HVLS Fan Design, Application & Specification

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Webinar Moderator

- Joined AMCA in February 2019
- Responsible for development of AMCA's education programs; staff liaison for the Education & Training Committee
- Projects include webinars, AMCA's online learning platform programming, presentations at trade shows, PDH/RCEP account management, and AMCA's Speakers Network

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Andy Dunst

Application Engineer Specialist – HVLS, AMCA Member Company

- Employed in the air movement/air control industry since 2016
- Currently an Application Engineer Specialist- Axial/Inline BU, with focus on HVLS and Circulators
- Previous roles included:
  - PRV- Product Specialist
  - National Distributors-Sales Account Specialist
- Graduated from University of Wisconsin-Stevens Point with a degree in Business Administration & Marketing

HVLS Fan Design, Application & Specification

Purpose and Learning Objectives

The purpose of this presentation is to explain the primary parts of an HVLS fan and why those design considerations will help make the selection and specification process easier.

At the end of this presentation you will be able to:

1. Identify the function and application of HVLS fans.
2. Describe the primary fan design considerations for specifying HVLS fans.
3. Explain the criteria and processes used to make appropriate HVLS fan selections.

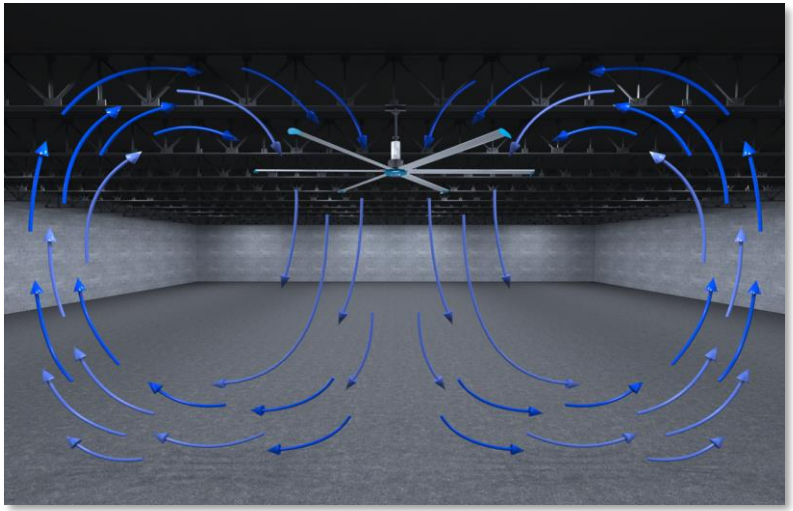
What is an HVLS Fan?

HVLS = High Volume Low Speed

Large diameter ceiling fans designed to circulate high volumes of air using low operational speeds

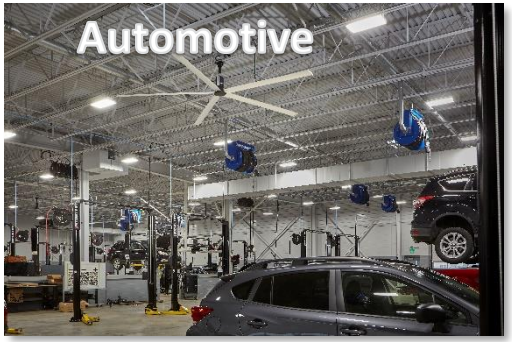
HVLS Fan Operating Principles

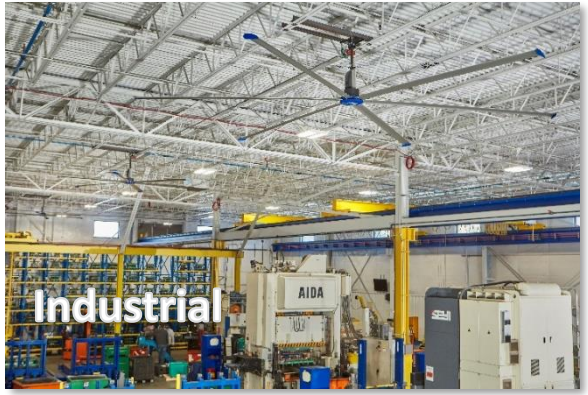
- High volume air movement
  - Large diameter results in large column of air being displaced
- Low operational speeds
  - Gentle air movement with minimal turbulence
  - Low sound levels
  - Less horsepower required to operate fan
- Large area of effect
  - Coanda effect causes air to cling to surfaces and entrain surrounding air
  - Large air mass capable of traveling long distances

