HIGHER PERFORMANCE AND LOWER COSTS WITH HVLS FANS

Presented by:

ENTREMATIC

LEARNING OBJECTIVES

Upon completion of this course the student will be able to:

1. Identify the function and benefits of HVLS fans.
2. Examine the application of HVLS fans in specific commercial and industrial settings.
3. Understand specification and operation best practices.
4. Explain the use of performance criteria for appropriate fan selection.
5. Describe how HVLS fans help meet performance and sustainability standards for savings.

CONTINUING EDUCATION

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By Aphrodite Knoop

SECTION 1—FUNCTION AND BENEFITS

HVLS fans are engineered to provide a high level of comfort, efficiency, and productivity in large and public buildings in all seasons. This section will outline how HVLS fans work to decrease the burden on HVAC systems and reduce the costs of heating and cooling. It will also cover the concept of destratification as a means of energy efficiency.

Introduction to HVLS Fans

A high-volume low-speed (HVLS) fan, unlike its smaller residential counterpart, is a mechanical fan with a diameter greater than 5 feet that moves large volumes of air at a low rotational speed.

Walter Boyd invented the HVLS fan during the 1990s to address the needs of the dairy farming industry because when dairy cows experience heat stress, they become sluggish and their milk production goes down. HVLS technology provided an energy-efficient way to keep dairy cows comfortable. And, just like humans, farm animals that are breathing in pollutants can develop health issues. These health and productivity problems, in turn, pose a threat to a farm's bottom line. HVLS fans cool the cows and help boost their milk output while also circulating air to reduce risk of disease.

HVLS Technology

HVLS fans are designed based on the laws of physics and aerodynamics and incorporate airfoil technology to provide greater efficiency. They move air consistently and evenly, but slowly, throughout a space because a high velocity of wind indoors is both unpleasant and inefficient, even in warm or hot climates.

The large column of air produced by an HVLS fan travels farther than that of a smaller fan. When this downward column of air hits the floor, it moves horizontally in all directions, away from the column as shown in Figure 1.

Smaller high-speed fans produce a high velocity jet of air that is turbulent and quicker to dissipate. In contrast, HVLS fans are able to get a large mass of air moving and take advantage of the inertia of the air itself. We tend to think of air as being weightless. In reality, air takes up a great deal of volume in a space. Therefore, far less power is required to keep an air mass moving than to start that volume moving in the first place.

In very large, or open air spaces (such as airplane hangars or arenas) where air conditioning is impractical and cost prohibitive, HVLS fans can make a significant impact simply by keeping air moving.

In facilities where there is mechanical cooling and heating, HVLS fans work in tandem with existing HVAC systems to reduce the energy load on those systems. In cold climates, the fans can either push the hot air down or push the hot air across the ceiling and down to the ground level without creating a wind chill effect, rather than letting it sit at ceiling level. For example, large industrial buildings have the heaters placed up high. Without supporting fan action, that heat will remain at ceiling level and the space will have layers of uneven—and uncomfortable—temperatures.

In addition to enhancing HVAC and natural ventilation systems, HVLS fans improve indoor air quality and ventilation. There is always need for ventilation in enclosed spaces to remove the buildup of carbon dioxide (CO_2), smoke, and fumes. If a space has dirty air, standard exhaust fans have a hard time removing that air from the center of the room because as fresh air comes in, it stays along a room's perimeter. HVLS fans mix and move that air to prevent stagnation, eliminate condensation buildup, and maintain an even room temperature without the wind chill effect.

The need to regulate room temperature is not just about human comfort. It's also about proper circulation of fresh, dry air to preserve sensitive products including food, produce, cosmetics, pharmaceuticals, and other fragile goods.

