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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 March 13, 2017

TC/TG/MTG/TRG TITLE Hydronic and Steam Equipment and Systems

DATE OF MEETING January 31, 2017 LOCATION Las Vegas, NV

MEMBERS PRESENT	YEAR APPTD	MEMBERS ABSENT	YEAR APPTD	EX-OFFICIO MEMBERS AND ADDITIONAL ATTENDANCE
Jason Atkisson	2016			
Niels Bidstrup (non-quorum)	2015			
Scott Fisher	2015			
Larry Konopacz	2015			
David Lee	2015			
Jessica Mangler	2016			
Frank Myers	2013			
Thomas Neill	2014			
Donald Prather	2013			
Rex Scare	2015			
Steve Tredinnick	2015			
Robert Walker	2015			

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

TAC Section Head:	Mark C. Hegberg
All Committee Liaisons As Shown On TC/TG/MTG/TRG Rosters (Research, Standards, ALI, etc.)	ALI/PDC – James W. Bochat Chapter Tech. Transfer – Maggie Moninski Research – Harvey M. Sachs Standard – Cyrus H. Nasser 2017 HB Fundamentals – Van D. Baxter 2020 HB Systems – Caroline Calloway

Mike Vaughn, Manager Of Research & Technical Services	MORTS@ashrae.net
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1. Call to Order:

Chair Scare called the meeting to order at 1:01pm. Chair Scare welcomed all in attendance and self-introductions were made. An attendance sheet was passed and signed by those in attendance. A roll call of voting members was conducted and a quorum was present with 10 of 12 voting members. One additional voting member arrived at 1:08pm. One (non-quorum) voting member left the meeting at 1:17pm. Member Jason Atkisson abstains from voting this meeting as he and voting member Jessica Mangler both work for the same company.

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 Frank Myers, second by Thomas Neill. Approved 10-0-2 CNV.

3. Approval of St. Louis Meeting Minutes:

Motion by Scott Fisher, second by Frank Myers to approve the past meeting minutes. Motion passed 10-0-2 CNV.

4. Recognition of Liaisons:

No liaisons were present.

5. Chair's Report

Vice Chair Scare summarized the key items from the Section 6 Breakfast.

- (a) The 2016-17 Hightower Award Recipient is Paul Lindahl, TC 3.6 & TC 8.6.
- (b) The 2016-17 Service to ASHRAE Research Award Recipient is Joseph Huber, TC 1.3.
- (c) A new ASHRAE Technology Portal is now available for free member access to ASHRAE Journal articles and ASHRAE Research Reports.
<http://technologyportal.ashrae.org>.
- (d) In partnership with AIA, IES, and USGBC and with support from DOE, ASHRAE has embarked on a new series of Advanced Energy Design Guides focusing on achieving zero energy performance. The first guide in the series is for K-12 School Buildings. Achieving Zero Energy will be available for review and feedback from February 6, 2017 to February 17, 2017. All review input must be received by February 19, 2017. To participate in the review, please go to www.ashrae.org/freeaedg to download the review process instructions.

- (e) One new Multidisciplinary Task Group (MTG) has been formed since St. Louis. MTG.ACR – Air Change Rate. For more information on this new MTG and the nine other existing MTGs can be found at <http://www.ashrae.org/tcs>.
- (f) A new restructured TC MOP (Manual of Procedures) will be issued after Las Vegas.
- (g) Program statistics for Las Vegas, with a total of 109 available slots: Seminars – 152 submitted, 76 presented; Workshops – 18 submitted, 7 presented; Forums – 8 submitted, 3 presented; Panel – 8 submitted, 3 presented; Conference Papers – 164 abstracts submitted, 145 approved, 81 presented in 22 Conference Paper Sessions
- (h) CEC has had an ongoing issue with presentations not being uploaded for commercialism review before the conference. Starting with the 2017 Annual Meeting in Long Beach, CEC will begin to enforce a 3 strike policy for speakers who do not upload their presentation by the published deadline. The deadline for Long Beach is June 2, 2017.

6. Sub-Committee Reports

- A. Programs: David Lee (Chair). Subcommittee meeting minutes of January 30, 2017, are attached.

