GREENHECK

Fan Application

FA/129-19

PRODUCT APPLICATION GUIDE

A technical bulletin for engineers, contractors and students in the air movement and control industry.

HVLS – High Volume Low Speed Fans

What is an HVLS fan?

The high volume low speed (HVLS) fan is a relatively new concept in the heating, ventilation and air conditioning (HVAC) industry. Development of the original HVLS fan occurred in the late 1990s for use in agricultural applications to keep dairy cows more comfortable and productive. Uses for the fan have grown and now offer circulation options in many commercial and industrial settings.

HVLS fans are large diameter, ceiling mounted axial fans designed to circulate considerable volumes of air at low operational speeds. The number of blades used varies by design and manufacturers, but most manufacturers today use between three and eight blades. A common assumption among those unfamiliar with HVLS fans is that more blades create more air movement. Therefore, if three blades do a good job moving air, then six blades should work twice as well. However, testing demonstrates little difference in performance between a three and six-bladed fan when motor power is held constant (Table 1).

	3- Blade Fan	6-Blade Fan
Motor Power	500 W	500 W
Max RPM	86	69
Max CFM	124,500	128,100

Table 1

Blade count alone does not indicate better HVLS design or higher performance. Factors such as output power and the torque of the motor, operating speed of the fan, and the aerodynamic design of the airfoil blades have a significant influence on performance. As such, making a selection solely on the number of blades to achieve a perceived level of performance often leads to undesirable results.

The motor technology used also affects HVLS design and performance. Two distinctly different types of motors in use today are gearbox motors and direct drive motors. Gearbox motors utilize common, high RPM motor designs coupled with a gear system to reduce speed and increase torque output. Direct drive motors are designed specifically for lower operating speeds, and generating high and continuous torque without the need for gears.

While both motor types deliver the required power and torque for HVLS fan performance, the two technologies produce noticeable differences in efficiency, reliability, and sound. Gearboxes have been the industry standard for HVLS fans, but the technology is outdated for this application and has several limitations. In particular, gearbox motors have many moving pieces including gears and bearings that require routine maintenance to ensure proper operation. These parts also introduce inefficiencies causing higher operating costs and increased downtime.

GREENHECK
Building Value in Air.

P.O. Box 410 • Schofield, WI 54476 • 715.359.6171 • Fax 715.355.2399

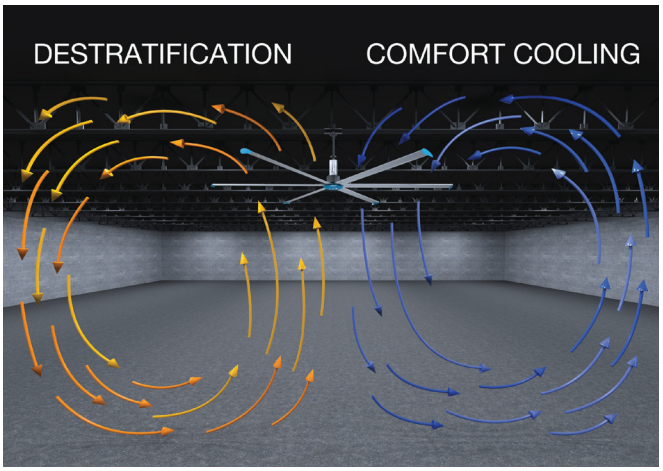
Gearbox technology also contributes to louder operating sound and continuous noise in a facility that may be objectionable to building occupants. Despite these concerns, many HVLS fans manufactured today still use gearbox technology. The direct drive motor, however, has gained industry favor because of many benefits it offers including quieter operation, minimal maintenance, and overall energy savings since it has no gears and fewer mechanical parts. As a result, settings where noise affects productivity and occupant comfort, such as commercial and institutional buildings, likely would opt for the quieter direct drive. Still, even noisy settings including factories and warehouses benefit from the efficiency and other features (i.e. reduced maintenance) that direct drive motors offer.

Why use HVLS fans?

The primary reason HVLS fans continue to gain in popularity is the ability to provide thermal comfort in commercial and industrial buildings. This ability to keep people comfortable relates to a standard of the American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE) known as ASHRAE 55. This standard addresses the thermal comfort that people feel in building environments. ASHRAE Standard 55 combines indoor thermal environmental factors and personal factors to produce conditions acceptable to a majority of the occupants within the space. Environmental factors addressed in this standard are temperature, humidity, and airspeed along with personal factors such as activity level (metabolic rate) and the type of clothing worn. Studies show that thermally comfortable people are more productive, and that well-designed HVAC systems including HVLS fans aid in the increase of thermal comfort, which correlates to overall productivity increases.

