SPRING 2010
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AMCA INTERNATIONAL inmotion

THE ONLY MAGAZINE DEDICATED TO THE AIR MOVEMENT & CONTROL INDUSTRY

IN THIS ISSUE:

- Fan efficiency guides: How to apply the new standard
- Quantifying the benefits of smoke dampers in sprinklered buildings

Supplement to Consulting-Specifying Engineer

Reed Business Information. RBI

Revit® add-in available from COOK

Loren Cook introduces
FanDrafter® 3D – MEP,
an “add-in” for use in Autodesk® Revit®.

Building on Cook’s complete catalog of Revit® models, this add-in simplifies placement and customization of the Cook models in your projects.

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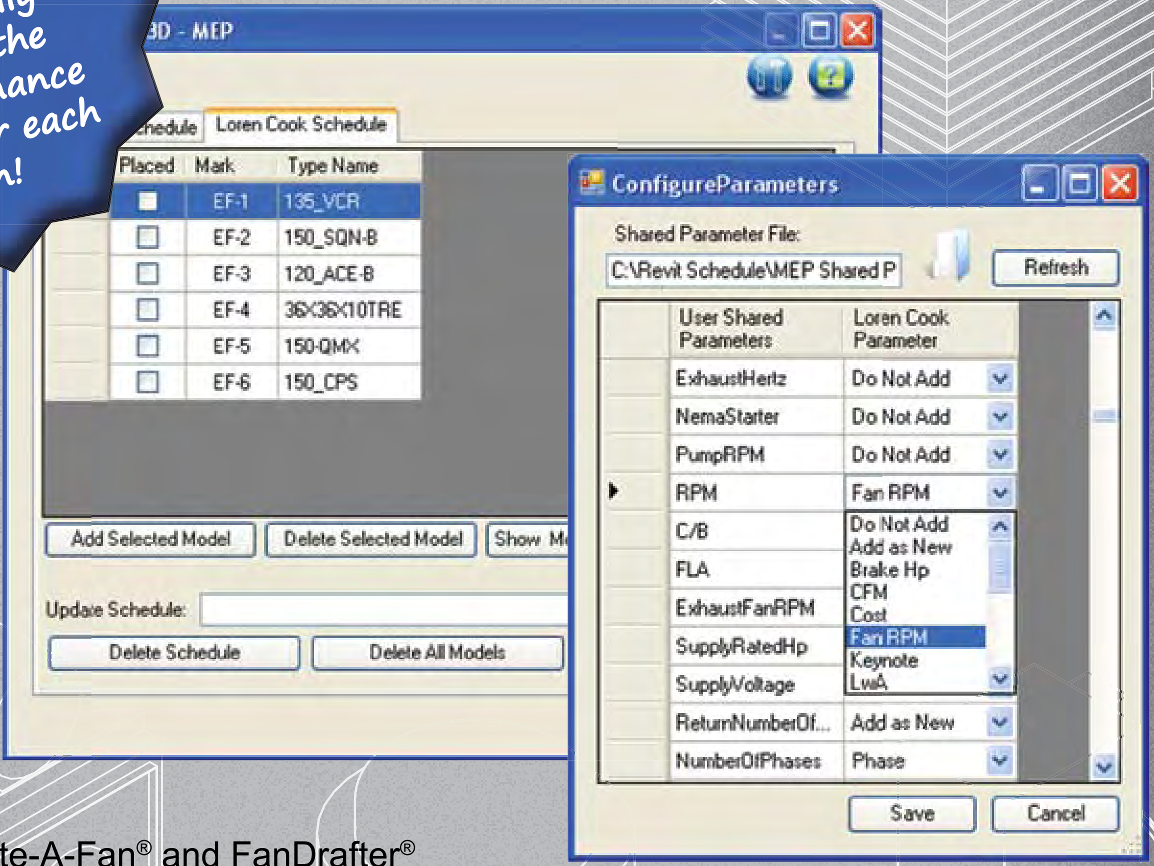

Placed	Mark	Type Name
☐	EF-1	135_VCR
☐	EF-2	150_SQN-B
☐	EF-3	120_ACE-B
☐	EF-4	36X36X10TRE
☐	EF-5	150-QMX
☐	EF-6	150_CPS

Shared Parameter File: C:\Revit Schedule\MEP Shared P

User Shared Parameters	Loren Cook Parameter
ExhaustHertz	Do Not Add
NemaStarter	Do Not Add
PumpRPM	Do Not Add
RPM	Fan RPM
C/B	
FLA	
ExhaustFanRPM	
SupplyRatedHp	
SupplyVoltage	
ReturnNumberOf...	Add as New
NumberOfPhases	Phase

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Michael G. Ivanovich, Editor-in-Chief, Consulting-Specifying Engineer

Amara Rozgus, Senior Editor & Manager of E-Content, Consulting-Specifying Engineer

Leslie Pappas, Manager, Creative Services

Patrick Lynch, Associate Editor

// PUBLICATION SERVICES

Reed Business Information
2000 Clearwater Drive
Oak Brook, IL 60523
phone: 630-288-8780
fax: 630-288-8782

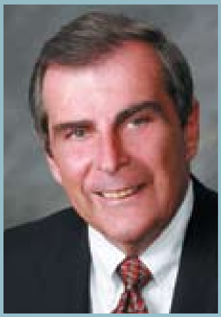
Jim Langhenry, Publisher

Trudy Kelly, Assistant to the Publisher

Elena Moeller-Younger, Marketing Director

Michael Rotz, Production Manager

president's message



In the Fall 2009 issue of AMCA inmotion, I commented that economists were reporting an uptick in the economy, but it would be a year or so before the commercial buildings industry felt any impact from it. Well, we're obviously still in that lag.