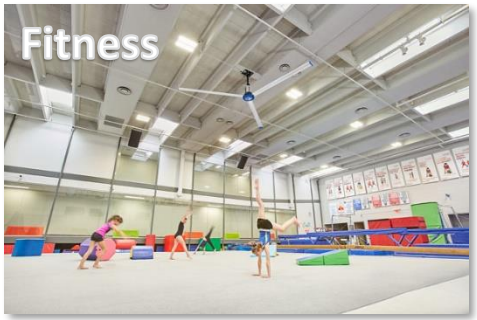


HVLS Fan Market & Applications

HVLS Market Distribution



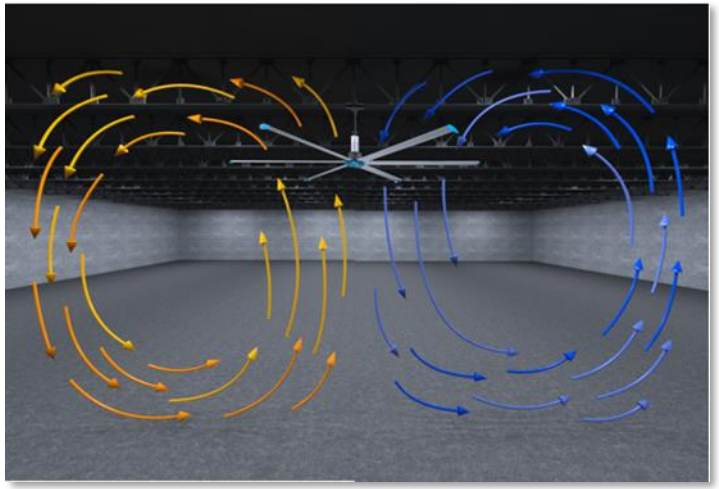




Applications – Thermal Comfort & Energy Efficiency

Winter

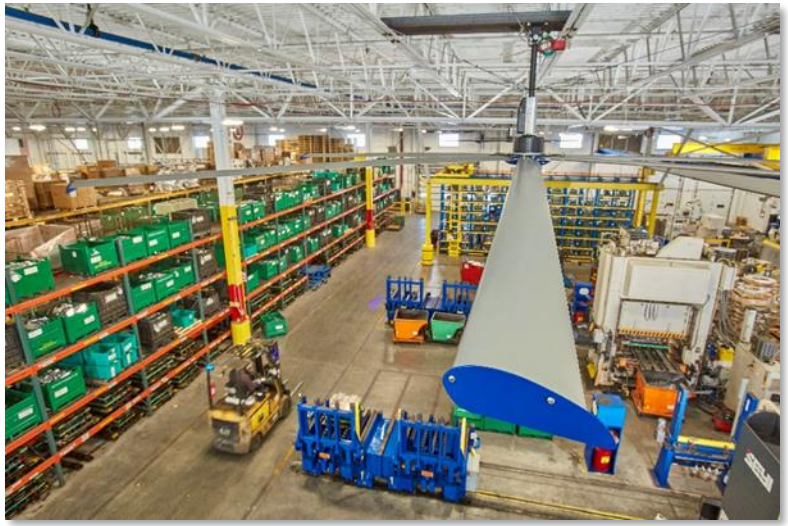
- Destratification
- Reduce heat loss through roof
- Save up to 25% on heating costs



Summer

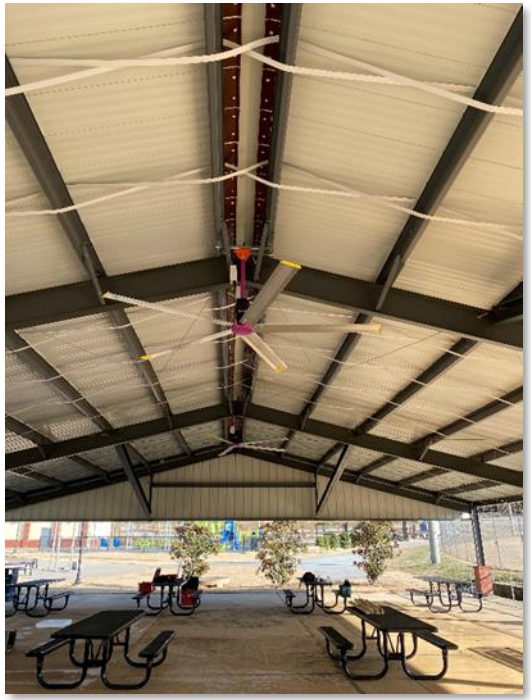
- Air circulation & evaporative cooling
- Improve occupant efficiency
- Save up to 30% on cooling costs

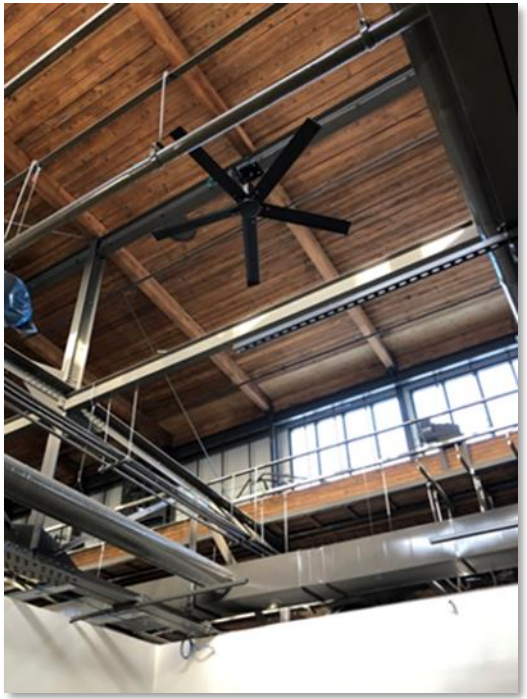
Applications – Safety & Inventory Integrity



