technical Paper</b>	Paper: September 14, 2015
<b>Conference Paper</b>	Abstract: Sept. 14, 2015; Paper: Jan. 4, 2016
<b>Seminar</b>	Proposal: February 8, 2016
	<ul style="list-style-type: none"><li>● Chiller Plant Control Fundamentals and Optimization Workshop- Ed T</li><li>● Valve Sizing and Selection - Robert Walker with TC-1.4 Steve Taylor</li><li>● Hydronic Commissioning - Mike McDermott</li><li>● ASHRAE Code Update For Hydronic System Design (Jason, Jeff Boldt, Julia Keen)</li><li>● Pipe Thermal Expansion Design - Bryson Borzini</li><li>● Impact of Multiple Parallel Pumping Arrangements for Large Chilled Water Systems - Jason and Mike (GSH Case Study)</li><li>● Steam System Design Fundamentals and Applications- Rex Scare</li><li>● Pump sizing and selection - Niels Bidstrup and Larry Larry Konopacz</li></ul>
<b>Forum</b>	Proposal: February 8, 2016

# TC 6.1 Hydronic and Steam Heating Equipment and Systems

## Research Subcommittee Meeting Agenda

### Atlanta Hilton Hotel

Monday, June 29, 2015

Research Subcommittee 3:15 to 4:15 PM in Room 405 on 4<sup>th</sup> Floor

#### Topics of Discussion

1. Notes from Research Subcommittee Breakfast.
2. Consideration of a research project that was rejected by RAC. This RTAR was proposed by Mehdi Shahrestani (University of Reading in the U.K.) and titled "Developing a New Model for Dynamic Simulation of Hydronic Systems." Mehdi's research project deals with developing a computational method of comparing simulations of constant flow hydronic systems to variable flow systems, including all components (pumps, control valves, balancing valves, heating/cooling coils, pipes and fittings). The research project is intended to provide an accurate modeling and precise performance evaluation of Hydronic systems. TC 6.1 intends to resubmit this RTAR by restating its format and purpose.
3. Review current Research Project - ASHRAE Standard 155P based on Research Project RP-1196 - "Develop Software to Calculate the Application Seasonal Efficiency of Commercial Space Heating Boiler Systems Based on ASHRAE Standard 155P". Project Chair - Thomas Butcher
  - a. SPC 155P meets at 1:00pm to 5:00 pm on Sunday, June 28, 2015 in the Room 311 on 3<sup>rd</sup> Floor.
4. Review of additional topics for development into RTAR submittals:
  - a. RTAR – Steam System vs. Heating Hot Water – Efficiency Comparison (Justin Westmorland).
  - b. RTAR – Copper Tube Fitting Flow Factors and the Hydronic Coil Characteristic Modeling (Mark Hegberg).
  - c. RTAR – Allowance for Aging in Steel and Iron Pipe (Scott Fisher and Mark Hegberg).
5. Potential new research projects submitted by ASHRAE's Multidisciplinary Task Group (MTG) "High-Performance Air Handling Systems for Buildings Except Low-Rise Residential Buildings."
  - a. Evaluate Heating & Cooling Delivery Systems.
  - b. Determine Diversity Factors for Hydronic Systems.

End of Agenda:

Attachments: Research Project 1196-RP Abstract and Communications  
Research Subcommittee Report – Chicago – January 26, 2015

## DRAFT RTAR Template

A novel approach for modeling of hydronic systems in Building Performance Simulation

Title: (BPS) tools

### Summary

Describe in summary form the proposed research topic, including what is proposed, why this research is important, how it will be conducted, and why ASHRAE should fund it (50 words maximum)

The proposed research will develop a novel approach for modeling of hydronic systems and integrate the model into the existing building simulation tools. This modeling approach fills the gaps in accurate modeling of hydronic systems which leads to both energy saving and improvement of thermal comfort in buildings.