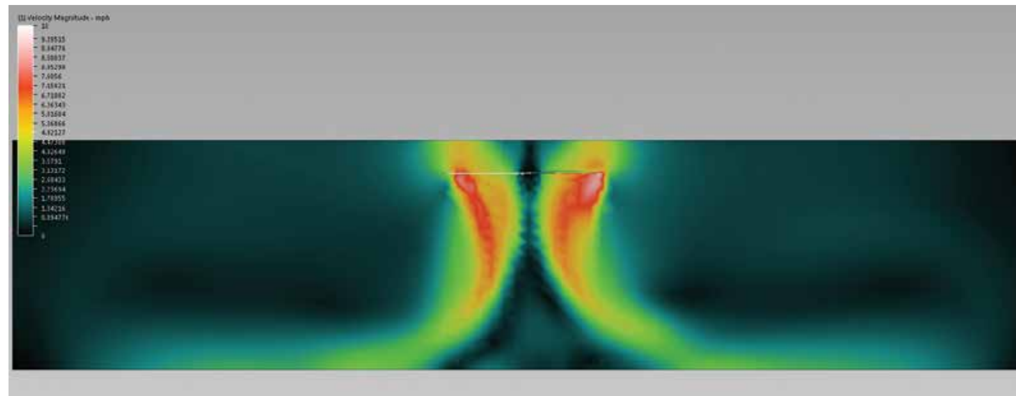


Figure 1: Horizontal Velocity Simulation. Computer simulation of air as it moves through a fan. Image shows air coming down in a vertical profile, then moving out and away from the fan, and the velocity dissipating. Airflow moving across the ground level (shown bottom of image) represents the floor jet. As the velocity dissipates, the air moves beyond until it circulates back up into the top of the ceiling (shown top of image) and is then drawn back into the fan.

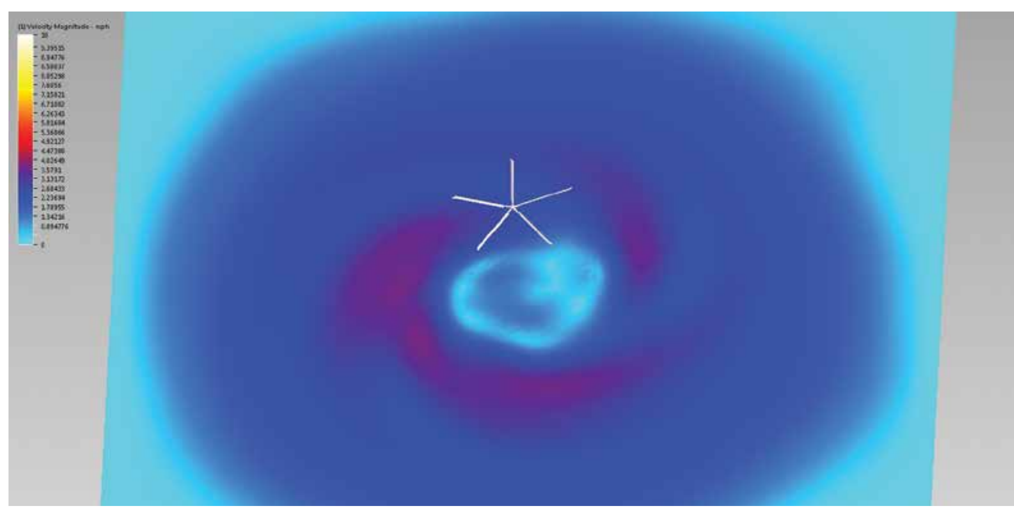


Figure 2: Floor Velocity Spill Pattern of a 5-Blade Fan. Computer simulation of air flow as generated by a 5-blade fan. Velocity magnitude is shown in mph.

Efficiency by Design

The profile of a blade, the spacing, and the RPM of the fan dictate how much airflow the fan can push. Originally, HVLS fans were designed with 10 blades. However, over time, blades were engineered with a larger airfoil shape, so that fewer blades were necessary for optimal performance and efficiency. As a result, HVLS fans are now down to 6-blade and 5-blade profiles, increasing airflow without increasing energy usage or causing undue stress to a building.

The decrease in blades also reduces the manufacturing carbon footprint of a fan because the aluminum production process for the blades requires large quantities of electrical power. Therefore, the amount of electrical power used to produce a 6- or 5-blade HVLS fan is less than what is used to produce a 10-blade fan.

Anatomy of a Blade

The 5-blade design is a further improvement over the 6-blade design and is optimized for low-speed rotary airfoil applications. Airfoils represent an evolution in HVLS fan engineering.

Airfoil Blades

Airfoils are designed to produce a massive cylindrical column of air that flows down to the floor and outward in all directions. The horizontal floor jet then pushes air out a great distance away from the center of the fan. It is then pulled back vertically toward the blades.

Winglets

Winglets increase a blade's efficiency by reducing the induced drag. The downward oriented winglets generate vortices below the airfoil, thus directing turbulence away from the trailing blade.

Destratification

Cold air is denser than hot air, so it drops to the ground while hot air rises to ceiling level.

