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AMCA INTERNATIONAL inmotion

THE ONLY MAGAZINE DEDICATED TO THE AIR MOVEMENT & CONTROL INDUSTRY

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Specifying Air Curtains

Supplement to Consulting-Specifying Engineer
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AMCA INTERNATIONAL inmotion

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inmotion is published biannually to keep HVAC professionals abreast of rapidly changing codes, requirements, laws, advancements, and best practices in the air movement and control industry.

president's message

AMCA inmotion is published specifically for hvac professionals who design, specify, purchase, install, commission, operate, and maintain ventilation systems.

First, the good news: Energy prices are down and so is the cost of construction materials. In fact, Reed Construction Data reported in March that the drop in materials costs in 2009 has erased the cost increases of 2008.

But, the bad news is of greater concern: Construction activity is down for the first time since 2003 marked the turning point of recovering from 9/11. A freeze in financing has caused the delay of planned projects, and halted construction on some projects that had already begun. From municipal bonds to capital loans, it's difficult for companies to get the short-term and long-term financing they need to fund construction and renovation projects.

But perhaps the bad news won't turn out so bad after all. The momentum for energy efficiency and green construction is still strong. As the stimulus bill directly and indirectly funnels billions into construction projects, commercial and industrial markets might experience some bounce back.

Also, with the bailout bill passed last October, tax credits for energy-efficiency projects were extended not for one year, but for a confidence-building five years. Also (finally) bank reform is of the highest priority of the Obama Administration; they seem to be gradually working toward a solution that Wall Street and Main Street will embrace. (We can only hope.)

Internationally, countries are working hard to right their economies and get things back on track. The economy truly is global, so we're all in this together.

As the year unfolds, you can count on AMCA International to monitor economic news and events and report to its members and the construction community.

Meanwhile, we invite first-time readers of AMCA inmotion and those who may not be familiar with AMCA International to visit amca.org to learn about our Certified Ratings Program, peruse our database of member companies with certified products, and add AMCA International manuals and testing standards to your company's engineering libraries.

Best wishes,

Denis Labelle
2008-2009 President, AMCA International
Executive Vice President, T.A. Morrison & Co. Inc.

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.

Accredited CRP Testing Lab Opens in Singapore

Air performance testing includes development of fan curves and measurement of airflow, pressure, power, and efficiency.

AFMA Technologies Pte Ltd in July 2008 opened a new testing laboratory in Singapore, becoming the Air Movement and Control Association (AMCA) International's first independent authorized Certified Ratings Program (CRP) agent to serve the regions of Southeast Asia, the Middle East, and India.

AFMA Technologies' testing laboratory is equipped with state-of-the-art equipment and is accredited to perform both air and sound tests in accordance with AMCA International's test standards. Testing capacities will range from air volume of 650 cmh to 140,000 cmh. Damper leakage and pressure drop testing capabilities will be added later this year.

Through its administration of the CRP program, AFMA Technologies will be able to assure buyers, specifiers, and users of air movement and control equipment that published ratings are reliable and accurate. At the same time, the program assures manufacturers that competitive ratings are based on standard test methods and procedures.

Going forward, AFMA plans to use the facilities to verify energy-efficiency ratings for ventilation and air conditioning equipment. This will enhance the requirements of minimum environmental sustainability standards, ensuring that environmental quality and comfort are not compromised.

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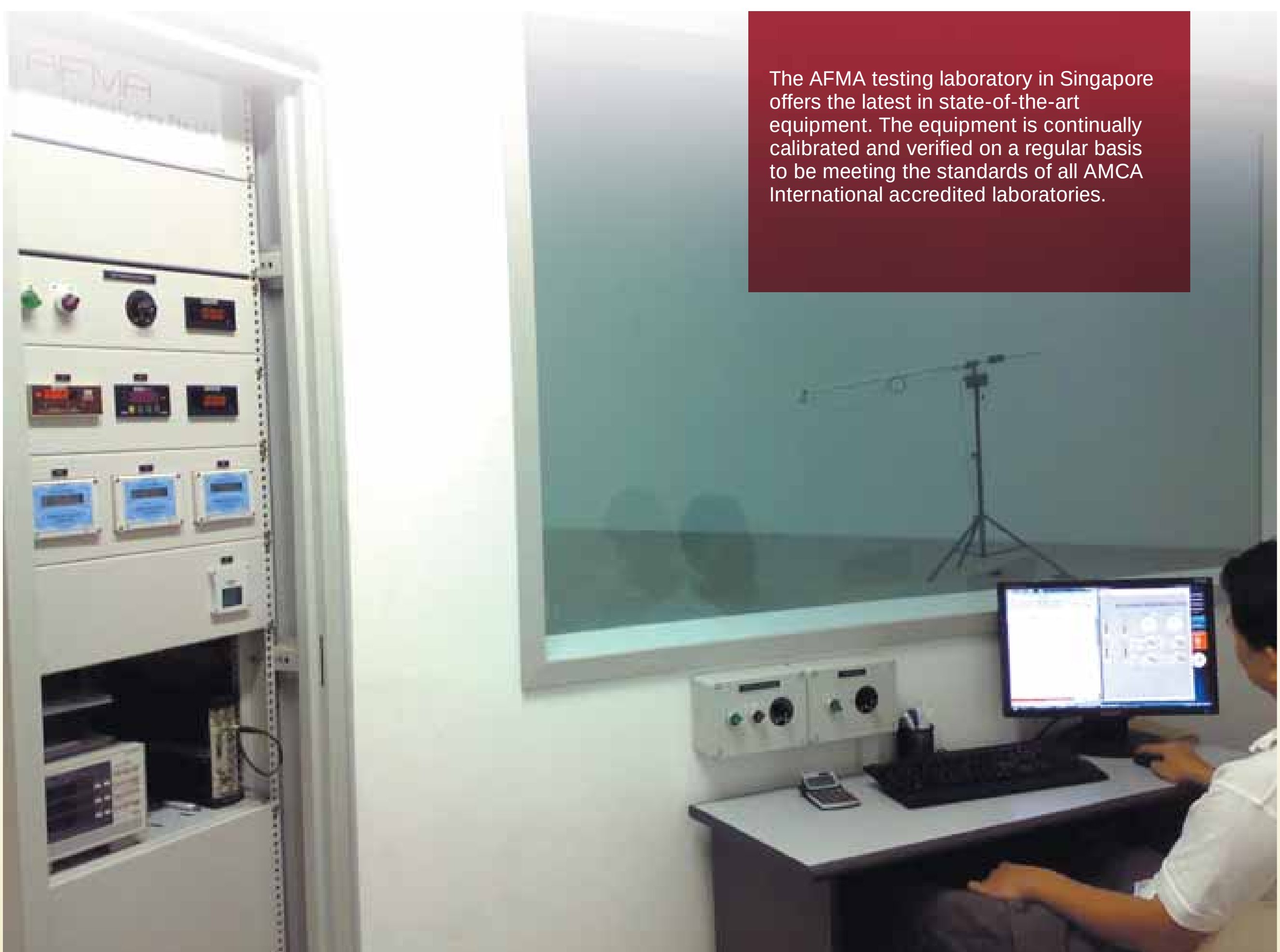

The AFMA testing laboratory in Singapore offers the latest in state-of-the-art equipment. The equipment is continually calibrated and verified on a regular basis to be meeting the standards of all AMCA International accredited laboratories.

ask hans

Q: When the price of raw materials goes down, does the cost for manufactured goods such as fans and louvers go down as well?