There were five sponsored programs at this meeting:

Seminar 3 – Hydronic Water Flow Measurement

Seminar 28 – When Good Valve Sizing Goes Bad

Seminar 50 (Co-Sponsor) – Flex Ducts, Hard Ducts and No Ducts: Migrations Patterns for Duct Hunters (or not) in the Land of Thermal Comfort.

Seminar 53 – Commissioning a Central Chilled Water Plant

Seminar 71 – What's New In HVAC Pumping Efficiency? A Look at 90.1-2016 Updates, EU Legislation and U.S. DOE Efficiency Legislation.

Chair Lee asked for input and suggestions for programs at future meetings.

- B. Research: Tom Cappellin (Chair). Subcommittee meeting minutes of January 30, 2017, are attached.

The Work Statement 1454-WS *Control Valve Selection for Improved Controllability* has been withdrawn by TC 1.4 for further review.

- C. Handbook: Tricia Bruenn (Chair). No subcommittee meeting was held in Las Vegas. Notes from the Handbook Committee Meeting are attached from Chair Bruenn.

- D. Chilled Water Plant Sub Committee: Steve Tredinnick (Chair).

Chair Tredinnick the started meeting with brief introduction to scope of new chapter.

Simultaneous editing of the chapter material is now easier with the use of ASHRAE's

Authoring Portal (authoring.ashrae.org). As long as the individual is on the roster of TC 6.1, they can review and add content to the document.

Progress from last meeting include miscellaneous text additions, adding tables for comparing chiller plant configurations and the efficiency gains (series vs. parallel chiller efficiency).

Shortly after the meeting started, guest Brandon Gill of Taylor Engineering inquired how the new chapter was different than the Self Directed Learning (SDL) Course on Chilled Water Plant Design that Taylor Engineering just prepared. The SDL course was being reviewed by Society and getting ready for publication. Chair Tredinnick was unaware of the SDL course and made several inquiries to Mr. Gill. This effectively derailed the meeting while Tredinnick struggled with the value of continuing the meeting until more information was uncovered on the SDL content. The meeting was adjourned.

Subsequent to the meeting, the SDL content was received by the chief author via ASHRAE Publications. Upon a quick review, the SDL course material appeared similar in content to the Cool Tools Guide published several years ago by SDG&E. While the SDL material has similar goals to educate engineers in CHW plant design, it can be used as a reference material for the completion of the new Chapter. Chair Tredinnick plans to continue in his efforts.

- E. Membership: Larry Konopacz (Chair). Chair Konopacz reminded all to update their member profiles, especially their e-mail addresses. The Chair brought the complete roster and asked for those present to verify they are on the roster and verify the listed data. To be placed on the roster and update their data it must be done by the member through the ASHRAE website.
- F. Standards: Mike O'Rourke (Chair). Chair O'Rourke was not in attendance.

Frank Myers reported 90.1-2016 is complete and was published last summer. The progress indicator for boilers based on the 2004 baseline indicates an increase of 6.2% from 90.1-2013.

Frank Myers also reported SPC 155 is in committee review and the plan is to have it released for full public review prior to the summer meeting.

- G. Web: Jessica Mangler (Webmaster). Webmaster Manger reports the website is up to date. Google Analytics has been activated to monitor traffic to our website.

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

No reports.

8. Old Business:

- (a) MTG-O&MEE – Don Prather says there are no updates.

- (b) SPC 208 – Method of Test for Determining Hydronic System Balance Valve Capacity. Mark Hegberg reports there are member comments which are being incorporated into the document. Plan is to put the document out for public review.

9. New Business:

- (a) The TC is looking for a new webmaster to replace Jessica Mangler who will take the Research Subcommittee Chair position after the next meeting.

10. Meeting Adjournment:

Motion by Bob Walker, second by Frank Meyer to adjourn the meeting. Motion passed 9-0-2 CNV. Meeting adjourned at 1:52pm.