This process is called "stratification." As a result of stratification, the thermostat in a space detects the colder air and works harder to reach the desired set point. This creates system inefficiency and results in higher operating costs for a facility.

Destratification is when the layers of air are blended together to create a uniform temperature throughout a space. In a stratified space, HVLS fans mix the air and push it down to occupant level. To avoid a draft, which can decrease comfort and productivity, fan blades need to rotate slowly at the occupant level. This blending decreases heat loss through the building envelope and reduces energy consumption. The reverse function of an HVLS fan is an important component of destratification.

During warm or hot seasons, you can destratify by running an HVLS fan in forward motion, creating a downward column of air. This air movement significantly enhances human comfort.

However, wind chill in colder seasons has a negative impact on human comfort. Therefore, you can destratify by running an HVLS fan in reverse. When in reverse, the fan pushes hot air down to blend the different layers into a uniform, comfortable temperature. This reverse function eliminates wind chill and allows you to more efficiently heat a large space while reducing the cost of heating.

SECTION 2—APPLICATION IN COMMERCIAL AND INDUSTRIAL SETTINGS

The heating and cooling requirements of commercial and industrial facilities differ significantly as each environment has its own unique set of challenges. This section provides an overview of how HVLS fans are used in an array of commercial and industrial facilities to improve thermal comfort, energy efficiency, and building performance.

Commercial Applications

In a commercial setting, commercial grade HVLS fans deliver greater airflow than residential fans. Therefore, you can increase efficiency by replacing multiple residential ceiling fans in a given space with a single commercial fan. A commercial fan produces a consistent airflow at any speed setting for more effective cooling and enhanced efficiency. In addition, commercial fans are ideal for acoustically sensitive spaces such as libraries, museums, and schools.

Commercial applications encompass the following:

Restaurants and Bars
In restaurants and bars, fans should be both functional and an enhancement of the décor. As with lighting, furniture, and materials, fans help create mood and atmosphere. Commercial fans are designed to be quiet and efficient even at low speed settings, and maintain a comfortable environment even as temperatures and crowds fluctuate. They also help control rising temperatures in outdoor patios and keep temperatures consistent in heat-sensitive areas such as tasting rooms by providing steady air movement and ventilation.

Retail and Public Spaces
In large public spaces with high ceilings, temperatures can vary widely from the ground to the upper levels. A commercial fan evens these variations so that in a theater, for example, audiences from the orchestra level to the balconies can be equally comfortable. The fans also improve efficiency in areas such as high-traffic lobbies by helping reduce the loss of conditioned air. They promote productivity in office spaces through noise reduction and comfortable temperatures and air movement.

The goal in retail and public spaces is to keep eyes focused on merchandise; at a display, on a screen, or at a stage. Commercial fans are designed to blend into most backgrounds and are available in a variety of colors and patterns to complement a space's design without being a distraction.

Sports Centers and Outdoor Spaces
Sports venues are activity hubs, with people coming and going, machines whirring, music blaring, and spectators cheering. Commercial HVLS fans work quietly in the background, providing comfort without the disturbance and commotion of standard high-speed fans.

Whether a large space is air-conditioned or not, fans can increase comfort for both athletes and spectators. Hot, humid environments such as indoor pools or theme parks can be tempered by a Commercial Class fan's cooling breezes, while the reverse functionality can make outdoor venues and private airplane hangars more bearable in winter months.

Health and Fitness Facilities
Gyms and fitness facilities can get hot and crowded. Overheated workouts are not just miserable; they are very dangerous for some segments of the population. Therefore, it's vital

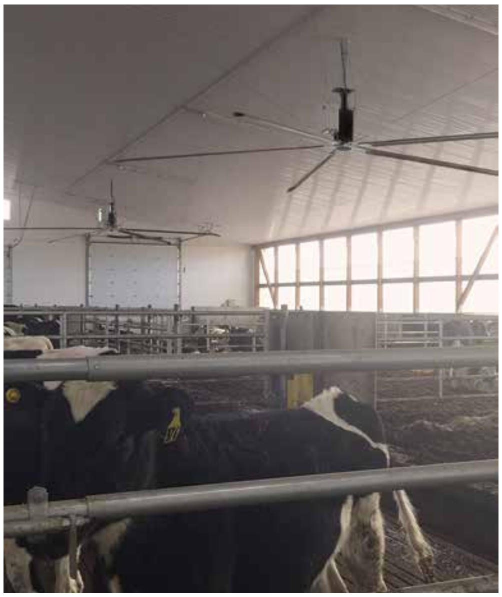
Commercial HVLS fan used in bar. Fan was specified to complement interior design and colors.

to keep these facilities cool and comfortable for all patrons. Even if a fitness center has an HVAC system, the large spaces, high ceilings, and hard-working crowds are all taxing the air conditioning systems, especially during summer. In these scenarios, a commercial HVLS fan can be used alone or as a supplement to an HVAC system to enhance cooling and comfort. In cold seasons, the fans can destratify the air spaces for even warmth by running in reverse.