A: Falling material prices present a classic good news/bad news scenario for business. The cost of raw materials is lower, but so is the demand for the products.

First, let's start by talking about which prices are down, how far they have fallen, and the reasons for the declining price of production inputs. The primary nonferrous metals price index declined 30.8% from the official start of the recession in December 2007 to December 2008. The decline in steel prices began more recently, but steel mill product prices declined 12.4% from November 2008 to December 2008. Oil prices have declined precipitously as well. For the first time in 20 years, the U.S. Energy Information Administration (EIA) is forecasting no growth in U.S. demand for oil. According to the EIA, the price per barrel of oil is expected to average $60 (in 2007 dollars) during 2009. Steel, copper, and aluminum all owe their declining prices to the same source as declining oil prices—slack in global demand.

As for demand for products, the collapse of the credit markets has made it increasingly difficult to finance commercial and industrial construction projects. Falling corporate profits also have reduced the ability of firms to provide internal financing for projects. Therefore, there is less need for the products that go into the buildings, including fans and louvers.

At the time of this writing, the first quarter 2009 results were not final; however, the preliminary fourth quarter 2008 Gross Domestic Product (GDP) results showed a 6.2% decline. That is the steepest decline since the 6.4% decline that occurred back in 1982. Embedded in this decline are a 5.9% decline in nonresidential structures and a 22.1% decrease in durable goods. Data from the U.S. Census Bureau on orders for newly manufactured ventilation, heating, air-conditioning, and refrigeration equipment declined 23%, 4%, and 18%, each month from September 2008 to November 2008 when compared to the same time frame in 2007. According to data from AMCA International, dollar volume of orders for power roof ventilators, centrifugal fans, and axial fans declined by 1.7% in 2008 compared with 2007.

Commodity prices have fallen because the demand for the goods that use those commodities has fallen. Businesses can certainly expect their production input prices to fall during the recession. Falling input costs are unlikely to be offset by rising wage costs during a period of deflation or stagnant prices. Overall, it should cost businesses less to produce fans, louvers, etc.

The trouble though, as we discussed earlier, is that there will be less demand for these types of products by way of credit constraints and reduced ability to internally finance. This may create increased competition among manufacturers to acquire what little new business is in the marketplace. This could cause companies to lower prices in an attempt to attract new business. Companies would then be competing for less business at a lower price, but presumably at a profit margin similar to the one they had before the decline in commodity prices. Even though the marginal profit (profit per unit) may be the same with reduced production input costs, it is likely that total profits are lower because fewer units will be sold.

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Fan Industry Meeting Energy Challenges

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How the industry is finding ways to improve the energy use of fans.

More than 50 years ago, the industry formed the Air Movement and Control Association (AMCA), now AMCA International. Right from the start, AMCA implemented a Certified Ratings Program (CRP) for fan performance. The HVAC industry in the United States and Canada accepted certified fan performance instantly. As AMCA spread outside of North America and became AMCA International, so too did the acceptance of AMCA-certified performance of fans in other regions of the world, including Europe, Asia, and India.

In addition to and complementing the needs of the CRP, AMCA first began to develop standards for air performance, sound, balance quality, and vibrations for fans. Some of these standards were further developed as joint standards in conjunction with ASHRAE. The next step, accomplished in the last two decades, was developing American National Standards in these fields. Through this process, almost all AMCA standards for fans became American National Standards.

Members of the fan industry also participate in ASHRAE technical committees, and specifically in ASHRAE TC 5.1, Fans. Also, AMCA International is active in developing international standards for fans in the International Organization for Standardization (ISO) through the American National Standard Institute (ANSI), the U.S. member body in this organization. The center of this activity is in the ISO Technical Committee for Fans. This committee developed a number of ISO standards for fans, and some of them were developed from ANSI/AMCA standards.

RECENT AND CURRENT DEVELOPMENTS

Both ASHRAE and ISO are presently working on standards leading to reduction of energy use by fans. While ASHRAE is addressing the needs for HVAC in nonresidential buildings in the United States, the ISO's work is geared toward the usage of fans, with specific regard to needs in the European Union (as required by the European Union's Energy Using Directive) and the United States.

In fall 2007, the ASHRAE Standing Standard Project Committee (SSPC) 90.1 Mechanical Subcommittee invited ASHRAE TC 5.1, Fans, to participate in the development of the requirements for fan efficiency. An ad hoc working group was formed promptly.

The group first developed a system for energy-efficiency classification of fans. It also recognized that requirements for the application of the fans was just as important; after all, it would not be wise to require a highly efficient fan if it was used on the low efficiency part of the fan curve!

In 2008, the British delegation to ISO/TC 117, Fans, submitted a proposal for developing a new ISO standard on efficiency classification for fans. The ISO committee established a Working Group to develop the new standard. At this time, the Working Group has completed its work on the committee draft, and the draft has been presented to all member bodies of the committee for comments.

AMCA International recognized the importance of this effort, and its Fan Committee is participating in developing these requirements through its members working in the ISO and ASHRAE committees. As a result, the members of AMCA International are actively participating in these efforts, sharing their ideas and proposals with the members of these committees. It should be noted that while the United States and the European Union approaches are not identical, they are complementary.

Furthermore the AMCA Fan Committee established a subcommittee for development of an ANSI/AMCA Standard on fan energy efficiency. This standard will be harmonized with the new ISO Standard 12759.

FAN ENERGY EFFICIENCY

Due to the historical practice in fan applications, fan energy-efficiency issues need to be addressed before the details of the energy-efficiency classification for fans.

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JOHN MURPHY, PhD, is a principal of JOGRAM.

The roots of today's practice are based on using fan static pressure for fan selections. It is difficult to follow the trail all the way back, since the first historical record concerning fans is found in a book on mining written by Agricola in 1550. It is certain that the most important quantity sought has been the flow of air through a fan. Later, another quantity significant for fan selection was added—fan pressure—and that undoubtedly was the pressure we today call fan static pressure.

In the last five decades, it has been a common practice to select fans for applications using static pressure rather than total pressure, despite the fact that the pressure required by a system must be satisfied by the fan total, not static, pressure. As a result, static efficiency has been used as the measure of efficiency because it conveniently tied the fan power to the commonly used fan pressure. That is not to say that the fan total pressure has not been used at all; however, the use was limited primarily to selection of axial flow fans.

For HVAC systems, we define the fan as a motor-driven machine for delivering air. The fan energy input is from the motor shaft. The inlet and outlet of the fan are used as control surfaces in determining the energy transferred to the air by the fan. Therefore, the energy the fan delivers to the air is the difference in total energy between these control surfaces. This energy generally has two components: the dynamic one, because the air is in the motion, and the static one. The sum of both is the total energy delivered by the fan into the air.

The ratio of this energy to the energy delivered by the motor is the fan energy efficiency. It is also, and more frequently, called the fan total efficiency. This characteristic reflects the quality of the aerodynamic design of the fan and in no way reflects how this energy can be used in a fan application. However, there is no reason to condemn the use of the fan static efficiency because it may be used for other purposes.

Fan energy efficiency is a function of flow, even for operation at constant speed. At very low flow, this efficiency is low, but increases with increasing flow. At some particular flow, the efficiency reaches a maximum, and this value is frequently referred to as "peak" or "optimal" efficiency. With further increasing flow, the efficiency decreases.

