FINAL MINUTES January 29, 2013

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

1791 Tullie Circle NE
Atlanta, GA 30329
404-636-8400

TC/TG/TRG MINUTES COVER SHEET

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

TC/TG/TRG No. 6.8 Date 2013

TC/TG/TRG TITLE: Geothermal Heat Pump and Energy Recovery Applications

DATE OF MEETING: June 25, 2013 LOCATION: Denver, CO

Members Present	Year APPTD	MEMBERS ABSENT	Year APPTD	EX-OFFICIO MEMBERS AND ADDITIONAL ATTENDANCE
Lisa Meline (Chair)	11-13	JB Singh	10-14	Michel Bernier (CM)
Jeff Smith (Vice Chair)	11-15	David Pleasants (ALI)	10-14	Steve Carlson (CM)
(Donald) Cary Smith (Sec)	12-16	Ed Lohrenz (MNQ-V)	11-15	Chris Gray (CM) – (Web &
Robert Koschka	10-14	Scott Hackel (Hndbk-34)	11-15	Hndbk-9)
Kay Thrasher	10-14	Mike Kuk (Program)	10-14	Mike Filler (CM)
John Shonder (Research)	09-13	(5)		Steven Hamstra (CM)
Roxanne Scott (Pub)	11-15			Carl Huber (CM)
Jeremy Fauber	12-16			Steve Kavanaugh (CM)
Gary Phetteplace	12-16			Bill Murphy (CM)
David Dinse (MNQ-V)	12-16			Howard Newton (CM)
Jeff Spitler	12-16			Chris Paraskevakos (CM)
Charles Reymund	12-16			Harvey Sachs (CM)
(11 Voting and 1 Voting NQ)				Keith Swilley (CM)
				Shaojie Wang (CM) – (13)
				GUESTS
				Rupert Alfilaz
				Harrison Crecraft
				Massimo Cimmino
				Darryl Denton
				Ron Domitrovic (EPRI)
				Scott Emery
				Porham Eslami
				Drew Frye
				Pat Goethel
				Rachel Grundmurn
				John Kelly (GEO)
				Nick Kassanis
				Matt Mitchell (Stu)
				Doug McLellan
				David Schluckebier
				Sudla Sikla
				Harrison Skye
				Jeremy Smith
				Laura Southard
				Rechel Spitler
				Ningyue Wang
				Lu Xing
				Zeyu Xiong (Stu) (23)

DISTRIBUTION - ALL MEMBERS OF TC/TG/TRG

TAC Chairman: _____William McQuade
TAC Section Head: _____ John Dunlap
ALI/PDC:_____Donald Brandt

LIAISONS

RAC Research:_____Stephen Hancock
Chapter Technology Transfer Committee: _____ Marian Roll
Special Publications: _____ Francis Mills
Standards:_____ Debra Kennoy
Handbook: _____ Patrick Marks

MANAGER OF RESEARCH/TECHNICAL SERVICES: _____ Michael Vaughn
MANAGER OF STANDARDS:_____ Stephanie Reiniche

MINUTES

Pursuant to an announcement sent to all members, ASHRAE Technical Committee TC 6.8, *Geothermal Heat Pump and Energy Recovery Applications*, met on Tuesday, 25 June 2013 at 3:34 PM in the Director's Row E meeting room, Downtown Sheraton, Denver, CO. The meeting was held in conjunction with the ASHRAE 2013 Summer Meeting.

I. CALL TO ORDER, WELCOME, INTRODUCTIONS

Chair Lisa Meline called the meeting to order at 3:34 PM. The Chair welcomed everyone. Members, guests, and ASHRAE Committee liaisons were requested that they introduce themselves. The Chair requested that the sign-in sheet be filled out completely, and that attendees check their information on the roster sheet and make any changes through ASHRAE's website.

II. QUORUM CHECK

Fifty percent of the voting members of the technical committee, present in person, constitute a quorum for the transaction of business. The Chairman read the list of voting members to confirm that the roster was correct. The roll call revealed that eleven (11) of fifteen (15) Quorum members of the technical committee were present and one (1) member voting, Non-Quorum present, establishing that a quorum was available to conduct committee business.

III. APPROVAL OF MINUTES

The Secretary distributed copies of the minutes of the January 29, 2013 Winter meeting in Dallas, TX, and the Chair requested that members review them. Roxanne Scott moved that the Minutes be accepted. The motion was seconded by John Shonder. The Minutes were approved (11-0-CNV).

IV. ANNOUNCEMENTS FROM ASHRAE

Section Head

1. John Dunlap presented Lisa with an award for her service as Chair.
2. John will no longer be our section head after Denver. The new section head will be Mark Hegburg.

V. ANNOUNCEMENTS FROM THE CHAIR

A. Jeff Smith reported on the Chairs' breakfast.

1. Electronic Meetings are approved and there are 6 or 7 happening in Denver.Let section chair know if we want to do one at the next meeting.
2. If TC 6.8 does a "GoToMeeting", the same meeting rules apply. If discussion of research project occurs, research principals must be taken off line.
3. Make sure TC members update their bios so ASHRAE can ensure proper balance on committees.
4. ASHRAE is looking for people willing to be technical paper reviewers.
5. TC Members need to edit their roster information in the meeting if it needs to be corrected.

B. Lisa Meline (Chair)

1. The Chair reminded the committee that if anyone wanted a letter to their Employer thanking them for giving the member time to participate, please let her know.

2. If any of the meeting participants that are corresponding members wanted to participate on subcommittees to please let the Chair know of their interest and they will be assigned to an appropriate sub-committee.
3. If anyone present wanted to be corresponding members, please give Lisa or Jeff their contact information and ASHRAE member number.
4. The chair asked any young engineers in the meeting to identify themselves. She thanked them for participating.
5. Steve Kavanaugh has retired as Handbook 34 Chair and Scott Hackel has agreed to take over the position.
6. 2013-14 Committee Rosters were announced (See Attachments at the end of the minutes.

VI. ACTIVITY (EXTRAORDINARY)

Subsequent to the meeting in Denver, Lisa Meline, past Chair, reminded the committee that there needed a vote to affirm the recommended Chair (Lisa Meline) for the proposed Standard Development Committee. All voting members were duly notified of the request and responded with a unanimous vote in the affirmative. (14-0-2-1) See VII.F also.

VII. SUBCOMMITTEE REPORTS

A. RESEARCH – John Shonder

1. Two Active projects, Steve's rewrite of the blue book:
   a. RP-1385 Surface Water Heat Pumps: Need new estimated end date or final report to MORTS.
   b. RP-1674 Blue Book Revision: Need regular progress reports from PI to receive payments.
2. WS-1498 Optimized Design of Outdoor Air for GSHP: resubmit WS or drop. Topic will expire from plan Feb 2014. Xiaobing does not believe it is worthwhile pursuing further.
3. RTAR 1680 Environmental Effects: Lisa and John are revising this RTAR and are going to try to submit it again.
4. Two prioritized ideas for RTARS:
   a. Design of GSHP Central Plant Systems, Xiaobing Liu and Scott Hackel are working on the RTAR.
   b. Design of Systems using Multiple Variable Speed Devices. At this time no one is working on a proposal.
5. John received an idea for an RTAR from Xiaojie Wong to revise the ground temperature map. This idea needs some work but it may be worth pursuing. The Research sub-committee discussed this at the Research meeting. Additional discussion regarding the accuracy and local variability was had in the TC meeting and the general consensus was that more definitive information was needed. John is going to use this as the test case for the new RTAR format.
6. Two other topics were mentioned as carry-overs from Winter meeting:
   a. Design for deep boreholes (500-800 feet).
   b. Maintenance Costs of GSHP Systems (Keith).

B. HANDBOOK COMMITTEES

1. Steve Kavanaugh will step down as Handbook Chair for Chapter 34 and Scott Hackel will replace him. Chris Gray will continue on in his co-chair role for Chapter 9.

2. Chapter 34– Steve reminded the TC that major revisions need to be completed before the January meeting in NYC. There are a large number of changes submitted from 7 people after the Dallas meeting. Scott was not at the meeting but sent a message that there would be several conference call meetings shortly after the Denver meeting.
   Going forward, changes can be made annually but it will only be published in book form every 4 years. Changes to the Online version of the Chapter would be made annually

3. Chapter 9 - ASHRAE TC 9.4 Handbook (Applied Heat Pumps and Heat Recovery) Sub-committee report. Chris reminded TC that the handbook subcommittee meeting was moved to Saturday Noon to 3:00 pm starting at the Denver meeting. One major and two minor additions will be made to the Chapter.
   a, Update to the limitations and availability of industrial heat pumps.
   b. Information on heat pumps in district energy systems.
   c. Design and application guidance for heat recovery heat pumps.