Applications – Pest Deterrence

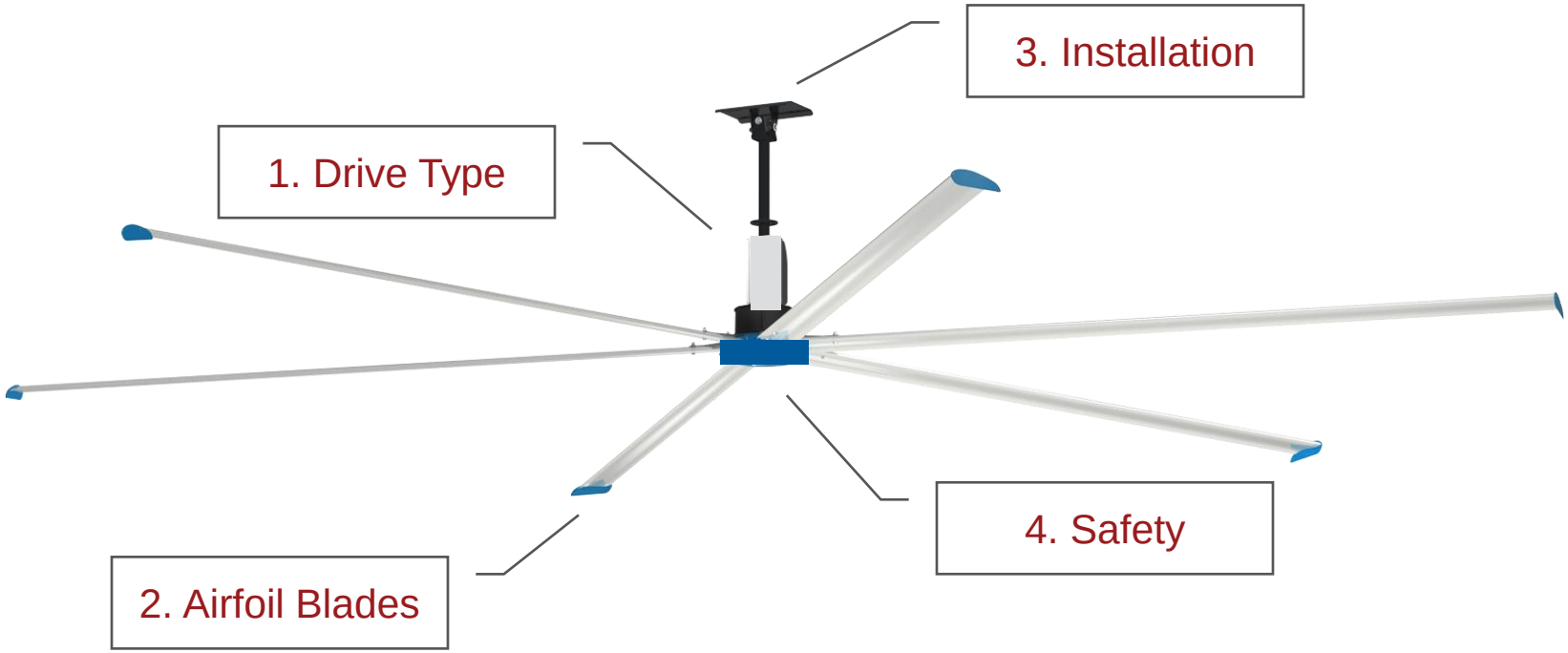
Applications – Architectural Design





HVLS Fan Design Considerations

Fan Design Considerations



Drive Type

	Description	Pros	Cons
Gearbox	• High RPM motor with gear system that reduces speed to maximize torque ($P = \tau * RPM$)	• Motors more readily available • Lower first-cost • Easily applied to any diameter	• More maintenance (oil changes) • Physically larger/heavier • Efficiency losses • Can be noisy
Direct Drive	• Low RPM motor designed for high continuous torque	• Little to no maintenance • Compact design • High efficiency • Quiet	• Limited motor availability • Higher first-cost • Not always available for large diameters

Airfoil Blades

- Factors to consider
  - Blade count
    - More blades not necessarily better
      - More blades may move more air, but less efficient

$$P = \tau * RPM$$

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

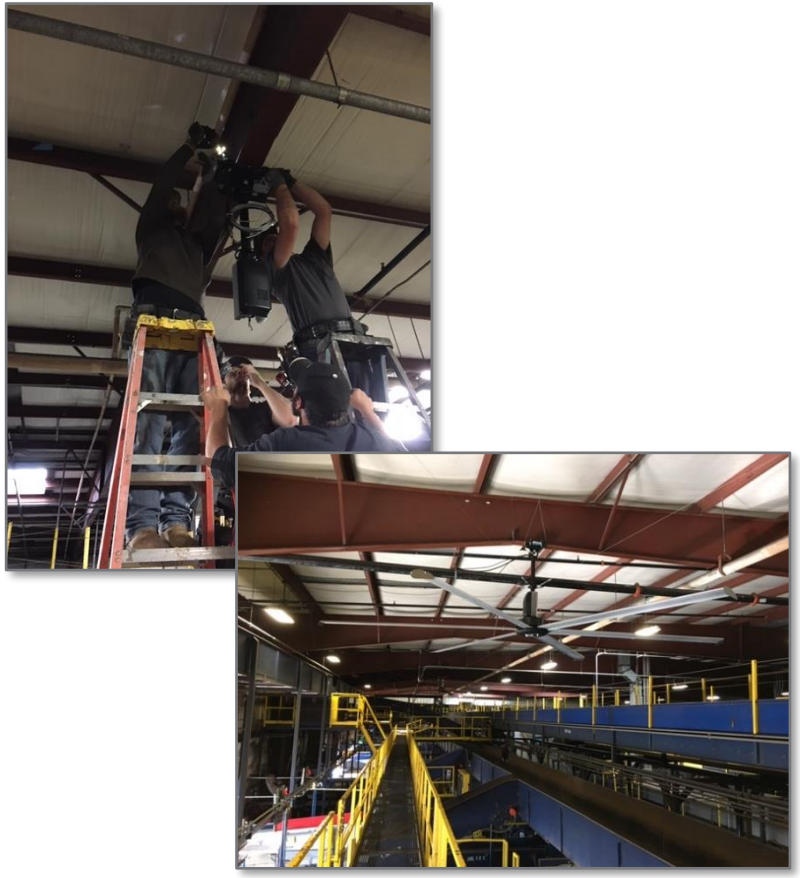
Airfoil Blades

- Factors to consider
  - Blade count
    - More blades not necessarily better
    - 5 or 6 blades = best balance of airflow & efficiency
  - Blade deflection
    - Blade structure and materials vary
    - Critical for preventing unsafe operation

24 ft. Diameter	Static Blade Deflection
Fan 1	3.7 in.
Fan 2	9.0 in.

