AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS, INC.
1791 Tullie Circle, N.E./Atlanta, GA 30329
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. TC 5.1 DATE 23 Jul 2015

TC/TG/MTG/TRG TITLE Fans
DATE OF MEETING 29 Jul 2015 LOCATION Atlanta

MEMBERS PRESENT	YEAR APPTD	MEMBERS PRESENT	YEAR APPTD	MEMBERS ABSENT
Patrick Chinoda	2014	Greg Wagner	2012	John Murphy (2012)
Franco Cincotti	2014	Craig Wray	2014	John Cermak (2014)
Asesh Raychaudhuri	2012			Rad Ganesh (2011)
Mike Brendel	2012			Tim Kuski (2014)
Chuck Coward	2014			David Rasmussen (2012)
Harold Dubensky	2014			
Eric Tngloff	2014			

DISTRIBUTION

All Members of TC/TG/MTG/TRG plus the following:	
TAC Section Head:	Ken Peet
TAC Chair:	
All Committee Liaisons As Shown On TC/TG/MTG/TRG Rosters:	Annette Dwyer (HB systems & Equip) James Arnold, PE (CTTC) David John, PE (Research) Arsen K Melikov, PhD (Standards)
Manager Of Standards Manager Of Research & Technical Services	Stephanie Reiniche Mike Vaughn

EX-OFFICIO MEMBERS AND ADDITIONAL ATTENDANCE

Additional Attendance

Joseph Brooks -- Secretary
Brent Fullerton – Webmaster
Brian Reynolds – Research S/C chair
Zhiping Wang – Handbook S/C Chair
David Carroll
Jay Eldridge
Jay Fizer
Armin Hauer
Sanaee Iyama
Steve Idem
Patrick Keal
Rob Laneve
Zack Minear
Dustin Meredith
Kim Osborn
Robert Smith
Wade Smith
Detlef Westphalen
Lauren Zelinski

ASHRAE TC 5.1 Meeting
Monday, 29 Jun 2015

Atlanta Hilton, Atlanta, GA **Room: Pavilion 9**

Minutes

1. Call to Order – 4:15 pm

The Chair, Patrick Chinoda, will call the meeting to order at approx. 4:15 pm.

2. Roll Call

Current voting members present:

Patrick Chinoda – Chair
Joe Brooks – Secretary (non-voting)
Franco Cincotti – Vice Chair
Asesh Raychaudhuri – Program S/C Chair
Mike Brendel
Chuck Coward
Harold Dubensky
Eric Tingloff
Greg Wagner
Craig Wray

The following voting members of the committee were not present:

John Murphy – Standard S/C Chair
John Cermak
Rad Ganesh
Tim Kuski
David Rasmussen

A quorum was present.

3. Adoption of Agenda

The agenda was adopted by consensus.

4. Approval of the Minutes

Motion TC5.1-04-2015 Moved by: Craig Wray
Seconded: Greg Wagner

"Move to approve the minutes of the last meeting of this TC held on 26 January 2015 in Chicago, IL."

Passed unanimously

5. Items of business

5.1 ASHRAE Code of Ethics

The code of ethics can be found on this link:

http://www.ashrae.org/codeofethics

These were reviewed by the committee

5.2 TC 5.0 Section Head/Liaison Reports

Ken Peet, the Section Head for section 5, discussed section issues later in the meeting. The main issue was the proposed name and scope change for TC 5.2. It was noted that the scope change only reflected what that committee is already engaged. Several committee members supported the change, no opposition was voiced in TC 5.1.

5.3 Chairman's report

Highlights of the chairs report were:

- Persons wanting to join the TC can now take steps to do so via on-line.
- ASHRAE continues to look for qualified reviewers,
- It was requested that member biographies be updated,
- Discussed ways to increase membership in this TC, ideas were:
  - It's now easier to join a TC: ashrae.org/joinatc
  - Work at the local level (liaison with CTT)
  - Work with YEA
  - Assign mentor to new people when the show up at a meeting.

5.4 Old business

There was no old business.

6. Subcommittee reports

6.1 Standards subcommittee – John Murphy

The following standards are under the auspices of this TC:

ASHRAE Standard 87.3-2001 (RA 2010)
ASHRAE Standard 149
ASHRAE 68/AMCA 330
ASHRAE 51/AMCA 210

No report was given.

6.2 Handbook subcommittee – Zhiping Wang

The Handbook Subcommittee report is attached. Highlights of the report are:

- The 2016 revision was approved by the committee and submitted last month, the next step is to proof the Galley Proofs. Mike Brendel, Armin Hauer, and Zhiping Wang volunteered to proof the galleys,
- Should reach out to outside reviewers for the 2020 revision,
- Out of Cycle revisions can be made to the on-line version of the handbook,
- Handbook comments can be submitted on-line,

- The ASHRAE Handbook on-line has 12,000 subscribers, can be updated frequently, and can use interactive spreadsheets, etc.
- Would like to schedule a one hour Subcommittee meeting in Orlando to discuss plans for the next cycle.

6.3 Research subcommittee –

Brian Reynolds, Research Subcommittee chair, reported on the subcommittee activity and status of research within the TC. His report is attached. Highlights of his report were:

- A technical paper is still due from the Principle Investigator for RP 1420 (need to talk with Mark Stevens), and
- The RTAR for V-belt research was rejected by RAC due to them thinking that V-belt were a mature technology and their efficiency should already be addressed. The committee was advised on how to proceed to obtain approval.

He also commented on the current status of research within ASHRAE:

- There are currently 61 active research projects,
- Eleven research projects were completed last year,
- Eleven research projects were approved last year,
- Thirteen research projects are currently out for bid.

6.4. Program subcommittee –

Asesh Raychaudhuri, the Program Committee Chair reported on the programs lined up for future meetings. There were no programs sponsored by TC 5.1 at this meeting. Asesh noted that at the last meeting (in Chicago) TC 5.1 sponsored a Seminar on 1420/1216 research projects. He also noted that if the technical paper for RP 1420 a conference paper, he might be able to get it in the program for Orlando. Other suggestion included:

- A seminar on a wire–to-air metric for Fan System performance,
- A form on fans operating in parallel,
- A seminar on fan laws, fan selection, and system interfaces (by Tim Mathson and Steve Idem),
- An update on the fan regulation
- The final rule on circulator fans that was issued earlier this year by the DOE.

7. Website Report

No report given.

8. New Business

The committee recognized Brian Reynolds for the work he has done within ASHRAE which resulted in his ASHRAE Distinguished Service Award.

The committee also would like the following schedule for Orlando on Sunday:

2:00 – 3:00 pm Handbook Subcommittee

3:00 – 4:00 pm	Research Subcommittee
4:00 – 4:30 pm	Program Subcommittee
4:30 – 5:30 pm	Hot Topic

9. US DOE Fan Regulation Status and Update

Status of negotiations with the US Department of Energy (US DOE) to regulate fans was reported.