Nonetheless, AMCA continues to work toward improving not only the products of our members, but the resources available to our customers for improving their processes for designing, sizing, and selecting air movement and control systems.

One way AMCA is instrumental to our industry is in the development of testing standards for the AMCA Certified Ratings Program, which provides engineers, contractors, and owners with the assurance that AMCA-certified products will perform as expected in the field.

AMCA also develops standards and guidelines that help engineers with the design and specification of systems. I am excited to report that AMCA Standard 205-10, Energy Efficiency Classification for Fans, was approved by the AMCA International membership in February, and that this issue of AMCA inmotion has an in-depth article on how to apply this standard.

For information on this standard and all AMCA standards and guidelines, and for electronic versions of this and other issues of AMCA inmotion, visit AMCA's Web site at www.amca.org.

Sincerely,

Arthur J LaPointe

Art LaPointe
2009-2010 President, AMCA International
Vice President and General Manager, Construction Specialties Inc.

feature articles

departments

AMCA International, Inc. is a not-for-profit association of the world's manufacturers of related air system equipment. For over 80 years, it has led the way in standards development and application research.

PUBLICATION UPDATES

Product Rating Manual for Acoustical Duct Silencers

AMCA International reaffirmed AMCA publication 1011-03, a Certified Ratings Program Product Rating Manual for Acoustical Duct Silencers, and provides a program for certifying a product's sound dynamic insertion loss, airflow generated noise, and pressure drop performance ratings.

Products that can be licensed by AMCA to bear the AMCA Certified Ratings Seal are prefabricated acoustical duct silencers. Prefabricated acoustical duct silencers are defined as silencers that are constructed in advance, or manufactured in standard assemblies or sections ready for field installation.

The program applies to acoustical duct silencers within the scope of AMCA International for which performance rating catalogs are published and made available to the public. When performance ratings for both licensed and unlicensed products are contained in the same catalog, a clear distinction must be made between licensed and unlicensed products, as required in Section 11 of AMCA International Publication 11, Certified Ratings Program Operating Manual.

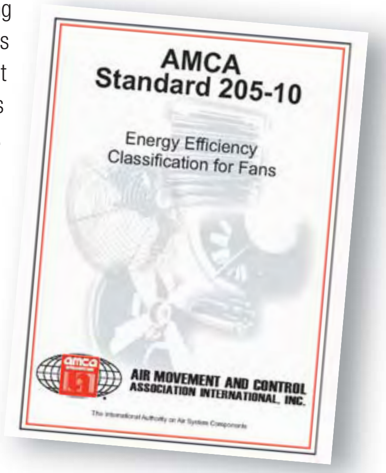
When licensed products are used as component parts of a larger unit, the AMCA International Certified Ratings Seal shall not be applied to the complete unit. The seal can only be applied to the individually licensed components.

Energy Efficiency Classification for Fans

The Air Movement and Control Association International, Inc. (AMCA International) announced that AMCA STANDARD 205-10, Energy Efficiency Classification for Fans, was approved by the AMCA International membership on February 19, 2010.

This standard defines the classification for all fan types designed to be driven by motors of nominal rating 125 W (1/6 hp) and above. The fans can range from the purpose-built single fan to series-produced fans manufactured in large quantities. This standard applies to the fan and not to the fan system, and it excludes classification for circulating fans.

This standard may be used by legislative or regulatory bodies for defining the energy efficiency requirements of fans used in specific applications.



AMCA
Standard 205-10

Energy Efficiency
Classification for Fans

AIR MOVEMENT AND CONTROL
ASSOCIATION INTERNATIONAL, INC.