No. of words: 48

### Background

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

In hydronic systems, the flow rate of thermal fluid is defined based on the pressure distribution and the operating point of the system (Petitjean 1994). The literature reveals two dominant approaches for the modeling of hydronic systems (Gamberi et al. 2009; Klein et al. 2009; EnergyPlus 2011; IES 2011; ASHRAE 2012). The first approach is based on using a pre-set operation point. Under a constant flow regime, this approach can be used for simulation of a hydronic system as long as an accurate pre-set operating point is defined. Due to the complexity of finding the actual operating point, the second approach automates the process through a successive mathematical operation to find the intersection of pump and hydronic system performance curves (EnergyPlus 2011). However, when the system performs under a variable flow regime, neither of these methods can provide an accurate operating point. This is mainly due to the ever-changing nature of the system performance curve under the variable flow regime (Petitjean 1994). In the real-world, the performance of a variable flow hydronic system depends critically on the operation of control valves (Hegberg 2000). Any small alteration in the opening fraction of these control devices significantly changes the system performance curve (Parsloe 1999), which is not considered within the existing simulation tools such as TRNSYS, IES and EnergyPlus (Klein et al. 2009; EnergyPlus 2011; IES 2011).

Deficiency of the existing Building Performance Simulation (BPS) tools in the estimation of actual operating points of hydronic systems leads to inability of these tools to predict the starving (during off-design conditions) and over-flow (during warm-up period) phenomena together with the lack of controllability of the control valves. All of which are influential factors in the energy consumption of hydronic systems and the control of indoor environment (Avery 1993; Lau 1996a; Lau 1996b; Taylor 2002).

No. of words: 300

## Research Need

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

The importance of balancing and tuning of the control loops has been targeted in a recent research project RP 1587. However, the existing simulation tools (EnergyPlus, TRNSYS, etc.) are not capable to accurately model hydronic systems considering the pressure governing nature of variable flow regimes. In existing building performance simulation tools, the flow rate of thermal fluid in hydronic systems is defined by a predefined input for the flow rate of the pump at design condition and flow rate of the branches should be also determined as a predefined fraction of the main loop. However, in the real world, the flow rate of each section and the entire system relate to the ever-changing pressure drop in variable flow hydronic systems. The existing BPS tools are not capable to simulate hydronic systems considering these changes, which directly influence the flow rate of thermal fluids in the entire system as well as in each single branch. Therefore, the hydronic systems that are designed using the existing BPS tools are not balanced and also suffer from starving, overflow and lack of construability in especially during off-design conditions. Without providing an accurate simulation approach, designers will not be able to design a tuned hydronic system. As such, the huge responsibility for balancing of hydronic systems is passed to the commissioning stage. Developing a new pressure governing approach for simulation of hydronic systems provides an opportunity for designers to ensure that hydronic systems are reliably designed and tuned at the early stage of projects.

No. of words: 249

## Project Objectives

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

The aim of this study is to develop a new pressure governing approach for simulation of hydronic systems and integration of the model with the existing BPS tools. The research objectives to meet the aim are:

1. To develop a set of models for simulation of the most influential components within hydronic systems including circulation pumps, control valves, coils, pipes and fittings.
2. Integration of the newly developed components of hydronic systems into the existing BPS tools, for example, EnergyPlus and TRNSYS.
3. Verification of the proposed integrated model using a set of laboratory experiments and assessment of the ability of the proposed model in the simulation of the often ignored phenomena such as, starving and over-flow together with the lack of controllability of the control valves.
4. Dissemination of the research outputs in ASHRAE annual conference, HVAC&R Research Journal and ASHRAE handbook, HVAC Systems and Equipment, Chapter 13.

No. of words: 149

## Expected Approach

Describe in a manner that may be used for assessment of project viability, cost, and duration, the approach that is expected to achieve the proposed objectives (200 words maximum).