Municipal and Education Buildings
Where quiet is essential—such as in schools and libraries—a buzzing fan is a distraction. In addition, large public spaces including recreation centers, auditoriums, courts, and town halls require balanced, comfortable temperatures throughout to accommodate for the ever-shifting flow of people.

Although commercial fans are quiet even when producing enough air to blow papers off a table, they don't need to be set on high to provide both comfort and energy efficiency.

This cost-saving aspect of commercial fans is especially important for public institutions that rely on taxpayer dollars. When every dollar counts, planning commercial ceiling fans into a new building means you can install minimal HVAC, thereby reducing expensive ductwork.



Series of Industrial Class fans used in dairy barn for ventilation and destratification.

In the winter, simply reverse fans to circulate warm air for continued energy and cost savings.

Industrial Applications

Industrial spaces are huge energy consumers. Industrial HVLS fans are made to move very large volumes of air to reduce stagnation, alleviate hot and cold spots, and keep products such as food fresh and dry. Spaces will feel more comfortable, with a perceived reduction in temperature, providing substantial energy savings in the process.

Industrial environments include the following:

Farms and Ranches

In settings such as rodeos, agricultural fairs, or indoor shows involving animals, stagnant air and lack of air-conditioning or breezes make for uncomfortable conditions for humans and non-humans alike. Industrial fans are designed to provide gentle breezes and can be adjusted to accommodate for small or large crowds. The fans can also help keep down dust and reduce or eliminate stale, smelly air. In addition, the constant air circulation helps repel flies from the animals and controls moisture levels.

Industrial-grade HVLS fans are an energy-efficient way to keep farm animals comfortably cool and productive and avoid overheating and illness. And though farm animals may be used to life outdoors, winter still takes a toll on their health and on a farm's bottom line. That's because when animals are cold, they tend to eat more, which dramatically raises the amount that farmers have to spend on feed. HVLS fans destratify barn air with reverse circulation to keep livestock more comfortable even in winter.

Aviation Facilities

Airplane hangars are large spaces with very high ceilings, and hangar doors are often wide open for hours at a time. In winter, massive amounts of cold air flows through those doors as any heated air floats over the airplanes and away from hangar workers. HVLS fans can pull that warm air down and push it out at ground level, warming workers and preventing any condensation on the floors from freezing. If a commercial hangar or large private hangar has a heating system, the industrial fan will help circulate that warm air more effectively throughout the space, so the heating system won't have to work as hard, which in turn reduces spending on energy bills.

QUIZ

1. For what purpose were HVLS fans originally designed?
   a. Aviation hangars b. Ranches
   c. Dairy farms d. Sports facilities

2. Where is destratification particularly effective?
   a. Warehouses b. Distribution centers
   c. Airport terminals d. All of the above

3. Which is not a LEED Certification credit category?
   a. Energy and Atmosphere b. Innovation in Design
   c. Carbon Footprint Impact d. Indoor Environmental Quality

4. Which is not one of the benefits of HVLS fans?
   a. Improved ventilation b. Wind-chill cooling
   c. Energy efficiency d. Enhanced HVAC performance

5. Which of the following can be considered a commercial building?
   a. Gallery b. Restaurant
   c. Gymnasium d. All of the Above

6. True or False? Destratification is ideal in all seasons.

7. True or False? Industrial and commercial HVLS fans produce the same airflow.

8. Which of the following is not a function of industrial fans?
   a. Move air down and outward b. Dry condensation
   c. Control noise levels d. Move air over obstructions

9. What is the maximum number of fans in a facility that can be linked through an HVLS networking system?
   a. 50 b. 2–100
   c. 5 d. 1–30

10. What percentage of savings on a facility's energy bill can be achieved with every degree of temperature change?
    a. 4.5% b. 5%
    c. 6% d. 3%

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ENTREMATIC

Entrematic is a leader in engineering products that help businesses across a wide variety of industries perform more efficiently and profitably. Our HVLS fans have been beautifully designed and expertly engineered to improve energy efficiency in commercial and industrial spaces, and our sophisticated wireless networking system and networking solutions provide even greater control.