11. Time and Place of Next Meeting

The next meeting will be the winter meeting in Orlando FL. This meeting will be held on Monday afternoon at 4:15 pm EST.

12. Adjournment

The meeting was adjourn at 6:30 pm.

Attachments:
1) Handbook Subcommittee Report
2) Research Subcommittee Report
3) US DOE Fan Regulation Update Presentation

TC 5.1 Handbook Subcommittee Meeting Notes (06/28/2015)

Zhiping Wang

- The 2016 version of the fan chapter was approved and submitted to the ASHRAE handbook staff in May, 2015. I would like to thank every member and contributor for their time and efforts to get this done on time.
- Next step will be the galley proof in this Fall (around September). Armin Hauer, Mike Brendel, and myself will do the galley review.
- ASHRAE is working on a collaboration tool (or a share point) to help the TCs to share and track the handbook progress. Once complete, staff will conduct training. After the training, we will discuss how to utilize that tool in our next cycle.
- For the 2020 cycle, ASHRAE encourages:
  (1) TC reaches out to get the outside reviewer(s) for the chapter (Craig W mentioned one potential reviewer);
  (2) Do the out-of-cycle revision for the handbook online (about 12,000 subscribers for the handbook online now according to the staff). The print version will still be updated every four years.
- We are looking for ideas of adding extra features to the handbook online. Some ideas came out during this meeting include: 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;
- ASHRAE Terminology – We will dedicate some time on this topic in the next cycle. See links below (https://www.ashrae.org/resources--publications/free-resources/ashrae-terminology).
- We are going to discuss and layout a plan in our next Orlando meeting for the 2020 revision.

TC 5.1 (Fans) Research Committee Meeting
June 29, 2015 (Atlanta)

Research Chairs Breakfast meeting (notes)

RP 1420 & RP 1216 – Seminar was in Chicago. Is a conference paper required per the contact? Confirm with Mark Stevens if everything is completed (Joe).

- Research Liaison report states P.I. still needs to provide TP draft to earn final payment.
- Contract states that a TP is required.

RTAR's in progress

1. Experimental Evaluation of (the Part Load) Efficiency of V-Belt Drives used on Fans – (authors Tim Mathson and Craig Wray)
   - Reviewed by liaison (David John)
   - One negative vote (with comments). Scope too broad. Seek co-funding.
   - Submitted to staff for RAC review in Atlanta
   - RAC negative vote. '100 year old technology must already be addressed.'
   - Suggestion to have Research Chair & RTAR authors attend next RAC meeting. Explain why research is needed and what information does not currently exist.
   - Add to Summary section or background -- V-belt drives have been in use for 100 years but the data to predict efficiency, especially at part load…
   - There is a paper on this subject that Craig can share
   - Belgian group is also working on the subject (Mike Brendel contact). There are two papers.
   - Needed by AMCA 207 (especially part load)
   - Look at RP 1471
   - Recent Browning webinar
2. Series & Parallel fans system effects (Patrick)
   - TC 2.6 is interested in helping RTAR draft (Kim Osborn) for parallel only.
   - TC 5.1 (Steve Idem) suggestion – RTAR is too large. Need to narrow scope. What problem are we trying to solve? Not about fan arrays.
   - Not sure if RTAR should include CFD.
   - Example - Multiple identical fans ducted into a common plenum. Total airflow is not the sum of individual fans (even if at a stable operating point).
   - An industrial problem (not commercial or AC).
   - Both inlet and outlet.
   - Direction – Patrick & contributors from the other TC's to draft new RTAR, concentrate on parallel fans, narrow down to a fan type and configuration, experimental only.
   - *Confirm if TC 2.6 is really thinking about plenum fan arrays.*
3. Fan load profile data (Tim Kuski, Michael Ivanovich, Craig Wray).
   - Craig created 3 profiles

- Preso on part load profiles 6/29 (9:00 -10:00) at the TC 5.2 meeting.
- No immediate action to lead to RTAR, depends on fan regulation direction

New topic (Dustin Meredith)

1.Plenum fan spacing guidelines; especially parallel
   a. Effects on both air and sound performance
   b. Effects on both the inlet and the outlet
   c. Mismatched walls (not uniform)
   d. Push the limits, don't use conventional rules-of-thumb (e.g., 0.5D)
   e. Counter rotation vs. same direction
   f. Is this the same subject as Patricks RTAR with TC 2.6?
   g. Scope is very large, may need smaller
   h. RTAR authors – Patrick & Dustin

- Suggestion to split up into smaller parts.
- Hot topic at next TC 5.1 meeting (or a forum?)

List from the ASHRAE Multidisciplinary Task Group (MTG)

1.019-10 Develop Method of Test (MOT) for Large Circulating Fans – coordinate with TC 5.3 and AMCA.

2.020-10 Investigate Fan Stall - Greg Sanchez will review handbook. Make recommendation. Update HB or RTAR?

3.021-10 Fan Efficiency at Low Flow and Low Speed Operation - No action from 5.1

4.Suggestion to combine the next three MTG ideas:

- 023-00 Overall Fan System Efficiency with VFD
- 025-10 Motor and Variable Speed Drive (VSD) Efficiency
  - Wire to gas AMCA 207 committee to address the three MTG fan drive efficiency ideas. Start with currently available information to provide a tool. (shaft power, v-belt, motor, VFD) Mike Brendel
  - Coordinate with TC 1.11 (Armin Hauer)
  - AMCA committee may identify research to improve tool (i.e. belt efficiency)

5.026-10 Energy Impacts from Air Handler Casing Leakage – AHRI has a new standard (1350) for Mechanical Performance of Central Station Air Handler Unit Casings. It includes a MOT for casing leakage. And a certified ratings program.

6.018-10 Study of Air Curtains – TC 5.3 is the lead, possibly coordinate with 90.1 & 5.1, 4.3, & SPC ?

Information from previous research projects to include in the HB Chapter.