Check all that apply: Lab testing , Computations , Surveys , Field tests , Analyses and modeling , Validation efforts  Other (specify) ( )

The objectives of this study are planned to be achieved through the following steps:

1. Literature review on the existing approach for simulation and balancing of hydronic systems. (months 1 to 2)
2. The numerical models of the new components for hydronic systems are to be developed in MATLAB/Fortran programs. The performance of each individual model will be contrasted with the outcomes of previous studies. (months 3 to 7)
3. The newly developed components for hydronic systems will be integrated to the existing building performance simulation tools such as TRNSYS, IES and EnergyPlus. (months 8 to 9)
4. The results of the proposed approach for simulation of hydronic systems will be validated using a set of laboratory experiments. In addition, the ability of the proposed models to assess the most controversial and often ignored phenomena in hydronic systems such as, starving, over flow and lack of controllability of control valves will be examined. (months 10 to 11)
5. Finally, the outcomes of this research will be presented/published in ASHRAE annual conference, HVAC&R Research Journal and ASHRAE handbook. (month 12)

No. of words: 182

## Relevance and Benefits to ASHRAE

Describe why this effort is of specific interest to ASHRAE, its impact, and how it will benefit ASHRAE and the society. How does it align with ASHRAE Strategic Plans and Initiatives? How does it advance the state of the art in this area in general? Are there other stakeholders that should be approached to obtain relevant information or co-funding? (350 words maximum)

Heating and cooling distribution systems are the most common parts of HVAC&R systems, which account for a significant portion of energy used in HVAC&R systems. For instance, in office buildings, the distribution systems account for more than 20% and 30% of the energy consumption and CO2 emissions of HVAC&R systems respectively (CIBSE 2004). Therefore, an accurate modelling of distribution systems is essential to achieve energy efficiency in HVAC&R systems. The proposed simulation model significantly enhances the existing simulation programs such as EnergyPlus and TRNSYS by introducing a simulation-real-time assessment of hydronic systems under a pressure governing regime rather than assuming predefined flow rate for the entire system and predefined fractions for the flow rate of thermal fluids in each individual branch. It can also support the current work within the Hydraulics Working Group of the Mechanical subcommittee of SSPC90.1, who are researching additional energy saving tools and methods to support the 90.1-2016 Work Plan. In addition, this research will introduce a tool for accurate modeling of hydronic systems that can be used to tune the system in design stage and to assess the control quality factor which is under development in the current research project (RP 1587). Moreover, it will complement the long-standing attempt to integrate the pressure drop of components into hydronic systems modeling (RP 825).

The proposed modeling approach is applicable to the design of a variety of HVAC&R systems regardless of type and combination of primary and secondary systems. In addition, the proposed model is valuable for those involved in commissioning of HVAC&R systems and can provide quantitative measures to estimate the often ignored phenomena such as starving (during off-design conditions), over-flow (during warm-up period) and the lack of controllability of the control valves in hydronic systems. This research will contribute to the fourth strategic goal of "ASHRAE strategic plan-starting 2014" by developing a new method and incorporating the science and technology into a practical tool for effective building design. Finally, the proposed model for simulation of hydronic systems can be reflected in ASHRAE handbook, HVAC Systems and Equipment, Chapter 13: Hydronic heating and cooling.

No. of words: 348

## Anticipated Funding Level and Duration

Funding Amount Range: \$ 150000

Duration in Months: 12

## References

List the key references cited in this RTAR

- ASHRAE. 2012. ASHRAE handbook-HVAC systems and equipment. Atlanta: American Society of Heating, Refrigeration and Air-conditioning Engineers.
- Avery, G. 1993. "Designing and commissioning variable flow hydraulic systems." ASHRAE Journal 35(7): 45-49.
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- Gamberi, M., R. Manzini, and A. Regattieri. 2009. "Simulink simulator for building hydraulic heating system using the Newton-Raphson algorithm." Energy & Buildings 41: 848-855.
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- Klein, S. A., W. A. Beckman, J. W. Mitchell, J. A. Duffie, N. A. Duffie, T. L. Freeman, J. C. Mitchell, and J. E. Braun. 2009. TRNSYS 17: A transient system simulation program. Wisconsin: Solar Energy Laboratory, University of Wisconsin.
- Lau, K. K. 1996a. "Differential pressure, bypass chilled water systems: Capacity ratios between on-off and modulating units." Building Services Engineering Research and Technology 17(4): 177-183.
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- Parsloe, C. J. 1999. Variable speed pumping in heating and cooling circuits. Bracknell: Building Services Research and Information Association.
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- Taylor, S. 2002. "Balancing variable flow hydraulic systems." ASHRAE Journal 44: 17-24.