Submitted by,
Bob Walker.
TC 6.1 Secretary



Shaping Tomorrow's
Built Environment Today

TC Sign-in Sheet

Meeting Info: TCG-1 MEETING Date: 1/31/17

Name	Affiliation	E-mail	Member (Voting, Corresponding, or Guest?)	YEA Member? (Yes/No)
LARRY KONGPAREZ	XYLEM-B&G	larry.kongperez@xyleninc.com	Voting	No
STADKUTIS	XYLEM INC.	STAD.KUTIS@XYLENINC.COM	Guest	No
Tom Cappellin	Consultant	tcappellin	Corresponding	No
Scott Fisher	State Farm Retired	sfishbmi@gmail.com	Voting	No
Bob Walker	Belimo	robert.walker@us.belimo.com	Sec / VM	No
Rex Seave	Armstrong Intl	rexseave@armintl.com	Chair / VM	No
JASON ATKISSON	AEI	jackson@aeieng.com	Vice Chair / VM	No
NIELS BIDSTROP	GRUNDFOS	nbidstrop@grundfos.com	VM	No
DON PRATHER	ACCA	donald.prather@acca.org	VM	No
Don Heitzinger	VAV	Don.Heitzinger	VM	Yes

Aykur Yilmaz ATRI ayilmaz@atri.org CM Yes.

Name	Affiliation	E-mail	Member (Voting, Corresponding, or Guest?)	YEA Member? (Yes/No)
EVANS J. LIZARDS	LIZARDS ENGINEERING	EVANSOLIZARDS @LEAPC.COM	CORRESPONDING	NO
Tricia M. Bruenn	Belmont	tricial6@msn. com	Corresponding member	no
JESSICA MANGLER	AEI	jwangler@aie.org.com	VM	Y
Frank Myers	The Myers Group	frankmyers@ix.netcom.com	VM	
THOMAS NEILL	MESTEK	tn111@metstek.com	VM	
DAVID LEE	ARMSTRONG	dlee@armstrongfluidtechnology.com	VM	N
Star Tredinnick	Burns & McDonnell	stredinnick @burnsmcd.com	VM	N
Mark Heberle		mhqberg@ concast.net	CM	N
Edward T sui	Intelligent Tech	edward.t.sui@intelligent-net.com	CM	N

Name	Affiliation	E-mail	Member (Voting, Corresponding, or Guest?)	YEA Member? (Yes/No)
Andrew Koppi	UENOR	andrew.koppi@uonor.com	Pres Corresponding	No
Chris Haldiman	Watts Water Tech	chris.haldiman@wattswater.com	Corresponding	No
Mike Schwedler	Trane	mschwedler@trane.com	CM	No
Mike Trantham	IMI Hydronic	Mike.Trantham@imi-hydronic.com	PCM	No
REDDY PALICHARLA	PENTAIR/ AURORA Pump	reddy.palicharla@pentair.com	CM	No
Daniel Chudecke	Molecular Co	dchudecke@molecularco.com	CM	No
Jennifer Guerrero-Ferreira	Bekaert	jennifer.guerrero@bekaert.com	CM	No

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Name	Affiliation	E-mail	Member (Voting, Corresponding, or Guest?)	YEA Member? (Yes/No)
Viral Dharaiya		viral.dharaiya@ hoyesfluidcontrols.com	Guest	NO
Justin Westmoreland	AESC Inc.	justinwestmoreland@aesc-inc.com	Corresponding	Yes
Art Gieseler	PENAPPE	ART.GIESELER@ NIT-Net	PCM	NO
CHRIS HAWS	INTERTEK	CHRIS.HAWS@ INTERTEK.COM	Guest	NO
JENNIFER LEACH PATTERSON-VALLEY	HARSCO	pennstojen@yahoo.com	CM	NO
Kevin Summers	Boiler Equipment Company	KJSummer@gmail.com	PCM	Yes

TC 6.1 Program Subcommittee Meeting - Minutes:

January 30, 2017

Attendees:

David Lee, Armstrong Fluid Technology – Program Subcommittee Chair

Larry Konopacz – Xylem

Stan Kutin – Xylem

Jason Atkisson – AEI

Bob Walker, Belimo

Rex Scare, Armstrong International

Jennifer Leach, Patterson Kelley

Jon Heitzinger, Northern Arizona University

Tricia M. Bruenn, Belimo

Vanessa Castro, Zen Ecosystems

Scott Fisher, State Farm – Retired

Niels Bidstrup, Grundfos

Minutes:

