

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

**1791 Tullie Circle, N.E./Atlanta, GA 30329
404-636-8400**

TC/TG/TRG MINUTES COVER SHEET

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

TC/TG/TRG NO TC 8.5 DATE May 17, 2004

TC/TG/TRG TITLE Liquid to Refrigerant Heat Exchangers

DATE OF MEETING Monday, January 26, 2004 LOCATION Anaheim, CA

MEMBERS PRESENT	YEAR APPTD	MEMBERS ABSENT	YEAR APPTD	EX-OFFICIO MEMBERS AND ADDITIONAL ATTENDANCE
Jim Bogart	2003	Art Fovargue	2000	Dominique Hantz
John Thome	2003			Mark Paquette
Satish Oza	2003	<i>Corresponding Members:</i>		Jon Hartfield
Ben Dingel	2002	Satheesh Kulankara	2003	Olivier Pelletier
Petur Thors	2001	Nabil Hanna	2003	Oliver Woolflik
Zahid Ayub	2001	Ming Chyu	2000	Samuel Yana
Josua Meyer	2001	James Larson	2001	Ty Newell
James Bryan	2000	Parviz Payvar	2002	Ben Newell
John Judge	2000	Ralph Briesch	2002	Andreas Knoepfler
Louay Chamra	2000	Keith Starner	1999	
<i>Corresponding Members:</i>		Michael Ohadi	2001	
Ken Schultz	2003	Steve Eckels	2003	
Axel Kreigsmann	2000			
Joe Huber	2003			
Kash Oza	1999			
Russell Smith	2003			
Mahesh Valiya-Naduvath	2003			
William McQuade	2002			
Jamal Yagoobi	2003			

DISTRIBUTION

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

TAC SECTION HEAD:	Eckhard Groll
TAC CHAIR:	Mark Hegberg
ASHRAE MANAGER OF RESEARCH AND TECHNICAL SERVICES:	Michael R. Vaughn, P.E.
ALL COMMITTEE LIAISONS AS SHOWN ON TC/TG/TRG ROSTERS:	Ron Davis—Handbook Liason Brian Dougherty—Standards Liason Arthur Garbarino—Program Liason William Klock—TEGA Liason Thomas Kuehn—RAC Research Liason Marilyn Listvan—Special Publications Liason Julian R. Debullert—ALI Liason

ADDITIONAL DISTRIBUTION

MANAGER OF STANDARDS	Claire Ramspeck
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**AMERICAN SOCIETY OF HEATING, REFRIGERATION,
AND AIR-CONDITIONING ENGINEERS, INC.**

Minutes

Technical Committee 8.5

Liquid-to-Refrigerant Heat Exchangers

January 26, 2004

2004 ASHRAE Winter Meeting, Anaheim, CA, January 24 – 28, 2004

1. Call to Order and Reading of TC8.5 Scope

Chairman Jim Bogart called the meeting to order at 4:18 PM. The scope of TC8.5 was read. The scope of TC 8.5 is: "TC8.5 is concerned with the thermal and mechanical design, performance, and application of devices for accomplishing heat transfer between refrigerants (including secondary refrigerants) and liquids. Such devices include liquid cooled refrigerant condensers and refrigerant evaporators for cooling liquids".

2. Introduction of Members and Guests (Sign attendance sheet)

Members and guests introduced themselves. The following were present:

Ben Dingel	The Trane Company 3600 Pammel Creek Road La Crosse, WI 54601
Ken Schultz	The Trane Company 3600 Pammel Creek Road La Crosse, WI 54601
Jon Hartfield	The Trane Company 3600 Pammel Creek Road La Crosse, WI 54601
Zahid Ayub	Isotherm, Inc. 3305 Thorntree Ct. Arlington, Texas 76016
Kash Oza	Standard Refrigeration Co. 2050 N. Ruby St. Melrose Park, IL 60160
Louay Chamra	Mississippi St. University 210 Carpenter Eng. Bldg. Mississippi State, MS 39762
John Thome	Swiss Federal Institute of Technology Lausanne, Switzerland 1015
Petur Thors	Wolverine Tube Inc. 2100 Market St. NE Decatur, AL 35601
Satish Oza	Wieland Metals Inc. 1052 Harvard Lane Buffalo Grove, IL 60089