The International Authority on Air System Components

Laboratory Methods for Testing Actuators

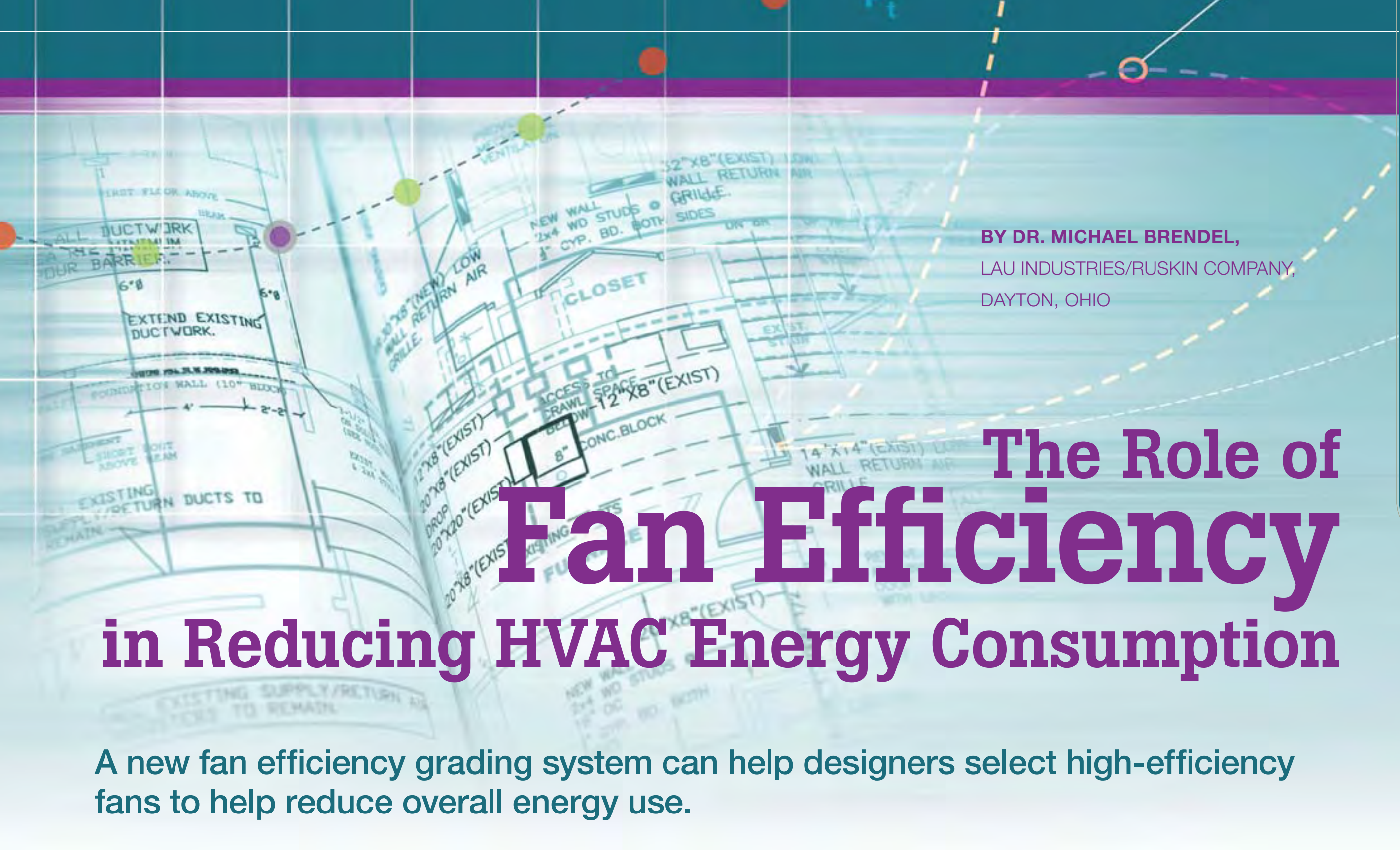
AMCA International announced that the Board of Standards Review of the American National Standards Institute (ANSI) approved the following document on December 2, 2009: ANSI/AMCA STANDARD 520-09, Laboratory Methods for Testing Actuators. This standard establishes an industry standard for minimum rating and testing of actuators used on fire/smoke dampers. The testing requirements for ANSI/AMCA Standard 520-09 will cover torque or force rating, long-term holding, operational life, elevated temperature performance, periodic maintenance, production, and sound testing for both pneumatic and electric operators.

Application Manual for Airflow Measurement Stations

AMCA International has reaffirmed AMCA 600-06, Application Manual for Airflow Measurement Stations, which provides important points to be considered when designing or specifying HVAC and other applications in installations requiring airflow measurement stations (AMS) for use in temperatures from -30 C to +120 C (-20 F to +250 F), pressures to 250 Pa (10 in. wg), and velocities to 28 m/s (5,500 fpm).

The AMCA 600-06 manual is intended to assist designers and users with proper application, performance considerations, selection, and limitations of airflow measurement stations. This guide provides an overview of permanently installed airflow measurement stations and their application. Such information is not readily available in current texts on HVAC or ventilation system design and will help designers to avoid typical problems, including incorrect location, inappropriate measurement range, mismatched accompanying instrumentation, AMS incompatible with the intended application, and the like.

All AMCA publications are available at www.amca.org/store/default.aspx



BY DR. MICHAEL BRENDEL,
LAU INDUSTRIES/RUSKIN COMPANY,
DAYTON, OHIO

The Role of Fan Efficiency in Reducing HVAC Energy Consumption

A new fan efficiency grading system can help designers select high-efficiency fans to help reduce overall energy use.

In 2008, the United States consumed about 100 quadrillion BTU (106 EJ) of source energy to power everything from lightbulbs to automobiles. That is the equivalent of over 29 million kWh, or a per capita energy consumption rate of 11 kW. The vast majority of this energy comes from a limited supply of nonrenewable resources. This has led many industries to implement far-reaching initiatives and policies to address energy conservation, and the HVAC industry is no exception.