Fan Installation

- Factors to consider
  - Installation location
    - Accessibility, clearance, structure, etc.



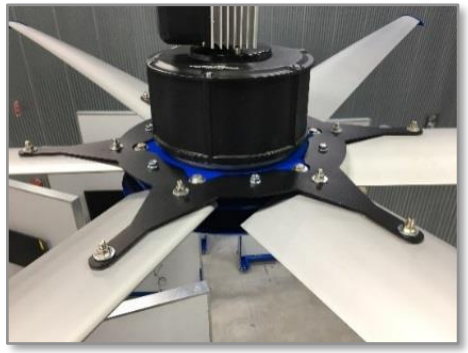
Fan Installation

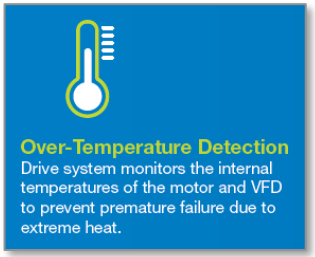
- Factors to consider
  - Installation location
    - Accessibility, clearance, structure, etc.
  - Fan weight
    - Lighter weight = lower installed costs

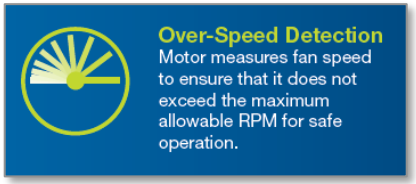
24 ft. Diameter	Weight (lbs.)
Fan 1	214
Fan 2	231
Fan 3	239
Fan 4	300
Fan 5	347

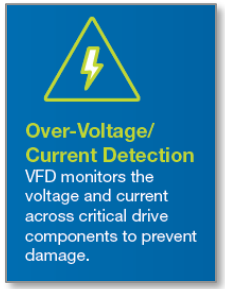
Product Safety

- Factors to consider
  - Mechanical safety systems
    - Factory-installed systems prevent installation problems
  - Electrical safety systems
    - Prevent damage to motor and VFD
    - Intelligent products can also prevent unsafe operating conditions (fan impact, etc.)