   Patrick Marks (Handbook Liaison) attended the start of the meeting to discuss deadlines for chapter submission to ASHRAE . The March 28, 2015 submittal deadline will be met. The full meeting minutes are included at the end of these minutes.

C. MEMBERSHIP COMMITTEE – Gary Phetteplace

Roll-on members after July 1 were announced. There will be 15 Voting Members, 2 Voting Non-Quorum, 88 Corresponding members.

D. PROGRAMS COMMITTEE – Michael Kuk by Lisa Meline

1. TC 6.8 hosted Session 7:. The Seminar was chaired by Lisa Meline The Presenters were Dominque Durbin, Mark Morelli, and Kirk Mescher. There were over 50 attendees.
2. Lisa discussed ASHRAE's New York and Seattle program tracks. The following dates are important regarding program and technical paper submittals for the conference:
   a. August. 13-Seminar, Forum, Technical Paper and Conference Paper program proposals due.
   b. August 13 – Technical Papers final review.
   c. September 20-Seminar and Forum Accept/Reject are distributed
   d. Dec. 6- Upload of PPTs begin
   e. January 3- All PPTs due online
   f. January 18 Speaker's Lounge is opened.
3. New York Tracks (January 18-22, 2014)

   Track 1: HVAC&R Systems and Equipment
   Track 2: HVAC&R Fundamentals and Applications
   Track 3: Indoor Environmental Health/IEQ
   Track 4: BIM: Integrating Technology for Control, Management Optimization and Efficiency
   Track 5: International Design
   Track 6: Building Performance and Commissioning for Operation and Management

Track 7: Hydronic System Design for Large Buildings
Track 8: Tall Buildings: Performance Meets Policy

4. Submission for New York Seminar
   Fundamentals of System COP and EER:
   Chair: Cary Smith
   a. Kavanaugh, Steve. Converting Imaginary (Rated) Efficiency to Real Efficiency
   b. Hackel, Scott. More than Just a Borefield, Impacts of different System Choices for Geothermal Projects
   c. Swilley, Keith. Keep it Simple and GSHP will win the Efficiency Debate
   The Committee approved the plan for the New York Meeting. (11-0-1-CNV)
5. Seattle Meeting, (June 28-July 2, 2014)
   Track 1: Environmental Health/IEQ
   Track 2: Research Summit
   Track 3: **Ground Source Heat Pumps: State of the Art Design, Performance, and Research**
   Ttack 4: HVAC&R Systems and Equipment
   Track 5: HVAC&R Fundamentals and Applications
   Track 6: Standards, Guidelines, and Codes
   Track 7: Refrigeration
   Track 8: Installation, Commissioning, Operation, Maintenance of Existing Buildings
   Track 9: Professional Skills
6. Lisa and Dr. Spitler initiated a discussion about submitting a GHP Systems track for the Seattle meeting.
   a. The group discussed the need for our committee to start lining up topics and speakers for this track. We don't "own" the track, but we want to make sure that the track is successful so we want to promote the track to other TC's, line up topics, and spread the word to outside organizations. It was proposed that we could put out a call for papers to other GHP related organizations so that they can present at the ASHRAE meeting (e.g. IGSHPA, NGWA, GEO, etc.).
   b. Lisa Meline has generated a list of potential topics for this track. (These notes are attached.)
      i. Next step is to finalize topics and find speakers
      ii. Coordinate getting proposals to ASHRAE.
      iii. Feb. 13, 2014 Seminar and Forum program proposals due. March 25 Notifications of accept/reject
      iv. May 6, upload PPTs, June 2, PPTs online

E. WEBMASTER – Chris Gray

The webpage was up to date in preparation for the 2013 Annual meeting including updated draft minutes from the 2013 Winter meeting in Dallas, the meeting times and locations, and the full committee meeting agenda. Based on feedback from the Dallas meeting, the ASHRAE Code of Ethics was added to the front page of the TC 6.8 website. Recent ASHRAE Journal articles were added to the "Published Content" on the website.
Chris addressed a question to the committee regarding the age of articles to be added to the website: the Chair left this decision to the discretion of the webmaster.

F. STANDARDS – Lisa Meline

The Committee approved the development and presentation of a proposal to ASHRAE to develop standards for closed loop borehole construction vote 14-0. It will follow normal ASHRAE channels moving forward.

G. EDUCATION and SPECIAL PUBLICATIONS/JOURNAL – Roxanne Scott

There are no major updates. ASHRAE is happy that the Blue Book revision is underway.
ASHRAE Exchange forum is up and running.
ASHRAE is working on developing social media guidelines for the Society.

VIII. LIAISON REPORTS

A. ALI COORDINATOR – David Pleasants

No Report.

B. T.C. 8.11, Unitary Systems – Roxanne Scott

No report

C. IGSHPA – Lisa Meline, Cary Smith, Howard Newton

1. IGSHPA would like to know how they can get ASHRAE to publicize their events. Person from CEC at Chair's breakfast will respond.
2. Roshan Revankar is the new Director of Training and has been on the job for seven months.

D. CEC – Jeff Spitler

1. – Less than 50% of spaces that are requested are available so don't be disheartened if your program is not accepted by CEC.

IX. OLD BUSINESS

National Certification Standard – John Kelly GEO

Development of Standard for qualifications for specific jobs personnel in the Geothermal industry for 14 specific jobs.

1. Categories are there for regulators and trainers.
2. Wants this TC to be aware of the project and then shortly to look at the draft and give feedback where needed.
3. There is no expectation that DOE will adopt any of this in the immediate future.

Geothermal **Heat Pump National Certification Standard** Project www.ghpncs.org

X. NEW BUSINESS

A. Code update from ICC

1. Seeking industry experts to participate in the next revision.
2. Kay tried to download the proposed standard and it wouldn't download.
3. They want to add in a section to increase piping and fitting types

B. ASTM committee looking at BTU metering E44.25

1. Gary Phetteplace. is on the working group
2. Being driven by solar and biomass companies
3. Geothermal is going to be eligible in some states for renewable credits
4. Currently no standard to meter this energy for renewable credits

XI. ADJOURN

1. Jeff Spitler made a motion to recognize Lisa Melin's service as Chair of TC 6.8. The motion was carried unanmously with the attending Corresponding Members and Guests adding their applause.
2. Gary Phetteplace moved that the meeting be adjourned. Second by Jeff Smith. The motion carried. The meeting ended at 5:27 PM.

Twenty-three pages of attachments follow:

1. Committee Assignments as of July 1, 2013
2. Programs Subcommittee Report
3. Applied Heat Pump Handbook Subcommittee Report
4. Proposal to Develop Closed Loop Standards
5. Proposed GSHP Track descriptions.
6. Track Notes
7. *"A Plea for Transparent Unitary Equipment Ratings"*
8. ASHRAE Meeting Report

Committee Assignments (2013-2014)

Programs: (Kuk)
- L. Meline
- C. Smith
- D. Pleasants
- B. Koschka
- K. Thrasher
- S. Hackel

Research (Shonder)
- G. Phetteplace
- D. Dinse
- S. Hackel
- B. Koschka
- C. Remund
- X. Liu

Handbook - 9: (Gray)
- X. Liu
- J. Smith
- D. Pleasants
- E. Lohrenz
- M. Filler
- F. Pucciano
- G. Phetteplace
- C. Smith
- C. Paraskevakos

Handbook 34 (Hackel)
- M. Kuk
- J. Faber
- M. Bernier
- A. Chiasson
- M. Green
- X. Liu
- L. Meline
- K. Rafferty
- K. Mescher
- C. Smith

TC 6.8 Geothermal Heat Pump and Energy Recovery: Programs Committee Minutes

To: TC 6.8 Chair , Lisa Meline

Topic: TC 6.8 Programs Subcommittee Minutes

Date of Meeting: 1/27/13 6:20-7:00 PM

From: Michael Kuk, Programs Subcommittee chair
mkuk@CERxSolutions.com 630-631-9483

Committee:
Cary Smith
Lisa Meline
Kay Thrasher
Robert Koschka
Frank Pucciano
Jeff Spitler

-We are looking for new members to the committee.
-We will likely hold our TC subcommittee meeting via teleconference prior to the Denver Meeting.