The fan designer and manufacturer are responsible for the fan energy efficiency, while the HVAC system designer and the system user are responsible for the use of the fan energy. In other words, to get the minimum energy consumption for a given purpose, the fan efficiency has to be high and the fan has to be operated at or near its peak energy efficiency.

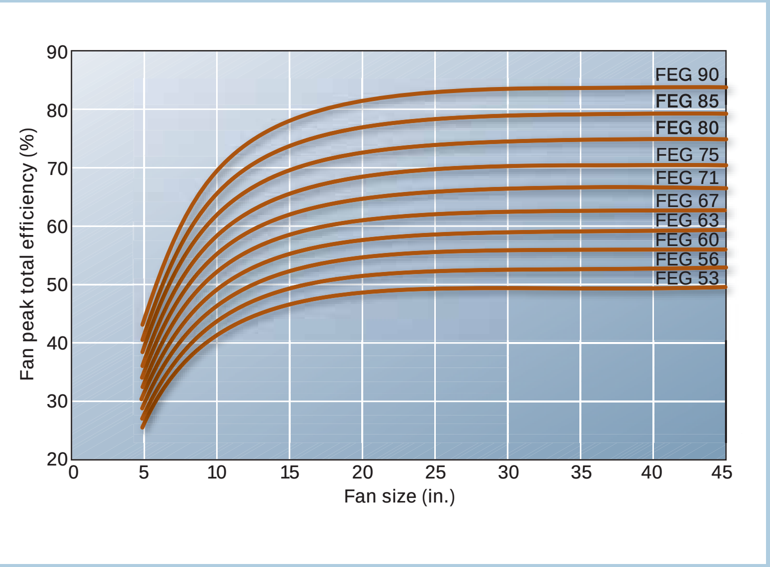
ENERGY-EFFICIENCY CLASSIFICATION FOR FANS

The U.S. approach to the energy classification for fans was designed by a large group of professionals organized in different bodies within AMCA International and ASHRAE.

The cornerstones of the approach were:

- The classification has to be based on the fan energy efficiency; i.e., fan total efficiency.
- The classification should allow regulatory bodies easy and meaningful declaration of fan energy-efficiency requirements for immediate needs as well as indicate the requirement for further reduction of fan energy use.
- The classification must encourage the fan manufacturers

Figure 1: Fan efficiency grades (FEGs) for fans without drives.



Notes:
1) Fan size is the impeller diameter.
2) The optimum (peak) fan efficiency can be calculated from the total fan pressure.
3) The FEG label for a given fan size is assigned when the optimum (peak) fan efficiency is equal to or lower than the efficiency at the grade upper limit and higher than the efficiency at the grade lower limit for the fan size.
4) No label is considered for the fans with the optimum (peak) efficiency below FEG 53.
5) For any fan size equal to or larger than 40 in., the values of the grade limits are the same as for the fan size of 40 in.
6) If this method is used for a direct-driven fan without the shaft and bearings integral to the fan, the fan efficiency is the impeller efficiency.

to improve the energy efficiency of their homologous products.

- The fan peak total efficiency of a fan series is dependent on fan size.
- The classification should, when possible, keep a series in one efficiency grade.

As a result, fan efficiency grades (FEGs) were defined as areas between two adjacent efficiency limits. The limits were shaped to follow the efficiency dependence on the fan size. The actual shapes of these limits were agreed upon after matching these shapes to the test data collected from national and international sources. The spacing of these limits was chosen to make the areas approximately equal for all grades. The relative difference between the upper and the lower limit for any grade is approximately 6%. The grade boundaries are depicted in Figure 1.

It was assumed that the FEG would be based on certified fan performance data and each fan size in the fan series would be assigned a grade label. In the proposed classification system, either all fan sizes of a series may be assigned the same grade label, or groups of adjacent sizes may be assigned the same label. For an example of grade assignment of a fan given the peak total efficiency, see Figure 2.

The ISO working group that is developing fan energy-efficiency grades is planning to define grades by fan type and include motor and drive losses.

The idea of establishing separate FEGs for each fan category (e.g., centrifugal fans with airfoil blades, vaneaxial fans, plenum fans, etc.) was abandoned in the early stages of the development process because it did not make sense to encourage the use of any fan category with low fan energy efficiency when the goal is to reduce the energy used by fans. Fans that do not fit into the

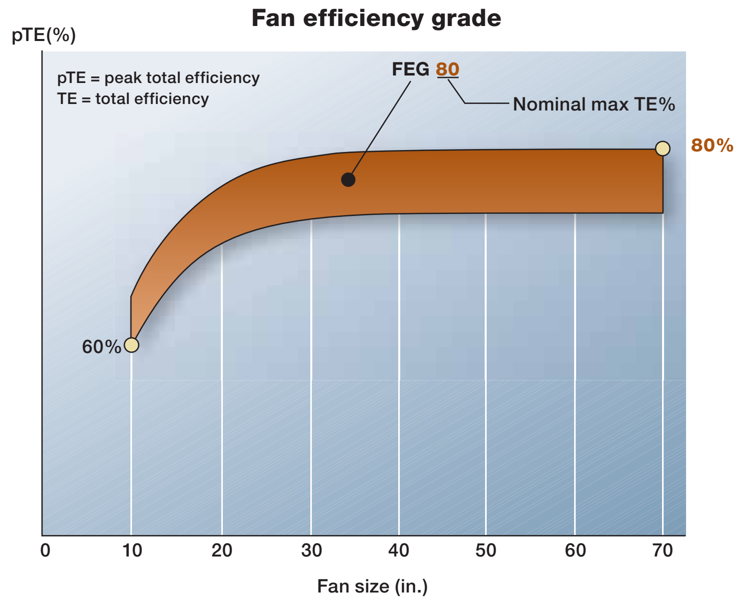


Figure 2: How a FEG is determined from a fan's peak total efficiency.

energy-efficiency requirement should not be used regardless of category.

The combination of the fan and motor also was considered for classification, but it was concluded that would be counterproductive to the effort because it would make the responsibility areas ambiguous. In many instances, the motor is not part of the fan delivery, and in other instances, the motor efficiency level is dictated by the customer. Furthermore, during the fan selection process, it is acceptable to select the fan on the basis of its energy efficiency and make the requirements for the motor efficiency the responsibility of the motor manufacturer. In addition, a motor's efficiency may be

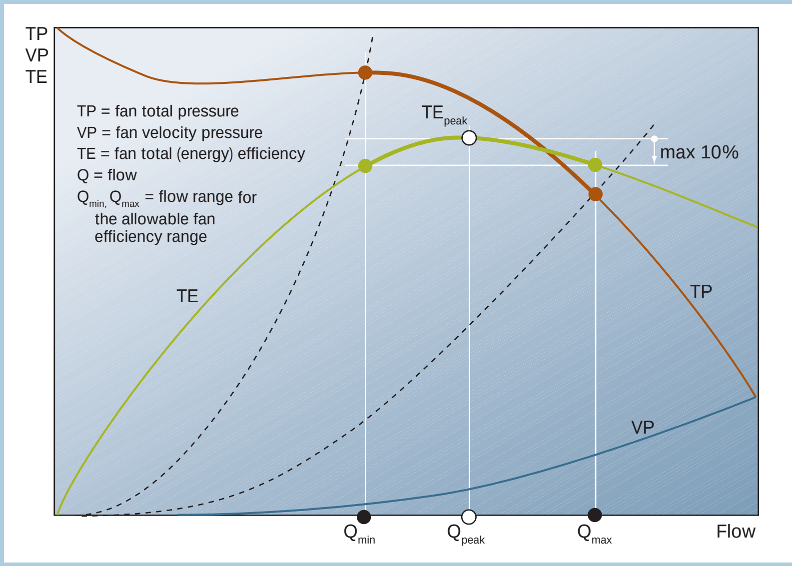


Figure 3: A typical fan performance curve, efficiency curve, and two system curves are shown. The system operating point should fall within a range around the peak efficiency. This figure shows an efficiency range on either side of the peak efficiency, the corresponding point on the fan curve, and the two associated system curves. The system should be designed to operate between these two system curves.