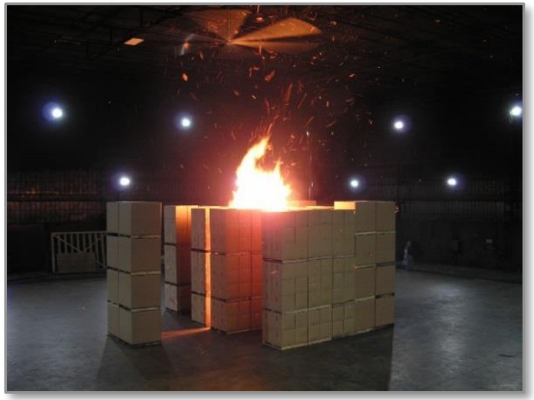


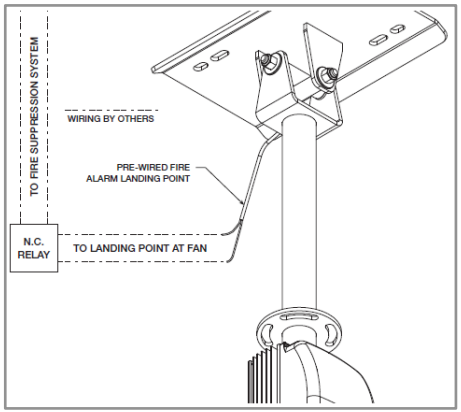




Product Safety

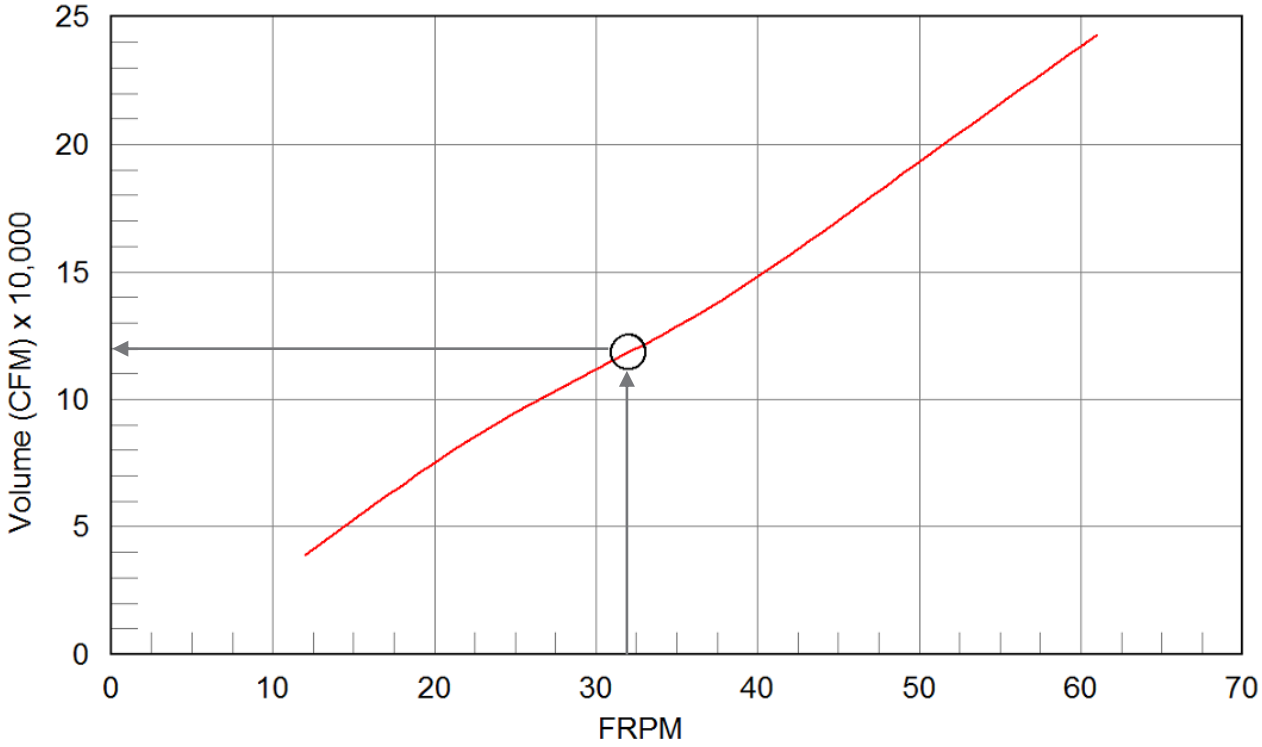
- Factors to consider
  - Mechanical safety systems
    - Factory-installed systems prevent installation problems
  - Fire system integration
    - NFPA 13 requires:
      1. Maximum fan diameter shall be 24 ft.
      2. Fan shall be centered between 4 sprinklers
      3. Vertical clearance to sprinkler deflector shall be minimum of 3 ft.
      4. Fans shall be interlocked to shut down upon receiving fire alarm
    - Factory-supplied parts simplify installation





HVLS Fan Performance

Fan Curves

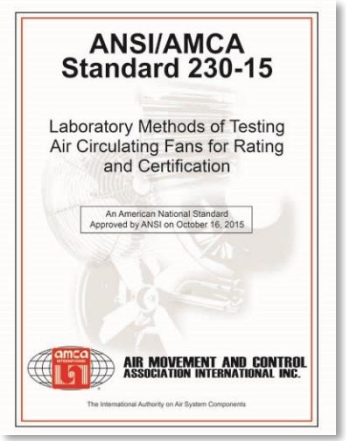


AMCA International

- Air Movement and Control Association
  - Independent third-party verification
  - International Certified Ratings Program (CRP)
  - Guaranteed performance as stated with AMCA seal

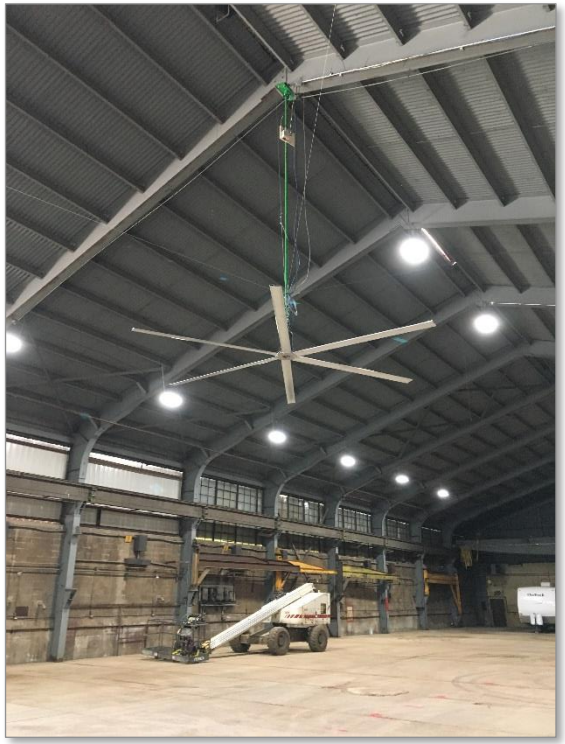
amca INTERNATIONAL

MEMBER



HVLS Fan Testing

- Cannot be tested using traditional air chamber
  - Requires large open area with high ceilings
- Airflow is not measured directly
  - Measure thrust generated by fan using a load cell
- Power determined in two ways
  - Measure torque and RPM to calculate mechanical power
  - Measure input electrical power using power meter



Importance of AMCA Certification

- Guaranteed performance as stated with AMCA seal
- History of inaccurate performance data in HVLS industry
  - Previous performance calculations incorrectly included √2 correction factor resulting in ~30% higher CFM values
  - Many manufacturers continue to publish data calculated using these equations
  - No driving force for correcting published data until recently

Previous Calcs.	AMCA 230-15
$Q_0 = 340.3\sqrt{\frac{2AF_t}{\rho_{std}}}$	$Q_0 = 340.3\sqrt{\frac{AF_t}{\rho_{std}}}$
$F_t = 37.0$	$F_t = 37.0$
$A = 113\ ft^2$	$A = 113\ ft^2$
$Q_0 = 113{,}664\ CFM$	$Q_0 = 80{,}365\ CFM$