Axel Kriegsmann	Wieland-Werke AG Seldcheck 7 Ulm, Germany D89081
Jim Bogart	Flat Plate, Inc 2161 Pennsylvania Ave York, PA 17404
John Judge	York International P.O. Box 1592-191A York, PA 17405
James Bryan	University of Missouri-Columbia Dept. Mechanical and Aerospace Engineering Columbia, MO 65211
Joe Huber	Ketema LP 2300 W. Marshall Grand Prairie, TX 75051
Samuel Yana	Honeywell 20 Peabody St. Buffalo, NY 14210
Satheesh Kulankara	York International 631 S. Richland Ave.-191A York, PA 17403
Andreas Knoepfler	Wieland-Werke AG Graf-Arco Str. 36 Ulm, Germany D-89079
Jamal Yagoobi	Illinois Institute of Technology 10 W. 32 nd Street, E1 Bldg. Chicago, IL 60616
Yongfang Zhong	University of Illinois 1206 W. Green St. Urbana, IL 61801
Mark Paquette	Intertek 3933 US Route 11 Cortland, NY 13045
Rusty Smith	SWEP 3483 Satellite Blvd. Duluth, GA 30019
Dominique Hantz	CETIAT 25, Avenue des Arts Villerbaunne, FR 69100
Josua Meyer	University of Pretoria Pretoria, South Africa 0002

Olivier Pelletier SWEF International
Box 105
Landskrona, Sweden 26122

Oliver Woolflik Wieland-Werke AG
Graf-Arco Str. 36
Ulm, Germany D-89079

Mahesh Valiya Naduvath York International
631 S. Richland Ave.-191A
York, PA 17403

Ben Newell Newell Instruments
2004 S. Wright St.
Urbana, IL 61802

Ty Newell University of Illinois
1206 W. Green St.
Urbana, IL 61801

Bill McQuade York International
P.O. Box 1592-191A
York, PA 17405

3. **Establish Quorum Requirements**

Voting members present included: Jim Bogart, Ben Dingel, James Bryan, Louay Chamra, Satish Oza, Josua Meyer, John Thome, John Judge, Zahid Ayub, and Petur Thors. Ten of the eleven voting members were present, establishing the quorum.

4. **Review/Approve Previous Meeting Minutes**

Minutes from the Kansas City (Summer 2003) meeting were unanimously approved.

5. **Chairman's Comments**

Jim Bogart passed along the following comments and information from the Chairman's breakfast. Additional comments were covered under the appropriate agenda items.

- With the reorganization of the Technical Committees, some concern was expressed about maintaining the continuity of Handbook chapter review/updates. Extra attention/cooperation by TCs may be required.
- Technical Committees are encouraged to incorporate material from ASHRAE research projects into handbook chapters.
- In terms of handbook material and research results, member feedback has suggested that the publishing of example problems with specific application examples and recommendations in more of a "how-to" format is desirable.

6. **Section Head Comments**

Eckhart Groll will be assuming the position of Section 8 Head.

7. **Comments from Liasons (Handbook, Standards, Journal, Research, Program, TEGA, Technical Services, Refrigeration)**

Tom Kuehn, the Research liaison, offered the following comments:

- There is a greater focus on doing "filtering" at the front end of research projects, which suggests that greater attention on quality RTARs is likely to increase chances for progression through the research funding process.
- ASHRAE is trying to develop an electronic RTAR and WS management tool.

8. Handbook Subcommittee Report

Louay Chamra reported that updates to Chapter 37 (Liquid Coolers) in the 2004 Systems and Equipment handbook were approved prior to the deadline in July. The changes were circulated to the committee via email and were approved by electronic vote. Changes were approved by the vote of 7-for, 0-against, with 4 abstentions.

Chapter 35 (Condensers) was significantly revised without any involvement of TC8.5, primarily due to a lack of communication.

Unlike the direction suggested last year, the “official” version of the handbook will be the printed copy as opposed to an electronic copy. ASHRAE is suggesting that a CD (electronic version) will be distributed with handbooks.

Jim Bogart stressed the concept of making handbook chapters “living” documents rather than trying to review updates/changes at the last minute.

It was suggested that an attempt be made to incorporate the results of RP-984 (EFFECTS OF INUNDATION AND MISCIBLE OIL UPON THE CONDENSATION HEAT TRANSFER PERFORMANCE OF R-134A) into the Condensers handbook chapter. Joe Huber volunteered to contact Steve Eckels about this possibility. The goal would be to have comments to review by February 2005.