1) **Discussed Dallas Programs**

Seminar 9: Foundation Heat Exchangers for Low Cost Residential Ground Source Heat Pumps, on January 27, was attended by approximately 100+ people. Three speakers did an outstanding job.

Programs Rejected for Dallas

- "GSHP and Energy: Matching the Model to the Measurement and Keeping Those Hard Earned Incentives and Rebates,"
- "Top Dumb Things Engineers and Designers Do to Drive Up Geothermal Heat Pump System Costs,"

2) **Discussed Tracks for Dallas and New York**

Denver Tracks:
Track 1: Research Summit
Track 2: Integrated Project Delivery (mini conference)
Track 3: Building Energy Modeling vs. M&V
Track 4: Mile-High Efficiency and Equipment
Track 5: Renewable and Alternative Energy Sources
Track 6: HVAC&R Systems and Equipment
Track 7: HVAC&R Fundamentals and Applications

Key Program Dates
***Feb. 11-Seminar, Forum, Technical Paper and Conference Paper Program Proposals Due
March 25-Seminar and Forum Accept/Reject Distributed
May 6- Upload of PPTs Begin
June 3- All PPTs due online
June 22- Speaker's lounge opens

June 22-26
Denver, CO
www.ashrae.org/denver

2014 Winter Conference
January 18-22
New York, NW
www.ashrae.org/newyork

New York Tracks
Track 1: HVAC and R Systems and Equipment
Track 2: HVAC&R HVAC&R Fundamentals and Applications
Track 3: Environmental Health through IEQ
Track 4: Building Information Systems Integrating Technology for control, Management Optimization and Efficiency
Track 5: International Design
Track 6: Building Performance and Commissioning for Operation and Management
Track 7: Hydronic System Design for Large Buildings
Track 8: Tall Buildings: Performance Meets Policy

2013 Paper Dates
March 15- Conference Paper Abstracts Due
April 19- Technical Papers Due for Review
April 5- Conference Paper Abstracts Accept / Reject Notifications
July 3-Final Conference Papers Submitted for Review
August 12-Technical Papers Final Review Due

3) **Discussed meeting topics for Denver and New York**

Denver

a. Lisa Meline agreed to chair a seminar focused for Track 7, by "repackaging" the rejected seminar she submitted for the Dallas Meeting. "Top Dumb Things Engineers and Designers Do to Drive Up GHP System Costs"
b. Frank Pucciano and Michael Filler are putting together two seminars (Track 5)
    i. Part I: Heat Recovery Heat Pump Applications as an

ASHRAE TC 9.4 Handbook Applied Heat Pumps and Heat Recovery (AHPHR) Sub-committee report

(Systems Ch. 9)

Date: 6/22/13 12-3PM

Attendees: Gary Phetteplace, Chris Paraskevakos, Mike Filler, Frank Pucciano, Chris Gray, Patrick Marks (Handbook Liaison)

The handbook subcommittee for Systems Handbook Chapter 9: Applied Heat Pump and Heat Recovery Systems met at a new time from Noon to 3pm on Saturday, June 22nd for a working session. The goals of the meeting were to finalize the information that will be added to the chapter and to outline the updates. One major and two minor additions will be made to the content of the chapter including: an update to the limitations and availability of industrial heat pumps based on new equipment availability since this area's last update, information on heat pumps in district energy systems, and design and application guidance for heat recovery heat pumps. An outline of the content for the heat recovery heat pump design and application guidance will be sent to the subcommittee for comments before assigning responsibilities to the subcommittee members.

Handbook liaison, Patrick Marks attended the start of the meeting to discuss deadlines for chapter submission to the handbook committee. The chapter will be submitted to the handbook committee by March 28th, 2015, and it is anticipated the final version of the handbook will be voted on by the committee at the January 2015 meeting.

NEW STANDARD OR GUIDELINE PROJECT PROPOSAL FORM

Name: Lisa Meline, P.E.
Address: P.O. Box 276665
Sacramento, CA 95827
Phone: 916.366.3458
Fax: 916.366 3958
Email: LISA@MELINE.COM

Representing:
☐ Self
☒ TC/TG 6.8
☐ ASHRAE Committee _____
☒ Other Standards Writing Organization: IGSHPA Standards Committee Co-Chair

The following to be completed by the recommending TC/TG:

TC/TG Vote for TPS _____ (Yes-No-Abstain-Absent)

TC/TG Recommendation for Chair: _____

TC/TG Vote for Chair: _____ (Yes-No-Abstain-Absent)

These TC/TG votes was taken at a TC/TG Meeting: Date: _____ Location _____

These TC/TG vote was taken by Letter Ballot: Date: _____

TC/TG Chair: _____

Please complete the following:

1. **This is to propose a new** ☒ **Standard** ☐ **Guideline**

2. **If a standard is being proposed, indicated the type of standard that is being proposed** (See Item 2 of Procedures for Requesting a New Standard or Guideline – check one):

   ☐ **Design** ☒ **Protocol** ☐ **Method of Test and Classification** ☐ **Rating**

3. **Is research required on this project before the standard or guideline can be written?**
   ☐ **Yes** ☒ **No** **If yes, please explain:**

4. **Proposed Cognizant TC/TG (if known): Geothermal Heat Pump and Energy Recovery Applications (TC6.8)**

5. **Can the topic be addressed through revision of an existing document?** ☐ **Yes** ☒ **No**

6. **Can another group produce the document more effectively?**

   ☐ **Yes** ☒ **No** **If yes, please explain:**

7. **Is this a consumer product?** (A consumer product is generally any tangible personal property for sale and that is used for personal, family, or household purposes.) ☐ **Yes** ☒ **No**

8. **What is the purpose of this standard/guideline? Please give a brief explanation of the need for the project and its expected impact.**

The purpose of this standard is to create a single document which may be adopted by federal, state, and local agencies that permit closed loop boreholes and enforce proper design and installation practices. The closed loop boreholes are typically coupled to geothermal heat pump systems for efficiently heating and cooling buildings.

9. **Provide an estimate on the amount of time needed to develop the document: 24 months**

10. **Are there any known negatives associated with the document being proposed?**

☐ **Yes** ☒ **No** **If yes, please explain:**

11. **Identify Stakeholders (i.e., code developers, consumers, government, design engineers, facility owners/operators, producers, regulatory agencies, utilities, etc.) likely to be directly and materially impacted by the standard or guideline:** building owners, code developers, government, regulators, engineers, utilities

12. **Identify specific industry groups/organizations that would be interested in the proposed new project/document; and provide contact information for these groups, if known (e.g., IES, NFPA, NEMA, AHRI, National Labs etc.):**

13. **List at least five people (the recommended chair plus four others) who have expressed an interest in being part of the committee (*with contact information if known*):**

Name	Stakeholder Group Represented /Interest Category	Email address (if known)
1. Chair: Lisa Meline, P.E.	Consulting Engineer	lisa@meline.com
2.Allan Skouby	Grout Manufacturer	askouby@grti.com
3.Kirk Mescher, P.E.	Consulting Engineer	kirk@cmeng.com
4. Cary Smith, CGD	Geothermal Designer	dcsmith@soundgt.com
5.Bob Brown	Heat Pump Manufacturer	bob.brown@waterfurnace.com

Additional Subcommittee Members:

Ted Striplin	Fusion Equipment Manufacturer	tstriplin@mceltroy.com
Daniel T. Meyer	Drilling Contractor	dantmeyer@hotmail.com
John Pitz	Drilling Contractor	john@nlpitzinc.com
Todd Hunter	Drilling Contractor	thunter@travelin.com

Proposed Title, Purpose, Scope

Title: ANSI/ASHRAE/IGSHPA/NGWA Standard for Closed Loop/Geothermal Heat Pump System Specification and Installation

Purpose: The purpose of this standard is to create a single document which may be adopted by federal, state, and local agencies that permit closed loop boreholes and enforce proper design and installation practices. The closed loop boreholes are typically coupled to geothermal heat pump systems for efficiently heating and cooling buildings.

Scope: This standard will address the specification and construction of the ground heat exchanger system from the borehole to the point at which the connecting piping system(s) terminates to serve the building hydronic distribution system.

