## 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.)

<table>
<thead>
<tr>
<th>TC/TG/MTG/TRG No.</th>
<th>DATE</th>
<th>TC/TG/MTG/TRG TITLE</th>
<th>DATE OF MEETING</th>
<th>LOCATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.1</td>
<td>22 Jan 2018</td>
<td>Fans</td>
<td>22 Jan 2018</td>
<td>Chicago, IL</td>
</tr>
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</table>

### MEMBERS PRESENT

<table>
<thead>
<tr>
<th>Member Name</th>
<th>Year Appointed</th>
<th>Member Present</th>
<th>Year Appointed</th>
<th>Ex-Officio Members and Additional Attendance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Franco Cincotti</td>
<td>7/01/16</td>
<td>John Cermak</td>
<td>7/01/14</td>
<td>Asesh Raychaudhuri</td>
</tr>
<tr>
<td>Armin Hauer</td>
<td>7/01/16</td>
<td>Chuck Coward</td>
<td>7/01/14</td>
<td>Rad Ganesh</td>
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<tr>
<td>Joseph Brooks</td>
<td>7/01/16</td>
<td>Jay Fizer</td>
<td>7/01/16</td>
<td>Walt Mecozi</td>
</tr>
<tr>
<td>Harold Dubensky</td>
<td>8/06/15</td>
<td>Tim Kuski</td>
<td>7/01/14</td>
<td>Tim Mathson</td>
</tr>
<tr>
<td>Brian Reynolds</td>
<td>7/01/16</td>
<td></td>
<td></td>
<td>Adam Sterne</td>
</tr>
<tr>
<td>Zhiping Wang</td>
<td>7/01/16</td>
<td></td>
<td></td>
<td>Rob Valbracht</td>
</tr>
<tr>
<td>Jay Eldridge</td>
<td>7/01/16</td>
<td></td>
<td></td>
<td>Larry Smith</td>
</tr>
<tr>
<td>Michael Feuser</td>
<td>7/01/16</td>
<td></td>
<td></td>
<td>Jeremy Smith</td>
</tr>
<tr>
<td>Eric Tingloff</td>
<td>7/01/14</td>
<td></td>
<td></td>
<td>Sanaee Iyama</td>
</tr>
</tbody>
</table>

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

- **TAC Section Head:** SH5@ashrae.net
- **All Committee Liaisons As Shown On TC/TG/MTG/TRG Rosters (Research, Standards, ALI, etc.):**
  - David John davidjohn.tarpon@gmail.com
  - Dr. Melikov, PhD akm@byg.dtu.dk
  - James Bochat jimbuchta@cxconcepts.com
  - James Arnold jarnold@live.com
  - Folorentino Roson Rodriguez f.rosen@supsercontrols.com.ar
  - Michael Bilderbeck mbilderbeck@pickeringfirm.com
Note: These draft minutes have not been approved and not the official, approved record until approved by the TC.

Additional Attendance (continued)

Kevin Gildea
Kevin Gebke
Louis Starr
Kristin Sullivan
Jay Baggett
Jamie Yeh
Larry Hopkins
Mark Vanderkooy
Ken Kuntz
Mike Ivanovich
Mark Bublitz
David Carroll
Zash Minear
Paul Lin
Chandra Gollapudi
Rich Stauter
Jennifer Kane
Ned Bent
Greg Wagner
Trent Marshall
Madan Baral
Z. Patrick Chinoda
Mark Fly
Lee Buddrus
Peter Bushnell
Mark DeRoo
Dustin Meredith
Ken Takahashi
Nathan Fetting
Kim Osborn
Ross Mielke
Brent Fullerton
Craig Wray
Minutes

1. **Call to Order**

   The meeting was called to order by the chair at 4:22 pm.