The annual energy consumption for heating and cooling of commercial buildings is estimated at 5 quadrillion BTU (5.3 EJ). About one-third of this energy is used by the supply, return, and exhaust fans. While this estimate represents a small fraction of overall energy consumption, responsible energy awareness and management at all levels is necessary to achieve long-term energy reduction goals. This article reviews the energy requirements of HVAC air distribution systems and shows how a new fan efficiency grading system, embodied in standard AMCA 205, will play a role in assuring energy-smart fan selections. See the related news story on the recent passage of AMCA 205 on Page 4.

ENERGY REQUIREMENTS

A typical HVAC distribution system includes a network of ductwork, coils, filters, dampers, diffusers, and many other specialized components. Airflow through these devices encounters resistance, in the form of a pressure drop, which must be overcome by adding energy to the flow. This energy can be separated into potential and kinetic components, corresponding to the static and velocity pressure. The total energy, or total pressure (P_t) by analogy, is the sum of the two components: potential plus kinetic. Static pressure (P_s) and velocity pressure (P_v) can be traded back and forth in a duct system, so both need to be correctly accounted for when considering energy consumption. Ignoring compressibility effects, the rate at which energy must be added to maintain a prescribed airflow rate is the total pressure drop multiplied by the flow rate. This is called the air power and in I-P units it is calculated as $H_o = P_tQ/6362$ where H_o is the air power (hp), P_t is the total pressure drop (in-wg), and Q is the flow rate (cfm). Although the air power must be provided by the fan, it is important to recognize that the required air power is a result of system design and does not depend on the fan selection. A clear goal in reducing HVAC system energy consumption is to minimize the required air power through proper design of the air distribution system; that is, minimize the system pressure drop and/or the flow rate. This responsibility rests with the system designer and is the first step in achieving energy reduction.

Specifying an energy-efficient fan can go a long way toward reducing energy consumption, but it is not a sufficient requirement. A poorly designed air distribution system with a high total pressure drop might utilize a high-efficiency fan, but the net energy consumption could be higher than a properly designed system with low total pressure drop, utilizing the same fan. One way to assure good system design is to specify a maximum allowable air power per unit flow rate, H_o/Q. This effectively places an upper limit on the system pressure drop, P_t. A variation of this approach is currently used in the ASHRAE 90.1-2007 standard to encourage good system design.

FAN EFFICIENCY

Figure 1 is a Sankey diagram showing the energy flow through a fan system. A typical fan system consists of a motor,

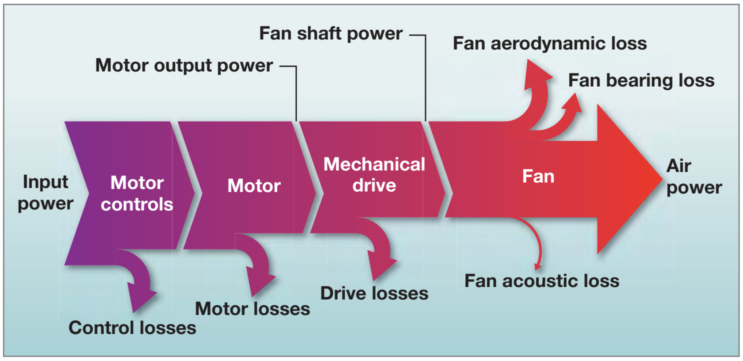


Figure 1. Fan energy flows from left to right through a typical fan system.

motor control, mechanical drive, and the fan. Power flows from left to right, with each component rejecting a portion of the input energy as a result of inefficiencies. Energy efficiency of each component is the ratio of the output power to the input power. The fan imparts energy to the air stream by converting mechanical power at the fan shaft to air power at the outlet. Some of the input energy is rejected due to aerodynamic losses, mechanical losses (e.g., bearings), and, to a much lesser extent, acoustic losses. The total efficiency of the fan is given by the ratio of air power to fan shaft power.

Establishing energy-efficiency goals for fans presents a number of challenges. Fan total efficiency is a function of many variables including fan type, airflow, speed, and impeller size. For example, HVAC fans are often designed as a product series that includes multiple sizes to meet different airflow requirements. Fans within the series generally have geometric similarity whereby key dimensions scale in direct proportion to the fan impeller diameter. However, it is well known that smaller HVAC fans do not perform as well as larger fans from the same series. This is due to practical limits in manufacturing tolerances, aerodynamic effects, and disproportionate mechanical losses that occur as the fan size is reduced.