Source for all figures: John Cermak

regulated by another authority. For example, in the United States, public law requires minimum efficiencies for motors with power ratings of 1 hp or greater.

It also was agreed that to achieve the expected energy savings, the fans must have high peak efficiency but also must be operated near peak efficiency. Therefore, two additional measures are proposed.

First, the fan must be selected near peak efficiency for all expected operating points. The fan efficiency at any operating point should not be more than 10% (points) less than the fan peak total efficiency (see Figure 3). This requirement will go a long way toward correcting the tendency to weigh initial cost far more than operating cost.

Second, if the fan is intended to operate only part of the time or has been selected for multiple operating points, possibly at different fan speeds, the overall energy consumption of the fan over one year must be calculated using estimated times of operation for each point. This requirement is important because it opens up the possibility for a regulatory body to make exceptions from application-required FEGs because the overall energy used by the fan is acceptably small. This approach is already a part of the ISO 12759 and the AMCA 205 standards currently under development. The work on both standards may be accomplished by the end of 2009.

CONCLUSIONS

The fan manufacturers within AMCA International, in conjunction with professionals from ASHRAE, have designed a program to allow long-term support for reduction of energy consumption by fans. The program includes labeling fans for their energy efficiency and adds requirements for fan selection and use at high levels of fan peak energy efficiency. It also opens the opportunity for possible exceptions when the fan energy consumption in one year falls below some limit, which could be defined by a regulatory body. The program allows a regulatory body to simply and effectively define fan energy-efficiency requirements for immediate as well as future needs.

This classification system for fan energy efficiency will be a part of the ISO 12759 and AMCA 205 standards currently under development. AMCA International is developing its own standard, AMCA 205, and, through its members and staff, is instrumental in the development of the international standard ISO 12759.

We're greening up the marketplace as well as our manufacturing space.

In 2005, Greenheck was one of the first manufacturers in the air movement and control industry to join the U.S. Green Building Council. Since then, the company has worked closely with the USGBC, ASHRAE and its in-house product engineers to identify specific Greenheck products mechanical engineers can use when designing ventilation systems for Green Buildings.

By carefully analyzing certification guidelines in the LEED new construction categories for Energy and Atmosphere and Indoor Environmental Quality—as well as pertinent ASHRAE requirements and local codes—Greenheck has developed a list of its own products that can support building designers' efforts to obtain LEED certification. Each of the company's 138 U.S. manufacturing representatives now has this information readily available and is prepared to assist with LEED certification efforts.

From Energy Recovery Ventilators, Make-up Air Units and Variable Volume Kitchen Ventilation Systems to Mixed Flow Inline Fans and Lab Exhaust Systems, more than 20 different Greenheck products can help improve a building's overall energy efficiency, indoor air quality, and thermal comfort.

Greenheck recognizes that many developers and building owners do not have the budget or the need to create a Green Building—but that doesn't mean they won't appreciate the added value Greenheck designs into every product it manufactures. Many years prior to the Green Building movement, the company embraced an ongoing commitment to "Building Value in Air" by producing the quietest, best performing, energy-efficient air movement and control equipment available. Those benefits are typically realized and highly valued by the users of the building—whether it's a Green Building or not.

Reducing its own energy costs, too.
Greenheck also believes strongly that energy conservation begins at home. Last year, the company saved $656,000 in energy costs when a group of employees formed an energy team to identify and prioritize energy-saving improvements the company could make within its 15 production facilities. This year, the company is anticipating energy cost reductions of more than $787,000.

Greenheck's innovative Energy Recovery Ventilators are just one of over 20 different products that can help support efforts to earn LEED credits.

Some of the many projects Greenheck's in-house energy team has taken on include:

- upgrading high-pressure sodium to more energy efficient fluorescent lighting throughout 1.2 million square feet of facility space,
- replacing older model air compressors with new compressors that fluctuate with facility demand, and
- installing welding ventilation systems that run only during the actual welding process.

In addition to directly reducing energy costs, Greenheck's internal conservation efforts have resulted in significant new financial incentives from utility companies.

For more information about Greenheck products, visit greenheck.com.

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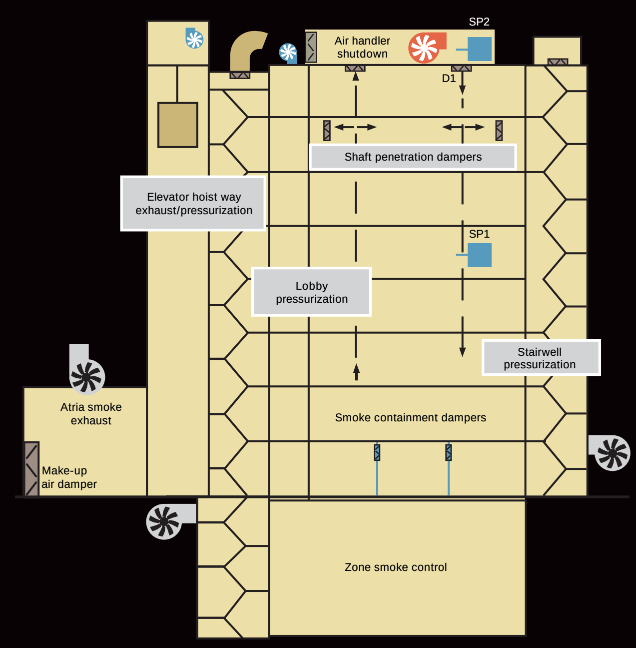
Integrating smoke control dampers and fans

Careful design considerations and proper interconnections are key.

Coordination between fans and dampers in smoke control systems requires consideration of the installation geometry, control sequence of operation, and sensor locations. There are both mechanical and electrical concerns. Among the basics are fan volume and pressures, damper tolerance to the pressures, and straight duct entrances to the equipment.

Figure 1: Primary smoke control systems showing fans and dampers.



Source for all figures: Larry Felker

Smoke control system design and installation is multi-disciplined and complicated. Care with details is required in design, installation, and commissioning to ensure integration of components.

This article covers some of the smoke control basics of atria, air handling units (AHUs), shafts, vestibules, and stairwells. Figure 1 shows these typical smoke control systems. Each of the subsystems requires different control methods.

ATRIA

Atria and large spaces have large volumes, and exhaust is the best way to remove smoke from the occupied space. Unless natural ventilation is employed, make-up air dampers are installed in the lower side walls (see the lower left grey components in Figure 1).

