Reality-based Metrics

The Development of the Fan Energy Index (FEI)

Developing standards to rate and regulate products such as fans can take different approaches. One would be to group similar-sized products together, measure their relative efficiency against a standard metric, and assign each a rating. Another approach would be more complex and challenging, but can establish a rating that reflects all the factors contributing to the energy efficiency of a given fan for specific applications. The past decade has offered a case study regarding the market impact of standards developed using different approaches.

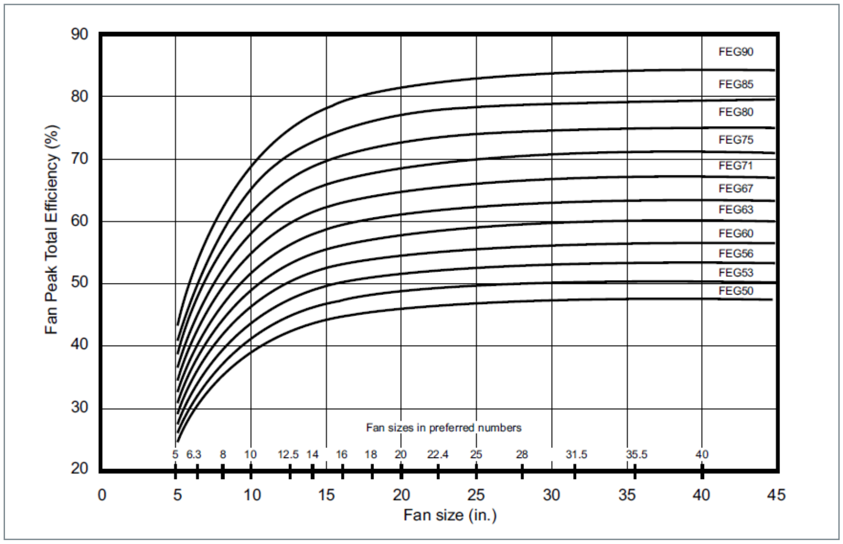
FEG and FMEG grades: different bands for different fans

More than 10 years ago, the Air Movement and Control Association (AMCA) and the International Standards Organization (ISO) tasked their respective technical committees with measuring, categorizing and rating the energy efficiency of fans. Their objective was to establish clear metrics to support the proposed fan energy efficiency regulations for the European Union (EU).

But as the technical groups began their evaluations, they found that they had opened up a Pandora's Box of fans: thousands of fan models and designs over a wide range of motors for use on a variety of applications with multiple output requirements. Given these tens of thousands of data points, the technical teams realized it would be nearly impossible to establish a single bright line of fan efficiency for fans of any shape or size.

Searches of technical literature and market data indicated that the relative efficiency of a given fan within a family of similar fan products was largely determined by that fan's diameter. Efficiency drops off rapidly as the fan diameter grows smaller. It is extremely difficult to make a small-diameter fan anywhere nearly as efficient as a larger-diameter fan of the same model, i.e., bigger was better. However, smaller-diameter fans are essential for many applications, and the technical committees realized they couldn't impose the same efficiency standards for large fans on small-diameter fans.

In an attempt to organize energy efficiency measurements of thousands into easily understood metrics for ratings, different efficiency ranges for different diameter fans were put into buckets, with curves developed to visually indicate their relative efficiency within a set of bands, with the number of bands and their related performance values negotiated with manufacturers. The final metric resulted in a Fan Efficiency Grade (FEG), with a sister metric called the Fan Motor Efficiency Grade (FMEG), as shown here:



The FEG and/or FMEG grade of any given fan is based on its peak fan efficiency associated with its size, and is assigned the grade indicated at the left of the band. For example, a 24-inch fan with a peak total efficiency of 60 percent would be assigned a grade of FEG 67. Similarly, an 8-inch fan with a peak total efficiency of 48 percent would also be assigned a grade of FEG 67.

Almost 50 percent of existing fan products had been pulled from the market.

The EU drew up legislation using FMEG as the standard metric for fan performance and efficiency, and restricted the sale of products below a given grade. The goal was to incrementally increase the minimum FMEG to the next highest band every three years, in order to steadily reduce the production of lower-efficiency fans and motors.

For companies and their customers in the EU, the impact of this grading system on the industry was devastating. After the first two incremental increases in efficiency grades, almost 50 percent of existing fan products had been pulled from the market.

Why efficiency isn't always graded on the curve

As the EU was implementing the new fan regulations, the AMCA was developing similar metrics to establish regulatory standards for the North American marketplace. Based on the original FEG grading metrics, the organization developed its Standard 205 Energy Efficiency Classification for fans. Because many fans are sold in North America without motors, adding motors from different manufacturers for different customers, the efficiency metrics would be applied to fans only.