1.1. This standard will address the qualification requirements of the design and installation personnel.
1.2. Development of site will be covered including site planning, documentation and restoration

1.3. Planning for Site Containment
1.3.1 Dealing with contaminated soils and other environmental issues
1.3.2 Hauling off or recycling drilling fluids

1.4. Borehole construction methods will be determined, specifically:
1.4.1. Drilling techniques/casing
1.4.2. Drilling fluids
1.4.3. Piping materials
1.4.4. Grouting requirements for ground water protection and heat transfer

1.5 Vertical and lateral pipe joining methods.
1.6. Working fluid selection and application to different climate zones will be addressed.
1.7. System flushing, purging and testing requirements

1.8 System specification Guidelines.
1.8.1. Basic flow requirements
1.8.2. Temperature guidelines (long term thermal effects)
1.8.3. Ground heat exchanger configuration recommendations

1.9. Procedures and specifications for decommissioning all or part of a closed loop ground heat exchanger system

Return Form to:
Attn: Procedures Administrator
ASHRAE
1791 Tullie Cir, NE
Atlanta, GA 30329
Telephone: 404.636.8400 x1111
Fax: 678.539.2111
Email: procadmin@ashrae.net

Proposed:

Ground Source Heat Pumps State of the Art: Design, Performance and Research

Track Chairs: Jeff Spitler, PhD; Michael Kuk, P.E.

Email: spitler@okstate.edu; Michael.p.kuk@gmail.com

Ground-source heat pump (GSHP) systems are known to be one of the most energy-efficient, cost effective, and environmentally benign HVAC options available. This has been proven over and over again through energy efficient buildings which are the highest performers in Energy Star and LEED performance ratings. However this performance only comes with proper design and application of the technology. This track will take the engineer through all aspects of design that lead to optimally performing systems and satisfied building owners. It will also help the engineer avoid common pitfalls that lead to poorly performing systems. Research into innovative systems, heat exchanger performance, design and simulation methods, and optimal operation will also be covered. Papers/presentations are invited for all types of GSHP systems– including closed loop, open loop, vertical, horizontal, standing column wells, energy piles, and surface water heat pump systems.

Seattle GSHP Track Preliminary Notes

4/23/2013
These are the "brainstorming" notes from the 4/23/2013 teleconference.

1. Title: Overview of Geothermal Heat Pump Industry
Possible TC Co-Sponsors: TC 3.1/3.2/3.3: Refrigerants
TC 2.8 Building environmental impacts
TC 8.1 Positive Displacement compressors
Overview (Could include a historical perspective and current status + moderator could introduce the track);
Possible speakers Steve Smith, Gary Phetteplace, maybe someone from Sweden, Doug Dougherty, Jim Bose – how did it get restarted in the 1970's?; establishing single point responsibility) Refrigerant History, Environmental benefits

Chair: Gary Phetteplace
The Road Well Traveled - Steve Smith or Dr. Bose (IGSHPA)
The Current State of the Industry - Doug Daugherty (GEO)
Overview of track (Gary; mention of 'single point of responsibility')

2. Title: GHP Site Development
Possible TC Co-sponsors: None
Site development (site assessment/permitting, why are some states more strict than others?, Summary of state-by-state requirements, what has gone wrong in the past, thermal property characterization, drilling conditions, vertical/direction drilling, horizontal, groundwater, system selection - closed loop, open loop, SWHP;
Possible speakers: NGWA, Prof. from Cal, State Fullerton)
Chair: Harvey Sachs
Site Assessment - Richard Layton, CSUF(NGWA)
Drilling 101- Dominique Durbin (NGWAjIGSHPA)

3. Title: Design for Outside the Building
Possible TC Co-sponsors: TC4.7: Energy Calculations

Design: Outside the building (start with 12-step; innovative ground heat exchangers; vertical borehole design procedures; horizontal design procedures; water treatment plants, sewer water plants; SWHP; thermal piles; possibly divide this into two sessions: conventional vertical borehole systems and alternatives.) loop field modeling.

Chair: ??? (2 sessions)
- Research Papers - Thermal Plies (Spitler & Pals)
- Open Loop Design - Kevin Rafferty
- Surface Water - Jeff Spitler or one of the graduate students
- Novel Applications (Waste water treatment plans, industrial, etc) - ??

4. Title: Design for Inside the Building
Possible TC Co-Sponsorship:
- TC 1.4: Control theory and applications
- TC 2.8: Building environmental impact
- TC4.7: Energy calculations
- TC 5.5: Air-Air Energy Recovery
- TC6.5; Radiant Heating and Cooling
- TC 6.6: Service water heating systems
- TC 7.1: Integrated building design

Design: Inside the building (system configuration: central VS. distributed heat pumps, hybrid vs. non-hybrid, water-to-air vs. water-to-water, EER vs. SEER, heat pump ratings, pumping and piping strategies: one pipe, primary secondary pumps; building modeling; loop modeling; how many LEED points can you get?) Control systems (install or not install a building management system). Energy recovery systems, domestic hot water systems, radiant heat and cooling.

Chair: Dave Dinse
- 12-Step (Give him 45 minutes and he can cover most of this) - Kirk Mescher
- EER vs. SEER Progress (Central vs. Distributed Systems) - Steve Kavanaugh
- Chair: Michel Bernier
- lEED - How Many Points can you get? *n*
- Hybrids (Research area?) - Scott Hackel

5. Title~: Construction Phase
Possible TC Co-sponsorship:
- TC 7.2: HVAC&R construction and design-build technologies
- TC 7.7: Test, Adjust, and Balance

Construction and construction documents (IGSHPA standards, USACE/GSA specifications, what should go into specification package, guidelines in the ASHRAE Handbook, flushing and purging, pressure testing, missing items from typical specs: trenching, backfilling, antifreeze requirements, coordination of flushing, tracer wire, metallic tape, points of responsibility, construction coordination). Sequence of operations for GHP systems. Test adjust and balancing of GHP systems.

Chair - Ed Lorenz
- IGSHPA Design and Installation Guidelines - Ryan Carda (IGSHPA)

ASHRAE Handbook/Blue Book Specifications (name it?) - Jeremy Fauber (someone from the committee)

6. Title: Commissioning and Project Closeouts

Possible TC Co-sponsorship:

TC 7.3: O&M management
TC7.6: Building energy performance
TC7.7: Test, Adjust, and Balance
TC 7.9: Building commissioning

Commissioning and Project Closeouts (commissioning, design phase, construction phase, close-out (training, O&M manuals, as-builts). ASHRAE book, case studies of things gone bad, stuff not to do: Kirk, Lisa, Mike have examples).

Chair - Cary Smith

What not to do - Lisa Meline
Commissioning/Close-out Tips for GHPs- Mike Kuk

7. Title: Operation and Maintenance

Possible TC Co-Chairs:

TC7.3: O&M management
TC7.6: Building energy performance
TC7.8: Owning and operating costs

Operation and Maintenance (To include optimal control for HGSHP, optimizing the operation, maintenance needs, future retrofits? Sequence of operations? Training. Any historical data - Oklahoma state capitol; ORNL operation cost studies? ASHRAE Std. 180 Monitoring could go here also, especially if maintenance was covered. Perhaps we could get an owner to speak on this. Testimonials.)

Chair- Keith Swilley

Marco Alvarez – PAE Engineers
Steve's EPRI Study
Any other Case Studies

Jeff's notes based on conversation with Tony Giometti
4/23/2013

Typical ASHRAE Program Schedule; it is possible that this might be done differently, as it apparently will be in Denver where there may be a 60 minute session on Sunday. 90 minute sessions should have 3-4 speakers though 2 speakers is permissible if we have a good reason); 60 minute sessions should have 2 speakers (though 1 speaker is permissible if we have a good reason). There could also be Monday and Tuesday afternoon sessions, though typically only a few rooms are available.