9. Program Subcommittee Report

The program subcommittee chair (Rusty Smith) shared the following comments related to Programs:

- Program submissions are an on-line electronic process.
- ASHRAE is adopting a policy of placing seminar presentations on the web starting with the Anaheim meeting.
- ASHRAE is considering offering seminar audio recordings online starting with the Nashville meeting.
- The number of symposiums has been declining in recent meetings. ASHRAE is encouraging technical committees to promote symposiums and/or convert seminars to symposiums.

No programs are planned for the Nashville meeting. April 2 is the deadline for submitting material for the Orlando meeting (Winter 2005), with final program material and reviewed papers to be completed by August 6. A suggestion was made to organize a seminar consisting of a summary of recently completed TC 8.5/1.3 research projects (potential presenters include J. Thome, S. Eckels, T. Newell, and J. Yagoobi). Sufficient material might exist for two seminars. A working title of “Recent ASHRAE Research in Thermal and Fluid Flow Characteristics of HVAC, Refrigeration and A/C Processes” was suggested. A motion was made by James Bryan to have TC8.5 attempt to organize two seminars for the Orlando meeting followed by one symposium at the Denver meeting (Summer 2005). The motion was seconded by Ben Dingel and approved unanimously. Joe Huber volunteered to chair the effort.

10. Membership Subcommittee Report

The current roster has 11 voting members, two of which are international members. Samuel Yanna Motta was accepted unanimously as a member of the committee.

Mark Spatz and Neel Gupte will be removed from the membership list due to non-participation.

Due to the impending retirement of Satish Oza, a new membership subcommittee chair is needed. Kash Oza volunteered and was subsequently appointed by Chairman Jim

Bogart to accept this position. The committee would like to thank Satish for his years of service.

11. Standards Subcommittee Report

James Bryan discussed Standards activities that focused on the development of a standard for a Method of Testing (MOT) that would accompany ARI Standard 400-2001 LIQUID TO LIQUID HEAT EXCHANGERS. The ARI standard is available for review at <http://www.ari.org/std/individual/400-2001.pdf>. The creation of a new MOT standard is part of a general ASHRAE/ARI philosophy that ASHRAE should be responsible for MOT's and ARI for performance standards.

Prior to the meeting James circulated a draft copy of a "Title, Purpose, and Scope" (TPS) form to the committee. A motion was made by John Judge to accept the Title, Purpose, and Scope form as circulated by James Bryan. The motion was seconded by John Thome and approved unanimously. A second motion was made to have James Bryan chair the effort to create the Method of Testing Standard that would support ARI Standard 400. The motion was made by James Bryan and seconded by John Thome. The motion was approved unanimously. Jim Bogart had received a request from ARI that the following individuals associated with ARI be involved with the standard creation activity: Alison Andrews, Jeff Pearson, and Al Valentino.

12. Journal/Insights/Webmaster Subcommittee Report

Joe Huber reported that because ASHRAE will be providing web space for TC websites, he will be redesigning the website to follow the standard "ASHRAE format". Joe also requested that updates to the publication list be submitted to him so that the reference list for TC sponsored research can be kept up to date.

13. Research Subcommittee Report

Ken Schultz led a discussion on a number of general items related to ASHREAE research.

- ASHRAE is working on a new process for determining what research to fund. The process has been approved by the RAC (Research Administration Committee), and now requires Tech Council approval. The Strategic Research Plan is a cornerstone of this process, which is set by a Research Advisory Panel. The Research Advisory Panel is set by Tech Council, not the RAC.
- With the new process, ideas are still submitted via RTAR, but the format will change slightly.
 - RTARs will have a new form and will have a 3 page limit
 - The focus will be on conciseness and quantifiable benefits to ASHRAE
 - It is recommended that new RTARs or RTARs not currently on a priority list should be massaged into the new format.
- Additionally, some changes will be made to the recommended Work Statement format.
 - Inclusion of 100 word executive summary
 - WS cover sheet will require four potential bidders versus three.
 - Work statements are expected to build and expand on an existing RTAR, and should include a literature survey, the identification of holes in the current body of knowledge, and a specific description of the benefit to ASHRAE.
- There is an effort to eliminate the situation of the approval of an RTAR and/or Work Statement followed by a subsequent killing of the project.
- Due to fund availability, there is an emphasis on competition for research funds to be sure only the best research projects move forward.
- Current active projects is approximately 70, down from ~100 a few years ago.