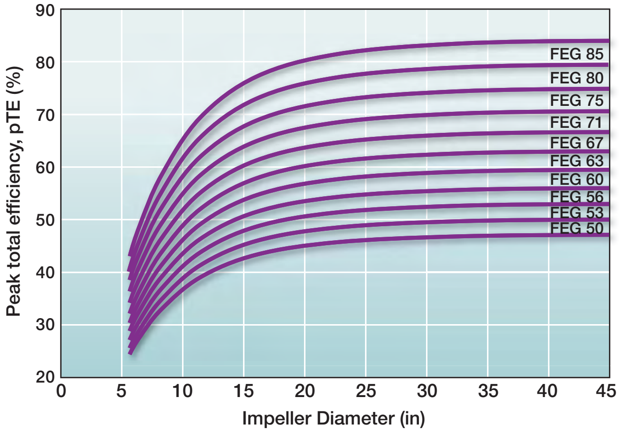


Figure 2. Fan Efficiency Grade curves are used to classify fans by their energy efficiency.

Over the past several years, fan industry leaders within the AMCA and ASHRAE communities have developed a simple metric to classify fans by their energy efficiency: the Fan Efficiency Grade (FEG). The FEG has been proposed in draft standards AMCA 205 and ISO 12759, and offers code/regulatory bodies a tool for specifying fan energy-efficiency targets.

The FEG for a given fan is determined from the peak total efficiency (pTE) and the impeller diameter using the curves shown in Figure 2. These curves are constructed so that fans in a given geometric series should all have the same FEG regardless of fan size. The FEG is established by plotting the impeller diameter and peak total efficiency, then reading the associated FEG band in which this point falls. For example, a fan with an impeller diameter of 15 in and a peak total efficiency of 71% would have an FEG of 80.

The FEG applies to a fan without any drive components. It is customary in many parts of the world for manufacturers to sell fans without motors or drives. Selection of efficient motors, controls, and drive systems is left to the buyer, which provides flexibility in designing custom HVAC products. This also places the responsibility for achieving higher FEGs directly in the hands of the fan manufacturers. More details concerning the

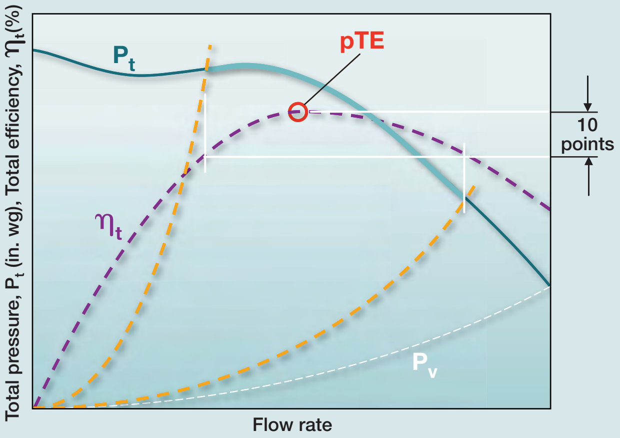


Figure 3. This diagram depicts a typical fan curve and the proposed 10-point total efficiency band.

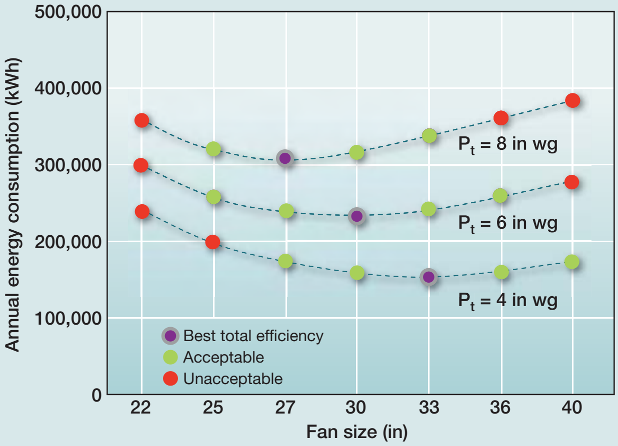


Figure 4. This chart shows examples of fan selections in terms of annual energy consumption.

Table 1. Selections for 25,000 cfm @ 6 in-wg (total pressure)

FAN SIZE	SPEED (RPM)	SHAFT POWER (HP)	TE	pTE	DIFFERENCE
22	2507	36.1	65.6%	78.0%	12.4%
25	1992	31.7	74.6%	80.0%	5.4%
27	1656	29.2	80.9%	82.0%	1.1%
30	1399	28.3	83.5%	83.5%	0.0%
33	1247	29.4	80.3%	83.5%	3.2%
36	1138	31.6	74.7%	84.0%	9.3%
40	1044	33.8	69.9%	84.0%	14.1%

history, development, and scope of the FEG may be found in a previous article.

The FEG is not the fan efficiency. It is a classification that represents the energy efficiency potential of a fan. It is the responsibility of the system designer to properly select fans to best suit the needs of the application. Future regulations may place a lower limit on acceptable FEG as part of an overall strategy to reduce fan energy consumption. However, this alone will not guarantee that fans are properly selected. Per AMCA 205, codes that specify a minimum FEG must also require that fan selections be within 10 points of the peak total efficiency. This additional requirement assures high-efficiency operation and helps place emphasis on total operating cost, rather than first cost.

But how restrictive is the 10-point limit on fan selection?