RESEARCH SUBCOMMITTEE REPORT  
ASHRAE TC 6.1 "Hydronic & Steam Heating Equipment & Systems"  
ASHRAE WINTER CONFERENCE – Chicago, Illinois  
Monday, January 26, 2015  
Thomas E. Cappellin – Chair

**NOTES FROM RESEARCH SUBCOMMITTEE CHAIR'S BREAKFAST:**

1. Service to ASHRAE Research Award
  - Iain Walker – TC 4.3 'Ventilation Requirements and Infiltration'.
2. ASHRAE Grants-in-Aid
  - 59 Grant-in-Aid Applicants (GIA) submitted by grad-students.
  - 21 Were approved for a \$10,000 Grant.
3. New Investigator Award
  - 14 Nominees were received from around the globe.
  - The winner will be announced at a later date.
4. RTAR and WS Status as of Chicago Meeting:
  - RAC evaluated 4 RTARs (conditionally accepted 3 / rejected 1).
  - RAC evaluated 8 WSs (conditionally accepted 5 / returned 2 with comments / rejected 1 with comments).
  - RAC approved 7 Tentative Research Projects (TRPs) for bid in Spring-2015.
    - i. 7 TRP bid packages were reviewed at the Chicago meeting.
  - RAC and TCs are currently reviewing 1 Unsubscribed Research Project (URP).
5. ASHRAE's Current Projects:
  - 59 active RPs having total value of \$ 11-million.
  - Since July, 2014:
    - i. 5 projects were started.
    - ii. 15 New Projects (TRPs) were approved for bid.
    - iii. No projects are on-hold due to a shortage of funding.

**NOTES FROM RESEARCH SUBCOMMITTEE MEETING:**

1. Mehdi Shahrestani RTAR:

RAC has rejected this RTAR (No. 1736) during ASHRAE's Annual meeting in Seattle-2014.

RAC's comments were:

  - a. Project needs more justification before acceptance.
  - b. Coordinate with other TC's, especially TC 1.4 and TC 4.7.
  - c. Need is not well established.
  - d. How would this study improve what is currently available in the market?
  - e. By rejecting this RTAR, RAC is strongly suggesting to the TC that this particular topic be dropped from the TC research plan based on the information that has been provided.

- i. A copy of ASHRAE's Michael Vaughn (MORTS) is attached to this report for additional reference.

This Chair has approached the Research chairs of TC 1.4 and TC 4.7 to ask if they will review a revised/updated RTAR and express their thought to co-sponsor, approve, or recommendation that it be removed from consideration by RAC. Both subcommittee chairs agreed to review and provide their comments.