- RP 1216 & 1420

Possible Research Topics

(in search of RTAR authors)

2. Develop criteria for improving the design of flow settling means utilized in multi-nozzle chamber performance testing defined in AMCA standard 210/ASHRAE standard 51.
   - See what happens in the next revision of AMCA 210. Not ready for an RTAR.
   - Limited audience, manufacturer specific.
   - Maybe remove from list?
3. Round robin test program to establish the accuracy of AMCA 300 tests.
   - Might remove from list pending round robin conclusions from AMCA (almost complete).
   - Staff has almost completed analysis for presenting to AMCA Fan committee.
4. Fan outlet discharge effects would be the next logical step for future research projects?
   - RP 1420 (plenum) includes discharge effects.
5. Develop practical process to determine velocity pressure. Accurately determine the energy flux leaving the fan.
   - Project should measure outlet velocity profile. But that is difficult to measure.
   - Possible program to predict the outlet velocity profile of a fan. Obtain data for validation. Need an estimate for cost of the analysis. Could lead to a prediction tool.
   - Could improve how fans are designed or applied.
   - **John Murphy** will draft an RTAR (centrifugal). (Axial is predictable today)
6. Develop method for testing/rating/comparing air curtains (on MTG list)
   - Air curtain companies hired an expert CFD consultant to write a report. Then decide next step. It is a code issue. TC 5.3 (Room Air Distribution) is the sponsor.
   - Check back later in the year. Could be a good joint project.
   - WG 9 is developing a technical report on energy effectiveness of air curtains impact on other AC.
7. Develop method for testing/rating/comparing large circulating fans (on MTG list)
   - Mike Brendel paper describing issue.
   - The space these fans are applied in is significantly smaller than the space needed to test them.
   - Need to have a representative from a large circulating manufacturer report and author an RTAR.
   - Modifications are being made to AMCA 230 which may address the subject.
8. Fan stall research (on MTG list)
9. Fan efficiency effects and/or fan predictability effects at low-flow/low-speed operation?
   - MTG list
10. Fan efficiency related RTAR's on MTG idea list.
    - Overall fan system efficiency when used with VFD.

- Belt drive efficiency
- Motor & inverter efficiency, predict bhp from kW
- AMCA 207 will drive the need

Other ideas for research

1. Effect of impeller tip clearance on performance (added in NYC)
2. Improved fan noise predictions (added in NYC). AMCA 301? Needs better definition.
3. Fan Curve Fitting Development-Technique and curve models for axial and centrifugal fans. (Greg Sanchez)
    - This research will evaluate a selective number and sizes of fans using data collected from manufacturers to develop the fan performance curve, which may include stalling. Then curve fit the performance curve and develop a model (equation) that would represent this measured data. I find this information to be supplemental to the ideal graphical representation shown in Figure 1 of the handbook. We will of course need to disclose the detail information of the fan in regards to dimensions, layout, power, pressure, airflow.
4. Parallel/series jet fans (Greg Sanchez)

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

June 29, 2015
4:15 PM

UPDATE: DOE Fan Regulation

Wade Smith, AMCA International

- Director of Public Policy, AMCA International
- Staff support of AMCA's DOE Product Efficiency Task Force
- Member of the DOE Fan Efficiency Working Group (one of 25)

ASHRAE TC 5.1, Fans

Prior to DOE Public Negotiating Sessions #5

Agenda

- Background & Timing
- Review of FEI/FEP Metric in the DOE Notice of Data Availability
  - Compare to FEG
- Evaluating impact of FEI at different target efficiency levels
  - How many selections become non-compliant?
  - How will the engineer cure a non-compliance – cost change to customer, manufacturer, investment in design improvements
- Embedded Fans
  - In Air Handlers
  - In DOE Regulated Product (IEER revision planned)
    - Boundary conditions - Condenser Fan, Return Fan
    - Supply fan is the focus of debate
- Questions

Context:
Drive For Higher Efficiency

- Fans consume 15% of commercial/industrial electricity
- Fan efficiency varies from 5% to 95%, averages 57% at design pt.
- Fan Industry already make more efficient fans
- DOE regulation will save 2 to 4 quads ….. How?
  - By eliminating least efficient fans from the market (0.5)
  - By eliminating least efficient selections from the market (1.5)
- Proposed Rule will be published in 1H 2016, effective around 2020
- DOE regulation provides a foundation for utility rebates, codes, 90.1 requirements before 2020.

AMCA Consensus Advocacy

1. Scope of 1 – 200 bhp

2. Test Standard – AMCA 210

3. Fan Efficiency Index approach
   - Maximum power at any flow and pressure is determined by formula
   - Range of compliance (and non-compliance) for all fans established
   - Rep-Distributor-OEM must inform buyer of compliant range

4. "Wire-to-air" efficiency requirement, based on either
   - Test of assembly using particular motor, transmission, drive
   - Test of fan only, using default values for non-fan components

AMCA Consensus Advocacy

5. Two broad categories (sub-groups by fan utility)
   - Ducted Outlet - 62% target TOTAL efficiency, 15% non-compliance rate (in database of 2012 sales)
   - Not-ducted - 56% target STATIC efficiency, 21.6% non-compliance

6. Labeling
   - Max RPM, and Fan Efficiency Index at design point if known.
   - Selection programs, catalogs, order acceptance only in compliant range