So, without any Monday or Tuesday afternoon sessions, and with all speakers being allotted between 22.5 and 30 minutes, we have the following "budget";

	# 90 minute sessions	# 60 minute sessions	Typical Range without any "long" speakers.	
			Min	Max
Sunday	4	0	12	16
Monday	1	2	7	8
Tuesday	2	1	8	10
Wednesday	2	1	8	10
Total	9	4	35	44

Previous notes

Goal: Practical (Good) GHP Design – underlying theme will be focusing on providing attendees with information to help them prepare good GHP designs
Mike: I agree

Need to think about the best way to group the topics into sessions (two thoughts):

- As topics apply to a normal building construction project (site development, design development, construction documents, construction, Commissioning and project close-out)
- Inside the building, outside the building, distribution + other relevant topics

Mike: I think we could / should blend the two together. The speakers/authors should keep both in mind when putting together a talk. IE: Should stress an integrated design approach. This is I see Gx often falling apart, in which the architect/owner like the idea of geo, the mechanical designer buys into because of the owner/architect, but then outsource the work to a geo designer / loop installer who often doesn't have on-going design involvement with the team. So we could have a speaker talk on integrated design and touch on what needs to be done for integrated design at the various phases of a DD, CD, Construction, Cx, and project close out. Then when other speakers talk of lets say duct design, they also briefly touch on where they need coordinate during the design process. Same goes for heat pump selection, DOAS selection, loop design etc...
Jeff: My understanding of what Lisa was suggesting is a way to organize the talks into sessions of 2-4 speakers. I think either could work, but the first gives us 5-7 sessions and the second gives us 3 obvious sessions plus some specialty sessions. I like both approaches, but I suspect a hybrid might be best:

4. Overview (Could include a historical perspective and current status + moderator could introduce the track; possible speakers Steve Smith, Gary Phetteplace, maybe someone from Sweden, Doug Dougherty, Jim Bose – how did it get restarted in the 1970s?; establishing single point responsibility)
5. Site development (site assessment/permitting, why are some states more strict than others?, summary of state-by-state requirements, what has gone wrong in the past, thermal property characterization, drilling conditions, vertical/direction drilling, horizontal, groundwater, system selection – closed loop, open loop, SWHP; possible speakers: NGWA, Prof. from Cal. State Fullerton)
6. Design: Outside the building (start with 12-step; innovative ground heat exchangers; vertical borehole design procedures; horizontal design procedures; water treatment plants, sewer water plants; SWHP; thermal piles)
7. Design: Inside the building (system configuration: central vs. distributed heat pumps, hybrid vs. non-hybrid, water-to-air vs water-to-water, EER vs. SEER, heat pump ratings, pumping and piping strategies: one pipe, primary-secondary pumps; building modeling; loop modeling; how many LEED points can you get?)
8. Construction and construction documents (IGSHPA standards, guidelines in the ASHRAE Handbook, flushing and purging, pressure testing, missing items from typical specs: trenching, backfilling, antifreeze requirements, coordination of flushing, tracer wire, metallic tape, points of responsibility, construction coordination)
9. Commissioning and Project Closeouts (commissioning, design phase, construction phase, close-out, ASHRAE book, case studies of things gone bad, stuff not to do: Kirk, Lisa, Mike have examples)
10. Operation and Maintenance (To include optimal control for HGSHP, optimizing the operation, maintenance needs, future retrofits? Sequence of operations? Training. Any historical data – Oklahoma state capitol; ORNL – operation cost studies? ASHRAE Std. 180 Monitoring could go here also, especially if maintenance was covered. Perhaps we could get an owner to speak on this. Testimonials.)

The above 6 – 8 sessions would form the core material for practitioners. Then, the research topics could be added as separate sessions (and they will likely be separate sessions if they have papers, anyways). They will have to be organized depending on what papers are submitted, but this can be done later. We will have in September a reading on this when abstracts and conference papers are submitted.
Need to think about best way to integrate the research topics (i.e. thermal piles, surface water research)
Mike: Agree. We could either have separate topics so people are into research can focus on those topics, or have a talk each time we do a focused design topic on inside, outside, distribution tech talks
Need to schedule our next call from 4/22 or 4/23. Please advise as to your availability

Subjects/Topics:

Historical perspective on GHPs: Lessons learned (heard Steve Smith from Enertech do a talk on this at IGSHPA and it was very good).
Mike: Might also want to talk on refrigerant history (TC 4.1) and future, and any compressor technology changes (IE: variable speed compressors and ECM motors.)
Jeff: If we could find two or three speakers on this, I think it would be interesting. I could try to find someone from Sweden to discuss their experience in the 1970s and 1980s; we could also try to get Dr. Bose to come.
Site Assessment/Permitting (NGWA involvement)
In situ formation thermal conductivity Testing (IGSHPA Involvement?)
Maybe something on different types of vertical and directional drilling?

Pumping and piping strategies (Jeff: Part of inside the building)
12-Step (or just break out pieces we want to emphasize)
System Configuration
Central vs. distributed (could have one talk on EER vs. SEER in this segment)
Hybrid Systems – when to apply and how best to apply (and why do it in the first place)
Mike: Think need to stress K.I.S.S. Where I have seen systems go bad is when they tried to over-complicate the system by making primary/secondary pumping which ended up being multiple pumps, multiple drives and the pumping energy using more than the heat pumps. Too complicated for anyone to optimize and keep optimized for the future.
Jeff: If we could get someone who has seen a working/efficient variable speed system, that would be ideal.

Ground heat exchangers (design, type, innovative)
System control strategies
Mike: Control strategies could argue/debate no-BAS vs. BAS. If a BAS is installed, could have a topic on optimization strategies for energy savings. (relevant TC's = TC 1.2, TC 1.4

Managing Utility Peak Loads through GHPs
Mike: Would get the utility attendees to attend. Should also incorporate into the talk state/utility/federal rebates and incentives nation-wide.
Ground heat exchangers as another Utility (Ball State)

Energy Recovery (process, outside air, etc) Heat Pump Application
Mike: Include a talk of DOAS (which I think is integral to air-air heat recovery. But could also have an applications talk on process heat recovery (IE: waste water treatment plants, water treatment plants, industrial, domestic hot water production (TC 6.6)
Integration with alternative energy/renewable (TC 6.7?)
GHPs as a pathway to Zero Net Energy Buildings (TC 2.8 building environmental impact, TC 7.4, TC 7.6)

Commissioning Experiences with GHPs (What not to do) (TC 7.9)
Mike: Besides Cx experiences, it could just talk about how to Cx a Gx system (promote the ASHRAE GHP Cx guide) and the value of Cx.
- Talk optimization strategies for GHP systems

Jeff:
Designing for ease of GHP Maintenance
Mike: And talk if we have any research or results from user experiences 5 yrs or so after. Reference ASHRAE standard 180 and what the Mx requirements are. Misconceptions about maintenance issues of GHP systems. (TC 7.3)

Installed GHP Systems – Monitored Buildings/Field Studies (Kavanaugh's EPRI work)
Mike: Goes well with acceptance and maintenance and optimization and K.I.S.S.

Jeff: I agree.

Mike: Topic on building applications? What is the best application for GHP systems historically (and maybe under-utilized potential applications.
Jeff: If we could find 3 or 4 speakers, I think this would be good. An obvious "good application" is schools. What other good applications and/or under-utilized potential applications come to mind?

Mike: Topic on modeling. Building load modeling, loop field modeling and coordination of the two. Note: ASHRAE 90.1-2010/IECC 2012 does not allow for over-sizing of heating/cooling systems (has stipulated over-sizing allowances). Residential must do calculations to verify sizing.
Jeff: Modeling would fit well with research, especially if we could get a user of the models to speak also.

A Plea for Transparent Unitary Equipment Ratings

This article provides information on underlying assumptions and test conditions that are used to calculate air source heat pump (ASHP) seasonal energy efficiency ratio (SEER), ASHP heating seasonal performance factor (HSPF), water source heat pump (WSHP) energy efficiency ratio (EER), and WSHP coefficient of performance (COP). The ASHP rating system was developed in the 1970s and published several years later. The WSHP standards were modified in the 1990s to include a part-load factor that attempts to provide a somewhat equivalent indicator to SEER and HSPF, which are essentially part-load efficiencies.

The advent of multi- and variable-speed pumps has bearing on the validity of these standards. Many of the assumptions used to attain the high efficiency values mentioned above do not represent best practice and/or realistic operating conditions with regard to temperatures, air flow rates, duct and piping losses, fan and pump power requirements, dehumidification requirements, and heating mode air delivery comfort. This article will offer simple and more transparent alternatives to the current rating systems that will enable consumers, engineers, and electric utilities to more easily evaluate equipment performance, economic value, and impact on electric utility load factors.