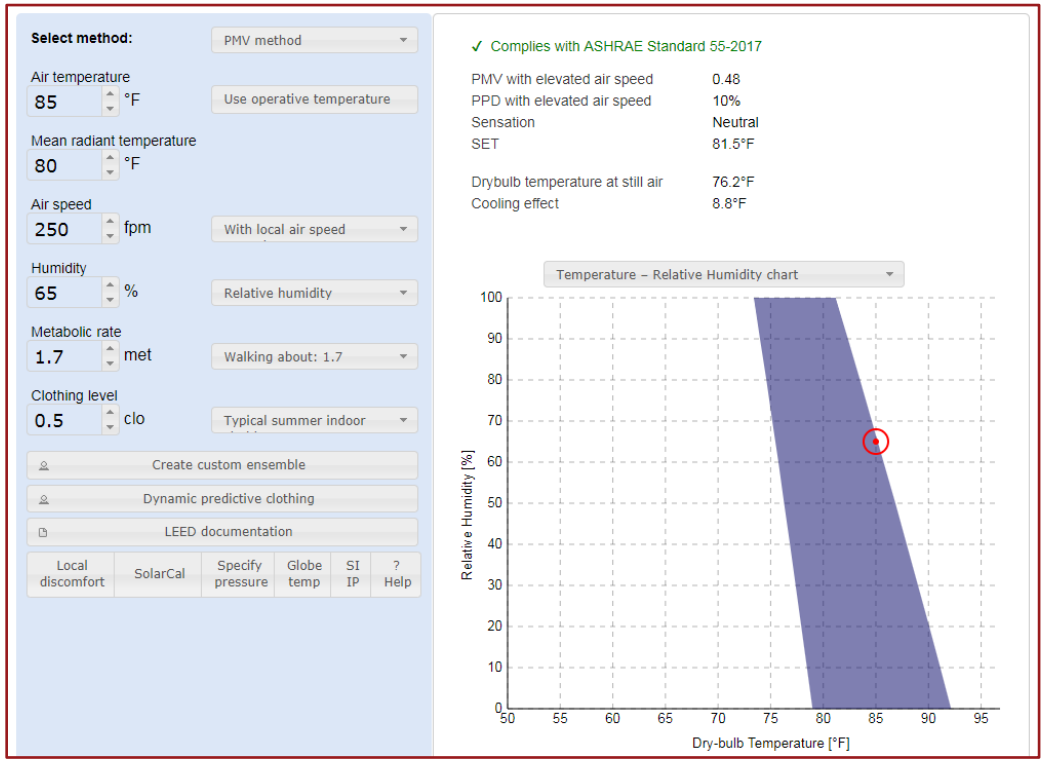
DOE Efficiency Legislation

- As of 5/27/2021, the DOE has replaced CFM/W with CFEI for large diameter ceiling fans (>7')
- CFEI compares a fan's relative wire-to-air efficiency to a baseline efficiency with values over 1.00 being more efficient than baseline
- Intended to simplify fan efficiency comparisons and close loopholes in previous legislation
- Design criteria to consider:
  - Verify that fan selection meets minimum efficiency criteria

Fan Diameter (ft)	Min. CFEI at 40% Speed	Min. CFEI at 100% Speed
8-24	1.31	1.00

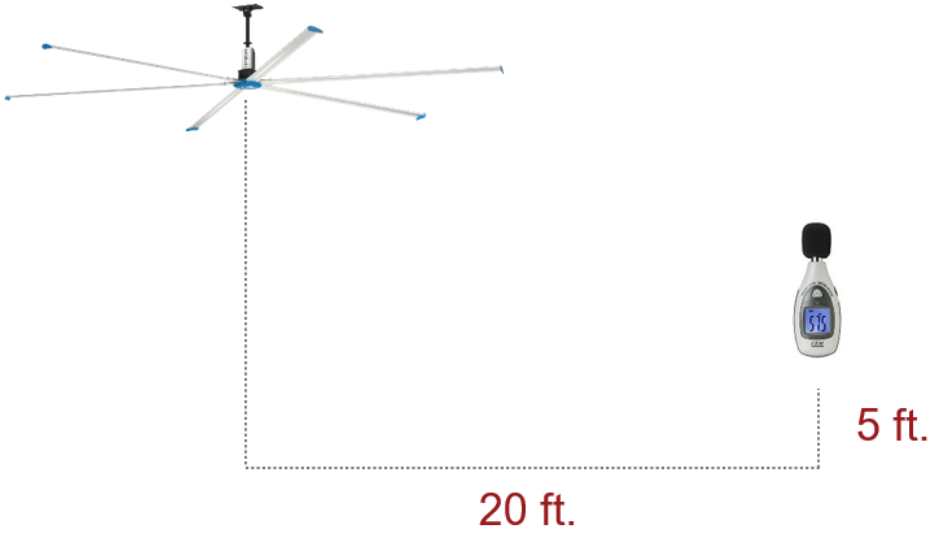
Other Performance Considerations

- Air velocity in occupied zone
  - Studies have shown employee efficiency and comfort benefits of higher air velocity when temperature/humidity are high
  - ASHRAE 55 establishes methodology for quantifying effect of air velocity on thermal comfort



Other Performance Considerations

- Sound
  - Typically published as total dBA (A-weighted sound pressure including fan & air noise)
  - No test standards so test procedures vary
  - Commonly shown at distance 20 ft. from fan, measured 5 ft. above floor



Performance Specification Language

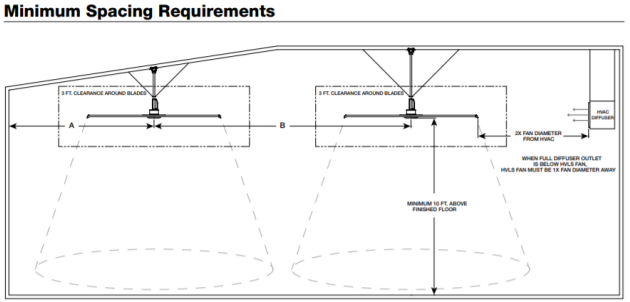
Ensure accurate performance on HVLS fans by specifying AMCA!