7. Exemptions limited to small market niches – no loopholes

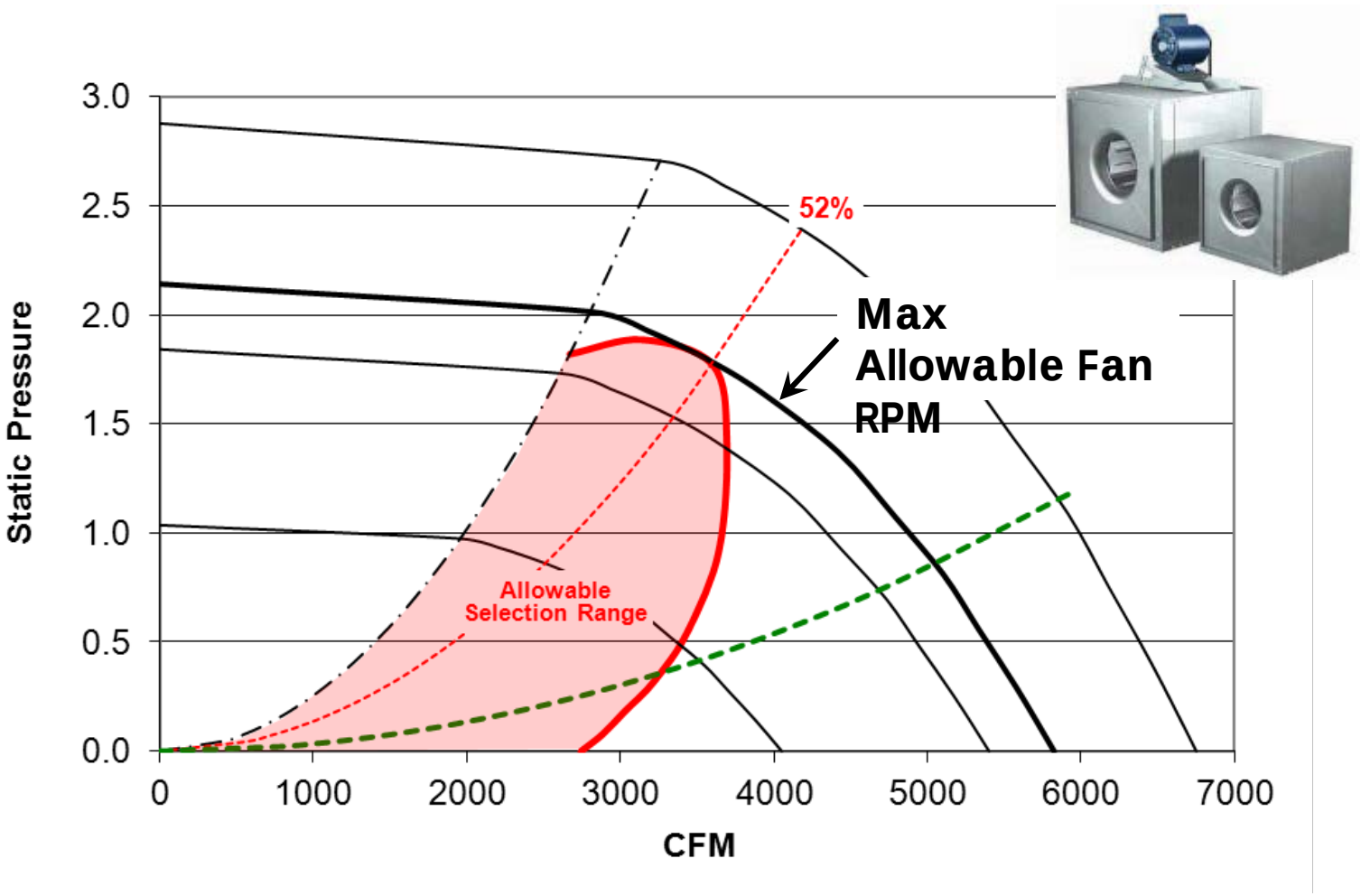
Evolution of Metrics for Fan Efficiency

- FMEG – Fan Motor Efficiency Grade (ISO 12759) used in Europe
- FEG – Fan Efficiency Grade (ISO 12759, ASHRAE 90.1)
- AMCA members form consensus on FEG levels (October 2013) – vary by fan type
- Data base is created to evaluate savings, impact (1Q 2014)
  - Poor linkage of FEG (peak efficiency) to savings on low pressure applications
  - All savings on FEG come from redesign investments – high impact
- FER – Fan Efficiency Ratio was then given full consideration
  - "Compliant Range" enabled by fan laws, labeling authority of DOE
  - Generates more savings from selection, less investment
- **FEI/FEP – Fan Efficiency Index / Performance in current NODA**
  - **Same as AMCA FER/PBER**

The cfm and ΔP constants

$$\text{DOE Required "Efficiency"} = \left[\text{Target Efficiency}\right] \times \left[\text{CFM Factor}\right] \times \left[\text{Pressure Factor}\right]$$

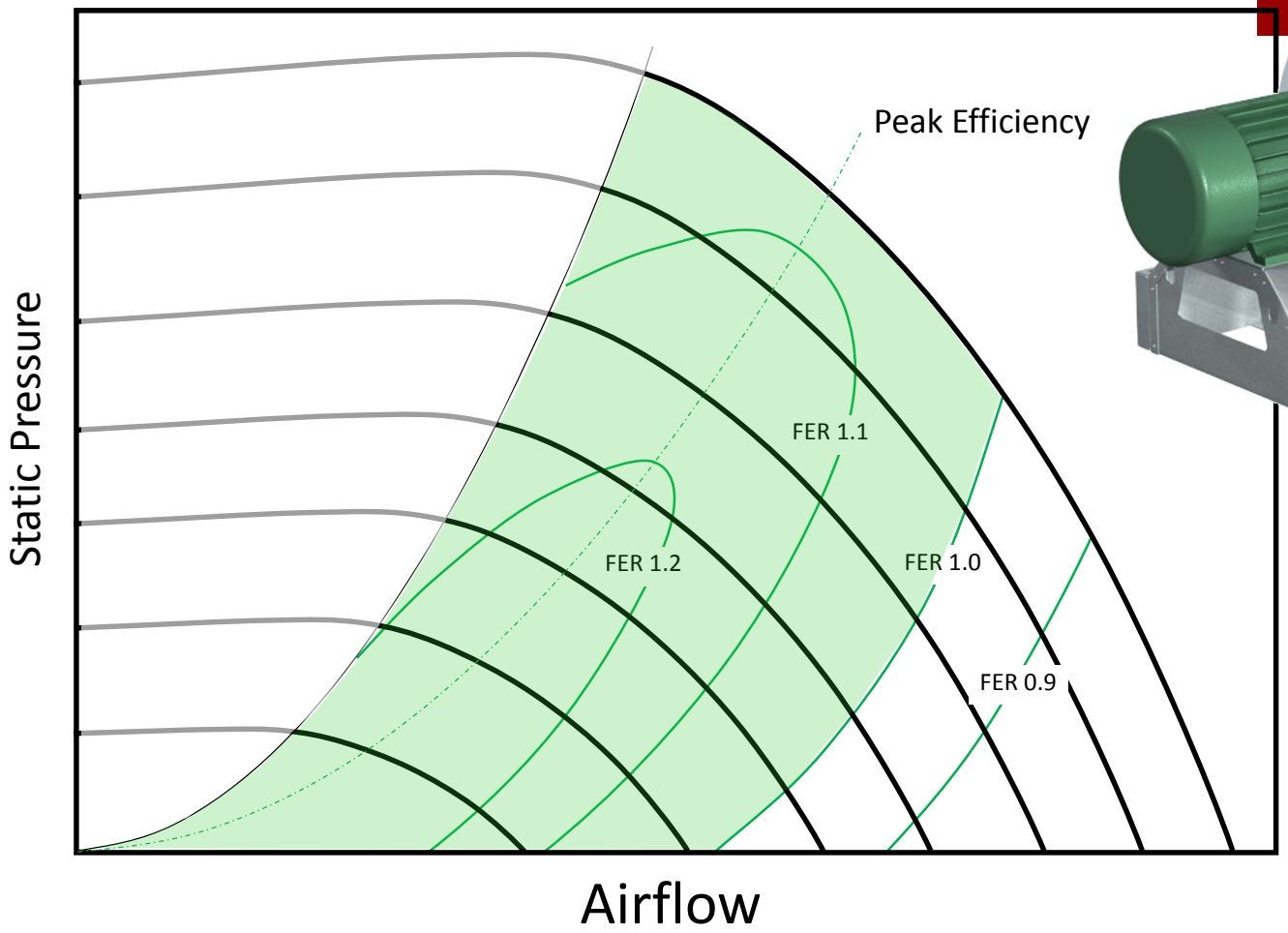
- **1. Target Efficiency** – establishes the "upper" limit of efficiency
- **2. Pressure Factor ΔP/(ΔP+0.4)** – reduces efficiency requirement at low pressures
- **3. CFM Factor = cfm/(cfm+250)** – reduces efficiency at low CFM
- SO – an exhaust fan at 10,000 cfm and 0.4" pressure ,
- DOE requirement would be Target x (10000/10250) x (0.4 / 0.8)
- In other words, the efficiency requirement is half of the target.