Ten Loopholes in ASHP Ratings (AHRI, 2008) and Related Practices

1) SEER for ASHPs is based on an IAT of 80°F (27°C) and an OAT of 82°F (28°C).
2) SEER for multi- and variable-capacity ASHPs is based on an IAT of 80°F (27°C) and 66% of the rating points are at OATs of 67°F, 72°F and 77°F. (So the outdoor air is colder than the indoor air for 66% of the numbers used to calculate cooling efficiency).
3) There is no upper limit to the airflow rate for the SEER and HSPF ratings. This could result in equipment being rated with no dehumidification capacity in cooling and relatively cool air being blown on occupants at high velocity in heating.
4) SEER and HSPF are based on air filter losses of 0.08 inches of water (20 Pa) and external static pressure (duct losses) of 0.1 to 0.2 inches of water (25 to 50 Pa). Actual combined requirements are typically 3 to 5 times greater with effective filters and typical duct designs (AAF, 2012, Parker and Proctor, 2001).
5) The method of computing HSPF assumes 34% of the OATs are above 50°F (10°C), conditions for which energy efficient buildings have little or no heating requirement.
6) HSPF calculation assumes the maximum heating load is twice the heat pump capacity at 47°F (8°C) OAT. If the capacity at this temperature could be reduced (which is easy with variable capacity heat pumps), the heating loads would be reduced at lower temperatures where COPs are low and auxiliary heat is needed. This would result in a higher HSPF even though the unit efficiency is the same.
7) The bin method of computing HSPF assumes the IAT for heating is 5°F (3°C) higher than the cooling mode set point even though the calculations assume the heating IAT is 70°F (21°C) and the cooling IAT is 80°F (27°C). (See Sidebar).
8) The coefficient of performance (COP) of ASHPs at an OAT of 17°F (-8°C) is not reported in the Directory of Certified Product Performance (AHRI, 2013) although the corresponding heating capacity is listed. Without COP, the computations of auxiliary heating capacity and net COP are impossible.

9) There are no requirements to rate performance of ASHPs at OATs above 95°F (35°C) or below 17°F (-8°C), conditions which frequently occur.
10) The rating standard for ASHPs (ANSI/AHRI Standard 210/240) is a complex 130-page document with detailed computations, assumptions and possibly additional loopholes.

Ten Loopholes in WSHP (ASHRAE, 1998) Ratings and Related Practices

1. The full load energy efficiency ratio (EER) for single speed WSHPs is based on an ELT of 77°F (25°C) and an IAT of 80.6°F (27°C).
2. The rated part-load energy efficiency ratio (EER) for multi- and variable-capacity WSHPs is based on an ELT of 68°F (20°C) and an IAT of 80.6°F (27°C).
3. Manufacturers and vendors can also choose to advertize EERs with 59°F (15°C) ELT and an IAT of 80.6°F (27°C). Thus 41 EERs are possible since the condenser fluid is 22°F (12°C) colder than the evaporator fluid. (This is like rating car mpg going downhill.)
4. WAHP EER and COP ratings include no fan power to circulate air through the ductwork.
5. WAHP EER and COP ratings include no power to circulate liquid through the piping.
6. There is no limit to the airflow rate for the EER and COP ratings which could result in equipment being rated with no dehumidification capacity in cooling and relatively cool air delivery temperatures with high velocity in heating.
7. The standard rates heat pumps with 0.0 ESP. Since air will not flow through the test chamber at 0.0 ESP, the procedure permits an assumed power to be subtracted from the required power to distribute the air. Thus, the fan power used to compute EER could be negative if the actual fan efficiency is greater than the assumed efficiency.
8. WAHP EER and COP are based on air filter losses of 0.08 inches of water (20 Pa).
9. There are no requirements to rate performance of water-to-air heat pumps at EWTs above 86°F (30°C), a condition which frequently occurs.
10. The performance of alternative refrigerant R-410a has a significantly lower efficiency at elevated water loop temperatures compared to R-22.

Energy Use Prediction with Single Rating Point

The desire to have single measure efficiency ratings for equipment developed in the 1970s so that energy costs could be predicted by using easy and quick calculations.

Cooling $ = Bldg. Load (Btu/h) × $/kWh × Oper. Hours ÷ SEER (Btu/W-h) × 1000 W/kW) (1)
Heating $ = Bldg. Load (Btu/h) × $/kWh × Oper. Hours ÷ HSPF (Btu/W-h) × 1000 W/kW) (2)
Results using these equations were acceptable estimates for occupants living in Climate Zone 4 who set their thermostats a little higher than the 78°F (26°C) President Jimmy Carter suggested and had oversized ductwork and always clean, inefficient air filters. The calculation was acceptable because there were consistent correlations between seasonal efficiency and efficiency at more extreme conditions. The introduction of multi- and variable-capacity unitary equipment has resulted in products that take advantage of loopholes in the rating procedures to generate seasonal and part-load efficiencies that are significantly higher than equivalent constant speed equipment. Consistent correlations SEER-to-EER (at 95°F/35°C) and HSPF-to-COP (at 17°F/-

8°C) no longer exist. Table 1 compares a 19 SEER with a 14 SEER split-system product line with matched coils (outdoor coil and indoor coil have similar capacity ratings). The table demonstrates although the advertised efficiencies are 35% higher (19 vs. 14) and the actual SEERs are 13.6% higher, but the EERs at 95°F (35°C) OAT are on an average 13.5% lower. This type of equipment will negatively impact electric utility load factor since demand during high OATs is increased while a decrease is experienced when OATs are mild.

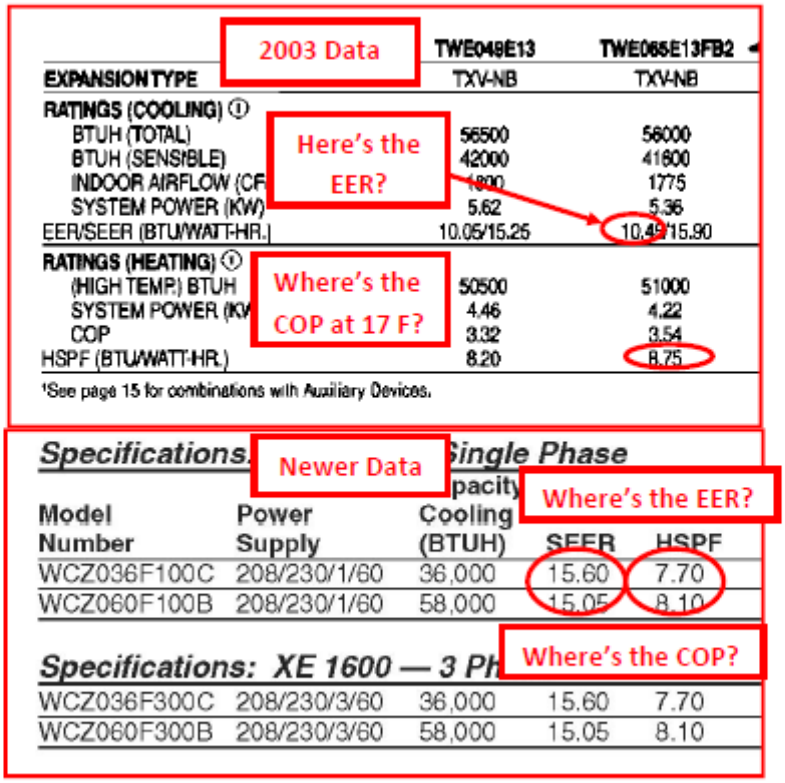
Outdoor Unit	Indoor Unit	Capacity	SEER	EER_{95}
XL19i (2TWZ9036)	TWE040E13	3-ton	17.6	12.1
XL14i (2TTX4036)	TWE040E13	3-ton	15.0	12.9
XL19i (2TWZ9048)	TWE049E13	4-ton	15.3	10.1
XL14i (2TTX4048)	TWE049E13	4-ton	15.0	12.9
XL19i (2TWZ9060)	TWE065E13	5-ton	15.9	10.5
XL14i (2TTX4060)	TWE065E13	5-ton	14.0	11.9
Average SEER Improvement from XL14i to XL19i = 13.6%				
Average EER_{95} Improvement from XL14i to XL19i = -13.5%				

Table 1. SEER 19 vs. SEER 14 Product Lines: Higher SEER but Lower EER (95°F/35°C)

Modern equipment performance is increasingly complex and applying simplistic equations in the form of (1) and (2) are likely to lead to gross errors. SEER and HSPF were never intended to be used in detailed energy calculations. In order to be accurate, models of equipment performance must be adjusted for a variety of temperatures and comfort conditions. The only verifiable operating point for cooling operation is EER and capacity at 95°F (35°C) OAT. It is not known if SEER rating is based on a bin calculation or performance at 82°F (28°C) OAT. Furthermore, the single point values contain no information regarding latent capacity needed to ensure comfort conditions are satisfied. Energy calculations that use single point ratings (like SEER, HSPF) to model modern HVAC equipment will result significant error.