“Performance ratings for HVLS fans shall conform to AMCA Standard 211. Fans must be tested in accordance with ANSI/AMCA Standard 230-15 in an AMCA accredited laboratory. Fans shall be certified to bear the AMCA Seal for Circulating Fan Performance.”

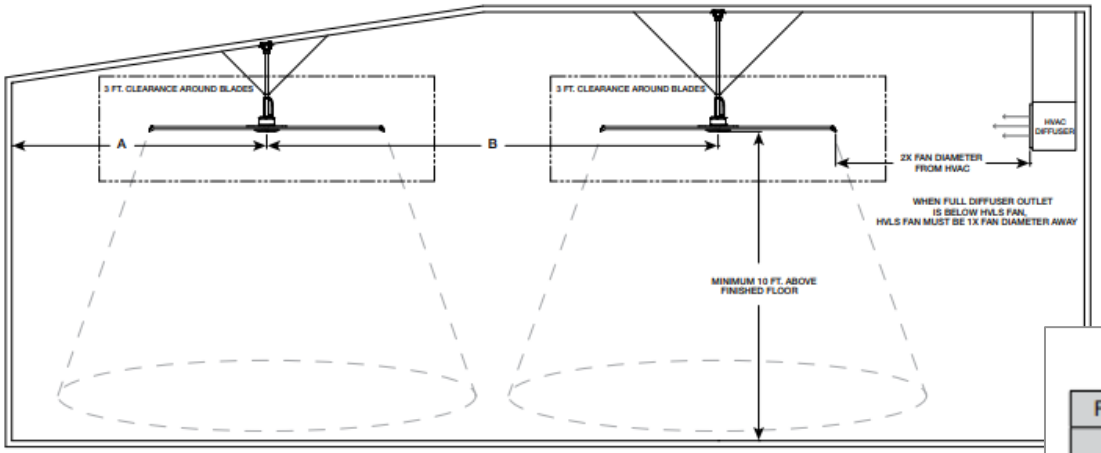
HVLS Fan Selection & Specification

Selection Considerations

- Building type & application
- Fan design
- Fan performance (airflow, efficiency, sound, air velocity)
- Installation location
  - Accessibility, structural support, etc.
- Airflow obstructions
  - Anything that disrupts air movement
  - Walls, furniture, equipment, racking, etc.
- Clearance requirements
  - Clearance to physical obstructions
  - Clearance to HVAC inlets/outlets



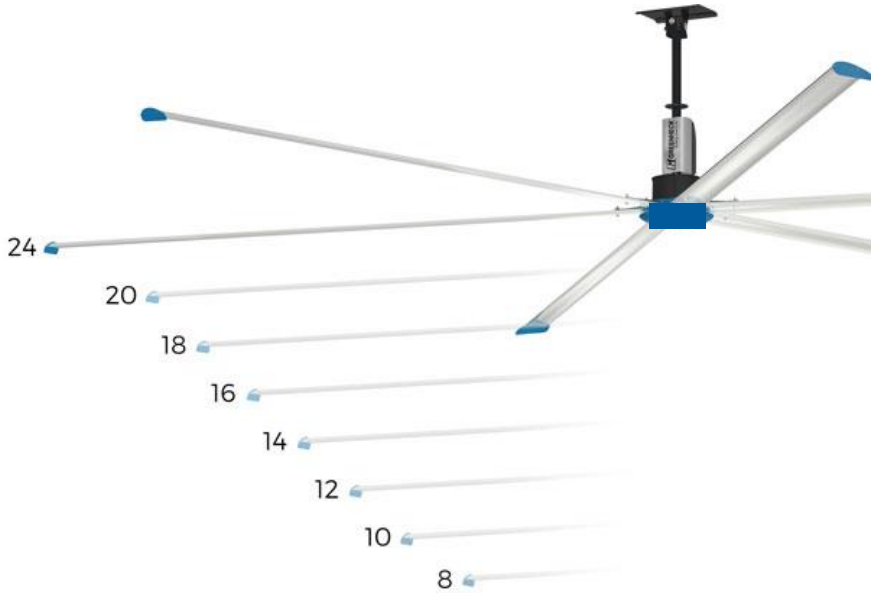
Spacing and Clearance Requirements



	Minimum Spacing From Center of Fan (ft.)	
Fan Size (ft.)	A	B
8	12	24
10	15	30
12	18	36
14	21	42
16	24	48
18	27	54
20	30	60
24	36	72