TC 8.5 currently has two active research projects and three RTARs (one with priority) which have been accepted by ASHRAE. The active projects are summarized below:

RP 1089 “Flooded Evaporation Heat Transfer Performance Investigation for Tube Bundles Including the Effects of Oil Using R-410A and R-507A”

Petur Thors reported that John Thome’s work is complete. A significant amount of material was presented at this year’s and previous year’s research review meetings. Testing and modeling activities focusing on refrigerant boiling on single tubes and tube bundles, plain and enhanced tubes, with and without the presence of oil were summarized in the final report. The report provides equations and correlations to model local behavior of two-phase flow pressure drop and heat transfer in tube bundles. The final report was submitted in September and was approved by the PMS. The committee as a whole subsequently approved the final report in December via email by a vote of 9-for, 0-against, and 2 abstentions.

The entire body of work covered by this project will be documented by potentially 7 technical papers. Three are currently in review and 2 papers have already been published.

RP 1205 “Water-side Fouling Inside Smooth and Augmented Copper Alloy Condenser Tubes in Cooling Tower Water Applications”

Kash Oza reported on this project, which has two main areas of focus: a water quality survey and experimental testing of 9 internal tube surfaces. After a significant number of debugging issues (data acquisition, software, system leaks) the experimental fouling test facility is operational and ready for testing. Some deviations from the original test plan were discussed. The water velocities planned for testing were originally 2, 5, and 8 ft/s. However, because of the pressure drop at higher velocities, the facility design requires that the testing be done with water velocities of 2, 5, and 7 ft/s. Also, since it is not possible to keep all variables of interest identical for each tube test section, the PMS has recommended that the saturation temperature and water velocity remain constant from test section to test section, while inlet water temperature and heat flux may be varied.

The other critical portion of this project was a national survey of water quality. After combining results of the current survey results with results from a previous fouling study (Webb and Li) there are 47 total water samples from which to estimate “low”, “high” and “average” fouling constituent levels. Originally, the PMS had recommended basing “high” and “low” concentrations of water contaminants using a $\pm 2\sigma$ approach. However, because most of the variation is somewhat one-sided in nature (contaminant concentration can vary widely, but cannot be less than zero), a -2σ value for the “low” is unattainable for some of the fouling constituents. Louay Chamra (Principal Investigator) has proposed using a $-1/2\sigma$ approach for the “low” fouling constituent case, but the PMS would like to solicit the opinion of a water quality expert prior to testing.

Louay has requested a six-month no-cost extension to continue the project. John Thome made a motion to grant this extension, and the motion was seconded by John Judge. The motion passed unanimously.

Research Plan

The status of the current TC 8.5 research plan and proposed research topics were discussed. Three projects currently have approved RTARs, two projects have completed work statements, and one project has a work statement that has been conditionally approved for bidding. The following is a prioritized list of research projects and the status of each project.

Priority 1: Experimental Evaluation of the Heat Transfer Impacts of Tube Pitch in a Highly Enhanced Surface Tube Bundle

Current Status: RTAR written and accepted by ASHRAE (RTAR# 2004-39) for priority status. Work Statement written and approved by TC8.5 via email in November (9-for, 0-against, 2 abstentions). The work statement was submitted to ASHRAE on December 10 and was conditionally approved (pending minor revisions).

Priority 2: Study of Single-Phase Flow-Induced Tube Vibration in Shell and Tube Heat Exchangers

Current Status: RTAR written and accepted by ASHRAE (RTAR# 2004-38). Work Statement written and approved by TC8.5 via email in November (9-for, 0-against, 2 abstentions). List of potential bidders is needed for WS submittal. Next deadline for submittal is May 15.

Priority 3: Performance and Cleanability of Brazed-Plate Type Condensers Operating Under Fouling Conditions

Current Status: RTAR written and accepted by ASHRAE (RTAR# 2004-40). Jim Bogart and Rusty Smith are working on drafting a Work Statement.

Priority 4: Electrostatic Removal of Contaminants from Refrigerant Flows

Current Status: RTAR written and circulated to committee members. Based on the new research approval process and RTAR guidelines, additional material will be required. August 1 is the next deadline for submission.

Priority 5: Study of Carbon Dioxide Condensation in a Chevron Angle Plate Geometry Exchanger

Current Status: RTAR written and circulated to committee members. Based on the new research approval process and RTAR guidelines, additional material will be required. August 1 is the next deadline for submission.

Priority 6: Heat transfer enhancement of in-tube evaporation and condensation through the use of liquid phase EHD pumping.

Current Status: Awaiting writing of RTAR

14. New Business

None

15. Schedule Next Meeting

The next meeting will be held on June 28 in Nashville, TN.