FAN SELECTION

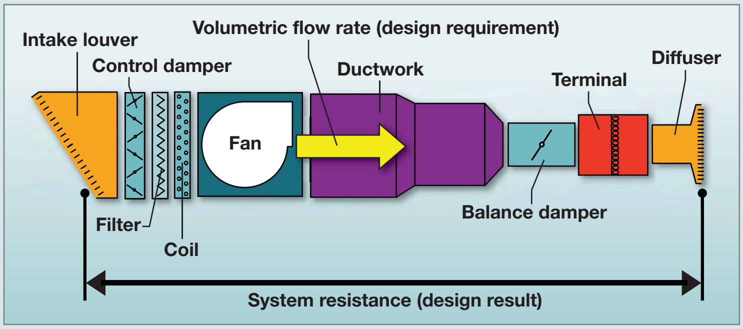
Figure 3 shows a typical fan curve with both the total pressure and efficiency characteristics as well as the proposed 10-point total efficiency band. For most common fan types (DWDI Airfoil, plenum, DWDI forward curved, etc.), approximately 50% of the fan capacity is available for selection. This is often comparable to the manufacturer's recommended selection range.

By way of example, consider an air handler that delivers 25,000 cfm (42,500 m^3/h) at 6 in-wg (1,500 Pa) total pressure. Selections were obtained from a series of belt-drive double-wide airfoil fans having a FEG of 85. Table 1 shows several selections meeting the performance target along with required shaft power and total efficiency. Five of the seven selections are acceptable based on the 10-point efficiency requirement.

Taking this one step further, Figure 4 shows the selections in terms of annual energy consumption. Here it is assumed that the motor and mechanical drive efficiencies are both 90%

DR. MICHAEL BRENDEL is vice president of Lau Industries/Ruskin Company.

> *The FEG is not the fan efficiency. It is a classification that represents the energy efficiency potential of a fan.*



A typical HVAC air distribution system consists of a variety of a/c and air control elements. The flow rate is a design requirement, while the system resistance is the result of component selection and design calculations.

and that the duty cycle for the fan is continuous. This plot also shows the importance of minimizing the system restriction by considering the same 25,000 cfm flow requirement for 8 in-wg (2,000 Pa) and 4 in-wg (1,000 Pa) systems. In both cases, several fan sizes meet the 10-point restriction, although the fan size for best performance increases with decreasing pressure requirement.

The number of available selections offers the system designer reasonable flexibility in selecting a fan size to meet other design requirements. For example, further energy reductions are possible with a VAV (variable air volume) system where fan speed is modulated based on a duct pressure signal. The fan must be selected to assure efficient operation and acceptable turndown to meet multiple flow conditions. This requires careful consideration of the fan operating schedule to determine the net energy consumption at each operating point. In some instances, this may lead to a fan size that is smaller than that selected for continuous operation.

SUMMARY

Energy consumption of HVAC systems is garnering much attention on both national and international fronts. Achieving energy reduction goals in HVAC air distributions systems can be accomplished on several levels. Designing systems that minimize pressure drop for a given flow requirement must be the first priority in reducing energy consumption. Selection of high-efficiency fans that operate near peak efficiency complements good system design and contributes to overall energy reduction.

The FEG, a new fan energy-efficiency classification that has been proposed in AMCA 205 and ISO 12759, offers a simple metric for code and regulatory bodies to formulate new energy standards for fans. The added requirement for selecting and operating fans within 10 points of peak total efficiency assures meaningful energy conservation without over-restricting system design options.

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2. Westphalen, D., and S. Koszalinski. Energy Consumption Characteristics of Commercial Building HVAC Systems, Vol. II: Thermal Distribution, Auxiliary Equipment, and Ventilation. DOE/BTX. October 1999.
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4. Brooks, J., J. Cermak, and J. Murphy. Fan Industry Meeting Energy Challenges. AMCA Inmotion Spring 2009.

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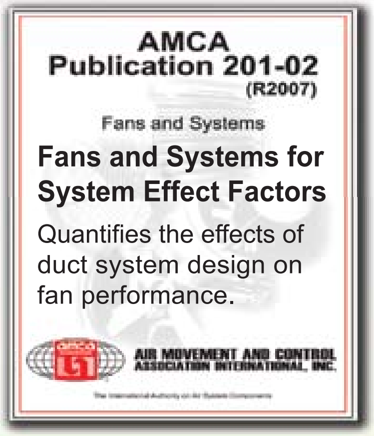
- Louver Performance against Wind Driven Rain
- Airflow Measuring Accuracy



AMCA
Publication 201-02
(R2007)

Fans and Systems

Fans and Systems for System Effect Factors

Quantifies the effects of duct system design on fan performance.

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30 West University Drive
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ASK ABOUT ENERGY STAR

BY VICKIE LOVELL,
INTERCODE INC.,
DELRAY BEACH, FLA.

DAMPERS:
An essential component of fire protection design

Automatic fire and/or smoke dampers and automatic fan shutdown in HVAC systems are effective in preventing the migration of smoke, flame, and heat during a fire.