If a fire occurs, the fire alarm system signals the atria exhaust system to start. As the exhaust fan starts, its discharge damper opens simultaneously (a barometric damper may be used instead of an actuated damper). In addition to the fan's discharge damper, a make-up damper in the space must open. Fresh air is pulled in to replace the smoke—typically via louvers located in the lower walls of the atria. There are several ways to wire fire alarms to fans and actuators; see Figure 2 for an example.

AHU SHUTDOWN

Regardless if AHUs are on or off, smoke will spread via the ducts and shafts (see Figure 3). As smoke cools, it drops and moves—both horizontally and vertically—down shafts and stairwells. If the AHUs are on, the smoke will spread even faster. In addition, open ducts allow passive airflow, supplying oxygen to the fire. For these reasons, smoke control dampers should be installed in all shaft penetrations. Dampers should close when the AHUs shut down to prevent the spread of smoke and feeding of oxygen to a fire.

ENGINEERED SMOKE CONTROL SYSTEMS

In an engineered smoke control system (such as a zoned smoke control system), the damper actuators are under automatic control

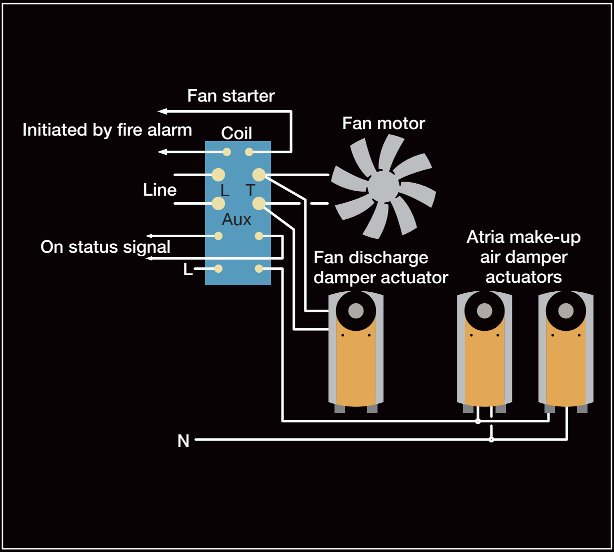


Figure 2: Fire alarm wiring to fan and actuator contactor or starter.

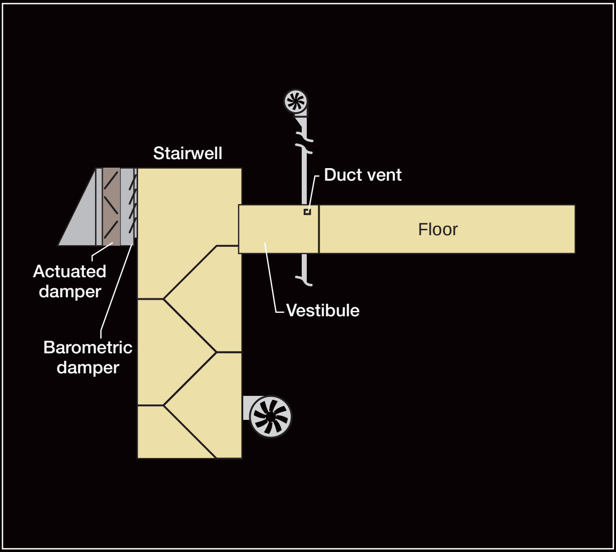


Figure 4: Vestibule between stairwell and occupied space.

of the smoke control panel. The dampers may open or close upon command from the automatic programming, or from command by the firefighters' smoke control system panel. Indication of open or closed status is achieved using actuator auxiliary switches, damper blade switches, or proximity switches.

Unless otherwise required by the International Building Code (IBC) 2006, Section 909, Smoke Control Systems, fans to spaces are typically shut down to (1) avoid fanning the fire with oxygen, and (2) prevent smoke from moving around the building. Wherever the ducts go through fire and smoke walls or barriers, combination fire and smoke dampers are installed.

It is common to find a static pressure (SP) sensor placed two-thirds of the way down the duct to control the inlet guide vanes or VFD to maintain pressure for the VAV boxes. In Figure 1, this is the blue sensor labeled SP1.

The same sensor can be used as a high-pressure limit for the fan. Take care to ensure that the controls contractor, concentrating on temperature control rather than smoke control, has not incorrectly programmed the system to use this sensor as a high limit for fan pressure.

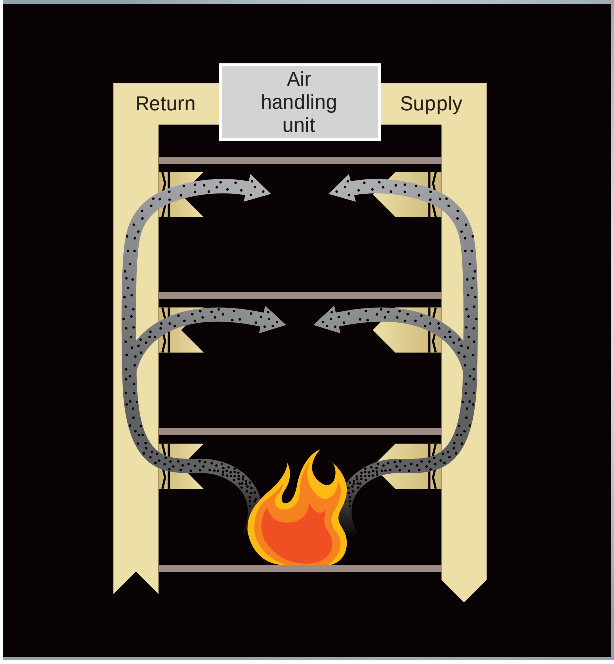
If the main shaft smoke damper (D1 in Figure 1) closes, SP1 will not be able to sense the high static at the fan discharge. Alternately, if all the floor dampers close, then SP1 cannot sense the high pressure. As a result, the AHU walls and/or any ductwork between them and D1 can over-pressurize and blow out the seams of the duct. This is the number-one problem that contractors and commissioning agents report in fan-damper coordination. To help avoid this problem, install an additional sensor (e.g., SP2 in Figure 1) in the fan discharge, before any damper.

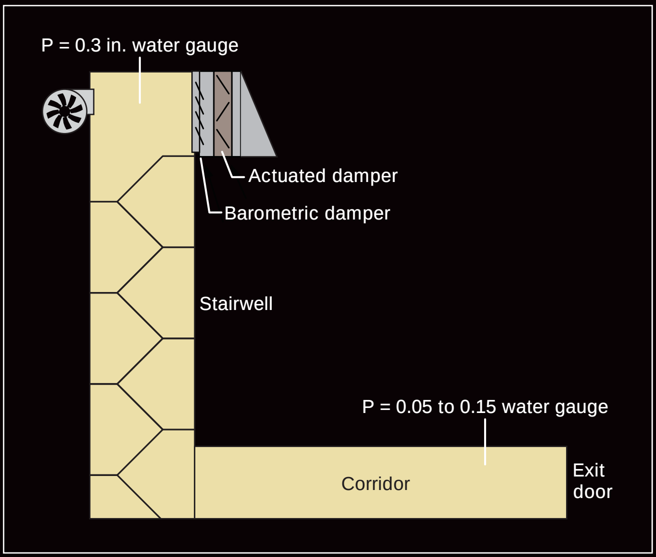
STAIRWELL PRESSURIZATION

It is critically important to prevent smoke in stairwells, as they are the primary means of egress in the event of a fire.

