Fan Efficiency Regulation Update
for
ASHRAE TC 5.1

Tim Mathson

Greenheck Fan

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Department of Energy (DOE)
Commercial & Industrial Fans & Blower (CIFB)
Rule Making Update
DOE CIFB Status / Timing

• **Term Sheet – September 2015**
  – “Letter of Intent” for Rule

• **Proposed Rule (NOPR) – Q1 2016***
  – Test Standard NOPR
  – Regulatory NOPR

• **Final Rule – January 2017***
  – 1st Potential for Compliance
  – Estimate Products on the Market by 2018

• **Mandatory Compliance – January 2022***
  – 5 Years after Final Rule*

*Anticipated Date
DOE CIFB Term Sheet

• 32 Recommendations
  – Submitted to Appliance Standards & Rulemaking Federal Advisory Committee (ASRAC)

• DOE ASRAC 25 WG Members
  • 1 DOE
  • 7 AMCA
  • 8 AHRI
  • 4 Energy Advocates
  • 3 AMCA/AHRI
  • 1 Consultant
  • 1 Motor/Drive Supplier

• Term Sheet “Consensus” (after 16 Meetings)
  – 23 “For” / 2 “Against”
    • Consensus on 28 of 32 Recommendations
DOE CIFB Term Sheet

- Fan Categories “In” & “Out”
- Scope
- Metric
- Test
- Certification/Labeling

❖ KEY Items NOT covered:
  - Efficiency Levels
  - Replacement Fans (rec. #28)
CIFB Fan Term Sheet
Categories/Equipment Classes “In”

• “Stand Alone Fans”:
  – Axial Cylindrical Housed
  – Panel
  – Centrifugal Housed & Unhoused (excluding inline & radial)
  – Inline & Mixed Flow
  – Radial Housed (shrouded impeller)
  – Power Roof Ventilators

Ref. Recommendation #1, 30
CIFB Fan Term Sheet
Categories “In”

• “Embedded” Fans in:
  – Equipment not Regulated by the DOE
  – Equipment Regulated by the DOE where the regulation does not capture the fan energy.
    » Fan will be tested outside of equipment (stand alone)
    » Fan will be tested as a defined “testable configuration”.

Ref. Recommendation #4 & 8
CIFB Fan Term Sheet
Categories “Out”

• Radial Housed Unshrouded
  – Diameter < 30” / Blade Width < 3”
• Safety
• Circulating
• Induced Flow
• Jet
• Cross Flow

Ref. Recommendation #2
CIFB Fan Term Sheet
Categories “Out”

• **Supply & Condenser Fans** in DOE Regulated Equipment where the Regulation captures the energy of these fans

• Fans “Embedded” in:
  - DOE Regulated Central AC & Heat Pumps
  - DOE Regulated Commercial AC & Heat Pumps
  - DOE Regulated Consumer Furnaces
  - Transport Refrigeration
  - Vacuums
  - Heat Rejection Equipment (per Cooling Tower Institute)
  - Air Curtains

Ref. Recommendation #2 & 3
CIFB Fan Term Sheet
“Scope”

• Fans offered for sale at Operating Points where:
  – Fan shaft power is greater than or equal to 1 BHP
  – Fan air power is less than or equal to 150 HP
    (approx. 200 shaft BHP)

Ref. Recommendation #5
CIFB Fan Term Sheet  
“Metric”

- **Fan Electrical (input) Power (FEP)**
  - Wire-to-Air (including motor & VSD when supplied by manufacturer)
  - Specific to Operating Point
  - Airflow and Pressure define Maximum Allowable Power – \( \text{FEP}_{(\text{std})} \)
  - Results in a Range of Airflow and Pressure that can be offered for sale

- **Fan Efficiency Index (FEI)**
  - \( \text{FEP}_{(\text{std})} / \text{FEP}_{(\text{actual})} \)
  - \( \text{FEI} \geq 1 \)
  - \( (\text{FEI} - 1) = \% \text{ savings relative to DOE minimum requirement} \)

*Ref. Recommendation #6, 10, 11, 12, 13, 14, 15, 16, 18, 19, 20, 21*
“Elements” of Fan Efficiency

Overall Fan Efficiency (wire to air)

Fan Efficiency (at the shaft)

- Electrical Power In
- Variable Speed Drive (1%-5%)
- Motor Loss (10%)
- Drive Loss (3% - 10%)
- Bearing Loss (3%)
- Aerodynamic Loss (10% to 20%)
- Fan Power Out
Compliant Fan Selections

FEI “Bubble”

Narrow selection range around peak efficiency at high CFM and Ps

Wide selection range at low CFM and Ps

Allowable Selection Range

Static Pressure in. wg

CFM X 1000
Allowable Fan Selections
Example: Inefficient Fan

Square Inline Fan
Allowable Fan Selections

Example: Efficient Fan

Mixed Flow
Inline Fan
Compliance Metric: Fan Electrical Power at Design Point ≤ FEP_{STD}

\[ FEP_{STD,i} = \frac{(Q_i + Q_0)(P_i + P_0)}{6346 \times \eta_{target}} \]

- \( FEP_{STD,i} \) = maximum fan input power at operating point \( i \)
- \( Q_i \) = flow (cfm) at operating point \( i \)
- \( P_i \) = total pressure for ducted fans, static pressure for non-ducted fans (in. wg.) at operating point \( i \)
- \( Q_0 \) = flow constant of 250 cfm
- \( P_0 \) = pressure constant of 0.4 inches water gauge
- \( \eta_{target} \) = target static and total efficiency levels to be set by DOE

Ref. Recommendation #18, 19, 20, 21
CIFB Fan Term Sheet
“Test”

- DOE Regulation based on:
  - AMCA Standard 210 (stand alone / non-embedded fans)

- Includes “default” losses for:
  - Drives, Motors, VSDs

- Allows Alternative Efficiency Determination Method
  - AEDM

Ref. Recommendation #7, 8, 9, 17, 22, 23, 24, 25, 29
Embedded Fan Testing

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

Ref Recommendation #4, 8
CIFB Fan Term Sheet
“Certification/Labeling*”

• Certification:
  – Submit Selection Software (like AMCA eCAT)
  – Submit Operating Range (equation or tabular)
  – Submit Literature
  – Info will be in “Public Domain”
  – Working to utilize AMCA CRP

• Labeling (design point dependent)
  – Model
  – Serial #, Date
  – Design Airflow, Pressure, FEI
  – Max RPM
  – Link to DOE website

*Likely to Change
Ref. Recommendation #26, 27, 31, 32
Impact of Selection-Based Efficiency Limits

- Graph showing the relationship between Fan Total Efficiency and Fan Brake Horsepower.
Future

• ASHRAE 90.1
  – FEI ≥ 1.0 at design airflow and pressure

• ASHRAE 189.1
  – FEI ≥ 1.1 at design airflow and pressure

• Utility Rebates
  – FEI ≥ 1.2 triggers $X per motor hp rebates
Questions / Comments
DOE CIFB Rule