- 3 seminars approved, 1 co-sponsored for Las Vegas conference
- Proposed seminars for Long Beach conference (see below for key dates):
 - PEX piping for chilled water and hot water instead of copper/steel, types of pipe fittings - Ryan Mallory [tentative]
 - Geothermal sizing and selection for residential - Larry Konopacz [tentative]
 - Pipe Thermal Expansion Design - Bryson Borzini co-sponsor TC6.2, TBA combine with underground piping jacketing of single vs multiple (Aaron Stotko has research paper) [tentative]
 - Low Delta T on Chilled Water Systems - Steve Tredinnick, Tricia B, Barry TC1.4 [tentative]

Key Dates for Long Beach conference:

- August 29, 2016 Conference Paper abstracts and Technical Papers due
- September 9, 2016 Conference Paper abstract Notifications due
- December 9, 2016 Final Conference Papers Submitted for Review (Includes Bio, Learning Objectives and Methods of Assessment)
- January 2, 2017 Website Opens for Seminar, Forum and Workshop Proposals
- January 16, 2017 Conference Paper Accept/Revise/Reject Notifications Due
- **February 6, 2017 Seminar, Forum and Workshop Proposals Due**
- February 10, 2017 Revised Conference Papers/Final Technical Papers Due
- February 20, 2017 Conference and Technical Paper Final Accept/Reject Notifications

To submit a Seminar:

<http://ashraem.confex.com/ashraem/s17/cfp.cgi>

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- Proposed seminars for Chicago 2018 conference:
 - Steam System Design Fundamentals and Applications- Chair: Rex Scare, SAC co-sponsor
 - Pumps in seismic areas and restraints (For earth, wind and fire track) – Chair TBA
 - Water Hammer & Steam (for earth, wind and fire track) – Chair: Rex Scare
 - Designing for HVAC resiliency / redundancy – Chair: Vanessa Castro, Jason Atkisson
 - HVAC for hospital equipment (co-sponsor) – Jessica Mangler / co-sponsor TC 9.6

Other:

- Best approaches to getting programs approved. Technical papers are given 1st priority followed by Conference papers. Technical papers do not go through CEC. 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.

ASHRAE TC 6.1 Technical Committee
Hydronic and Steam Heating Equipment and Systems
Research Subcommittee Meeting Minutes

Caesar's Palace Hotel – Las Vegas

3:15pm to 4:15pm - Monday, January 30, 2017

Discussion and Activity Notes:

1. Notes from the Research Subcommittee Chair's Breakfast are attached to these minutes.
2. Chair reviewed minutes made during ASHRAE'S 2016 Annual Conference in St. Louis.
 - a. Requests for TC 6.1 to co-sponsor RTARS and Work Statements with TC 1.4 are presently on hold due to TC 1.4 revisions of their documents.
 - b. An RTAR, addressing testing and adjustment of automatic balancing control valves, considered for development by Hooman Daneshmand and Tricia Bruenn, is on hold until the authors can decide to pursue the project and provide a theme and format.
 - c. An existing project – 1196-RP is overdue for completion due to the retirement of its research team's leader. The project's testing and report conclusions are for developing software to calculate the application seasonal efficiency of commercial space heating boiler systems based on ASHRAE Standard 155P. The project was contracted to Iowa State University who is willing to finish the project with the original team leader who is willing to return to finish the work. Members of SPC 155P have assured TC 6.1 that they will continue to monitor the project to assure its completion.
3. Scott Fisher has proposed to revamp a previous RTAR possibility relating to allowances to be considered for iron and steel pipe as they age during their years in service. Scott suggested that the project would include 6-inch and 8-inch pipes transferring condenser water between refrigeration machines and open cooling towers. It is hoped that Scott will be able to prepare this RTAR for review in Long Beach during ASHRAE's Annual Conference.