Barometric control. There are several different construction methods for stairwells. In high-rise buildings with vestibules (see Figure 4), the goal is to keep the stairwell air pressure positive with respect to the vestibules, and the vestibules positive with respect to the occupied floors. This keeps smoke from traveling toward the stairwell. There can be a single stairwell fan that pushes air toward the vestibule, or two fans: one for the stairwell and one for the vestibule. A duct runs from the vestibule fan with a takeoff to each vestibule. A simple blast gate can be used for balancing.

Figure 3: Smoke movement through shafts without shaft dampers.





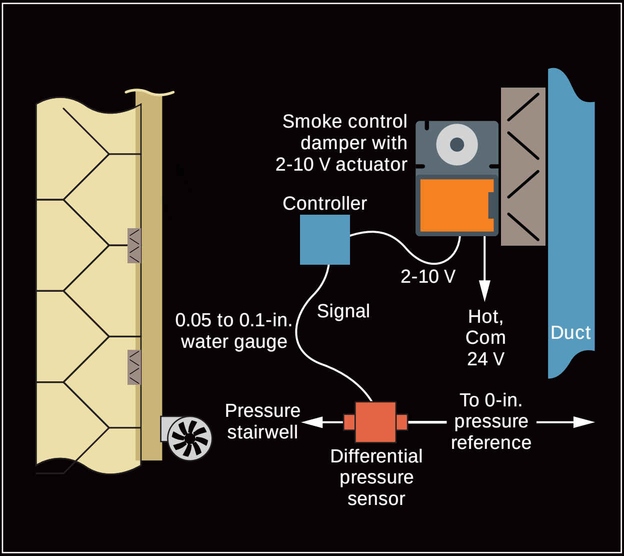


Figure 5: Fan discharge directly into damper prevents control at distant point.

Figure 6: Ducted air distribution for stairwell pressure control.

When a fire alarm occurs, the stairwell fan starts and pressurizes the stairwell. A barometric damper relieves excess pressure. When doors open, the barometric damper closes and pressure is maintained.

Barometric dampers are lightweight and quite sensitive. Corrosion can occur over time without proper maintenance and can interfere with operation. One way to protect a barometric damper is to have an actuated damper in series on the exterior. The actuated damper opens fully, and the barometric damper relieves overpressure. The wiring is similar to that shown in Figure 2 for the motor and one actuator.

> "Buildings can be noncombustible or fire resistive. People are neither and they are not smoke resistive either."
>
> —*Francis Brannigan*

Figure 5 shows a geometric arrangement that does not allow correct coordination of pressures. The exit door end of the corridor must be maintained from 0.05-in. water gauge (IBC requirement) to 0.15-in. water gauge (some local requirements). There is pressure drop in the stairwell and corridor. The fan blows straight into the relief damper and the pressure at the top of the stairwell is too high. A duct must be installed to deliver the air, and outlets at appropriate locations would allow more even pressures.

Proportional damper control. A more common stairwell design features doors that connect directly to the occupied space or lobby. In this scenario, a fan must be large enough to push a volume of air against space pressure through at least one open floor door. The pressure required to do so varies with the occupied space pressure, which is often positive and could push smoke into the stairwell.

The fan may be constant volume or have a VFD. It is likely that air must be injected at various points up the stairwell via a duct. Two-stage motors or two fans may be used; for example, when the outside exit door opens, the high-speed windings or the second fan turns on to maintain the pressure in the stairwell.

In most cases, a duct is run the length of the stairwell and proportionally actuated dampers are used to control pressure (see Figure 6). Typically, there is one damper for every three to five floors.

In the event of a fire, the fan is on and the damper actuators are powered. When an exit door opens and air starts to flow into the floor, stairwell pressure drops and the dampers modulate open to maintain pressure. The damper nearest the open door will provide more air at the point it is needed.

The duct may be run within the stairwell or within a shaft in a wall adjacent to the stairwell shaft.

CODES AND STANDARDS

Smoke exhaust fans must be rated and certified by the manufacturer for the temperatures to which they are to be exposed.[1] In addition, fans must have smoke detectors in their inlets to stop them and prevent them from injecting smoke into a protected compartment. Smoke exhaust fans are UL793 listed for operation at 500 F (260 C) for 4 hr or 1,000 F (538 C) for 1 hr. Fan status and on-off-auto override switches are required at the firefighters' smoke control panel.

All dampers used in smoke control systems must be listed to UL555S.[2] However, exceptions are sometimes granted when the dampers will not be applied at high temperatures, or when they do not need to be low-leakage smoke rated (e.g., the barometric and outside air dampers used to relieve pressure at the top of a stairwell).

BELKE is director—damper products, at Greenheck Fan Corp., and is the AMCA chair for life safety code action review. He has written numerous articles about life safety dampers and has presented on the topic in eight countries.

FELKER is fire and smoke product manager at Belimo Americas. He is a 30-year member of ASHARE and a member of NFPA and the International Code Council (ICC). He has been involved in control system design and installation for more than 40 years.

The connections to and from fans and dampers must take system effect into account. High pressure losses due to construction geometry can cause insufficient pressure. About three duct diameters upstream of a fan and one duct diameter per 1,000 fpm velocity downstream are required to avoid system effect.[3]

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1. IBC 2006, 909.10.1.

2. IBC 2006, 716.3 in conjunction with 909.10.4.

3. Stevens, M. "Fan Specification System Effect." www.amca.org. Fall 2008. Also see AMCA Publication 201.

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NFPA 72, National Fire Alarm Code, 2007.

NFPA 92A, Standard for Smoke-Control Systems Utilizing Barriers and Pressure Differences, 2009 Edition.

NFPA 92B, Standard for Smoke Management Systems in Malls, Atria, and Large Spaces, 2009 Edition.

BY DAVID JOHNSON,
BERNER INTERNATIONAL CORP.,
NEW CASTLE, PA.

Specifying air curtains for savings and performance

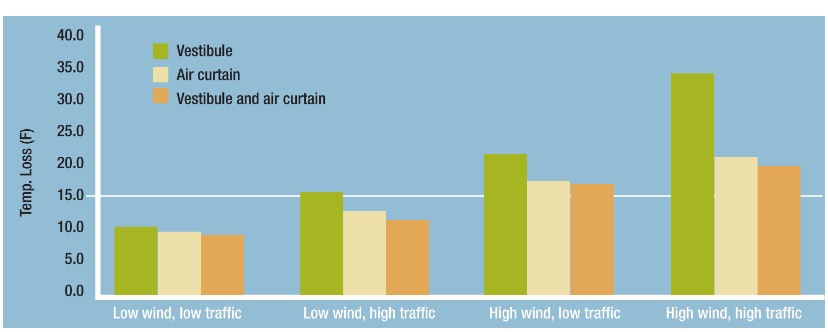
Air curtains can provide low-first cost and low total cost of ownership for entrances, loading doors, and other applications.

Air curtains provide a controlled stream of air across a building entrance or doorway to separate interior and exterior environments. When the conventional door is opened, the air curtain's airstream prevents cold, hot, or humid outdoor air, as well as insects and dust, from infiltrating the indoor environment.

Although air curtains require power to run the blowers that create the airstream, they save much more energy than they expend, making them an attractive option for building owners and operators. Air curtains have long been used in industrial settings; however, they are increasingly finding their way into new markets such as hotels, hospitals, stores, public facilities, and other commercial buildings.