2. **Roll Call**

   The following TC 5.1 voting members were present:
   - Franco Cincotti –Chair
   - Armin Hauer – Vice Chair
   - Joseph Brooks - Secretary
   - Harold Dubensky - Webmaster
   - Brian Reynolds – Research S/C Chair
   - Zhiping Wang – Handbook S/C Chair
   - Jay Eldridge
   - Michael Feuser
   - Eric Tingloff

   The following voting members were unable to attend:
   - John Cermak
   - Chuck Coward
   - Jay Fizer
   - Tim Kuski

   Non-Voting S/C Chair:
   - John Murphy (absent) – Standard S/C Chair
   - Walter Mecozzi (present) – Program S/C chair

   A quorum was present.

3. **Adoption of Agenda**

   The committee approved the agenda by consensus with Lee’s presentation moved to the beginning of the business section.

4. **Approval of the Minutes**

   The last meeting of this committee was held on 26 June 2017 in Long Beach, CA.

   **Motion TC 5.1 - 01-2018**
   Moved by: Michael Feuser
   Seconded: Armin Hauer

   “Move to approve the minutes from the 26 June meeting of TC 5.1 as distributed.”
Passed unanimously

5. **New Business**

5.1 **An Alternate Efficiency Metric**
A presentation promoting the use of an alternate fan efficiency metric for ASHRAE 90.1 was made. The presentation slides are attached. An AMCA member requested time for a rebuttal at the next meeting.

6. **Items of business**

6.1 **ASHRAE Code of Ethics**
In this and all other ASHRAE meetings, the ASHRAE Code of Conduct requires us to act with honesty, fairness, courtesy, competence, integrity and respect for others, and that we avoid all real or perceived conflicts of interests. (See full Code of Ethics: [https://www.ashrae.org/about-ashrae/ashrae-code-of-ethics](https://www.ashrae.org/about-ashrae/ashrae-code-of-ethics).)

6.2 **TC 5.0 Section Head/Liaison Reports**
The new section head, Larry Smith introduced himself. His report included:

- Student Activities committee met on Saturday with 400 young men and women discussing their exciting activities.
- TAC and CEC have a good working relationship. Please copy the section leader on all program submittals.
- Asked all to think about the question, why are you here? If anyone wants a letter of appreciation, please inform the section head (e-mail: SH5@ashrae.net)

6.3 **Chairman's report**
The chair reported the following information from the section meeting:

- The Committee Scope of TC 5.1 is: TC 5.1 is concerned with the selection, application and testing-for-rating of fans, including recommended installation practices and field test procedures. Members of the TC should consider at next meeting if the scope should be revised or expanded.

- Program proposal deadline for next meeting is 9 Feb 2018

- 2019 – 2020 is ASHRAE's 125th anniversary. ASHRAE is asking for papers on technologies and topics that occurred between 1920 – 2000; the topic can be specific or broad, and should document the history.

6.4 Old business
No other old business was brought to the floor.

7. Subcommittee reports

7.1 Standards subcommittee – John Murphy

7.1.1 ASHRAE 149-2013: Laboratory Methods of Testing Fans Used to Exhaust Smoke in Smoke Management Systems
This standard was withdrawn and will not be reported upon again.

7.1.2 ASHRAE 51/AMCA 210
It was reported that, in reply to an interpretation request for AMCA 210-16, it was clarified that the testing of fan arrays was not strictly in the scope of AMCA 210 and that other standards would be better suited for aerodynamic test of fan arrays.

7.2 Handbook subcommittee
Zhiping reported on the activities of this subcommittee. Handbook liaison will be asked when revisions are due. S/C will be looking at outside reviewer comments. S/C is also reviewing Table 1 revisions and a reader’s comment that pointed out an error. A small group of S/C members will be looking at efficiency metric sections. The S/C will be looking at adding a section on fan airflow measurement.

The subcommittee chairs report is attached.

7.3 Research subcommittee
The research subcommittee reported on the activities of the research subcommittee. His report is attached.

7.4 Program subcommittee
The program subcommittee chair reviewed the program track for the Houston meeting. Program topics from the committee were suggested. The subject of fan efficiency metrics, it was thought it would be a good panel discussion for Houston program.

7.5 Efficiency metric subcommittee – Tim Mathson

The chair reported that the subcommittee has met three times since the Long Beach meeting. Recommendations from the subcommittee to the main committee were discussed: that the fan power limits remain in SSPC 90.1, and that FEG be deleted or replaced. Other motions, to table the recommendation to TC 5.1 to substitute anything for FEG at this time, and another to take the motion for more data off the table were reported upon.