Based on an examination of NFPA data in the 1930s, in 1939 the National Board of Fire Underwriters recommended that dampers be installed in HVAC systems to interrupt the passage of smoke, flame, and heat during a fire. Since that time, numerous experts in the field of the fire sciences have substantiated the effectiveness of automatic closing fire and/or smoke dampers and automatic fan shutdown in HVAC systems in preventing the migration of smoke, flame, and heat to areas of a building remote from the area of origin. Throughout the world, fire protection engineers and mechanical engineers continue to incorporate fire and/or smoke dampers into the fire protection design of many types of modern buildings.

CODE REQUIREMENTS

A fire damper is a device, installed an HVAC system, that closes automatically upon the detection of heat in accordance with UL standard 555. A smoke damper is a device

> *“The International Code Council (ICC) voting membership has consistently rejected proposals to entirely remove smoke dampers from duct penetrations from shafts.”*

installed in an HVAC system to control the movement of smoke in accordance with UL 555S. Combination fire/smoke dampers fulfill the function of both fire and smoke dampers, and must meet the testing requirements of both.

In the United States, the legacy model codes contained provisions for requiring construction capable of resisting smoke spread. Some of those requirements included the installation of smoke dampers. The 2000 Edition of the International Building Code (IBC) retained the requirement for smoke dampers in corridor walls when the corridor has a fire resistance rating in language similar to the legacy codes.

But the 2000 IBC added a new requirement that requires smoke dampers at the penetration of shaft enclosures in lieu of requiring engineered smoke control systems, which had also been mandatory under certain conditions in two of three of the legacy codes. This code change was accepted in the new IBC on the basis that many of the previously required fire-rated and smoke-resistant floor and wall requirements in the legacy codes were permitted to be weakened or eliminated when automatic sprinklers were installed.

Because smoke dampers installed in duct penetrations of shaft enclosures is a relatively new building code requirement, and despite the concern about smoke spread throughout buildings (including sprinklered buildings), the requirement for smoke dampers in duct penetrations of shafts has been under attack in every IBC change cycle since 2000. The opponents of smoke dampers have previously cited the installed cost and maintenance cost of smoke dampers as an “unreasonable expense” to building owners, without increasing the safety of the building occupants. The debate will occur again during the hearings for the public comment on FS 113 May 18 to 19 in Dallas at the ICC Final Action hearings for the 2012 IBC.

The reliability and effectiveness of sprinklers is often cited as a justification for removing the requirement for smoke dampers in shafts. The International Code Council (ICC) voting membership has consistently rejected proposals to entirely remove smoke dampers from duct penetrations from shafts. Although the ICC has voted to support some revisions since the proposal was approved, it still applies to many buildings. However, the valid question remains as to the cost benefit of smoke dampers in shafts in sprinklered buildings.

AMCA RESEARCH

In 2008, the Air Movement and Control Assn. International (AMCA) contracted with Koffel Assocs. Inc. to conduct a literature search to identify credible work on this subject, and to use the research findings (if any) as the basis for additional computer modeling. The literature search resulted in two interesting findings:

First, no documents were found that would support the removal of smoke dampers in shaft penetrations. On the contrary, the literature search provided a sampling of fires from the past 25 years where smoke spread was an issue for occupant life safety. Many of the fires occurred in occupancies in which at least some of the legacy building code requirements would not specifically have required smoke dampers but would have required construction capable of preventing smoke spread, which could have included dampers. The data collection methods from the time period studied would not have specified when smoke dampers would have been required, or even if they had been provided as an above-code provision.

Second, the literature search identified a relatively recent modeling effort and some full-scale fire tests on the vertical spread of smoke in buildings via shafts. The additional modeling research, which has been contracted to be completed by Koffel Assocs., expands on these two studies in an attempt to better quantify the benefit of smoke dampers at duct penetrations of shafts in sprinklered buildings. (The report on the research and modeling conducted by Koffel Assocs. was nearing completion at the time of this article’s printing, and will be available in the near future through AMCA’s website at www.amca.org.)

THE SPRINKLER RELIABILITY DEBATE

At the heart of every debate in the decision to eliminate a fire or smoke protection feature in order to offset the expense of automatic sprinklers are two issues: reliability of automatic sprinkler systems and their relative cost/benefit. The fact that sprinkler systems fail to perform satisfactorily from time to time is not debated. However, the frequency and the causes of such failures stir controversy. When such malfunctions occur, a fire that would have been a nuisance can quickly become a potential catastrophe.

Sprinkler reliability figures are tossed about casually to promote their installation without much consideration given to the consequences of sprinkler failures in buildings where many other features have been eliminated. In 2009, NFPA’s John Hall authored the report, “U.S. experience with Sprinklers and Other Automatic Fire Extinguishing Equipment.” The fire data used to support the study was gathered from 2003 through 2006. In the study, Hall states that “automatic sprinklers are highly effective elements of total system designed for fire protection in buildings with sprinklers cover the area of origin, they do they operate in 95% of all reported structure fires large enough to activate sprinklers. When they operate,

IN A FIRE,
THE HIGHEST RISK TO LIFE
IS SMOKE.

they are effective 96% of the time, resulting in a combined performance of operating effectively in 91% of reported fires were sprinklers was present in the fire area and the fire was large enough to activate."