Manufacturers acknowledged that while a metric based on the peak total efficiency of a product could arbitrarily eliminate many lower-efficiency products, the standard did not take into account other factors that have an equal or greater impact on energy savings, such as: proper selection, application, installation, motor power load and the maintenance of a fan.

The elimination of certain fans on the basis of FEG and FMEG metrics had, in some cases, actually forced the use of substitute fans in applications they were not designed for, or eliminated fans that in some applications were more efficient than their replacements. An example would be using a backward-curved centrifugal fan in a wall fan application. Although the wall fan would have a lower peak total efficiency, in this application the fan would have a higher applied total efficiency, and would consume less energy than the centrifugal fan. The application was a better predictor of energy efficiency than the simple metrics of the fan in isolation.

Developing a more realistic metric

When the United States Department of Energy (DOE) announced their intent to regulate fan efficiency in June 2011, the industry quickly realized they needed to advocate for regulatory metrics that would reflect the efficiency of fans used in different applications, rather than metrics based primarily on fan size. Developing such a metric would be more complicated than drawing the tidy FEG and FMEG efficiency bands, but would be a better measure of the true energy efficiency of a fan on the job.

The North American fan market is mostly comprised of hundreds of small companies, and if energy regulations became too stringent too quickly, many of those companies would be forced out of business. Balancing the risk of industry disruption versus the need to reduce fan energy consumption was a difficult task.

In order to develop new, application-based metrics, 22 AMCA member companies submitted all of their 2012 sales data for analysis. The various fan types sold were grouped into application categories, such as Wall Ventilators, then technicians assigned “typical” efficiency levels for fans used in the different categories as a performance baseline.

In negotiating with the DOE and energy advocates, industry advocates acknowledged that some low-efficiency products would still need to be removed from the market, but an impact similar to the EU regulations would have a devastating effect on U.S. companies. By presenting the analysis of the 2012 sales database, the industry compromised on regulations that would potentially eliminate 25 percent of the products sold in 2012 — but only for certain applications. Under the proposed regulations, many of those products would remain on the market. They just couldn’t be sold for applications where a more energy-efficient product was required.

FEI: an application-based metric

To develop application-based standards, the industry pushed to include more metrics in the standards, such as a 'wire-to-air' efficiency metric measuring the total energy input needed to produce the required flow and pressure for any particular application. Since many fans in the U.S. rely on oversized motors, the goal was to include calculations of part load efficiency for these products.

Rather than referring to FEG curves to account for varying fan efficiency, the new metrics would incorporate adjustment factors to compensate for smaller fans or fans applied in low-pressure applications. Using the "typical efficiencies" of the 2012 sales database as a starting point, the metrics established adjustment factors of 250 cfm and 0.4 inches of pressure.

All these factors were incorporated into a new standard: the AMCA Standard 208 Calculation of the Fan Energy Index, or FEI.

Calculating the FEI

FEI "levels the playing field."

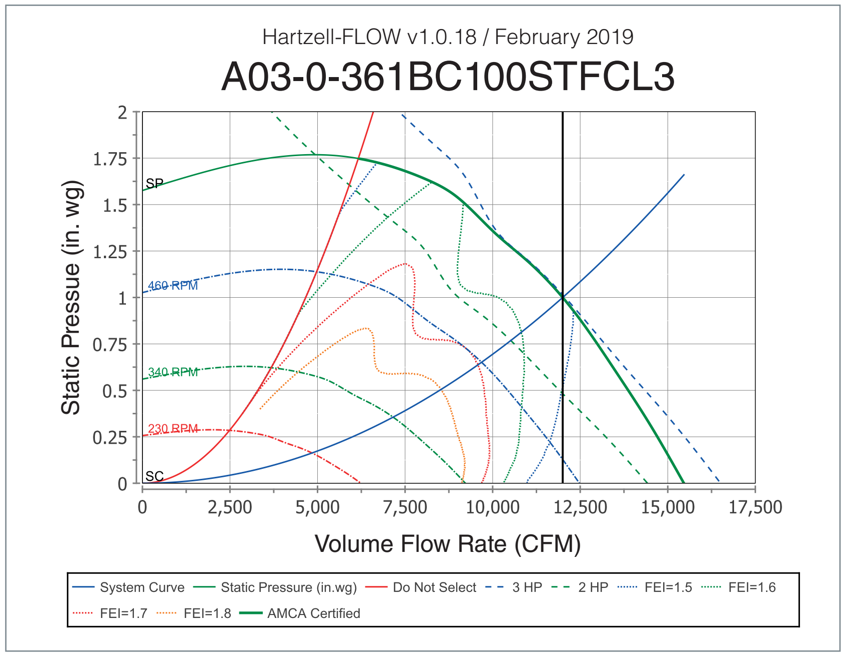
The basis of the FEI is the ratio of the electrical power of a "reference fan" — one powered by a four-pole, premium-efficiency regulated motor — to the electrical power of an actual fan, calculated at identical airflow and pressure duty points, while reflecting transmission loss factors such as the belt drive, motor or VFD. This allows a comparison of all fan types for the demands of a given application. FEI "levels the playing field," enabling meaningful comparisons of many different fan types.