The committee was asked for suggestions on how this subcommittee can move ahead more efficiently. It was noted that the SSPC 90.1 Mechanical Subcommittee (MSC) chair provided some clear direction, and that the MSC will modify to improve the fan power limit. Also, it appeared that consultants would like to see a fan efficiency proposal in parallel with the fan power limit work.
Motion TC 5.1 - 02-2018  Moved by: Armin Hauer  Seconded: Michael Feuser

“Move that the TC recommends that the ASHRAE 90.1 section 6.5.3.1.3 ‘Fan Efficiency’ be deleted or replaced with a new fan efficiency metric.”

Passed 6 Yes, 2 – No, 0 – Abstentions  (chair did not vote)

During the discussion, the question was raised on the content of Section 6.5.3.1.3 of Standard 90.1. It was provided:

8. Website Report

The TC 5.1 webmaster reported the analytics for the TC website. They are attached.

9. Time and Place of Next Meeting

The next meeting will be held in conjunction with the Houston Annual meeting on 25 June 2018

10. Adjournment

The meeting adjourned at 6:35 pm CST.

Attachments:  1) An alternate metric presentation  2) Handbook subcommittee report  3) Research subcommittee report  4) TC 5.1 Website analytics
90.1 Fan Efficiency Standards

Where do we go now?

Lee Buddrus
President
Acme Engineering & Manufacturing

Background

- Past President of AMCA, Founder and Chairman of the AMCA Committee on Codes—Air Movement Code Action Review Committee AMCARC
- Rice U-Math and EE, Masters—Project Lead—NASA Space Shuttle

NOT REPRESENTING AMCA!!!!!

For the United States, Some Agree, Most Do Not
Asia/Europe
IECC April 2013 Dallas Meeting
Unanimous Vote, 2 minutes to decide
600+Proposals  90% Fail
Too Complex
Too Difficult to Enforce
Why FEG-IECC Voters Stated
1. Simple to Understand, 1 Number,
   And is Best Efficiency
2. Easy to Enforce, Equipment Label
   Equipment can be checked

FEI
Not Simple-208-32 pages and climbing
Enforcement Issue—Two Points
Manufacturer and Design Point

Equipment & Selection Standard
• FEG as Originally Proposed = Equipment Standard
• DOE First Notice Standard =
  Equipment Standard Only
• FEI = Equipment Standard +
  Selection Standard

Please not an Energy Equipment Classification Standard
similar to the rest of the 90.1 equipment tables
15% Selection for FEG
Both Equipment & Selection

Added-- IGCC Code Meeting
15% criticized

Selection

FEI

Equipment Classification

FEG only

FEG +15%

Not Opposed to Selection Metric

90.1 Already Incorporates

• Fan Power Limitations
• Allows Flexibility for Designer
• Easy to Understand
• Easily checked/enforced
FEI Limitations

- Customer supplies A Single Operating Point
- Our World is now ECM/VFD-infinite operating points, with variation in operation time
- Which Point?
- Enforcement

Are We All In? Partially In? Design Point What We Want!
Good for Goose
Good for Gander
90.1 1200 Pages

Tables are as follows:

a. Table 6.1.1-1, “Electrically Operated Unitary Air Conditioners and Condensing Units—Minimum Efficiency Requirements”

b. Table 6.1.1-2, “Electrically Operated and Applied Heat Pumps—Minimum Efficiency Requirements”

c. Table 6.1.1-3, “Chiller Packages—Efficiency Requirements” (See Section 6.4.1.2 for water-cooled centrifugal water-chilling packages that are designed to operate at design conditions.)