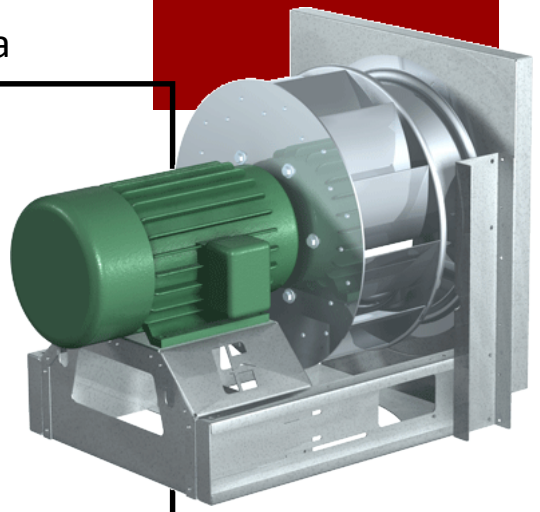


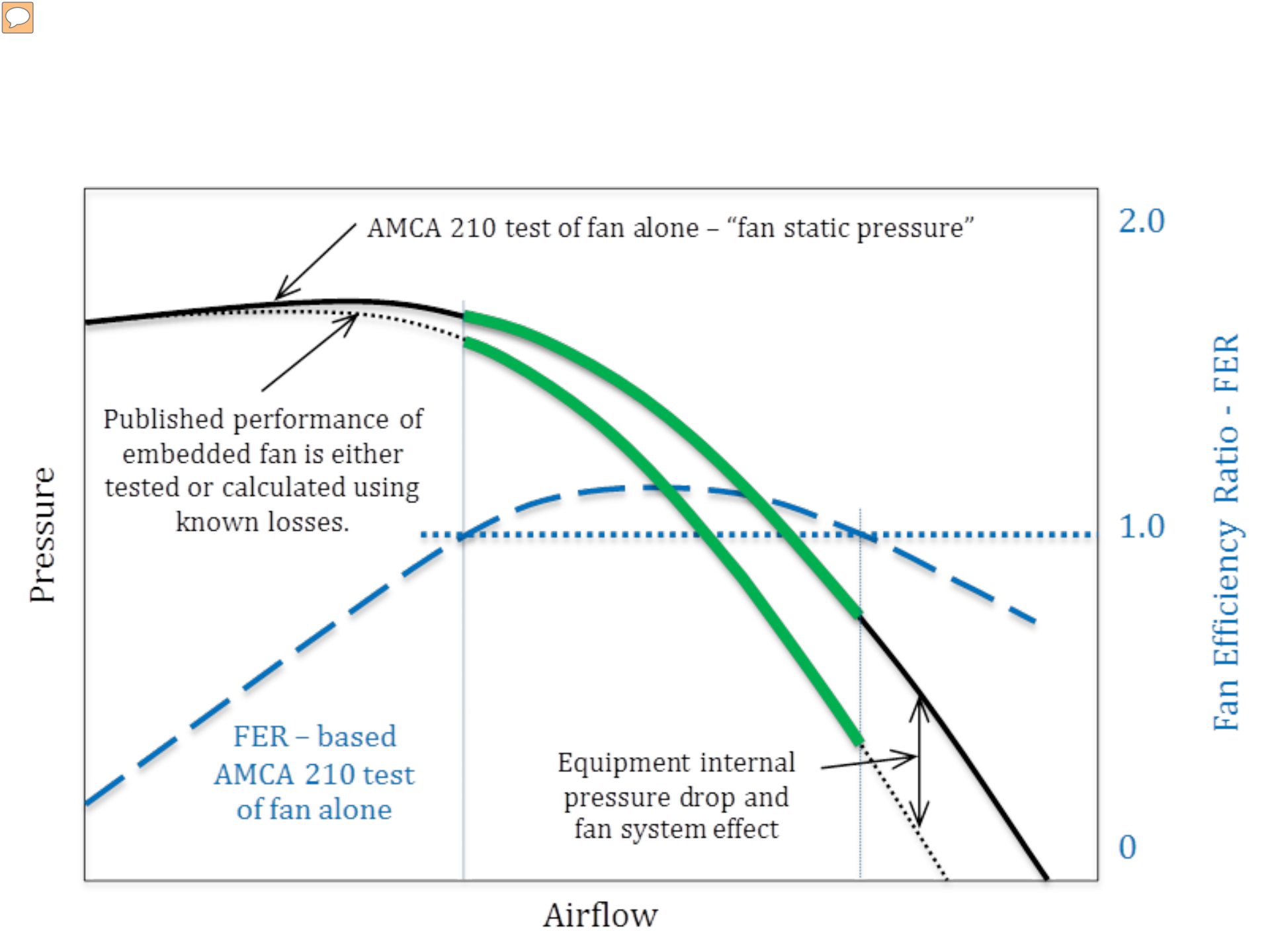
DOE reg. would limit the maximum allowable fan RPM!