End of Minutes:

Minutes prepared by Thomas E. Cappellin, Chair of TC 6.1 Research Subcommittee

Attachments: Attendance sign-in sheet
RAC Las Vegas Update Notes



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TC Sign-in Sheet

Meeting Info: TC 6.1 Research Subcommittee Date: JAN 30, 2017

Name	Affiliation	E-mail	Member (Voting, Corresponding, or Guest?)	YEA Member? (Yes/No)
STAD KUTIS	XYLEM INC.	STAD.KUTIS@XYLEMINC.COM	GUEST	No
LARRY KONOPACZ	XYLEM, INC	LARRY.KONOPACZ@XYLEMINC.COM	VOTING	No
BOB WALKER	BELIMO	robert.walker@us-belimo.com	VOTING	No
Rex Seave	Armstrong	alex@armstrongintl.com	Voting	No
Scott Fisher	State Farm Retired	sfishbmi@gmail.com	VM	No
JASON ATKISSON	Affiliated Engineers	jackson@aeieng.com	VM	No
JESSICA MANGLER	AEI	jmanager@aeieng.com	VM	Y
Tricia H. Bruenn	Belimo	triciah@msn.com	Corresponding Member	N
DAVID LEE	ARMSTRONG	dlee@armstrongfluidtechnology.com	VM	N
Andrew Kopp	Upacoe	andrew.koppi@upacoe.com	Guest	N
Tom Cappellin	Consultant	tcappellin@msn.com	Chair - Non-Voting	N

RAC UPDATE LAS VEGAS

Kishor Khankari, Ph.D.

Fellow ASHRAE

Vice-Chair RAC

Remember

- **Conditionally Accepted** – Provide a cover letter of how the conditionally accepted comments were addressed.
- **Co-Sponsoring TC's, etc.** – All co-sponsoring TC's should be providing input to the RTAR and WS development.
- **Important:** Obtain full TC votes on approvals of submitted RTARs and WSs for both sponsoring and co-sponsoring TCs
- **Abstentions and Negative Votes** – provide reasons for abstentions and negative votes.
- **If other outside organizations have interest** in the proposed research then provide a letter of support with RTAR/work statement.

Proposals Update

- **3 RTARs** considered by RAC – 3 accepted
- **4 Work Statements** considered by RAC - 1 was conditionally accepted, 3 returned.
- **Innovative Research Grant (IRG)** – 33 pre-proposals received – 6 are qualified for the full proposal
- **New Investigator Award** – 16 nominations received – 1 selected for award

PMS Training

- **Project Monitoring Subcommittee (PMS)** has the most important function.
- **PMS training** – a webinar will be announced soon!
- **Milestone/Task Monitoring procedure** will be announced.
- **PMS** will be required to report on the status of milestone.
- **Appropriate and timely actions** will be taken for the delayed or non-completed milestone

TC 6.1 Handbook Notes

Attended Handbook Training , 8 AM on Sunday, 1/29/17. Topics included new authoring portal. Forrest Yount spoke on the downward trend of revisions of the chapters and the initiative to reverse this. As a success story, 2016 version had highest number of revisions. There is a revision history matrix that shows last 2 cycles (8 years.) The goal is to have 10% revision over the prior version.

Notables:

Access: authoring.ashrae.org

Log-in is your standard ashrae.org

Must use Internet Explorer – not Microsoft Edge or other browsers

Advantages:

- NO lost work
- Access to all committee members of the TC in charge of the chapters. No access if not on roster; however, can have non-ASHRAE members given a number so that they can access to review.
- NO transmitting large files
- Tracking feature and version with note of who did the changes is created when document is saved
- New Material Folder to store content. Can submit material in color to be used in on-line version. Paper version will still be printed in black and white. Note: We will still follow the process of approving the changes for the chapters during the sub-committee meetings. If a change is not approved, then TC6.01 Handbook chair or assigned chapter responsible will edit in portal and overwrite change.
- Must use this portal to ensure that we maintain our copyrights. When you use another “dropbox” type service, you give these rights up and this is not wanted.

There was no TC6.1 Handbook Sub-Committee meeting in Las Vegas. This meeting will resume in Long Beach. Our next revisions are due in 2020 HVAC Systems and Equipment and 2021 Fundamentals. Any existing galley proofs for 2017 Fundamentals will be sent in standard way (not using portal.)

Chapter 99 was added for 2020 Version (Chilled Water Chapter to be covered by Steve Tredinnick.

New Liaison: Caroline Calloway, ccalloway@aerco.com She will attend our TC meetings in Long Beach.