INDOOR ENVIRONMENT TEMPERATURE LOSS

Analysis results summary		Low wind, low traffic	Low wind, high traffic	High wind, low traffic	High wind, high traffic
Vestibule	Building scenario	A1	A2	A3	A4
	Temp loss	10.3 F	15.5 F	21.2 F	33.5 F
Air curtain	Building scenario	B1	B2	B3	B4
	Temp loss	9.6 F	12.4 F	17.3 F	20.6 F
Vestibule and air curtain	Building scenario	C1	C2	C3	C4
	Temp loss	9.3 F	11.3 F	16.8 F	19.6 F



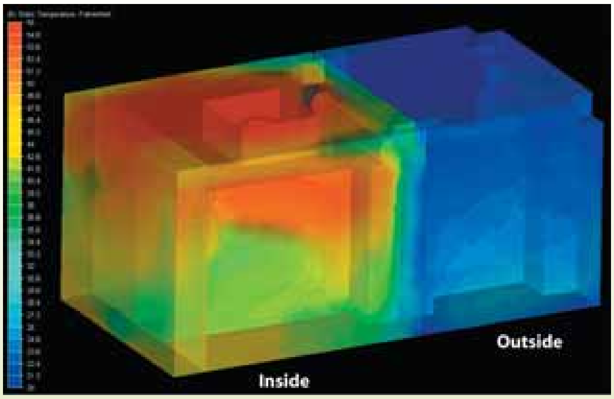
Source: Berner International Corp. and Blue Ridge Numerics

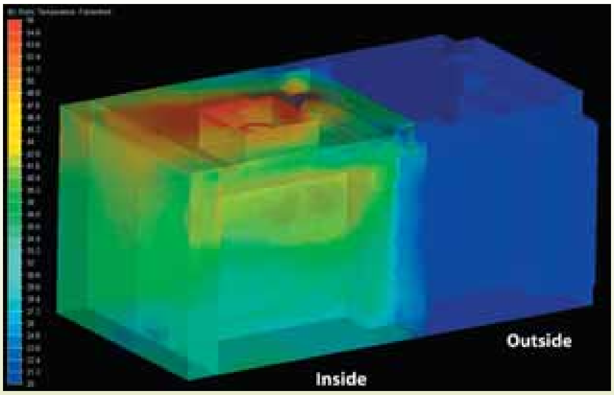
Figure 1a: Researchers CFD-modeled three scenarios to determine energy efficiency performance. Air curtain and automatic door combinations were found to be 10% more efficient than vestibules.

Air curtain manufacturers' catalogs can be misleading, however, because some manufacturers do not have their performance data certified. Such misleading information might not surface until after an installation, when an air curtain is found to be underperforming. For example, some manufacturers use the term maximum velocity, a specification that carries no industry certification. Determining the location of the maximum velocity, whether it's at the discharge nozzle, the floor, or somewhere in between, can lead to confusion. A more accurate term is velocity projection, which is the actual measured velocity at specific distances along the air curtain's airstream.

A better design parameter is the combination of velocity, volume, and uniformity and the proper balance between each.

Velocity. To properly design an air curtain installation, the airstream must hit the floor with enough velocity to create a split. The split, which creates stability, strength, and direction for the air entrained on each side of the airstream, should occur right at the doorway's threshold. An installation with a weak airstream (i.e., one that barely splits) is viable only for applications involving temperature differential without wind, such as internal doorways. These types of installations can stop infiltration or





Figures 1b and 1c: The CFD modeling showed that there is less cold outside air infiltration when an air curtain is employed (1b, top) versus when only a vestibule is used (1c, bottom).

Source: Berner International Corp. and Blue Ridge Numerics

cross-contamination of environments due to airflow caused by the temperature differential, but they become ineffective once wind is introduced. Few external doorways are not affected by wind loads.

Volume. Volume, on the other hand, is the building block that allows a properly designed and pressurized discharge plenum to generate a high-velocity laminar jet stream. The taller the opening, the more volume that is required to generate a thicker, higher velocity airstream to resist wind loads of 4 to 5 mph. Obviously, an air curtain for a fast-food restaurant's drive-through window doesn't need as strong a volume as a 16-ft-high door in a shipping area. Once an air curtain activates and creates a split, it creates a "skin" over the building's volume of indoor air and uses this internal pressure to resist wind. The split then rolls the entrained conditioned and unconditioned air back to their respective areas.

Uniformity. Uniformity impacts the airstream effectiveness only when it drops below 75%. An air curtain that focuses too much energy on generating a high uniformity loses velocity, therefore reducing its effective wind resistance.

Velocity, volume, and uniformity work together to create the ideal air curtain performance—relying on only one or two could skew performance results.

DESIGN CONSIDERATIONS

There are several considerations when specifying air curtains:

- Size of the doorway. Openings can range anywhere in size from drive-through windows to 16-ft-wide industrial building openings and even customized 140-ft-wide doorways in airplane hangers. Multiple air curtains can be tandem-mounted to work together for larger openings.
- Size of the building. Stable internal pressures typically exist with larger buildings that have multiple doors. Contrarily, smaller buildings with multiple doors have unstable pressurizations because each time an opening is breached, other areas such as doorways with air curtains are affected.
- Expected wind load. The building's geographical location and surrounding environment impact the expected wind load and exposure. The National Oceanic and Atmospheric Administration (NOAA) publishes geographical wind load data for all major cities.
- Exposure of the door. Outdoor temperature based on geographical location is vital. What direction the doors face, their relationship to prevailing winds, and nearby obstructions such as retaining walls, other buildings, and topography can all figure into air curtain sizing. Here again, NOAA provides data.
- Building pressurization. Most buildings that are designed with proper HVAC have a positive pressurization, which is ideal for air curtain performance. Standard air curtains don't perform well in negative pressure situations unless makeup air is involved or filtered bypass air is allowed.

Typically, an engineer starts with doorway size and wind load to specify the correct air curtain. There has to be proper design balance between the air curtain's fan motor hp, plenum size, discharge velocity, air thickness, etc., which all can be increased or decreased by selecting the correct model to reach ultimate performance.

Therefore, specifying the correct air curtain for an application is difficult when its performance specifications aren't accurate, which is frequently the case in the air curtain industry. One source engineers can rely on is AMCA International, which certifies many manufacturers' air curtain specifications through

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its Certified Ratings Program (CRP). AMCA International has just introduced a new publication developed by a committee of air curtain experts, AMCA Publication 222-08, Application Manual for Air Curtain Units.

AIR CURTAINS AS VESTIBULE SUBSTITUTES

Some engineers are using a recent study, "Air Curtains: A Proven Alternative to Vestibule Design," to lobby local code officials to allow the substitution of vestibules with air curtains combined with automatic doors on new building projects. The three-month-long research study was funded by Berner International and is available at www.berner.com. The study compiled certified results using computational fluid dynamics (CFD) analysis from second-party research/validation consultant Blue Ridge Numerics, of Charlottesville, Va. (see Figures 1a, 1b, and 1c).