In 1997, an NFPA study examined fire data from 1986 to 1995 to evaluate the extent of flame and smoke spread in sprinklered and nonsprinklered buildings. For high-rise buildings (seven stories or taller), the study showed that 11.4% of fires in sprinklered buildings resulted in smoke damage beyond the fire floor, while 15.4% of fires in nonsprinklered buildings resulted in smoke damage beyond the fire floor. For mid-rise buildings (three and six stories), 15.7% of fires in sprinklered buildings resulted in smoke damage beyond the fire floor while 34.4% of fires in nonsprinklered buildings resulted in similar damage.

While the study was unable to define the severity of the smoke damage or toxicity, it is significant that so many fires in sprinklered buildings had smoke damage beyond the fire floor. If smoke dampers were to be eliminated in sprinklered buildings, and the automatic sprinkler systems failed for whatever reason, the spread of smoke during fires would almost certainly increase.

It is important to note that neither NFPA report supports the position that sprinkler systems eliminate smoke, or that fires that are controlled by sprinklers do not continue to smoke production. G. W. Mullholland's paper entitled "Smoke Production and Properties," recorded in the 1995 SFPE Handbook of Fire Protection Engineering, estimated that if the airborne soot particulates produced by burning an upholstered armchair filled with 9 lbs of polyurethane foam were uniformly distributed throughout 1,800-sq-ft room, a person would not be able to see his or her own hand held at arm's length in front of his or her face. Even when sprinklers successfully suppress a fire, the fire can be expected to continue to burn and produce soot particulates and toxic gases.

Numerous studies have been conducted on fires where the sprinklers' water spray was shielded by some obstruction and never reached the item that was burning. Such fires effectively became nonsprinklered fires.

Experts confirm that automatic sprinkler systems are very effective, although not infallible or a panacea. The sprinkler industry, the fire service, and the fire protection community are continually striving to improve sprinkler reliability when the causes of sprinkler failure become known. John Klote, in an article entitled "Compartmentation and Dampers are Essential," stated, "in our ever-changing organizational functions, materials, construction methods, and architectural designs, it is reasonable to expect that new failure situations will arise. For that reason, sprinklered buildings need other fire (and smoke) protection features to ensure an adequate level of protection in the event of sprinkler failure."

Additionally, damper manufacturers, contractors, installers, and the fire service are cooperating to ensure that the dampers are both installed correctly and periodically inspected to ensure functionality.

Building codes can control the construction materials used in a building, which is taken into consideration when sprinkler systems are designed. However, neither building codes nor designers can control the materials that occupants bring into the building. If the wrong types of materials are brought into a building a sprinkler system that would otherwise control a fire can be easily overwhelmed. Therefore, sprinkler systems are best supported by designs, systems, and devices such as smoke dampers that help to manage smoke migration, even during successful sprinkler activation.

CONCLUSION

There is little debate as to whether an HVAC system can transport smoke to areas remote from the fire area's origin. However, there is still some debate as to how best to manage the smoke in both sprinklered and nonsprinklered fires. For many years, system shutdown was the standard approach to achieving some control over smoke migration.

Since 2000, however, the operation of the HVAC system in smoke control mode is not required in most buildings constructed to the IBC. Without an engineered smoke control system, or complete system shutdown and functional smoke dampers at shaft penetrations, the HVAC system can transport smoke to every building area the system serves. Even shutting down the HVAC system without dampers will not prevent it from supplying oxygen to the fire and will not entirely prevent smoke movement throughout the HVAC system.

The installation of smoke dampers at the shaft penetration by the duct can help inhibit smoke movement through the HVAC system.

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Vickie Lovell is the president of Intercode Inc., Delray Beach, Fla. Intercode specializes in national model building code development and consulting for companies with commercial markets that are affected by building codes and standards.

AMCA International's 2010 Event Calendar

AMCA Pacific Rim Region Meeting
Beijing, China
April 8, 2010

AMCA European Region Meeting
Lyon, France
April 12–14, 2010

AMCA Midyear Meeting
Elk Grove Village, Ill.
May 2–3, 2010

AMCA International 55th Annual Meeting
Fairmont Turnberry Isle Resort & Club
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AHR Expo Mexico
Mexico City
October 26-28, 2010

Big 5
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November 22-25, 2010

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Chicago
November 16-18, 2010

NFPA
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Miami
June 10-12, 25010

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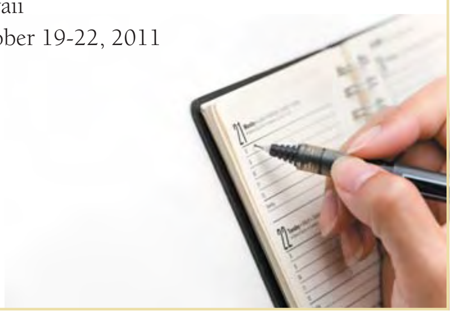
Beijing, China
April 7-9, 2010

AHR Expo
Las Vegas
January 31- February 2, 2011

AMCA International 56th Annual Meeting
Grand Hyatt Kauai Resort & Spa, Hawaii
October 19-22, 2011



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