Industrial fan as used in a large aquatic center.

During hot summer months, HVAC systems in airport terminals (and other transit hubs) struggle to keep pace with peak demands. Crowds of stressed, rushed travelers add to the rising temperatures. HVLS fans move large volumes of air while maintaining an even, air-conditioning set point.

Sports Facilities
Athletes and spectators alike appreciate fresh, cool air. But many older facilities, particularly university gyms and arenas, are not always equipped with HVAC systems. Industrial ceiling fans help with ventilation by creating soft breezes that help evaporate athletes' perspiration, a vital step in reducing body temperature. The fans also spread the cooling effect throughout a space. Newer facilities with HVAC also have problems with circulating cooled air.

HVAC ductwork is expensive and takes a great deal of energy to force air through the system. For new facility planning, incorporating industrial HVLS fans up front minimizes the ductwork needed while still achieving the desired temperature goals, including through a day's fluctuating loads and temperatures.

Service Centers
Fleet centers and maintenance facilities for big rigs and heavy machinery are massive spaces and difficult to heat and cool. Industrial fans come in diameters of up to 24 feet and can be networked together and controlled from one central location for consistent, controlled coverage.

Car dealerships and smaller service centers can also benefit from an industrial fans' ability to improve air circulation. The fan's reverse capability destratifies the air in winter and helps create a comfortable working environment all year long.

Mechanical work in primarily un-air-conditioned service centers can be very hot and dirty. With no HVAC, little to no insulation, open bay doors and running machinery, it is difficult for workers to get relief from the heat and limited natural air circulation. As a result, heat exhaustion and related illnesses are serious concerns. Industrial ceiling-mounted fans can cool the technicians without creating floor obstacles. These fans also help disperse odors and help circulate fresh air coming in through open bays, improving ventilation and air quality for employees.

Food and Pharmaceutical Facilities
Maintaining consistent temperatures is vital to preserving sensitive products like food, beauty items, and pharmaceuticals. Spoiled or damaged products can result in huge financial losses. However, air circulation from HVLS fans reduces stagnant air and evens out temperatures across a facility to eliminate hot and cold spots.

Condensation is another problem. On floors, it can create dangerous conditions for employees and reduce equipment performance. At worst, high moisture levels contribute to mold and mildew growth. HVLS fans help prevent condensation buildup and product spoilage by mixing and moving air.

Manufacturing and Distribution Centers
Many factors in an industrial setting can make for uncomfortable working conditions. Among these factors are a lack of air-conditioning, excess heat generated by machinery, and fumes from all the processes inside a manufacturing center. Industrial fans are engineered to solve these problems by generating breezes for a perceived temperature drop of 4 to 7 degrees. In colder months, reverse circulation destratifies the air and keeps it evenly warm and comfortable. HVLS fans also disperse fumes to improve indoor air quality and reduce potential for illnesses.

Cost management is another consideration in industrial environments. HVAC systems in larger facilities are very expensive to maintain, which results in higher operations and energy costs.

Commercial HVLS fan as used in a multi-level sports club for ventilation and destratification.

HVLS fans make HVAC use more effective by enabling users to raise the thermostat 3 to 5 degrees and get a potential energy savings of up to 4% per degree change.

SECTION 3—SPECIFICATION AND OPERATION BEST PRACTICES

This section will examine fan specification and installation guidelines and control options. It will also outline strategies for implementing one centralized, networked system for increased efficiency.

Specification and Installation

Architects and engineers who are tasked with specifying HVLS fans for a facility need to consider a number of factors regarding where and how to install the fans for the greatest functional impact and savings, including the following:

- Building size, location, and function
- Heating and cooling loads as determined by the number of occupants and types of activities occurring in the facility
- Potential obstructions such as racks, rolling conveyers, supplies, machinery, work spaces, mezzanines, and so forth

To properly size and place fans in a facility, it is important to know what a customer wants to accomplish as a primary goal because laying out fans to cool employees requires a very different approach than does laying out fans for destratification and industrial functions.

Fans with larger diameters might move air over obstructions more easily (depending on the height of the obstruction). Fans with smaller diameters, including those for commercial applications, are best for smaller areas or where installation space is limited.