16. Adjourn

At 6:15 PM the meeting was adjourned by unanimous vote.

ASHRAE TC/TG/TRG ACTIVITIES SHEET

DATE: January 26, 2004

TC/TG/TRG NO.: TC 8.5 TC/TG/TRG TITLE: Liquid-to-Refrigerant Heat Exchangers

CHAIRMAN: Jim Bogart VICE CHAIRMAN: _____ SECRETARY: Ben Dingel

TC/TG/TRG MEETING SCHEDULE				
Location-Past 12 Months	Date	Location-Planned Next 12 Months	Date	
Kansas City	June 2003	Nashville	June 2004	
Anaheim	Jan 2004	Orlando	Feb 2005	
TC/TG/TRG SUBCOMMITTEES				
Function	Chairman			
Program	Rusty Smith			
Membership	Satish Oza			
Research	Ken Schultz			
Handbook	Louay Chamra			
Standards	James Bryan			
Journal/Web/Insights	Joe Huber			
RESEARCH PROJECTS-CURRENT				
Project Title	Contractor	Monitoring Comm. Chpt.	Report Made At Meeting	
RP 1089 Flooded Evaporation Heat Transfer Performance Investigation for Tube Bundles Including the Effects of Oil Using R-410A and R-507A.	Swiss Federal Institute of Technology	Petur Thors	Yes	
RP 1205 Waterside Fouling Inside Smooth and Augmented Copper-Alloy Condenser Tubes in Cooling Tower Water Applications.	Mississippi State University	Art Fovargue	Yes	
LONG RANGE RESEARCH PLAN				
Rank	Title	W/S Written	Apprv.	To R&T
1.	Experimental Evaluation of the Heat Transfer Impacts of Tube Pitch in a Highly Enhanced Surface Tube Bundle	Yes	Yes	Yes
2.	Study of Single Phase Flow-Induced Tube Vibration in Shell and Tube Heat Exchangers	Yes	Yes	No
3.	Performance and Cleanability of Brazed-Plate Tube Condensers Operating Under Fouling Conditions	No	No	No
4.	Electrostatic Removal of Contaminants from Refrigerant Flows	No	No	No
5.	Evaluation of Enhanced Surfaces for Ammonia/Carbon Dioxide Cascade Condensers	No	No	No
6.	Heat Transfer Enhancement of In-tube Evaporation and Condensation Through the Use of Liquid Phase EHD Pumping	No	No	No

(OVER PLEASE)

HANDBOOK RESPONSIBILITIES					
Year & Volume	Chapter	Title	No.	Deadline	Handbook Subcom Liaison
2008 Systems	Chapter 37:	Liquid Coolers		7/31/07	Ron Davis
2008 Systems	Chapter 35:	Condensers		7/31/07	Ron Davis
STANDARDS ACTIVITIES-List and Describe Subjects					
Standard 22: No current activity					
Standard 24: No current activity					
Standard ???: Create new standard for Method of Testing for Liquid to Liquid Heat Exchangers (to accompany ARI standard 400)					
TECHNICAL PAPERS from Sponsored Research-Title, when presented (past 3 yrs. present & planned)					
<u>RP-1089</u> Thermal Performance of Flooded Evaporators, Part 1: Review of Boiling Heat Transfer Studies Atlanta, 2001 Thermal Performance of Flooded Evaporators, Part 2: Review of Void Fraction, Two-Phase Pressure Drop, and Flow Pattern Studies Atlanta, 2001					
TC/TG Sponsored Symposia-Title, when presented (past 3 yrs. present & planned)					
Advances in Thermal and Fluid Flow Characteristics of HVAC, Refrigeration and A/C Processes Atlanta, 2001 Advances in Thermal and Fluid Flow Characteristics of HVAC, Refrigeration and A/C Processes Honolulu, 2002					
TC/TG Sponsored Seminars-Title when present (past 3 yrs. present & planned)					
Heat Transfer and Fluid Flow in Visualization of HVAC and Refrigeration Processes Atlanta, 2001					
TC/TG Sponsored Forums-Title, when presented (past 3 yrs. present & planned)					
JOURNAL PUBLICATIONS, when published (past 3 yrs. present & planned)					
<u>RP-984</u> An Investigation of Condensation Heat Transfer Performance of HFC-134a on Single Enhanced Tubes <i>International Journal of HVAC&R Research</i> Volume 9, Number 1/January 2003 <u>RP-1089</u> Three publications in review, reference details not available.					

Submitted By: Ben Dingel