Table 1 also indicates the actual values of the 19 SEER product line are less than 19. When a small outdoor unit is matched with a large indoor unit, the resulting SEER will typically have a higher SEER than one for match coils. If one or more of the indoor-outdoor combinations attains a 19 SEER, the entire product line is advertized as 19 SEER.

Additionally, product data of certified efficiency are becoming less convenient to access for those who conduct energy studies. The data in Table 1 is taken from 2003 product literature, a portion of which is shown in the top half of Figure 1. Although the EER at 95°F (35°C) is shown, COP at 17°F (-8°C) is not. The lower portion of Figure 1 demonstrates the newer format of this manufacturer that does not list EER at 95°F (35°C) or COP at 17°F (-8°C). It is possible that the omission of EER and COP listings at extreme temperatures is not accidental and the values are likely to be mediocre compared to less costly single-speed high efficiency products.



EXPANSION TYPE	TWE048E13 TXV-NB	TWE060E13FB2 TXV-NB
RATINGS (COOLING) ①		
BTUH (TOTAL)	56500	56000
BTUH (SENSIBLE)	42000	41800
INDOOR AIRFLOW (CF	1800	1775
SYSTEM POWER (KW)	5.62	5.36
EER/SEER (BTU/WATT-HR.)	10.05/15.25	10.45/15.90
RATINGS (HEATING) ①		
(HIGH TEMP.) BTUH	50500	51000
SYSTEM POWER (KV	4.46	4.22
COP	3.32	3.54
HSPF (BTU/WATT-HR.)	8.20	8.75

¹See page 15 for combinations with Auxiliary Devices.

Specifications: Single Phase

Model Number	Power Supply	Cooling Capacity (BTUH)	SEER	HSPF
WCZ036F100C	208/230/1/60	36,000	15.60	7.70
WCZ060F100B	208/230/1/60	58,000	15.05	8.10

Specifications: XE 1600 — 3 Ph

WCZ036F300C	208/230/3/60	36,000	15.60	7.70
WCZ060F300B	208/230/3/60	58,000	15.05	8.10

Figure 1 Manufacturer's Product Data Formats: Older (with EER) and Newer (without EER)

The Big Impact of Fan Power on Cooling Efficiency

The heat pump that achieved an EER of 41 at part-load conditions has a full load EER of 21.7 Btu/W-h and a rated cooling capacity of 46,000 Btu/h (13.5 kW) with an air flow rate of 1500 cfm (708 Lps). The rated power input is therefore,

$$W_{Rated} = TC_{Rated} \div EER_{Rated} = 46{,}000\ Btu/h \div 21.7\ Btu/w\text{-}h = 2120\ W \quad (3)$$

The power must be corrected to include a reasonable ESP for a nominal 4-ton unit and a filter loss representative of typical values rather than the assumed 0.08 in. wtr. (20 Pa)

$$P_{Cor} = ESP + Filter\ loss = 0.5 + (0.3\text{-}0.08) = 0.72\ in.\ wtr.\ (175\ Pa) \quad (4)$$

The rating standard assumes a reasonable 30% wire-to-air fan efficiency for the squirrel cage blower wheel and the electronically commutate motor (ECM). Thus,

$$W_{Cor} = \frac{746\ \left(\frac{w}{hp}\right) \times P_{Cor}(in.) \times Q(cfm)}{6350 \times \eta_{w-a}} = \frac{746 \times 0.72\ in.\ \times 1500\ cfm}{6350 \times 0.30} = 423\ W \quad (5)$$

The heat pump capacity must also be adjusted due to the added fan heat.

$$TC_{Cor} = TC_{Rated} - q_{fan} = TC_{Rated} - \frac{3.412Btu}{W \cdot h} \times W_{fan} = 46{,}000\ Btu/h - 3.412 \times 423\ W = 46{,}000 - 1440 = 44{,}560\ Btu/h \quad (6)$$

The corrected full load EER is,

$$EER_{FLCor} = \frac{TC_{Cor}\left(\frac{Btu}{h}\right)}{W_{Rated} + W_{Cor}} = \frac{44{,}560}{2120 + 423} = 17.5\frac{Btu}{w \cdot h} \quad (7)$$

Since the EER at part-load was rated with the full load air flow rate the full-load corrections apply to fan power (423 W) and total capacity (-1440 Btu/h). The rated part load capacity is 19,000 Btu/h (5.6 kW) and the rated power is 463 watts (= 19000 Btu/h ÷ 41 Btu/W-h).

$$TC_{PLCor} == 19{,}000\ Btu/h - 3.412 \times 423\ w = 19{,}000 - 1440 = 17{,}560\ Btu/h \quad (8)$$

The corrected part load EER is,

$$EER_{PLCor} = \frac{TC_{Cor}\left(\frac{Btu}{h}\right)}{W_{Rated} + W_{Cor}} = \frac{17{,}560}{463 + 423} = 19.8\frac{Btu}{w \cdot h} \quad (9)$$

The full load EER declined from 21.7 to 17.5 Btu/W-h while the part-load EER declined from 41 to 19.8 Btu/W-h. Thus, the omission of the full fan power in the ratings for both WSHPs and ASHPs is highly significant at full load and borders on deceptive at part-load.

A simple and transparent alternative

Table 2 outlines the recommended rating conditions for ASHPs and WSHPs. These conditions simplify the rating procedure, provide a breath to include almost all climates, and provide realistic external constraints (air and water flow rates, fan and pump pressures). It will permit interpolation of non-rated conditions rather than excessive extrapolation. Table 3 includes recommendations for water-to-water heat pumps.

Indoor Air Flow Rate: 54 Lps/kW (402 cfm/ton)		
Return Indoor Air Temperature (IAT)		
25°C (77°F) Dry Bulb / 18°C (64.4°F) Wet Bulb = 51% Relative Humidity		
Air-to-Air Heat Pump Outdoor Air Temperatures (OATs) - Cooling		
25°C (77°F)	35°C (95°F)	45°C (113°F)
Air-to-Air Heat Pump Outdoor Air Temperatures (OATs) - Heating		
-10°C (14°F)	0°C (32°F)	10°C (50°F)
Water-to-Air Heat Source Loop Pump Entering Liquid Temperatures (ELTs) - Cooling		
20°C (68°F)	30°C (86°F)	40°C (104°F)
Water-to-Air Heat Pump Source Loop Entering Liquid Temperatures (ELTs) - Heating		
-5°C (23°F)	5°C (41°F)	15°C (59°F)
Water-to-Air Heat Pump Liquid Flow Rate @ 20°C (68°F) with 15% Methanol-85% Water		
3.0 Lpm/kW (2.8 gpm/ton)		
Air Side Filter Loss: 75 Pa (0.3 Inches of Water)		
External Static Pressure		
For TC $\leq$ 7.5 kW (2.1 tons): 100 Pa (0.4″H_2O), 7.5 < TC $\leq$ 15 kW (4.3 tons): 125 Pa (0.5″H_2O), 15 < TC $\leq$ 25 kW (7.1 tons): 150 Pa (0.6 ″H_2O), TC $\geq$ 25 kW: 200 Pa (0.8 ″H_2O)		
Water-to-Air Heat Pump – Pump Penalty: 20 watts/kW (70 watts/ton)		
Part-Load Performance for Multi- and Variable Capacity Heat Pumps		
Rated at 50% of Full-Load Capacity		
Air and water flows equal to full load per kW (or per ton) values but based on part-load capacity		
OATs, EWTs, and IATs = full-load values		
ESPs and Air Filter losses = 30% of full load values		
Required Reporting Ratings at all three OATs and EWTs – Cooling Mode*		
Total Cooling kW (Btu/h)	Sensible Cooling kW (Btu/h)	COP(kW/kW) or EER(Btu/W-h)
Required Reporting Ratings at all three OATs and EWTs – Heating Mode*		
Total Heating kW (or Btu/h)	COP (kW/kW)	
*Values expressed in net cooling or heating with subscripts noting outdoor air or water loop temperatures [i.e. TC_{35} (TC_{95}) = total cooling capacity at 35°C (95°F) outdoor air temperature]		
Values for the cycling degradation coefficient (C_D) and ASHP defrost penalties assume defaults values. Optional tests can be conducted to permit lower values.		