The following table provides key specification guidelines at a glance:

Networking and Controls

HVLS fans are effective because they do more than move air in circles; they circulate a gentle mass of air evenly throughout a space. The largest industrial fan, which has a 24-foot diameter, can improve airflow in a coverage area of up to 30,000 square feet.

Networking multiple fans greatly expands this coverage capacity and efficiency, especially in larger facilities.

Depending on the number of fans in play, building owners and facility operators should consider an HVLS networking system that gives them the ability to control up to any number of industrial fans from a touchscreen panel.

For example, some software allows the networking of industrial fans by "daisy chaining" them together via wire conductor cables and connecting the last fan to the wireless networking system computer. Thus, it is possible to control fans individually by zone in real-time, saving energy and increasing efficiency where less airflow is necessary.

The appropriate networking system can further enhance fan performance by providing the following control capabilities:

- Network any number of large fans per standard configuration.
- Control fans by zone settings to target different environmental conditions throughout a facility.
- Monitor and control fans by time settings, temperature settings, or temperature variance throughout the building.
- Make setting adjustments in real-time via the touch screen graphic display.
- Connect fans with a building's fire control system through a separate control panel.

TABLE: COMMERCIAL AND INDUSTRIAL HVLS FAN APPLICATIONS

	COMMERCIAL APPLICATIONS	INDUSTRIAL APPLICATIONS
FAN PROFILE	• High-visibility locations • Limited ceiling heights	• High ceilings • Exposed industrial ceilings • Not well visible
NOISE CONTROL	• Conversation areas • Sound-sensitive applications	• Existing ambient noise
SPACE REQUIREMENTS	• Small to mid-sized facilities • Limited installation space • Moisture levels controlled for human comfort	• Huge facilities • Obstructions, such as racks and machinery • Moisture controlled for sensitive products and equipment
DESIGN AESTHETICS	• More color and pattern options • Emphasis on design as well as function	• Function vs design

Fans with larger diameters might move air over obstructions more easily (depending on the height of the obstruction). Fans with smaller diameters, including those for commercial applications, are best for smaller areas or where installation space is limited.

SECTION 4—AIRFLOW AND PERFORMANCE CRITERIA

Understanding how airflow is measured helps architects and engineers select the appropriate fan profile for a space. This section will examine airflow measurement standards and testing methods and how to use that information to specify HVLS fans for optimal performance.

Measuring Fan Performance

HVLS fans are increasingly used in warehouse, manufacturing, and distribution facilities to improve air quality and human performance while reducing energy use and costs. Therefore, it's important to understand the type of airflow measurement that demonstrates a fans ability to push air.

Fan speed is measured using cubic feet per minute (CFM). CFM is the volume of air being pushed through a fan each minute. A higher CFM means a higher capacity to push a larger volume of air, which in turn, means higher efficiency. However, at this time, CFM cannot be tested accurately for HVLS fans.

Therefore, another way to measure a fan's efficiency is to look at air velocity, as measured in miles per hour (MPH) and fan speed settings. It's also important to understand that a fan's efficiency is dependent on a space's parameters and user settings. Not all users want to set a fan at maximum, so we need tests that can show how well fans can operate at lower settings.

As an example, let's take a look at an air movement test performed on an industrial fan with a 24-foot diameter (see Figure 3). This test was designed to determine how much air the largest diameter industrial fan moves by using velocity as a measure. Engineers took airflow readings using an anemometer at four different distances above finished floor (AFF): 4", 24", 43", and 67". This allowed the testers to gather information about the volume of air that is actually moved at these varying heights and how far out that air moves.

Figure 3: Horizontal Air Velocity of 24-foot Diameter Industrial Fan

A similar test was performed with a 14-foot diameter commercial fan with the fan set at 60% (42 revolutions per minute (RPM)) and at 100% (70 RPM), as shown in Figure 4.

Figure 4: Horizontal Air Velocity of 14-foot Diameter Commercial Fan

The key difference between the industrial and commercial fans is in application. Commercial fans are designed for conditioned spaces including museums, offices, gyms, retail, atriums, and daycare centers—all of which have specific acoustic requirements and high occupancy loads during certain hours. In these cases, the RPM of the fan is lower than that of an industrial fan, and the sound level is 35 dBA or less (depending on the ceiling and other variables). In addition, a commercial fan has a smaller chord length on the blade, which leads to less airflow.