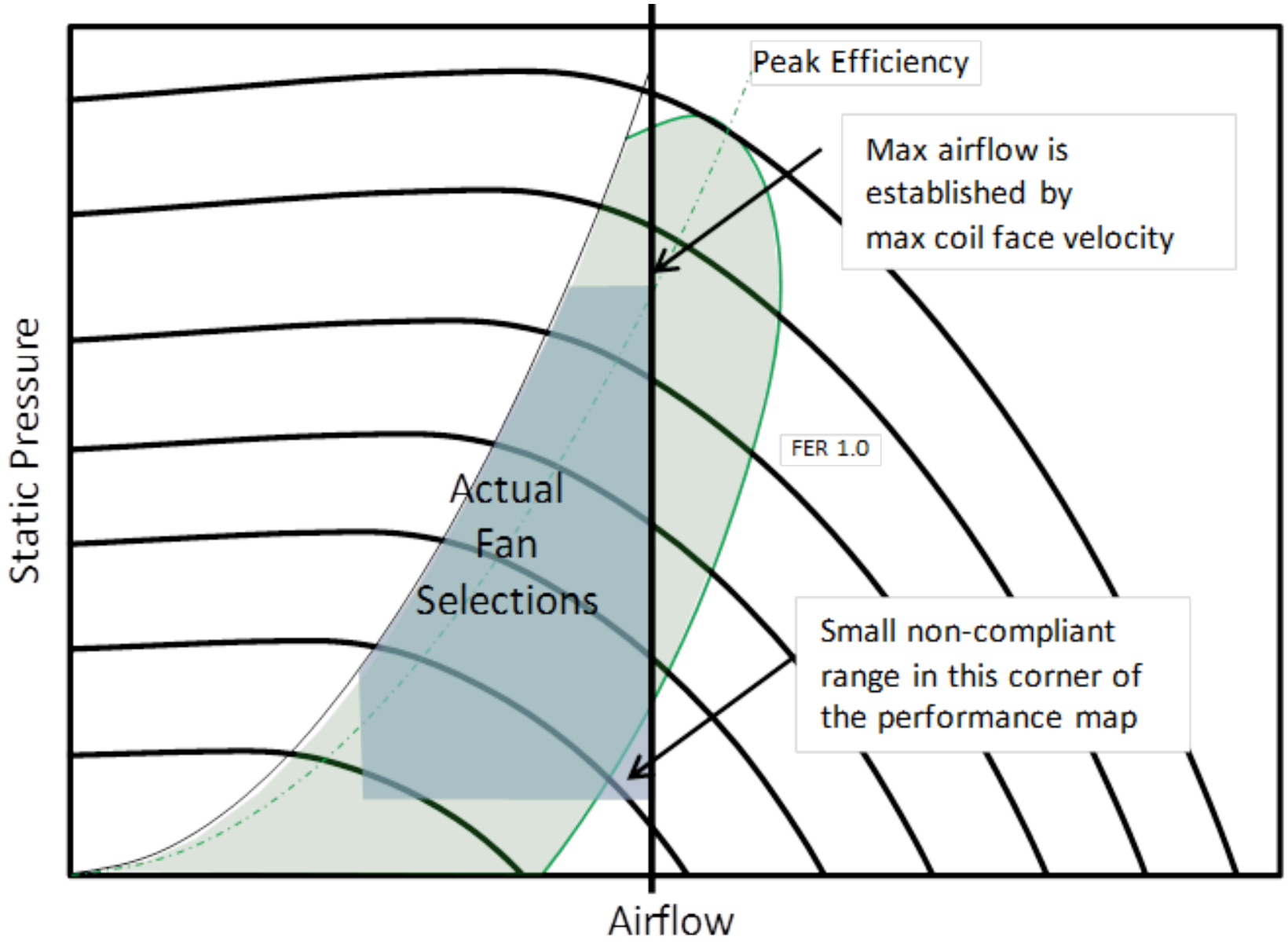
Multiple Speed Fan Performance Curves

"Relatively High Efficiency Fan" – Large selection area






AMCA 210 test of fan alone – "fan static pressure"
Published performance of embedded fan is either tested or calculated using known losses.
FER – based AMCA 210 test of fan alone
Equipment internal pressure drop and fan system effect
Pressure
Airflow
2.0
1.0
0
Fan Efficiency Ratio - FER


Peak Efficiency
Max airflow is established by max coil face velocity
FER 1.0
Actual Fan Selections
Small non-compliant range in this corner of the performance map
Static Pressure
Airflow

Advantages of Fan Efficiency Index

- Every fan is compliant in some range.
  - No fan is forced off the market on some date certain
- Every fan is **not** compliant in some range.
  - Every fan benefits from redesign to raise efficiency rating, expand its compliant range
- FEI deals with fan selection , which has greater impact on energy use than fan design
- **More savings, less investment**, more control over where manufacturer investments in redesigns are made
- Requires manufacturer, rep, distributor, OEM to inform customer of compliant operating range - labeling
- We “will not offer fan for sale in the non-compliant range”

Evaluation of impact

1. Requires actual selections to be considered

2. Requires knowledge of fan performance in 210 test, and casing losses used to determine fan operating point for each selection, establish compliant range of fan-bearing unit

3. Simple math to determine DOE requirement at fan operating point, expressed as maximum bhp (or watts in) allowed

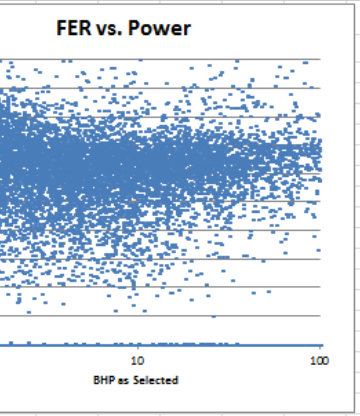
4. If selection is *not* compliant,
   - What is the reduction in bhp to become compliant? (Savings)
   - What percent of selections are not compliant?(Industry impact)
   - What is the cure? (Investment required)
     - A more efficient fan of the same diameter, fan category?
     - A different category fan
     - A more efficient motor and drive
     - A larger fan

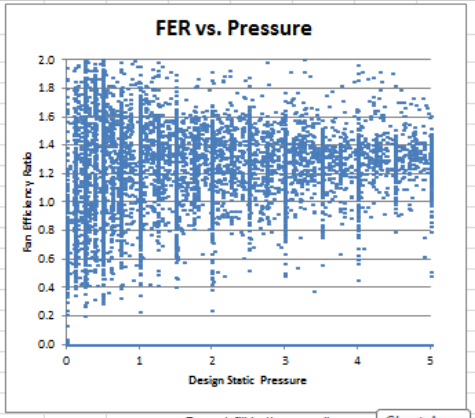
TCF FER Analysis.xlsx - Microsoft Excel

Chart Tools

Formulas | Data | Review | View | Acrobat | Design | Layout | Format

Ruler | Formula Bar | Gridlines | Headings | Show | Zoom | 100% | Zoom to Selection | New Window | Arrange All | Freeze Panes | Split | Hide | Unhide | View Side by Side | Synchronous Scrolling | Reset Window Position | Save Workspace | Switch Windows | Macros





FER Analysis

FER Parameters: (SI Units)

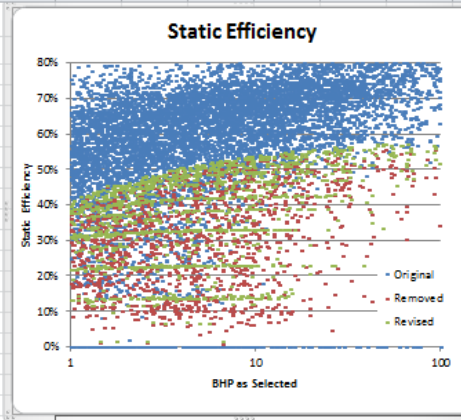
Q_0 =	250	(0.118 cms)
P_0 =	0.4	(100 Pa)
SE Target =	60%	
TE Target =	70%	

Filter Parameters:

