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Fan Application
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PRODUCT APPLICATION GUIDE
A technical bulletin for engineers, contractors and students in the air movement and control industry.

Fan Energy Index (FEI): A practical metric to assist the industry in selecting the most energy efficient fans for an application

The FEI metric is a "wire-to-air" metric that includes motor, belt and bearings (if the fan is belt-driven), and fan aerodynamic losses at an application duty point (flow, pressure) of a fan system representing true electrical power consumption. Traditional fan brake horsepower stated by manufacturers is only the shaft input power required by a fan to perform a specific design duty point and exclude the other fan drive system components (See Figure 1).

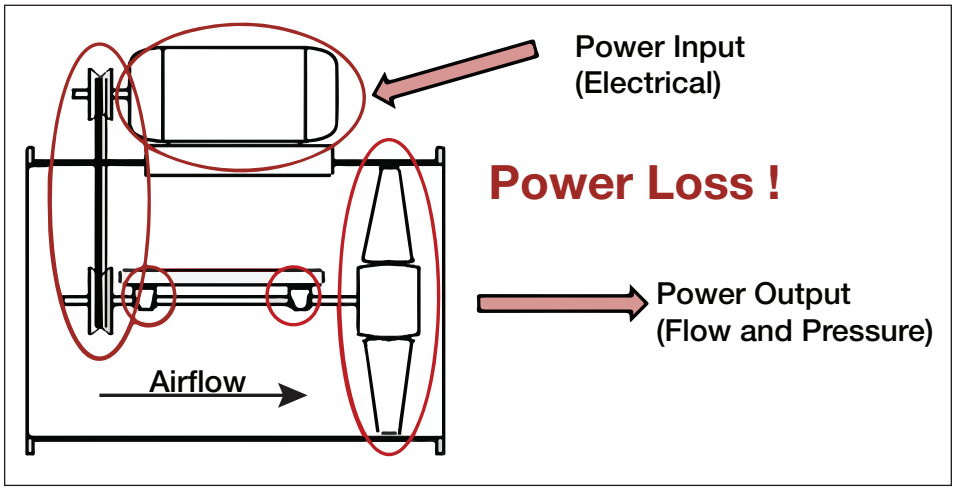
FEI is calculated as the ratio of Baseline Fan Electrical Input Power to the Actual Selected Fan Electrical Input Power (Equation 1) at the fan's design duty point.

Equation 1

$$FEI = \frac{\text{Baseline Fan Electrical Input Power}}{\text{Actual Electrical Inlet Power}}$$

Where: The **Baseline Fan Electrical Input Power** is a conceptual fan capable of producing the required airflow and fan pressure at a specified shaft input power using a v-belt drive, and having a motor efficiency based on 4 pole, 60Hz, IE3 motor and does not include a speed control (per the Air Movement and Control Association International, AMCA, Standard 208).

Figure 1: Fan System Energy Consumption



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Because the actual and baseline powers are obtained (calculated) at the same airflow and pressure, FEI is also defined as the ratio of Actual Fan System Efficiency to Baseline System Efficiency. (Equation 2)

Equations 1 and 2 illustrate the direct relationship of fan efficiency to fan power consumption, however since the objective in applying a fan is to select the fan that uses the least electrical energy consumption to meet the required design duty point, Equation 1 is preferred in presenting fan FEI data.

Equation 2

$$FEI = \frac{\text{Actual Fan System Efficiency}}{\text{Baseline Fan System Efficiency}}$$

From Equation 1, if the input electrical power of an actual fan selection is equal to the baseline, the FEI is 1.0. If the input electrical power of an actual fan selection is 90% of the baseline, the FEI is 1.1, and the actual fan selected is 10% more efficient than the baseline, using 10% less electrical power. The FEI metric is that simple to understand and apply.

Note: Fan manufacturers will calculate and present the FEI values in their literature and selection programs.

Table 1 illustrates the ease of using the FEI metric in identifying the more efficient fans, saving the most electrical input power. This example is for applying a fan with a design duty point of 10,000 cfm (4719 l/s) at 3 inches (747 pascal) static pressure.

Table 1: Data comparing FEI for multiple sizes of the same fan model for a specific Design Duty Point

Fan Size in. (mm)	Fan Speed	Fan Power bhp (kW)	Baseline Power	FEI
18 (460)	3,238	11.8 (8.8)	7.96	0.67
20 (510)	2,561	9.6 (7.2)	7.96	0.83
22 (560)	1,983	8.0 (6.0)	7.96	0.99
24 (610)	1,579	6.8 (5.0)	7.96	1.16
27 (685)	1,289	6.2 (4.6)	7.96	1.28
30 (770)	1,033	5.7 (4.3)	7.96	1.39
36 (920)	778	6.0 (4.5)	7.96	1.32

Table 1 illustrates how a manufacturer can present FEI values and other application data for a range of fan sizes for a specific fan model and design duty point.

Industry Standards and Codes

FEI is now being adopted into current revisions of industry standards and codes, replacing the previous flawed FEG (Fan Energy Grade) metric. Table 2 illustrates how FEI can be applied in regulatory and voluntary programs.

Additionally, the U.S. Department of Energy (DOE) requires State Energy Codes to meet or exceed the current edition of ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers) 90.1. (Reference 42 U.S.C. 6833).