d. Table 6.1.1-4, “Electrically Operated Package Terminal Air Conditioners, Package Terminal Heat Pumps, Single Package Vertical Air Conditioners, Single Package Vertical Heat Pumps, Room Air Conditioners, and Room Air Conditioner Heat Pumps—Minimum Efficiency Requirements”

e. Table 6.1.1-5, “Warm-Air Furnaces and Combination Warm-Air Furnaces/Air-Conditioning Units, Warm-Air Duct Furnaces, and Unit Heaters—Minimum Efficiency Requirements”

f. Table 6.1.1-6, “Gas- and Oil-Fired Boilers—Minimum Efficiency Requirements”

g. Table 6.1.1-7, “Performance Requirements for Heat-Rejection Equipment”

h. Table 6.1.1-8, “Heat Transfer Equipment”

i. Table 6.1.1-9, “Electrically Operated Variable-Refrigerant-Flow Air Conditioners—Minimum Efficiency Requirements”


k. Table 6.1.1-11, “Air Conditioners and Condensing Units Serving Computer Rooms”

l. Table 6.1.1-12, “Commercial Refrigerators and Freezers—Minimum Efficiency Requirements”

m. Table 6.1.1-13, “Commercial Refrigeration—Minimum Efficiency Requirements”

n. Table 6.1.1-14, “Vapor-Compression-Based Indoor Pool Dehumidifiers—Minimum Efficiency Requirements”


All furnaces with input ratings of 320,000 Btu/h, including electric furnaces, that are not located within the conditioned space shall have jacket losses not exceeding 0.75% of the input rating. Air conditioners primarily serving computer rooms and covered by ASHRAE Standard 124 shall meet the requirements in Table 6.1.1-11. All other air conditioners shall meet the requirements in Table 6.1.1-16.

Additional Issues

• Technical Issue- Total Efficiency on Some Fans, Static Efficiency on Other Fans

• Europe-Compares TE Applications to TE Applications and SE Applications to SE

• Asia- Uses Total Efficiency.

• USA- Defies Physics & Thermodynamics

• For Selection you should use Static or Total

• But to compare equipment on energy use—Total Only--- TE = PE + KE
Additional Issues

- If you could enforce the Design Point(s) Selection(s) as well as the Manufacturer’s Efficiency Catalog
- Are the Design Point(s) the Actual Operating Point(s) and if not, are you still saving energy.
- Numerous DOE and ASHRAE Studies’
- Last but not Least- If you don’t supply a design point, must be under a Max RPM, but can still be outside the FEI bubble not saving any energy. Rehab Market is growing.
- Distributor Market

WHY FEI

- Manufacturer Support- Change computer program.
- Motivation to improve Fan Energy Efficiency is Minimal
- DOE First NOPR– (FEI originally called PBER)
  - “DOE understands that neither of the two PBER approaches are likely to require redesign of a fan model that does not meet the PBER. Instead, the operating range of the fan model would be restricted to meet the PBER requirements.”
- Customers make modifications and incur brunt of energy improvement cost, if there is any energy saved
- DOE?????
FEG in 90.1 Today

- "6.5.3.1.3 Fan Efficiency. Fans shall have a fan efficiency grade (FEG) of 67 or higher based on manufacturers’ certified data, as defined by AMCA 205. The total efficiency of the fan at the design point of operation shall be within 15 percentage points of the maximum total efficiency of the fan.
  - Exceptions:
    - 1. Single fans with a motor nameplate horsepower of 5 hp or less
    - 2. Multiple fans in series or parallel (e.g., fan arrays) that have a combined motor nameplate horsepower of 5 hp or less and are operated as the functional equivalent of a single fan
    - 3. Fans that are part of equipment listed under Section 6.4.1.1
    - 4. Fans included in equipment bearing a third party-certified seal for air or energy performance of the equipment package
    - 5. Powered wall/roof ventilators (PRV)
    - 6. Fans outside the scope of AMCA 205
    - 7. Fans that are intended to only operate during emergency conditions”

A Better FEG

- Eliminate 15% Requirement
- Eliminate Following Exception

Powered wall/roof ventilators (PRV)
Similar to all 90.1 Tables add FEG minimum efficiency by type of fan