Min Motor HP >=	1
Max Motor HP <	200
Category =	
Model =	
Total Effic? =	

Results:

Total # Fans =	36113		
Total Connected BHP =	300919	BHP	0.1345
Minimum Savings =	40484	BHP	(13% of total)
# Fans req'd Size Change =	2983	Fans	(8% of total)
# Fans req'd Model Change =	3951	Fans	(11% of total)



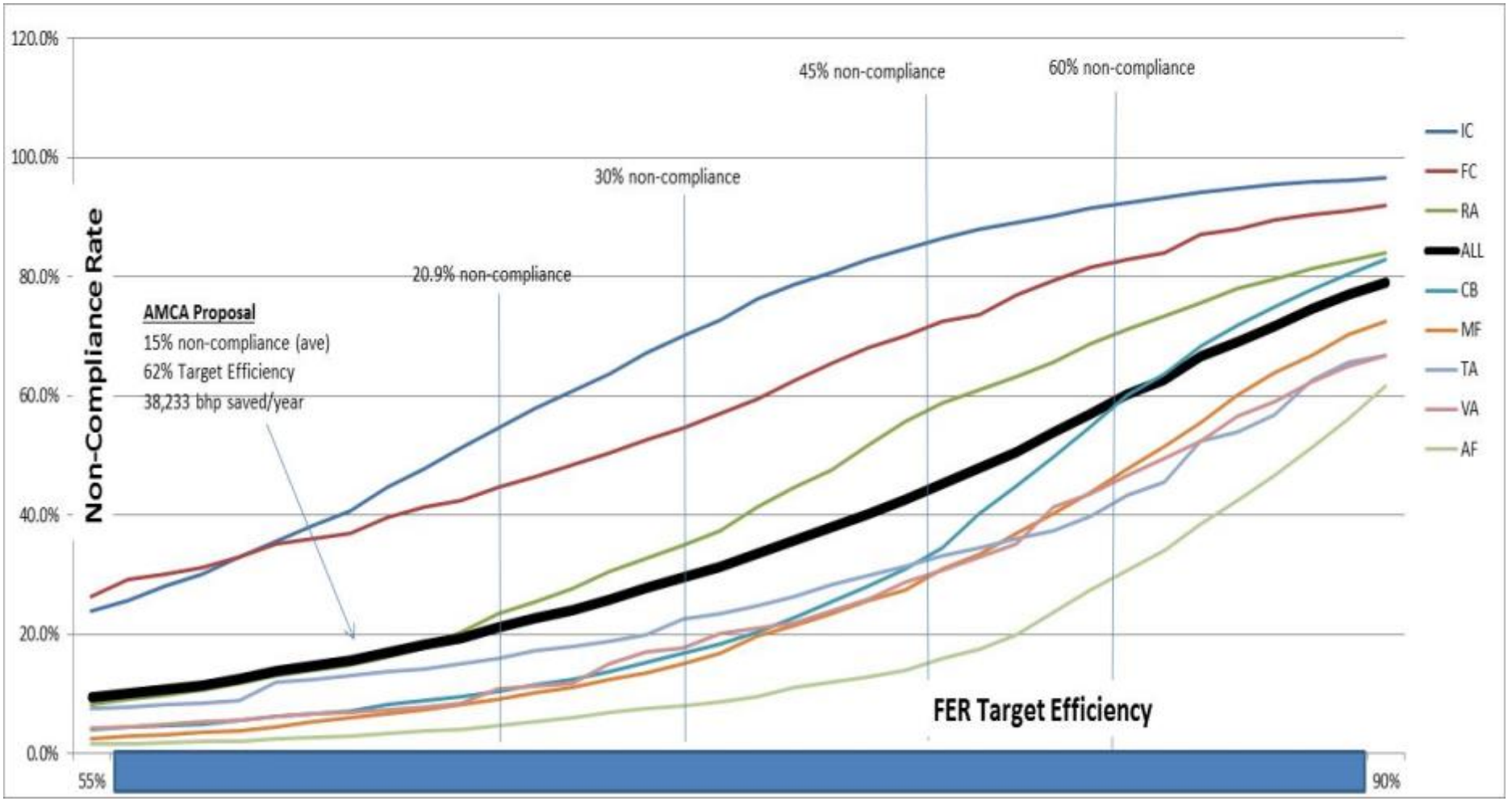
Do not fill in these cells | Chart Area | Data used for plotting only