HVLS fans have many uses that contribute to thermal comfort including destratification, comfort cooling and the mitigation of condensation in a building to increase safety. Destratification is the reverse movement of the fan to blend thermal layers in the affected space, which results in a uniform temperature throughout.

Comfort cooling is the forward movement of the blades to create circulation and an evaporative cooling effect for the occupants within a space. Both destratification and comfort cooling offer significant benefits to any application, and save building owners substantial cost by reducing the need for running other HVAC equipment.



Maintaining acceptable thermal environmental conditions make buildings more comfortable for occupants. However, another aspect of acceptable thermal environmental conditions is the impact those conditions have on a building structure. For example, when warm, humid air interacts with much cooler floors, it causes condensation to form on the surface. This increases the risk of trips, slips and falls resulting in injury and workers compensation claims. The National Safety Council reports the average workers comp claim in 2016-17 for slips and falls was $46,592 (https://injuryfacts.nsc.org/work/costs/workers-compensation-costs). Airflow from an HVLS fan maintains dry conditions even in warm, humid climates by increasing evaporation of condensation on surfaces. This eliminates the moisture and the potential risk associated with it. Another example is maintaining product viability in the same warm, humid conditions. These conditions can affect packaging aesthetics and even product integrity. A company could purchase between seven and ten HVLS fans for the cost of one workers compensation claim or product loss, making HVLS fans a wise investment.

There is also a perception that conventional circulators in certain applications could work as well as an HVLS fan and save on initial cost. The purchase price of numerous circulators is much less than that of an HVLS fan, implying coverage using multiple circulators could match that of an HVLS fan. However, using these fans in a large space exposes several deficiencies. The coverage area for conventional circulators is much smaller, resulting in the need for many more fans to cover the space effectively. Even with a number of conventional fans, the coverage in the space is not uniform, providing more air movement in one area and less in another. The smaller conventional fans also create more turbulence, which is a result of needing higher fan speed to move the same volume of air. One HVLS fan can cover a space up to 23,000 square feet, providing even and gentle air movement throughout the space.

Finally, aesthetics are a growing consideration for selecting HVLS fans. The HVLS fan not only achieves the desired thermal conditions, many architects now incorporate the aesthetic appeal of these fans as part of the overall building design. Architects cite reasons of configurability, custom paint options, and bold large design for their decision. HVLS fans provide numerous benefits to many different applications, all while doing it in style.

HVLS Fan Performance

Users of HVLS fans demand, as with any product, the assurance of quality, performance and reliability. Many manufacturers make claims that their product meets stated performance. However, unless performance is tested and certified by an industry-accepted independent organization, there is no assurance that a manufacturer's performance claims are accurate. The Air Movement and Control Association International, Inc. (AMCA) develops test standards, tests products and certifies the performance for the HVAC industry. Relevant standards now exist in the HVAC industry that will influence HVLS fan selection. These are AMCA Standard 203-15 and the U.S. Department of Energy (DOE) performance mandate for large diameter ceiling fans. These are important because both contribute in ensuring the HVLS fan investment is efficient and its performance data is accurate.

HVLS fan performance is measured using AMCA 230-15, the current and accepted industry standard. AMCA certifies air performance and efficiency with this standard, which includes the measurement of thrust and power consumption to characterize and compare the overall performance of HVLS air circulating fans.

The following graph (Figure 1) compares actual fan airflow (CFM) to manufacturers published airflow for three manufacturers. The actual airflow was obtained by tests in accordance with AMCA Standard 230-15. Only manufacturer 1 certifies and publishes their AMCA certified data. Manufacturers 2 and 3 publish and advertise airflow performance greater than that tested in accordance with the AMCA standard.