SECTION 5—PERFORMANCE AND SUSTAINABILITY

With tightening "green" regulations, architects and engineers need to specify fans that reduce a building's carbon footprint and meet the latest specifications. This section will outline how to select a fan for efficiency and all-season performance.

Achieving High Performance at Any Speed

According to the U.S. Department of Energy, residential and commercial buildings account for almost 39% of total U.S. energy consumption (*2008 Buildings Energy Data Book*, 2008). Much of this energy is for ventilation, heating, and cooling.

As a result, public and private sector organizations are looking for ways to reduce energy consumption and spending while increasing productivity and return on investment.

HVLS fans are powerful at any speed. Therefore, it's unlikely they will need to be run at full capacity. They are designed to be impactful at half the rate, so building occupants will feel a 4- to 7-degree temperature change at just 40% wattage use (or a speed setting of 4–5). And with every degree change, building owners will see up to 3% savings on their energy bills.

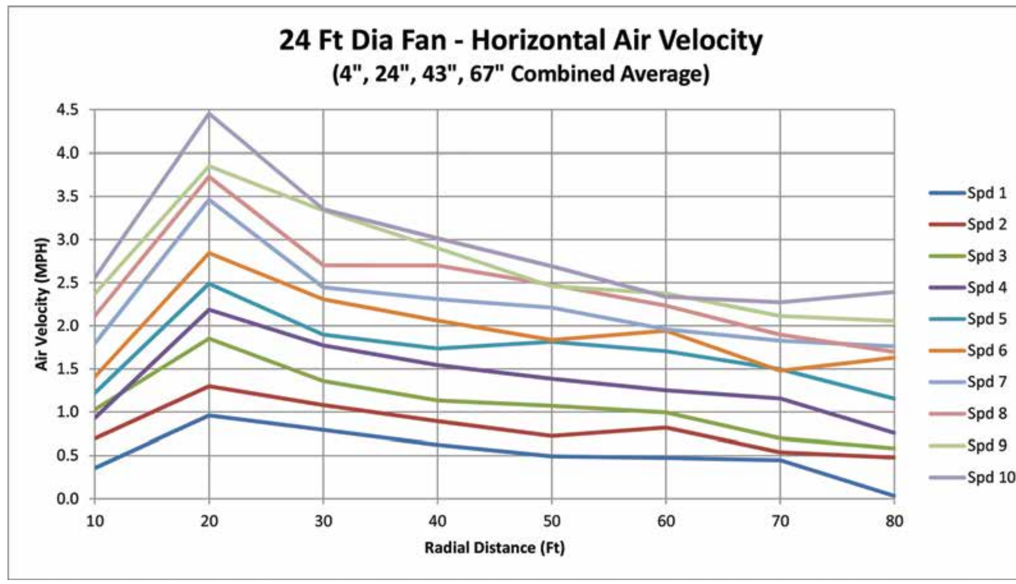

Figure 3: Horizontal Air Velocity of 24-foot Diameter Industrial Fan. Horizontal Air Velocity of a 24-foot diameter fan: Y-axis shows velocity in miles per hour, X-axis shows the radial distance from center in feet.

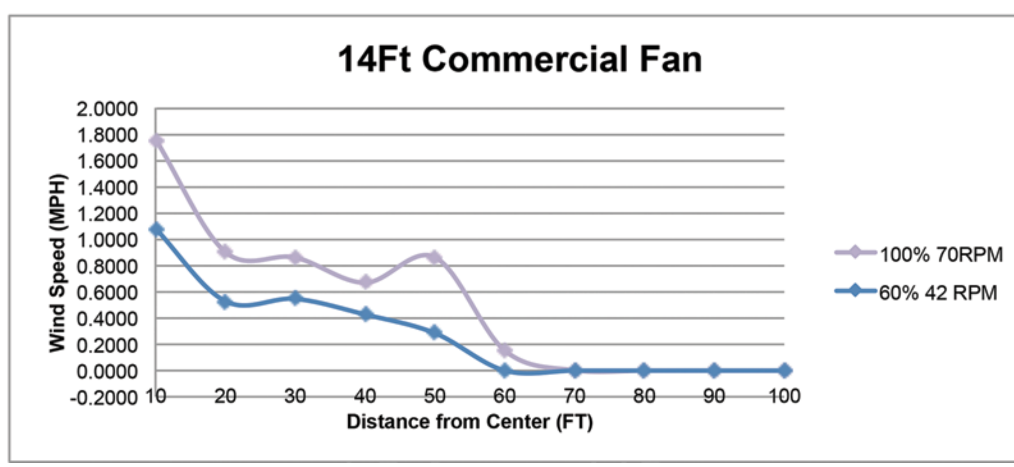

Figure 4: Horizontal Air Velocity of 14-foot Diameter Commercial Fan. Horizontal Air Velocity of a 24-foot diameter fan: Velocity is shown on the Y-axis and the the X-axis shows the distance from the center of the fan. The blue and yellow lines represent the two different speed settings.