2. This Chair is striving to learn the progress of TC 6.1's current Research Project (RP-1196) 'Develop Software to Calculate the Application Seasonal Efficiency of Commercial Space Heating Boiler Systems Based on ASHRAE Standard 155P'. There has been correspondence with TC 6.1's Project Subcommittee to determine the status of the project's development. This project appears to be lagging due to the recent retirement of the project contractor team leader (Iowa State University, Ames, IA).
  - a. The Team Lead has agreed to finish the project if provided with an additional year in which to complete the work and issue a final report in accordance with the original contract. This would be done at no additional cost to ASHRAE but needs the approval of the University for the Team Leader to use university equipment and facilities for the work.
  - b. This Chair will request ASHRAE's RAC/MORTS for approval to allow the extension of one year for the project to be completed
3. Review of additional topics for development into RTAR submittals:
  - a. RTAR – 'Testing automatic fluid control valves for flow limiting and flow regulating characteristics to determine if their built-in control devices perform with accuracy and dependability needed to achieve their design control strategy' (Robert Walker, author).
    - i. Prior to preparing this RTAR, Research Subcommittee will review sections of Standard 75 (ANSI/ISA-75) to determine if any of this standard's sections already address the above subject.
  - b. RTAR - Copper Tube Fitting Flow Factors and the Hydronic Coil Characteristic Modeling (Mark Hegberg).
  - c. RTAR - Allowance for Aging in Steel and Iron Pipes installed in open hydronic piping systems (Scott Fisher and Mark Hegberg).
4. Motion was tendered to adjourn (and unanimously accepted) the TC 6.1 Research Subcommittee meeting.

#### END OF MINUTES

Attachments: Attendance Sign-in sheets – two pages.  
1736-RTAR RAC letter with comments.

ATTENDANCE LIST

ASHRAE TC 6.1 HYDRONIC & STEAM HEATING EQUIPMENT & SYSTEMS - "RESEARCH" SUBCOMMITTEE

3:15 - 4:15pm - Monday, January 26, 2015 - Hancock Room 6th Floor

(YEA) ?

Name	Company and Address	Committee Position	Preferred Phone or E-mail Address
Thomas E. Cappellin	Cappellin Consulting Services 7209 Torrington Way Springfield, IL 62711	Subcommittee Chair	tcappellin@msn.com
Jason Atkisson	Affiliated Engineers, Inc.	Handbook Subcom Chair	jatkisson@aeeieng.com
Rex Seave	Armstrong Intl	Vice Chair	Rex@armstronginternational.com
BOB WALKER	BELIMO	Secretary	robert.walker@us.belimo.com
Larry Konopacz	Xylem, Inc. Morton Grove, IL	CM	larry.konopacz@xyleminc.com
STEVE HANCOCK	TRANE RESIDENTIAL	TAC Chairman	STEVE.HANCOCK@TRANE.COM
Gang Wang	University of Miami	Guest	g.wang2@miami.edu
DAVID LEE	ARMSTRONG FLUID TECHNOLOGY	CM	dlee@armstrongfluidtechnology.com

ATTENDANCE LIST

ASHRAE TC 6.1 HYDRONIC & STEAM HEATING EQUIPMENT & SYSTEMS - "RESEARCH" SUBCOMMITTEE

3:15 - 4:15pm - Monday, January 26, 2015 - Hancock Room 6<sup>th</sup> Floor

Name	Company and Address	Committee Position	Preferred Phone or E-mail Address
Byron Borani	BAS Engineering	Guest	byron.borani@baseng.com
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TO: Tricia Bruenn, Chair TC 6.1, [tricia16@msn.com](mailto:tricia16@msn.com)  
Thomas Cappellin, Research Subcommittee Chair TC 6.1, [tcappellin@msn.com](mailto:tcappellin@msn.com)  
Stephen Hancock, Research Liaison Section 6.0, [steve.hancock@trane.com](mailto:steve.hancock@trane.com)

FROM: Michael Vaughn, MORTS, [mvaughn@ashrae.org](mailto:mvaughn@ashrae.org)

DATE: July 24, 2014

SUBJECT: Research Topic Acceptance Request (1736-RTAR), "A novel approach for modeling of hydronic systems in Building Performance Simulation (BPS) tools "

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During their recent Annual meeting, the Research Administration Committee (RAC) reviewed the subject Research Topic Acceptance Request (RTAR) and voted 5-0-0 to reject it. The following is the consensus reason for rejecting this RTAR:

1. Project needs more justification before acceptance.
2. Coordinate with other TC's, especially TC1.4 and TC 4.7.
3. Need is not well established.
4. How would this study improve what is currently available in the market.