The study showed that air curtain and automatic door combinations are 10% more efficient than vestibules, and significantly less expensive in construction costs. The study's researchers used vestibule construction dimensions and statistics from three leading pharmacy chains as a model. Using a typical pharmacy chain entrance, the study CFD-modeled three scenarios: air curtain with automatic door, vestibule, and air curtain with vestibule. Each scenario was subjected to wind loads of up to 4 mph and different frequencies of traffic. It is hoped that the study will help air curtains become an optional alternative to vestibules in the International Energy Conservation Code (IECC), which is published by the International Code Council (ICC). Currently, the IECC doesn't disallow air curtains; there just isn't a provision for them as a vestibule substitute.

In an age when energy is one of the most important political issues on the planet, air curtains can be an invaluable energy conservation tool for consulting engineers. The bottom line, however, is that not all air curtains are the same, and they aren't just rectangular metal boxes with blowers. Extensive engineering is involved in creating a smooth, nonturbulent, projecting airstream with the properly designed air discharge that accomplishes the engineer's goal of effectively separating interior and exterior environments.

ENGINEERING RESOURCES

AMCA Publication 222-08, Application Manual for Air Curtain Units. www.amca.org.

"Air Curtains: A Proven Alternative to Vestibule Design." www.berner.com.

The National Oceanic and Atmospheric Administration (NOAA). Geographical wind load data for all major cities. www.noaa.gov.

FAMED TRAIN STATION SELECTS AIR CURTAINS FOR RETROFIT

Source: Berner International Corp.

Figure 2 (above): The entrance lobby was moved 100 ft out into the open-ended train shed; air curtains keep the lobby area and outdoor train shed environments separated. *Figure 3 (right):* Twelve sliding commuter doors are continually open during rush hours. The air doors protect the lobby from train emissions and help keep the lobby comfortable during the winter.

Architects are increasingly using air curtains for building designs such as the retrofit of the TD Banknorth commuter train station in Boston.

To eliminate pedestrian congestion, the entrance lobby of the renowned North Station terminal was moved 100 ft out into the open-ended train shed (see Figure 2). Air curtains keep the new lobby area and outdoor train shed environments separated and safeguard against the infiltration of train emissions (see Figure 3). Jerry Fleishman, HVAC project engineer, Cosentini Associates, Cambridge, Mass., specified high-efficiency, 3,624 cfm air curtains for 12 sliding commuter doors that are continually open during rush hours.

Aesthetics was a key factor in the project. Architect Sasaki Associates Inc. built a curtain wall with a perimeter soffit. Fleishman accommodated the quest for aesthetics by specifying in-ceiling mounted air curtains, which are hidden in the soffit and appear only as aluminum ceiling grills inside each doorway.

For added comfort during winter operation, the air curtains supplement the space's general heating with 95,600 Btuh coils supplied by the building's hot water loop. The air curtains also include a control package consisting of a thermostat, a three-speed fan, a timer delay function, and a low-voltage relay for tapping compatibly into any direct digital control (DDC) building automation system.

>> AMCA News continued from page 5 >>

Energy Star Revises Program for Residential Ventilating Fans

AMCA International, the Home Ventilating Institute (HVI), and Energy Star recently teamed up to revise the Energy Star program requirements for residential ventilating fans. The goal was to provide residential consumers with energy-efficient, quality ventilation products without sacrificing features, style, or comfort.

This collaborative effort resulted in revising the testing requirements, and partners (companies that participate in the Energy Star program) now have more options as to where they can test their products for Energy Star qualification, including AMCA's testing laboratory at the AMCA headquarters in Arlington Heights, Ill.

The revised program went into effect on January 15, 2009. The new requirements in the program do not grant exclusive rights to any organization to certify, verify, or challenge-test Energy Star-qualified products or products applying for Energy Star qualification. At the same time, the U.S. Environmental Protection Agency (EPA) has maintained the requirement on the part of the partner to have its Energy Star-qualified products ratings certified by an organization that regularly carries out verification and challenge testing in order to allow the EPA to verify that products meet the Energy Star requirements.

The most essential factors in demonstrating a certification organization's ability to meet the expectations of the Energy Star ventilating fan program include:

- Laboratory verification testing
- Defining challenge testing requirements
- Product rating limits
- Membership requirements
- Availability of the certification organization's procedures
- Organization must share the results with the EPA
- Testing must be performed in an independent, third-party laboratory.

The program is designed to include range hoods (up to 500 cfm), bathroom and utility room fans (from 10 to 500 cfm), and in-line single-port and multiport ventilating fans. Products that are excluded from this specification include residential ventilating fans used for cooling or air circulation (such as whole house fans), heat/energy recovery ventilation fans ducted to the ventilated space, powered attic ventilators, and residential ventilating fans with heat lamps and passive ventilation of any kind.

"The collaboration between AMCA, HVI, and Energy Star has resulted in a win-win situation for all parties involved," says Tim Orris, AMCA's director of technical services. "AMCA and HVI gain the recognition of their certification programs, and the consumer will benefit from having unbiased, accurate data on which to make a purchasing decision."

New ANSI/AMCA Standard and Publications Released

The Board of Standards Review of the American National Standards Institute (ANSI) on December 22, 2008 approved ANSI/AMCA Standard 540-08, Test Method for Louvers Impacted by Wind Borne Debris.

This standard establishes uniform methods for laboratory testing of louvers that are impact tested with the large missile described in ASTM E 1996-04 and E 1886-05.

The scope of this standard is for impact testing of louvers used on the outside of buildings as required by the International Code Council's (ICC) International Building Code (IBC), and the ICC International Residential Code.

ANSI/AMCA Standard 540-08 is available for purchase at www.amca.org.

A related publication, AMCA Publication 512-09, AMCA Listing Label Program, provides follow-up service for louvers tested in accordance with the new ANSI/AMCA Standard 540. The publication also covers louvers tested in accordance with AMCA Standard 550, Test Method for High Velocity Wind Driven Rain Resistant Louvers.

The products within the scope of this publication are louvers used for high wind and/or high intensity rain areas, as required by the ICC. This program applies only to complete cataloged series of sizes, and is not applied to individual sizes in a series, or parts of a series, or special units where catalog ratings are not published.

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

AMCA International's 2009/2010 Event Calendar

AMCA Midyear Meeting
Sheraton Chicago
Elk Grove Village, Ill.
May 3-4, 2009

National Green Builders Product Expo
Las Vegas
May 28-29, 2009

AMCA 2009 Sound and Sound Testing Seminar
AMCA International Headquarters
Arlington Heights, Ill.
June 1-3, 2009

National Fire Protection Assn. (NFPA) Conference & Expo
Chicago
June 8-11, 2009

AMCA International 54th Annual Meeting
Fairmont Tremblant
Mont Tremblant, Quebec, Canada
September 10-12, 2009

U.S. Green Building Council (USGBC) Greenbuild
Phoenix
November 11-13, 2009

Big 5 Expo
Dubai, UAE
November 23-27, 2009

AHR Expo
Orlando
January 25-27, 2010

AMCA Spring Meetings
Marriott Plaza, San Antonio
February 28-March 3, 2010

Mostra Convegno Expo Comfort (MCE)
Milan, Italy
March 23-27, 2010

AMCA International's 55th Annual Meeting
Fairmont Turnberry Isle Resort & Club
Aventura, Fla.
October 14-17, 2010

AHR Expo Mexico
Mexico City
October 26-28, 2010

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Hartzell Fan Inc.	23	256	800-336-3267	www.hartzellfan.com
Loren Cook Company	C-2	250	417-869-6474	www.lorencook.com
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