2020 HVAC Systems and Equipment

All Documents

✓	 Name		Modified	Modified By
	 11_2020_Steam Systems	...	June 17, 2016	<input type="checkbox"/> spadmin@iengineering.com
	 13_2020_Hydronic Heating and Cooling System Design	...	June 17, 2016	<input type="checkbox"/> spadmin@iengineering.com
	 14_2020_Condenser Water Systems	...	June 17, 2016	<input type="checkbox"/> spadmin@iengineering.com
	 15_2020_Medium- and High-Temperature Water Heating	...	June 17, 2016	<input type="checkbox"/> spadmin@iengineering.com
	 28_2020_Unit Ventilators, Unit Heaters, and Makeup Air Units	...	June 17, 2016	<input type="checkbox"/> spadmin@iengineering.com
	 32_2020_Boilers	...	June 17, 2016	<input type="checkbox"/> spadmin@iengineering.com
	 36_2020_Hydronic Heat-Distributing Units and Radiators	...	June 17, 2016	<input type="checkbox"/> spadmin@iengineering.com
	 44_2020_Centrifugal Pumps	...	June 17, 2016	<input type="checkbox"/> spadmin@iengineering.com
	 46_2020_Pipes, Tubes, and Fittings	...	June 17, 2016	<input type="checkbox"/> spadmin@iengineering.com
	 47_2020_Valves	...	June 17, 2016	<input type="checkbox"/> spadmin@iengineering.com
	 48_2020_Heat Exchangers	...	June 17, 2016	<input type="checkbox"/> spadmin@iengineering.com
	 99_2020_CHW Plant Design	...	August 31, 2016	<input type="checkbox"/> spadmin@iengineering.com

2020 Systems and Equipment Handbook

Chapter 11 – Steam Systems

Lead Author	Rex Scare	<u>Rexs@armstronginternational.com</u>
Reviewer	Jason Atkisson	
Reviewer	Stan Kutin	<u>Stan.kutin@xyleminc.com</u>
Reviewer		
Reviewer	<u>Kevin Summers</u>	<u>KJsummer@gmail.com</u>
Reviewer		

Chapter 13 – Hydronic Heating and Cooling System Design

Lead Author	<u>Mick Schwedler</u>	<u>mschwedler@trane.com</u>
Reviewer	Jason Atkisson	
Reviewer	Larry Konopacz	<u>Larry.konopacz@xyleminc.com</u>
Reviewer	<u>Aaron Stotko</u>	<u>aaron.stotko@uponor.com</u>
Reviewer	<u>Viral Dharaiya</u>	<u>viral.dharaiya@haysfluidcontrols.com</u>
Reviewer	<u>Ryan Mallory</u>	<u>Ryan.Mallory@uponor.com</u>
Reviewer	<u>EVANS J. LIZARDOS</u>	<u>EVANS.LIZARDOS@LEAPC.COM</u>
Reviewer	<u>Blair Hegberg</u> <u>OR LEAD AUTHOR</u>	<u>whegberg@comcast.net</u>

Chapter 14 – Condenser Water Systems

Lead Author	Steve Tredinnick	<u>stredinnick@burnsmcd.com</u>
Reviewer		
Reviewer		
Reviewer		
Reviewer		
Reviewer		

Chapter 32 - Boilers

Lead Author	<u>Don Prather</u>	<u>donald.prather@acc.org</u>
Reviewer	Thomas Neill (eth)	<u>tneill@mestek.com</u>
Reviewer	<u>JENNIFER LEACH</u>	<u>JLEACH@HARSCO.COM</u>
Reviewer	<u>MEHDI DOURA</u>	<u>mdoura@lochinvar.com</u>
Reviewer		
Reviewer	<u>Kevin Summers</u>	<u>KJsummer@gmail.com</u>

Chapter 36 – Hydronic Heat Distributing and Radiators

Lead Author

Reviewer

Reviewer

Reviewer

Reviewer

Reviewer

Ryan Mallory

Thomas Neill (aka)

Aaron Slotko

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Chapter 44 – Centrifugal Pumps

Lead Author

Reviewer

Reviewer

Reviewer

Reviewer

Reviewer

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Reviewer

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Chapter 47 - Valves

Lead Author

Reviewer

Reviewer

Reviewer

Reviewer

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Bob Walker

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Chapter 48 – Heat Exchangers

Lead Author

Reviewer

Reviewer

Reviewer

Reviewer

Reviewer

John Glunt

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