By rejecting this RTAR, RAC is strongly suggesting to the TC that this particular topic be dropped from the TC research plan based on the information that has been provided.

An RTAR evaluation sheet is attached as additional information and it provides a breakdown of comments and questions from individual RAC members based on specific review criteria. This should give you an idea of how your RTAR is being interpreted and understood by others.

If the TC wishes to pursue this topic further, please address the above issues noted by RAC in a revised version of the RTAR with the help of your Research Liaison, Arthur Giesler, [RL1@ashrae.net](mailto:RL1@ashrae.net), prior to submitting it to the Manager of Research and Technical Services for further consideration by RAC. In addition, a separate document providing a point by point response to each of these comments and questions must be submitted with the RTAR. The response to each item should explain how the RTAR has been revised to address the comment, or a justification for why the Technical Committee feels a revision is unnecessary or inappropriate. The RTAR and response to these comments and questions must be approved by the Research Liaison prior to submitting it to RAC.

The next submission deadline for RTARs and WSs is **August 15, 2014** for consideration at the Society's 2014 fall meeting. The submission deadline after that is December 15, 2014.

Project ID	1736	A novel approach for modeling of hydronic systems in Building Performance Simulation (BPS) tools	
Project Title	TC 6.1 - Hydronic & Steam Equipment & Systems	Sponsorship TC Coat/Duration 397,650 / 12M	
Submission History	RTAR 1st Submission	Basic/Applied Research	
Classification: Research or Technology Transfer	RAC 2014 Annual Meeting Review	Check List Criteria	
VOTER NO		Comments & Suggestions	
Is there a well-established need? The RTAR should include some level of literature review that documents the importance/magnitude of a problem. If not, then the RTAR should be returned for revision.		#10 - Need is not well established. It is not well stated the inaccuracies due to current approach in the calculations and resulting impact on the prediction of energy performance. #14- Maybe, but the case isn't clearly presented here. #7 - Would like to know how this study would improve what is currently available in the market. How accurate are the commercially available software packages? #2- Improvement in the simulation of the hydronic systems will provide better results and better understanding of the effect of different designs on a building's performance. #13 - Addresses substantial parts of the proposed work. (Need for TC coordination), DOE is developing an implementation of this approach using Modelica for incorporation in Energy Plus for supervisory control. There is a need for a controls design tool shell for a Modelica/Energy Plus implementation. #9 - The definition and performance requirements of "a novel approach" seem vague. The contractor could define based on his/her own understanding or preference, leading to the quality of research, potentially difficult to evaluate.	
Is this appropriate for ASHRAE funding? If not, then the RTAR should be rejected. Examples of projects that are not appropriate for ASHRAE funding would include: 1) research that is more appropriately performed by industry, 2) topics outside the scope of ASHRAE activities.		#8 - The project requires contractor to integrate the hydraulic model into an existing energy simulation tool such as Energy Plus or TRNSYS. This may be difficult for contractors who does not have prior experience developing those BPS tools.	
Is there an adequate description of the approach in order for RAC to be able to evaluate the appropriateness of the budget? If not, then the RTAR should be returned for revision.		#10 - There are several flow network analysis software both in public and commercial domain which can perform this analysis. It should be noted the key component in these analyses is pressure loss data of each element in the flow network. #7 - Would like to see more elaboration on how with robust metrics and an effective user interface. #8 - The objective need to be clear. Otherwise the level of efforts in both modeling and experimental validation are difficult to evaluate.	
Has the proper administrative procedures been followed? This includes recording of the TC Vote, coordination with other TCs, the preparation of the Strategic Plan, and if not, then the RTAR could be returned for revision or conditionally accepted based on adequately resolving these issues.		#14 - Seems like a very odd budget. Is this an RTAR estimate or a price quote? #7 - Hydraulic component manufacturers should provide cost funding. #13 - Already done for TRNSYS; implementation in Energy Plus would require > \$100k. #8 - The budget should be an estimate and leaves to the contractor to give an accurate number. #4 - As a non-specialist I think there might be some key missing links. The RTAR refers to issues of non-linearity, particularly in valves of different types, but I just don't know if there is enough documentation to guide designers of different types of variable flow hydronic systems about specifications they need for their systems. Tied to this is another area where I'm ignorant sort of an "extended products" question. Should engineers' design tools include modules that assume that branch controls are optimizing (valves and pumping)? How does this tie to some of the newer VSD cartridge pumps for zone control, and how they do or don't interact with boilers for other heat/cool sources)? I'd like to know how this RTAR fits into the TC's overall research plan, which I think should drive toward making good, robust designs easier for the consultant.	
		#4 - seems ok	
Decision Options	Initial Decision	Approval Conditions	
ACCEPT		#7 - Project needs more justification before acceptance. #13 - Coordinate with other TCs, esp. TC1.4 and TC4.7. #4 - I need a briefing to help me understand why this is the critical path, why my concerns are unfounded, and how this fits on the path to better designs and implementation. I'd also like to see more emphasis on tech transfer to the working designers, for example with an ASHRAE Journal article (update and how to avoid them?)	
COND. ACCEPT			
RETURN			
REJECT			