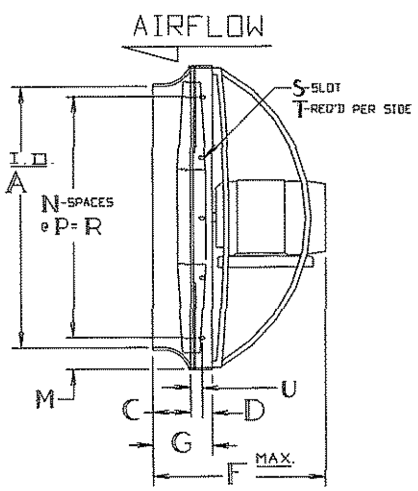
Application: 12,000 cfm/1 in static pressure - reference fan power = 4.74 kW

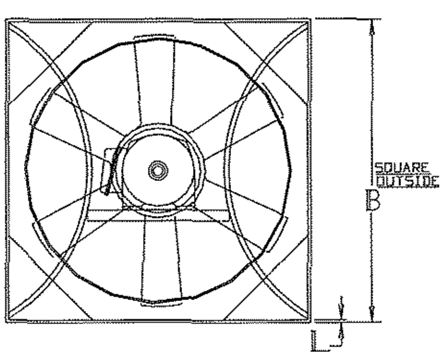
Type	Size	kW	FEI
Centrifugal Fans	27" BC	4.49	1.056
	36" BC	2.64	1.519
Direct Drive Axial Fans	30" AL	2.91	1.521
	40" AA	2.23	1.736
Belt Drive Axial Fans	28" W	4.18	1.119
	32" L	3.34	1.269
Propeller Fans	28" W	3.14	1.593
	32" AL	3.47	1.241

Tests or calculations are conducted on the fan, motor and transmission components of a product. These calculations start with the fan input power, and work backward to the actual input kW. (There are additional methods to test complete packages or individual components independently.) Once the calculated input kW is determined, it is divided by the reference motor's kW input. If the reference fan input is 3.7 kW and the selected product's input is 3.2 kW, its FEI is 1.16, meaning the tested fan will consume 86 percent of power used by the reference fan motor in the selected application; it will meet the standard.

Innovation replaces elimination







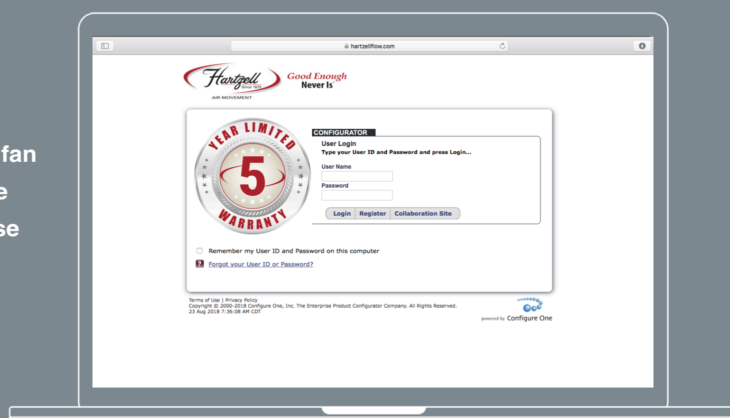
The FEI standard allows fan manufacturers to capitalize on innovative fan design features using FEI metrics as a performance benchmark, rather than designing against an arbitrary rating based on diameter. For example, Hartzell Air Movement uses airfoil cross-sections on all its props, and develops centrifugal fans with broad efficiency ranges for use in different applications. That makes them inherently more efficient than stamped or formed prop blades.

The FEI also is useful in utility rebate programs; they can plug in the FEI number to calculate rebates per kW saved (a higher FEI will yield a higher rebate).

The FEI is an example of an application-based metric. The original FEG and FMEG metrics were based on simple calculations of a fan's peak performance, without regard to its motor characteristics, actual energy load, or its efficiency when used in different applications, and took many perfectly good fans off the market. With the FEI, manufacturers can design and market fans based on the requirements of a specific application, for optimum performance with maximum energy efficiency.

Hartzell-FLOW® Fan Configurator

Calculating noise levels when trying to spec the right fan can be complicated. The Hartzell-FLOW fan configurator can help you identify and design the right fan for your site, while also factoring in noise level requirements. You'll get an exact drawing plus data and details to drop directly into your blueprints.



Hartzell Air Movement
910 S. Downing St.
Piqua, OH 45356
800-336-3267
hartzellairmovement.com