<table>
<thead>
<tr>
<th>Wheel Type</th>
<th>Equipment Category</th>
<th>Min Eff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Axial</td>
<td>Vaneaxial-Inline-(Includes Jet Fans with Vane)</td>
<td>60</td>
</tr>
<tr>
<td>Axial</td>
<td>Tubaxial-Inline-(Includes Jet Fans without Vanes)</td>
<td>53</td>
</tr>
<tr>
<td>Axial</td>
<td>Panel Propeller Fans</td>
<td>50</td>
</tr>
<tr>
<td>Axial</td>
<td>Power Roof/Wall Ventilators</td>
<td>45</td>
</tr>
<tr>
<td>Centrifugal</td>
<td>Housed Backwardly Inclined-Single Thickness and Airfoil</td>
<td>67</td>
</tr>
<tr>
<td>Centrifugal</td>
<td>Housed Forward Curved</td>
<td>60</td>
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<td>Centrifugal</td>
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<tr>
<td>Centrifugal</td>
<td>Power Roof/Wall Ventilators</td>
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<tr>
<td>Mixed Flow</td>
<td>InLine</td>
<td>48</td>
</tr>
<tr>
<td>Circulators</td>
<td>Circulating Fans: Ceiling Fans, Box Fans, Table Fans, Personal Coolers</td>
<td>*</td>
</tr>
<tr>
<td>Specialty</td>
<td>Air Curtains</td>
<td>*</td>
</tr>
<tr>
<td>Specialty</td>
<td>Ceiling Exhaust Fans</td>
<td>*</td>
</tr>
<tr>
<td>Specialty</td>
<td>Crossflow Fans</td>
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<tr>
<td>Specialty</td>
<td>Laboratory Exhaust Fans-Induced or High Velocity Discharge</td>
<td>Exempt</td>
</tr>
</tbody>
</table>

* Equipment has a different metric, e.g. cfm/watt, etc.
Summary of Improvements to Current 90.1 Fan Energy Standard

1. Delete 15% Requirement
2. Eliminate an exemptions
3. Add Min Efficiency by Type of Fan
4. Fan Power Limitations to Insure Better Selections

Future Improvements

FMEG similar to Europe
AMCA was almost complete
FMEG Will require additional study and investigation
Could propose 3pt BEP avg

Slightly more complicated but still very simple, still one number metric, really not needed
Thank You
According to the ASHRAE publication schedule, our revised and TC approved Fan chapter for the 2020 ASHRAE Handbook volume will be due first half of 2019. I will contact our handbook liaison after this meeting to find out the exact due date for our chapter and plan our schedule accordingly.

Two outside reviewers’ comments about our chapter were briefly reviewed in our last two subcomm. meetings. We will address those comments when we actually revise/rewrite the contents.

One user identified a “copy and paste” error in Table 1 for the propeller fan performance curve, and more importantly, the current nomenclature (Wo) and definition for fan power curve in the performance graph is wrong and will be fixed in this revision cycle.

During our last meeting, we agreed to revise the Selection section. A small group of members (Craig Wray, Greg Wagner, Tim Mathson, and Kim Osborn) volunteered to review and revise the section. Once they work out a draft version, I will schedule a separate meeting to review the content.

Tim Mathson and a few AMCA members put together a new Table 1 (new format and content) and it was forwarded to the members before this meeting. Send your comments/suggestion to me after you review it. We will schedule a separate meeting to review/discuss it as a group.

Armin Hauer will draft a new section about “Instrumented Inlet Cone” based on the already published AMCA-600.

As always, we are open for ideas, suggestions, and Handbook Online stuff.
List of Potential Topics for 2020 Version of the Fan Chapter

- **Fan Efficiency** – New section to define and discuss total efficiency vs. static efficiency
  - Examples of proper fan selection to save energy
  - Fan Selection (Total pressure based vs. Static pressure based)
  Actions: Wait after DOE publishes the new regulation on fans?

- **Fan Drive System** – Direct Drive vs. Belt Drive, VFD, VSD, etc.
  Actions: 05/23/14 – Greg S., Chuck, and Zhiping will draft up the content. Craig suggested Chpt.18 (9th ed.) of Fan Engineering covers information about motors and drives. AMCA 203 also has good information. AMCA 207 maybe, too.