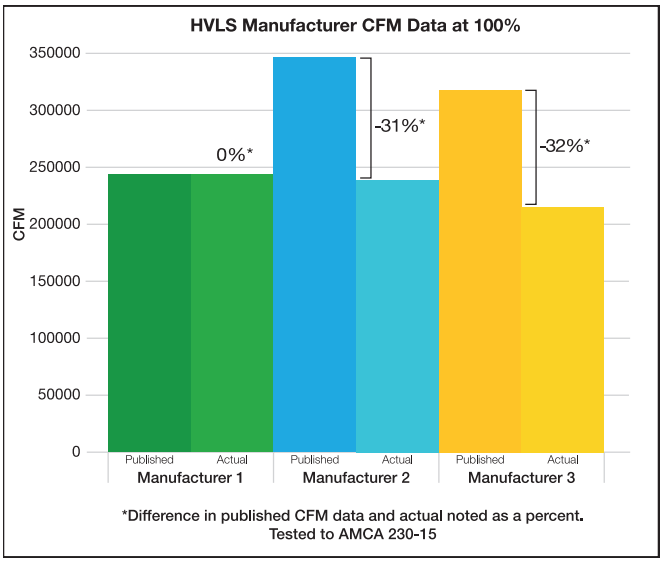


Figure 1

U.S. Department of Energy Regulation

The U.S. Department of Energy (DOE) recently introduced a regulation for HVLS fans effective January 21, 2020. The regulation pertains to all ceiling-mounted fans but specifically identifies two points that address HVLS fans.

First, the DOE regulation reference performance testing standards set by AMCA 230-15 require manufacturers to test products according to this standard. These regulations provide enforcement that will result in significant penalties for those manufacturers failing to comply. This will result in the publishing of accurate performance information once the DOE regulation goes into effect, allowing customers to make informed decisions.

Minimum energy efficiency is the other focus of the DOE regulation. Efficiency is defined as airflow per power consumed (CFM/watt). The DOE determines efficiency for HVLS fans by collecting data when the fan is in standby mode and operation at five distinct speeds.

Not all HVLS manufacturers currently comply with the DOE regulation. Figure 2 illustrates an example of the minimum efficiency manufacturers must meet for 24' diameter fans, and compares three current manufacturers' HVLS fans against the DOE minimum efficiency requirement. Manufacturer 1 meets and exceeds the DOE minimum efficiency.

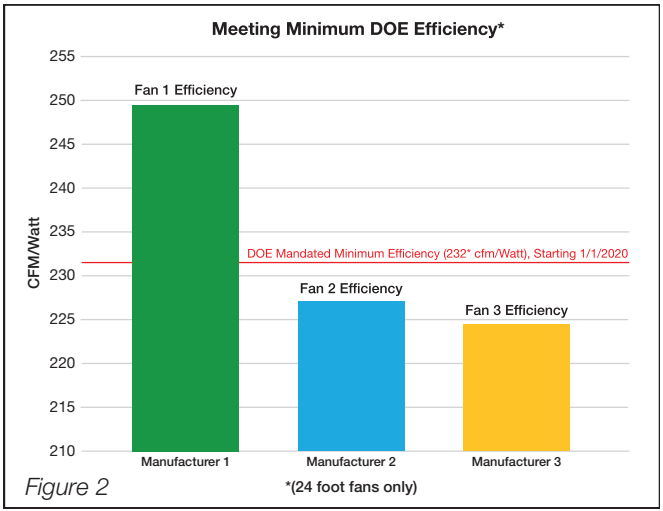


Figure 2

Selection Consideration and Conclusion

HVLS fans offer many safety, productivity and efficiency benefits for the building owner in large space applications including multifamily residential, commercial and industrial. Design professionals must ask two key questions to specify HVLS fans accurately: Is the manufacturer's performance data certified by an independent third party (AMCA)? And does the fan meet DOE minimum efficiency?

Design professionals should also consider fan placement, which is critical for maximum performance and occupant safety. Installed fans must use the manufacturer's recommended clearances around the fan for safety and reliable system design, including minimum distances between the fan and the ceiling, floor, walls, HVAC discharges or intakes, additional HVLS fans, and small obstructions like plumbing or ductwork. The ceiling structure must also support the hanging weight of the fan and operational torque for safe operation. Fans utilizing gearbox motors that require regular maintenance must be easily accessible from the floor below. Designers should avoid placing HVLS fans directly beneath light sources to prevent a strobing effect that fan rotation may cause.

Summary

Selecting an HVLS fan for use alone or as part of an HVAC system offers many safety, productivity and efficiency benefits for the building owner. HVLS fan design, application and selection should be based upon using independent third party tested and certified performance, which per the U.S. Department of Energy will be required in 2020.

Verify performance data using recognized standards from independent third parties. Choose direct drive motors over the gearbox power source. Direct drive HVLS fans have proven value in providing energy efficiency and eliminating sound, repairs, maintenance, and reliability issues that plague fans with gearboxes. Building owners will enjoy a positive HVLS experience by following these recommendations.

GREENHECK®

P.O. Box 410 • Schofield, WI 54476-0410 • 715.359.6171 • greenheck.com