Meeting Green Standards

HVLS fans can help a facility earn points toward Leadership in Energy and Environmental Design (LEED) certification in a number of ways:

- Reduce energy use by adjusting thermostats to more energy efficient settings
- Enable a healthy indoor environment by improving air circulation
- Use less resources and equipment than HVAC systems alone

The placement of fans for summer and wintertime benefit is critical. Because air circulation is the key to improving the energy efficiency of an HVAC system, HVLS fans can provide numerous benefits through reductions in the following:

- CO_2 emissions
- Thermal loads
- Electricity use
- Mechanical heating and cooling times

In large, open spaces, air-conditioned air can be moved farther with less ductwork and even reduced tonnage. Heated air from radiant heaters can be circulated more efficiently with HVLS fans, reducing or eliminating pooling, and increasing the efficiency of the heaters while potentially reducing the number of heaters required. Also, because of the destratification

Commercial HVLS fan used in reception area of daycare facility, which helps push air down from high ceiling.

effect discussed earlier, fewer ventilation fans are required to circulate clean air because the HVLS fans can move a higher volume of air more efficiently.

Savings Through Energy Efficiency

With a dedication to energy efficiency, planning HVLS fans into a design may help a facility qualify for rebates offered by some local utility providers and LEED certification credits in the following categories:

- Energy and Atmosphere
- Indoor Environmental Quality
- Innovation in Design

Commercial HVLS fans are efficient so that they do not need to be run at their maximum 250-watt usage. In many cases, commercial fans are designed to perform well at half that rate. As a result, building occupants should feel a 4- to

HVLS fan used in industrial hangar to provide air movement for comfort and keep surfaces dry for safety.

7-degree temperature change at just 50% max wattage use, or a mid-range speed setting (in accordance with the ASHRAE Standard 55-2010 Comfort Calculator). Every degree change is about 3% savings on a facility's energy bill.

One HVLS fan can replace several high-speed fans. In addition, industrial fans draw less power than HVAC, resulting in significantly lower monthly electric bills, which allows users to control specific zones separately. With zoning, there is no longer need for costly portable fans and swamp coolers.

SECTION 6—CONCLUSION AND ASSESSMENT

In conclusion, it takes a great deal of energy—and money—to heat and cool commercial and large industrial spaces. Yet proper temperature controls and airflow management are vital to maintaining healthy, comfortable, and productive facilities.

HVLS fans, both in commercial or industrial settings, are engineered to support existing HVAC and ventilation systems in all seasons so that building owners and operators can reduce operating costs and energy consumption.

To help customers optimize the benefits of their HVLS fans, architects and engineers need to specify fans based on a customer's goals for the facility, taking into account the location and climate, the overall layout, any potential obstructions or restrictions, occupant comfort and well-being, and the thermal/ventilation requirements of products being manufactured or stored. ■

CASE STUDY

A private airplane hangar in Dallas, Texas serves as a good case study of the application of an HVLS fan in a large space. Due to the high heat and humidity that are prevalent during the summer in this region, the hangar was exceptionally uncomfortable when staff members were working on airplanes or pilots were getting ready to fly. During rainy days, the interior of the hangar gets wet and causes dangerous conditions such as slipping.

Two 14-foot diameter, 5-blade Commercial Class fans were introduced by the hangar owner to address these problems. The fans now provide cooling comfort by creating a consistent, gentle breeze that moves throughout the entire hangar space and provides a 4- to 7-degree perceived temperature drop. This happens as a result of evaporative cooling, which occurs when air moves across the moisture on the surface of the skin.

The fans also address safety concerns because they are ideal for drying targets. Unlike air conditioning, which dries all the air in a space, HVLS fans dry whatever they are aimed at, such as water on the floor or condensation. In this hangar, the consistent airflow across the ground dries the surface and helps reduce slipping hazards and other problems when planes are being moved around the space.

As a result, the hangar is now both safe and comfortable, even during the high heat of summer.