How Equipped				How Applied				Calculated Values (do not fill in)										Non-Ducted			Ducted		
otor HP	Belt or Direct Drive (B or D)	Indicate if sold with ....? (VFD, ECM)	Safety Fan (Y or N)	Design Airflow (CFM)	Design Static Pressure (in.w.g)	Air Density (lb/ft³)	Fan BHP	Total Pressure (in. w.g)	Static Eff.	Total Eff.	Distance from Peak SE	Distance from Peak TE	Ducted Outlet	BHP as Selected	Baseline BHP for FER	FER as Selected	Total BHP as Selected	Total BHP Savings	Total # Fans	Change Size?	Change Model?	SE Original	SE Revised	SE Removed	TE Original	TE Revised	TE Removed
1	2		FALSE	0	0	0.075	0.001	0	0	0	0.54	0.57	No	0.00	0.03	26.28	0.00	0.00	1			0%	-100%	-100%	-100%	-100%	-100%
1.5	1		FALSE	2160	0	0.075	0.854	0.447	0	0.1783	0.64	0.5017	No	0.85	0.25	0.30	0.85	0.60	1	1		0%	-100%	-100%	-100%	-100%	-100%
3	1		FALSE	2600	1.25	0.075	2.53	1.8969	0.2025	0.3073	0.2475	0.1927	No	2.53	1.24	0.49	2.53	1.29	1		1	20%	41%	20%	-100%	-100%	-100%
3	1		FALSE	2500	1.25	0.075	2.29	1.8481	0.2151	0.3181	0.2349	0.1819	No	2.29	1.19	0.52	2.29	1.10	1		1	22%	41%	22%	-100%	-100%	-100%
	2		FALSE	2120	0.1	0.077	0.18	0.1889	0.1857	0.3507	0.3443	0.2193	No	0.18	0.31	1.73	0.18	0.00	1			-100%	-100%	-100%	-100%	-100%	-100%
20	1		FALSE	18000	0.5	0.075	12.676	1.7652	0.1119	0.3952	0.4781	0.2448	No	12.68	4.32	0.34	12.68	8.36	1		1	11%	33%	11%	-100%	-100%	-100%
7.5	2		FALSE	24999	0.28	0.067	6.35	0.6428	0.1738	0.399	0.4462	0.291	No	6.35	4.51	0.71	190.50	55.16	30		30	17%	24%	17%	-100%	-100%	-100%
3	1		FALSE	1630	2	0.075	1.31	2.0512	0.3923	0.4024	0.2277	0.3676	No	1.31	1.19	0.91	1.31	0.12	1		1	39%	43%	39%	-100%	-100%	-100%
1.5	1		FALSE	2160	0.5	0.075	0.777	0.9465	0.2191	0.4148	0.3309	0.1952	No	0.78	0.57	0.73	1.55	0.41	2		2	22%	30%	22%	-100%	-100%	-100%
7.5	2		FALSE	20000	0.25	0.075	5.66	0.7455	0.1393	0.4153	0.5507	0.3747	No	5.66	3.46	0.61	5.66	2.20	1		1	14%	23%	14%	-100%	-100%	-100%
1	1		FALSE	1600	1	0.0715	0.748	1.2336	0.3372	0.416	0.1128	0.084	No	0.75	0.68	0.91	0.75	0.07	1		1	34%	37%	34%	-100%	-100%	-100%
	1		FALSE	1000	1.25	0.075	0.488	1.2897	0.4038	0.4167	0.1562	0.2533	No	0.49	0.54	1.11	0.49	0.00	1			-100%	-100%	-100%	-100%	-100%	-100%
3	1		FALSE	1775	2	0.075	1.37	2.0607	0.4085	0.4209	0.2115	0.3491	No	1.37	1.28	0.93	1.37	0.09	1		1	41%	44%	41%	-100%	-100%	-100%
3	1		FALSE	2565	2	0.075	1.96	2.1267	0.4126	0.4388	0.2074	0.3312	No	1.96	1.78	0.91	1.96	0.18	1		1	41%	46%	41%	-100%	-100%	-100%
3	1		FALSE	2000	2	0.075	1.71	2.3828	0.3688	0.4394	0.1112	0.0806	No	1.71	1.42	0.83	1.71	0.29	1		1	37%	44%	37%	-100%	-100%	-100%
	1		FALSE	1400	1	0.075	0.59	1.1876	0.3741	0.4443	0.0759	0.0557	No	0.59	0.61	1.03	0.59	0.00	1			-100%	-100%	-100%	-100%	-100%	-100%
3	1		TRUE	2500	2.65	0.0523	2.685	3.0671	0.389	0.4502	0.091	0.0698	No	2.69	2.20	0.82	2.69	0.48	1		1	39%	47%	39%	-100%	-100%	-100%
1.5	1		FALSE	1850	0.5	0.075	0.532	0.8275	0.2741	0.4537	0.2759	0.1563	No	0.53	0.50	0.93	0.53	0.04	1		1	27%	29%	27%	-100%	-100%	-100%
2	2		FALSE	12500	0.125	0.075	1.337	0.3186	0.1842	0.4695	0.5158	0.3105	No	1.34	1.76	1.32	10.70	0.00	8			18%	-100%	-100%	-100%	-100%	-100%
10	1		FALSE	30000	0.5	0.075	8.35	0.839	0.2832	0.4752	0.2368	0.1948	No	8.35	7.15	0.86	25.05	3.59	3		3	28%	33%	28%	-100%	-100%	-100%
30	1		FALSE	57800	0.75	0.075	24.39	1.2724	0.2802	0.4754	0.2398	0.1946	No	24.39	17.54	0.72	73.17	20.55	3		3	28%	39%	28%	-100%	-100%	-100%
10	2		FALSE	28000	0	0.075	8.88	0.9712	0	0.4828	0.61	0.2472	No	8.88	2.97	0.33	8.88	5.91	1	1		0%	-100%	-100%	-100%	-100%	-100%
7.5	2		FALSE	20000	0.5	0.075	6.43	0.9955	0.2452	0.4882	0.4448	0.2918	No	6.43	4.79	0.74	6.43	1.64	1		1	25%	33%	25%	-100%	-100%	-100%
7.5	1		FALSE	5040	3.5	0.075	6.47	3.9892	0.4298	0.4899	0.0702	0.0401	No	6.47	5.42	0.84	6.47	1.05	1		1	43%	51%	43%	-100%	-100%	-100%
10	2		FALSE	13471	1	0.075	9.221	2.134	0.2303	0.4915	0.4697	0.2885	No	9.22	5.05	0.55	9.22	4.17	1		1	23%	42%	23%	-100%	-100%	-100%
100	2		FALSE	85000	2.5	0.075	98.04	3.6298	0.3417	0.4961	0.2183	0.2639	No	98.04	64.96	0.66	98.04	33.08	1		1	34%	52%	34%	-100%	-100%	-100%
2	1		FALSE	3440	0.28	0.075	0.81	0.7497	0.1875	0.502	0.3725	0.168	No	0.81	0.66	0.81	0.81	0.15	1		1	19%	23%	19%	-100%	-100%	-100%
15	1		FALSE	24000	0.63	0.075	13.03	1.7454	0.1829	0.5068	0.4771	0.2532	No	13.03	6.56	0.50	26.06	12.93	2		2	18%	36%	18%	-100%	-100%	-100%

rket | Instructions | Sheet1

70%

Evaluation of impact @ different levels



Life Cycle Cost => Max Tech

What would have to be true to change this?

- Fans consume their first cost in < one year
- Small costs adders drive large savings – fast payback

1. Small Business Impact (Manufacturer Impact Analysis)
   - 85% of industry is small business
   - Limited financial and human resources to redesign
   - Protecting employment in America

2. Utility (DOE Engineering Analysis)
   - Current fan utility musty be maintained
   - Categories are defined by common utility
   - Protects against elimination of fan categories

3. Consensus
   - Broad acceptance avoids lawsuits, delays, controversy

Challenging Issues

Fans embedded in regulated products

- Many AHRI members oppose regulation of supply fans in regulated products, citing double regulation
- AHRI & CTI members oppose regulation of condenser and cooling tower fan efficiency – no savings
- Advocates favor regulation down to 125 watts. Why?
  - To prevent loopholes. AMCA shares this concern $\geq$ 1 bhp
  - To save energy where existing metric does not fully account for fan energy use.
    - 2 mm bhp/year $\geq$ 1 bhp (3.6 mm in unregulated applications)
    - 2.5 mm bhp/year < 1 bhp

ASRAC Schedule

Dates	Times	Location
June 3, 2015	9:00 AM – 5:00 PM	DOE, Forrestal Building
June 4, 2015	8:00 AM – 3:00 PM	DOE
June 22, 2015	Noon – 6:00 PM	DOE
June 23, 2015	8:00 AM – 3:00 PM	DOE
July 21, 2015	9:00 AM –5:00 PM	AMCA – Chicago
July 22, 2015	8:00 AM – 3:00 PM	AMCA - Chicago
August 4, 2015	9:00 AM – 5:00 PM	DOE
August 5, 2015	8:00 AM – 3:00 PM	DOE