Table 2 Air-to-Air and Water-to-Air Heat Pumps Test Conditions

Source Loop Flows, Temperatures, Pump Penalties, Required Reporting Same as Table 2	
Building Loop Entering Water Temperatures (EAT)	
12°C (53.6°F) - Cooling	45°C (113°F) - Heating
Building Loop Liquid Flow Rate @ 12°C (53.6°F): 2.5 Lpm/kW (2.3 gpm/ton)	
Building Loop – Pump Penalty: 20 watts/kW (70 watts/ton)	
Indoor Air Flow Rate: 54 Lps/kW (402 cfm/ton)	
Fan Coil and Filter Loss: 100 Pa (0.4 Inches of Water)	
External Static Pressure	
For TC $\leq$ 7.5 kW (2.1 tons): 100 Pa (0.4″H_2O), 7.5 < TC $\leq$ 15 kW (4.3 tons): 125 Pa (0.5″H_2O), 15 < TC $\leq$ 25 kW (7.1 tons): 150 Pa (0.6 ″H_2O), TC $\geq$ 25 kW: 200 Pa (0.8 ″H_2O)	

Table 3 Transparent Water-to-Water Heat Pump Test Conditions

Advantages of Proposed Rating Conditions

1. Performance can be certified at a broad range of outdoor and water loop conditions that reflect nearly all climates in which heat pumps are applied.
2. Indoor conditions would reflect realistic air distribution and air filter losses so that fan power and heat penalties would be appropriate.
3. Realistic air distribution pressures would likely result in the abandonment of inefficient forward-curve fan wheels toward more efficient designs (Kavanaugh, 2012).
4. Indoor air flows would reflect rates that result in known latent heat capacities in cooling and comfortable air delivery temperatures and velocities in heating.
5. 5. The requirement to report sensible cooling capacity (and therefore latent capacity) would impose no additional testing requirements since the necessary input values are all available for the total cooling capacity calculation.
6. ASHPs and WSHPs would have a common rating system so that comparisons of alternatives will be less subject to deception by overly aggressive sales personnel.
7. Electric utilities would be able to more accurately predict demand in the many locations with OATs significantly higher than the current maximum rating point of 95°F (35°C).
8. Energy models would likewise more accurately predict energy consumption since the introduction of a broad range outdoor air and water loop temperatures would result in more accurate interpolations rather excessive extrapolations from a single rating condition.
9. The data listing will permit regional, state, or local authorities to select appropriate rating points to use for code compliance and incentives or values can be used to develop seasonal efficiencies appropriate to local climates.

Summary

1. The current rating standards for unitary ASHP and WSHP are outdated and allow gaming of loopholes to achieve high seasonal and part-load ratings that do accurately reflect conditions that normally occur in actual installations.
2. Inflated seasonal and part-load ratings are being aggressively marketed while full-load ratings are not as easy to access.
3. When the performance ratings of multi- and variable- capacity units are corrected to conditions and constraints that are more likely occur, efficiency improvements are modest or non-existent compared to high efficiency single-speed equipment.
4. The ASHP seasonal efficiency rating conditions contain a very high weighting toward mild outdoor temperatures while the entering water temperatures used in the WSHP cooling efficiency ratings can be as much as 22°F (12°C) lower than the indoor air temperature.
5. The ASHP ratings contain minimal certified rating points which make energy calculations ineffective for climates and constraints that are different than the assumptions used.
6. The rating procedures for ASHPs and WSHPs are substantially different, thus comparisons of alternatives are subject to error and misuse.
7. A revised and simpler multi-point rating procedure is necessary to more accurately reflect conditions and constraints that normally occur in actual installations and varied climates.

References

1. AHRI, 2013. Directory of Certified Product Performance: Heat Pump and Heat Pump Coils. Air-conditioning, Heating, and Refrigeration Institute. Arlington, VA.
2. AHRI. 2008. Standard for Unitary Air-Conditioning and Air-Source Heat Pump Equipment. Air Conditioning, Heating and Refrigeration Institute. Arlington, VA.
3. AAF, 2012 PerfectPleat Extended Surface, Pleated Filter, MERV 7. American Air Filter International, Louisville.
4. Parker, D.S. and J. Proctor, 2001. Hidden Power Drains: Trends in Residential Heating and Cooling Fan Watt Power Demand. FSEC-PF361-01, Florida Solar Energy Center, Cocoa, Florida.
5. Trane. 2003. Split System Cooling Product & Performance Data, XL14i. General Data, pp. 7-25. Tyler, TX.
6. Trane. 2003. Split System Heat Pump Product & Performance Data, XL19i. General Data, pp. 7-14. Tyler, TX.
7. ASHRAE 1998. Water-Source Heat Pumps-Testing and Rating for Performance-Part 1: Water-to-air and brine-to-air heat pumps. ANSI/AHRI/ASHRAE ISO Standard 13256-1. Atlanta.
8. Kavanaugh, S.P., 2012. "Twice as Nice: Backward-Curved Fans for Unitary Equipment", *ASHRAE Journal*, Atlanta, Vol. 54, No. 5.

TC/TG/TRG Activity Feedback Form

Please provide feedback on your TC/TG/TRG activities and return this form to your Section Head by email or drop off a printed copy in the Section Head's mailbox folder outside the ASHRAE Headquarters Room by Tuesday night 9:00 pm.

PLEASE DO NOT LEAVE NUMERIC CELLS EMPTY. ENTER 0 IN CELLS IF THERE IS NO COUNT.

TC#	6.8	Committee Name:	Geothermal Heat Pump and Energy Recovery Applications
		Chair:	Lisa Meline

Meeting was Held (City)	Denver	(Day)	Tuesday	(Date)	6/25/2013

Membership	Quorum Established (Yes/No)		
	Number Present	Remote Participants	Total on Committee
Voting Members (excluding Non-Quorum Members)	11	0	15
Non-Quorum Members	1	0	2
Corresponding Members	9	0	84
Provisional Members	2	0	4
Visitors/Guests	25	0	0
# members/guests who are also YEA members	8	0	8

Handbook Responsibilities	Standards Responsibilities
Volume and Chapter (i.e. A17 Printing Plants)	Standards Number (i.e. SPC 178, Std 90.1, Gdl 2)
App. Geothermal #34	
Sys Applied Heat Pump and Heat Pump Recovery Systems #9 (2009)	

Total Number of Chapters	2	Total Number of Standards	0
# Chapters voted out this meeting	0	# Standards recommended	0
Special Publications (last six months)	0	Title:	

Program Activities (For This Meeting)

Total # of Forums			Total # of Technical Paper Sessions			Total # of Conference Paper Sessions			Total # of Seminars		
Submitted*	Sponsor	Co-sponsor	Submitted*	Sponsor	Co-Sponsor	Submitted*	Sponsor	Co-Sponsor	Submitted*	Sponsor	Co-Sponsor
0	0	0	0	0	0	0	0	0	2	1*	0

Current Research Activities (active)	
# of active RTARs	1
# of active Workstatements	1
# of active TRPs	0
# of active RPs	2
Total # of Active Projects	4
Problems getting RTAR/WS approved?	NO

TC Management	(Yes/No)
Minutes completed on Time?	YES
Agenda distributed on time?	YES
Members asked to Reconfirm participation (winter)?	YES
Roster Workbooks Completed (Winter)	YES
Did Chair and Vchair attend Training?	NO
Did Handbook Chair attend Training?	NO
Did Program Chair attend Training?	NO

FAQ Responsibilities	
Total # of FAQ's	0
# FAQs updated this meeting	0
FAQ IDs	

TC Website	
TC has a website (yes/no)	YES
Website Up-to-date? (Yes/No)	YES
Website is on the ASHRAE Server (Yes or No)	YES
Link to website from www.ashrae.org/standards-research-technology/technical-committees is functional? (yes/No)	YES

Award Nominations (last six months)	
Distinguished Service Award	0
Exceptional Service Award	0
Other:Hightower, Research,etc (specify below)	0
Award :	

Any Concerns or requests for the Technical Activities Committee? (Please type in Space Below)

Total 48

*Special Program 7, "The Smartest and Top Dumb Things Engineers and Designers Do to Impact Geothermal HP System Costs."