Besides the tabular fan performance illustrated in Table 1, fan performance including the FEI metric can be illustrated in both single speed (Figure 2) and multiple speed fan curves.

For a fan application requiring multiple speeds (i.e. utilizing a VFD, Variable Frequency Drive) compliant FEI areas are graphically represented as bubbles (Figure 3).

Table 2: Possible regulatory and voluntary program applications of the FEI metric

Fan Regulatory of Voluntary Program Body	Possible FEI Requirement
U.S. Department of Energy	FEI ≥ 1.0 at Design Duty Point
ASHRAE 90.1 or International Energy Conservation Code	FEI ≥ 1.0 at Design Duty Point
ASHRAE 189.1	FEI ≥ 1.1 at Design Duty Point
Utility Incentive Programs	FEI ≥ 1.1 at Design Duty Point

Figure 2: Compliant range of operation of a fan operating at single speed

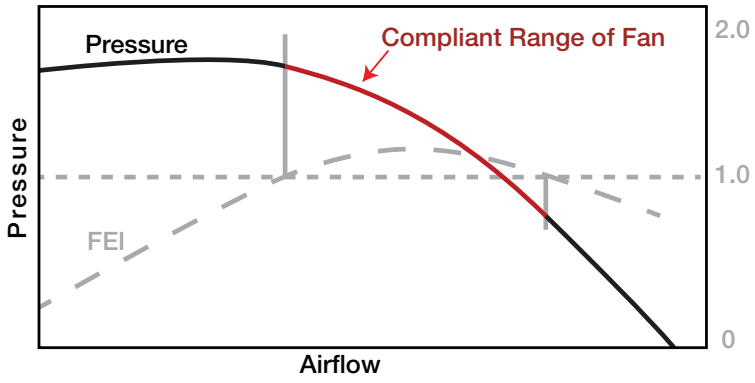
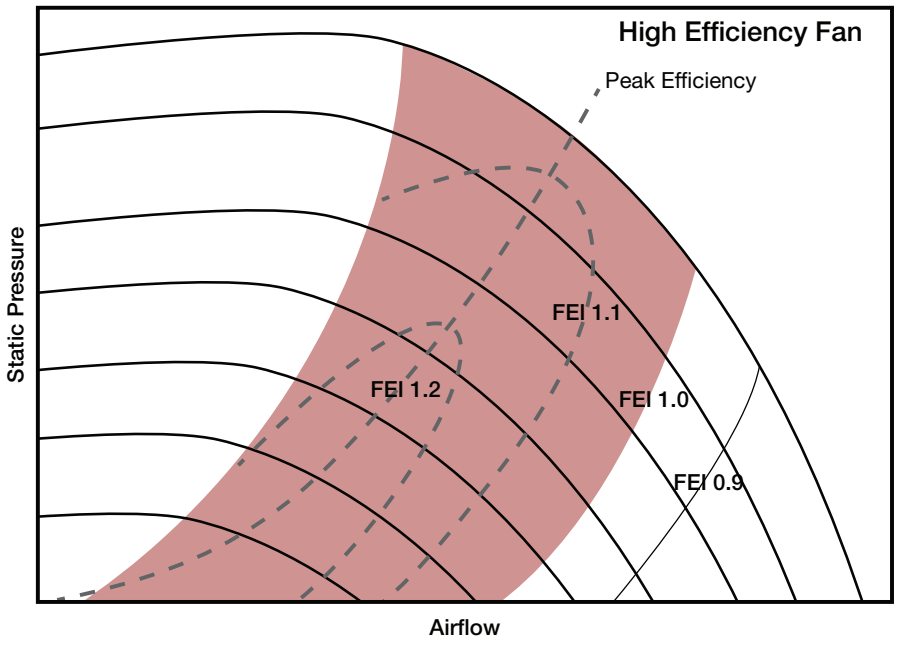


Figure 3: Compliant range of operation of a fan operating at multiple speeds



Summary and Conclusion

The FEI metric is a wire-to-air metric that includes motor, belt and bearing (if the fan is belt-driven), and fan aerodynamic losses at an application duty point (flow, pressure) of a fan system representing true electrical power consumption. FEI is calculated as a ratio of the baseline electrical input power compared to the fan system's actual electrical input power – either measured or estimated. The Air Movement and Control Association International, Inc. (AMCA) Standard AMCA/ANSI 214 defines the calculation and measurement methods used to establish FEI as a wire-to-air metric.

The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) and code authorities in addition to the U. S. Department of Energy will or have established minimum FEI (or maximum fan power) levels.

To ensure that a fan FEI value, flow, pressure, and acoustic performance data presented by a manufacturer are accurate, fans selected and specified must be tested in accordance with, performance rated and licensed by AMCA.

The fan, corresponding literature and submittals must bear the AMCA Worldwide Certified Ratings seal. This independent third-party testing to industry accepted standards assures the engineer, contractor, and facility owner that the fan will efficiently perform as stated by the manufacturer.

To ensure that projects are compliant it is recommended that fan specifications and schedules be updated with:

A. FEI requirements of the latest edition of 90.1(take exception to FEG)

B. Requirement for AMCA Certified Ratings on FEI

C. Incorporate the above items into a plan review, submittal review and a certificate of occupancy review

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