Selection Process

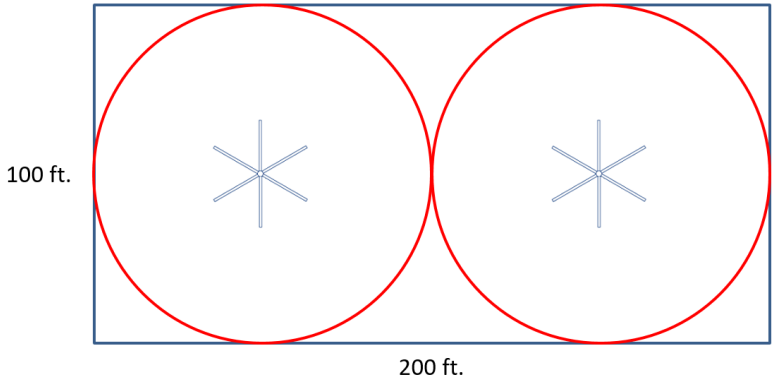
- Processes vary among design professionals
- Two primary methods
  - Size-based selection
  - Performance-based selection
- Size-based method is most commonly used today



Size-Based Selection

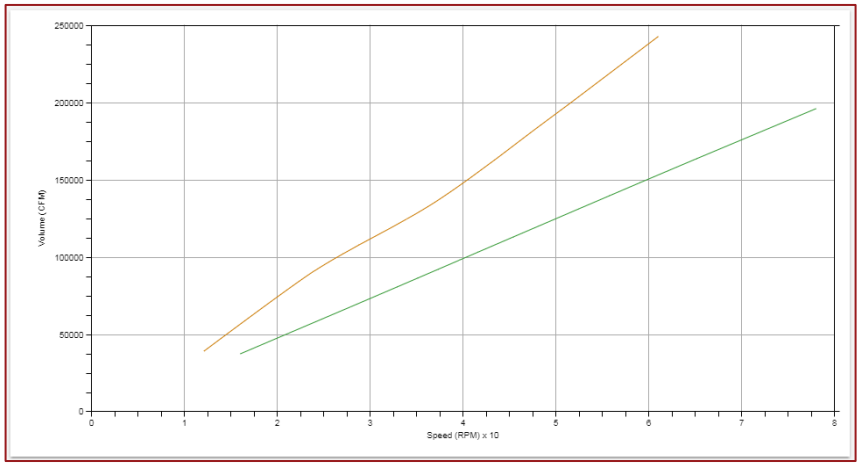
- Process
  - Utilize published coverage area or fan spacing values to identify quantity and size of fans that physically fit space
- Pros
  - Easy and fast
  - Generally a “safe” design
- Cons
  - No performance considerations
  - No data to support design decisions
  - Typically over-designs systems leading to higher first-cost

	Fan Speed (RPM)	Zone 1 375+ FPM Air Speed Radius (ft)	Zone 2 230+ FPM Air Speed Radius (ft)	Zone 3 105+ FPM Air Speed Radius (ft)	Zone 4 <105+ FPM Air Speed Radius (ft)	Recommended Coverage Radius Per Fan (ft)
Selected	61	42	62	79	94	87
Maximum	61	42	62	79	94	87



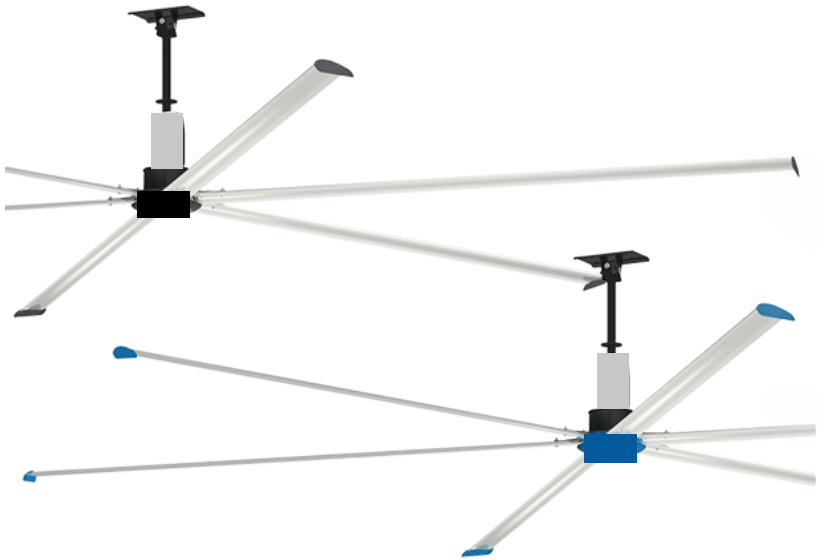
Performance-Based Selection

- Process
  - Utilize performance data to identify size and quantity of fans that deliver correct performance
  - Based on industry standards (AMCA, ASHRAE, etc.)
- Pros
  - Better system design that balances cost & performance
  - Data to support design decisions
- Cons
  - Few manufacturers that publish data
  - Software not always public
  - Can be more time-consuming



Summary

- HVLS fans are highly engineered products that can provide significant value to HVAC and ventilation system designs in any facility.
- Not all HVLS fans are created equal, so it is critical to be informed about product and performance differences.
- Design professionals need to account for a variety of factors to achieve cost-effective systems that meet customer performance requirements.



Resources

- **AMCA International**: *www.amca.org*
- **ANSI/AMCA Standard** (Available for purchase)**:** *www.amca.org/store*

  > **230-15:** Laboratory Methods of Testing Air Circulating Fans for Rating and Certification, Includes Errata (2021)

- **AMCA Publication** (Free PDF Download)**:** *www.amca.org/store*

  > **211-13:** Certified Ratings Program - Product Rating Manual for Fan Air

- **AMCA Advocacy Microsite– Large Diameter Ceiling Fans:** *www.amca.org/LDCF*

Thank you for your time!

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Questions?

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