## 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

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

### 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. Debullett—ALI Liason

### ADDITIONAL DISTRIBUTION

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

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 MISCLE 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. Samual 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**


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 ASHRAE 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:


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 $-2\sigma$ 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

<table>
<thead>
<tr>
<th>Location-Past 12 Months</th>
<th>Date</th>
<th>Location-Planned Next 12 Months</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kansas City</td>
<td>June 2003</td>
<td>Nashville</td>
<td>June 2004</td>
</tr>
<tr>
<td>Anaheim</td>
<td>Jan 2004</td>
<td>Orlando</td>
<td>Feb 2005</td>
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### TC/TG/TRG SUBCOMMITTEES

<table>
<thead>
<tr>
<th>Function</th>
<th>Chairman</th>
</tr>
</thead>
<tbody>
<tr>
<td>Program</td>
<td>Rusty Smith</td>
</tr>
<tr>
<td>Membership</td>
<td>Satish Oza</td>
</tr>
<tr>
<td>Research</td>
<td>Ken Schultz</td>
</tr>
<tr>
<td>Handbook</td>
<td>Louay Chamra</td>
</tr>
<tr>
<td>Standards</td>
<td>James Bryan</td>
</tr>
<tr>
<td>Journal/Web/Insights</td>
<td>Joe Huber</td>
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### RESEARCH PROJECTS-CURRENT

<table>
<thead>
<tr>
<th>Project Title</th>
<th>Contractor</th>
<th>Monitoring Comm. Chpt.</th>
<th>Report Made At Meeting</th>
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<tbody>
<tr>
<td>RP 1089 Flooded Evaporation Heat Transfer Performance Investigation for Tube Bundles Including the Effects of Oil Using R-410A and R-507A.</td>
<td>Swiss Federal Institute of Technology</td>
<td>Petur Thors</td>
<td>Yes</td>
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<tr>
<td>RP 1205 Waterside Fouling Inside Smooth and Augmented Copper-Alloy Condenser Tubes in Cooling Tower Water Applications.</td>
<td>Mississippi State University</td>
<td>Art Fovargue</td>
<td>Yes</td>
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### LONG RANGE RESEARCH PLAN

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<th>Rank</th>
<th>Title</th>
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<th>Apprv.</th>
<th>To R&amp;T</th>
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<tbody>
<tr>
<td>1.</td>
<td>Experimental Evaluation of the Heat Transfer Impacts of Tube Pitch in a Highly Enhanced Surface Tube Bundle</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<td>2.</td>
<td>Study of Single Phase Flow-Induced Tube Vibration in Shell and Tube Heat Exchangers</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
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<td>3.</td>
<td>Performance and Cleanability of Brazed-Plate Tube Condensers Operating Under Fouling Conditions</td>
<td>No</td>
<td>No</td>
<td>No</td>
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<tr>
<td>4.</td>
<td>Electrostatic Removal of Contaminants from Refrigerant Flows</td>
<td>No</td>
<td>No</td>
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<tr>
<td>5.</td>
<td>Evaluation of Enhanced Surfaces for Ammonia/Carbon Dioxide Cascade Condensers</td>
<td>No</td>
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<td>6.</td>
<td>Heat Transfer Enhancement of In-tube Evaporation and Condensation Through the Use of Liquid Phase EHD Pumping</td>
<td>No</td>
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## HANDBOOK RESPONSIBILITIES

<table>
<thead>
<tr>
<th>Year &amp; Volume</th>
<th>Chapter</th>
<th>Title</th>
<th>No.</th>
<th>Deadline</th>
<th>Handbook Subcom Liaison</th>
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<tr>
<td>2008 Systems</td>
<td>Chapter 37:</td>
<td>Liquid Coolers</td>
<td>7/31/07</td>
<td>Ron Davis</td>
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<td>2008 Systems</td>
<td>Chapter 35:</td>
<td>Condensers</td>
<td>7/31/07</td>
<td>Ron Davis</td>
<td></td>
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### 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)

- **RP-1089**
    - 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)

- **RP-984**
  - An Investigation of Condensation Heat Transfer Performance of HFC-134a on Single Enhanced Tubes

- **RP-1089**
  - Three publications in review, reference details not available.

Submitted By: Ben Dingel