- **Fan Part Load?**
  Actions: 05/23/14 – Good topic but Committee decided to put it on the parking lots for now. Maybe for next revision cycle after we collect enough information.

- **Fan Stall (Greg Sanchez wrote some content during our last revision cycle and will investigate further)?**
  Actions: 05/23/14 - Greg will send out information before the Seattle meeting for the committee members to review.
  06/29/14 - Greg Sanchez will have the information ready by mid. July.
  01/25/15 – No content yet. Will push back for next revision cycle.

- **Fan Noise (Greg S., predicting fan noise – AMCA 301, or aerodynamic noise?)**

- **Fan Law Applications and System Curves** – Craig Wray already sent the revised content last year. Need to review the content.

- **Handbook Online** - Some ideas came out from our last HB meeting.
  - 3D models of different types of fans and interactive performance curves within Table 1;
  - Interactive curves to demonstrate the fan laws;
  - Interactive contents to show the stall/surge;
TC 5.1 (Fans) Research Sub-Committee Report
January 22, 2018 (Chicago)

WS & RTAR’s in progress

1. Notes from Research Subcommittee Chairs Breakfast meeting
   - Added a March 15 deadline for RTAR and WS submissions
   - Now it is M-M-A-D
   - PMS training will be held in Spring 2018
   - Only 2 RTARS’s were considered at the RAC meeting (both accepted)
   - Only 2 Work Statements were considered, both returned
   - Voted to release all 15 outstanding TRP’s for bid
   - That includes WS 1769
   - Dennis Loveday is the new RL for Section 5

2. WS 1769 – ‘Experimental Evaluation of (the Part Load) Efficiency of V-Belt Drives used on Fans’ – (authors Tim Mathson and Craig Wray)
   - We should know by the summer meeting what bids are received.
   - PES – Craig Wray, Tim Mathson, Brian Reynolds
   - PMS – typically same as PES members
   - RL suggests to add 1 or 2 more PES/PMS members

3. RTAR 1829 - Inlet and Discharge Installation Effects on Multiple Plenum Fans in a Parallel Arrangement (authors Dustin Meredith & Patrick Chinoda)
   - RTAR approved
   - Distributed the RTAR to the TC members and corresponding members prior to Chicago
   - At the Research Subcommittee meeting, Kim Osborn, Patrick Chinoda, and Larry Hopkins agreed to be WS authors.
   - Goal is to draft a WS for TC letter ballot prior to Houston, including RL review.
4. Entrained Flow Stacks RTAR (TC 9.10) – looking for TC 5.1 volunteers for PES, PMS. Brent Fullerton, others?

*Is any Fan Research needed to support the Handbook or the Fan Efficiency Committee?* Committee could not think of anything.

Proposed new RTAR

<table>
<thead>
<tr>
<th>Topic</th>
<th>Contact</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>EC fan &amp; motor vs. traditional fan with induction motor &amp; inverter (Air &amp; sound)</td>
<td>Rad Ganesh &amp; Tim Mathson</td>
<td>Confirm plans &amp; timing prior to Houston meeting</td>
</tr>
</tbody>
</table>

Reviewed & scrubbed old list of possible fan research topics including from the MTG.

1. Fan load profile data. Energy Plus could be a resource for data, could be a student led project. Check with Craig Wray for suggestions on direction & potential for an RTAR.
2. Peter Bushnell suggestion – need specific speed chart examples for fan selection guidance. Sounds like handbook rather than research.

Other Fan research ideas? Send ideas to TC 5.1 Research Chair (Brian Reynolds)
### Audience Overview

**Sessions**

- **July 2017**: 25
- **August 2017**: 25
- **September 2017**: 50
- **October 2017**: 45
- **November 2017**: 50
- **December 2017**: 50
- **January 2018**: 75

**Users**

131

**Pageviews**

325

**Pages / Session**

2.24

**Avg. Session Duration**

00:01:36

**Bounce Rate**

60.00%

**% New Sessions**

82.76%

### Country Sessions

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<thead>
<tr>
<th>Country</th>
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