ACCEPT Vote - Topic is ready for development into a work statement (WS).  
COND. ACCEPT Vote - Minor Revision Required - RL can approve RTAR for development into WS without going back to RAC once TC satisfies RAC's approval condition(s).  
RETURN Vote - Topic is probably acceptable for ASHRAE research, but RTAR is not quite ready.  
REJECT Vote - Topic is not acceptable for the ASHRAE Research Program

## TC 6.1 Handbook Subcommittee Minutes

June 28, 2015

2015 Annual Meeting – Chicago

Attendees:

Jason Atkisson	Tricia Brueen	Scott Fisher
Bob Walker	Evans Lizardos	Tim Anderson
David Lee	Larry Konopacz	Niels Bidstrup
Thomas Neill	Aaron Stotko	Robert Bean
Steve Severini	Stan Kutin	Rex Scare
	Forrest Yount (S16 Liason)	Van Baxter (F17 Liason)

1. Introductions of Attendees
2. Reviewed Committee Assigned Handbook Chapters & Status

2016 Systems and Equipment

Chapter	Title	Lead Author	Status
11	Steam Systems	Ramez Afify	▪ Ready for TC Vote
13	Hydronic Heating & Cooling System Design	Mick Schwedler	▪ Sent to Handbook
14	Condenser Water Systems	Steve Tredinnick	▪ Sent to Handbook
15	Medium and High Temperature Water Heating Systems	N/A	▪ Sent to Handbook
28	Unit Ventilators, Unit Heaters and Makeup Air Units	Scott Fisher	▪ Sent to Handbook
32	Boilers	Evans Lizardos	▪ Ready for TC Vote
36	Hydronic Heat Distribution Units and Radiators	Scott Fisher	▪ Ready for TC Vote
44	Centrifugal Pumps	Neils Bidstrup	▪ Ready for TC Vote
46	Pipes, Tubes, & Fittings	N/A	▪ Sent to Handbook
47	Valves	Bob Walker	▪ Ready for TC Vote
48	Heat Exchangers	Scott Fisher	▪ Sent to Handbook

2017 Fundamentals

<b>Chapter</b>	<b>Title</b>	<b>Lead Author</b>	<b>Status</b>
22	Pipe Design: Fundamentals, Pipe Materials, and Applications	Scott Fisher	<ul style="list-style-type: none"><li>▪ Preliminary Review by Lead Author is complete</li><li>▪ Awaiting Final Review by Volunteer Reviewers</li></ul>

3. Forrest Yount noted that Handbook Central is being updated to ensure the most recent files are always available. He also noted that this allows for revisions out of cycle if the TC feels it is necessary.
4. Adjourn