Lab Exhaust System Fundamentals

June 23, 2015



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Laboratory Exhaust Support Team



Matt Gaedtke

- Director of Fume Exhaust Systems
- Employed at Greenheck since 1994
  - Business development
  - Product marketing
  - Application and product training
- Mechanical Engineering – UW Madison
- Masters of Business – UW Oshkosh

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Learning Objectives

- Laboratory exhaust fundamentals
- Laboratory exhaust stack and fan types
- Non-invasive flow monitoring
- Laboratory energy savings methods
- Maintenance Monitoring

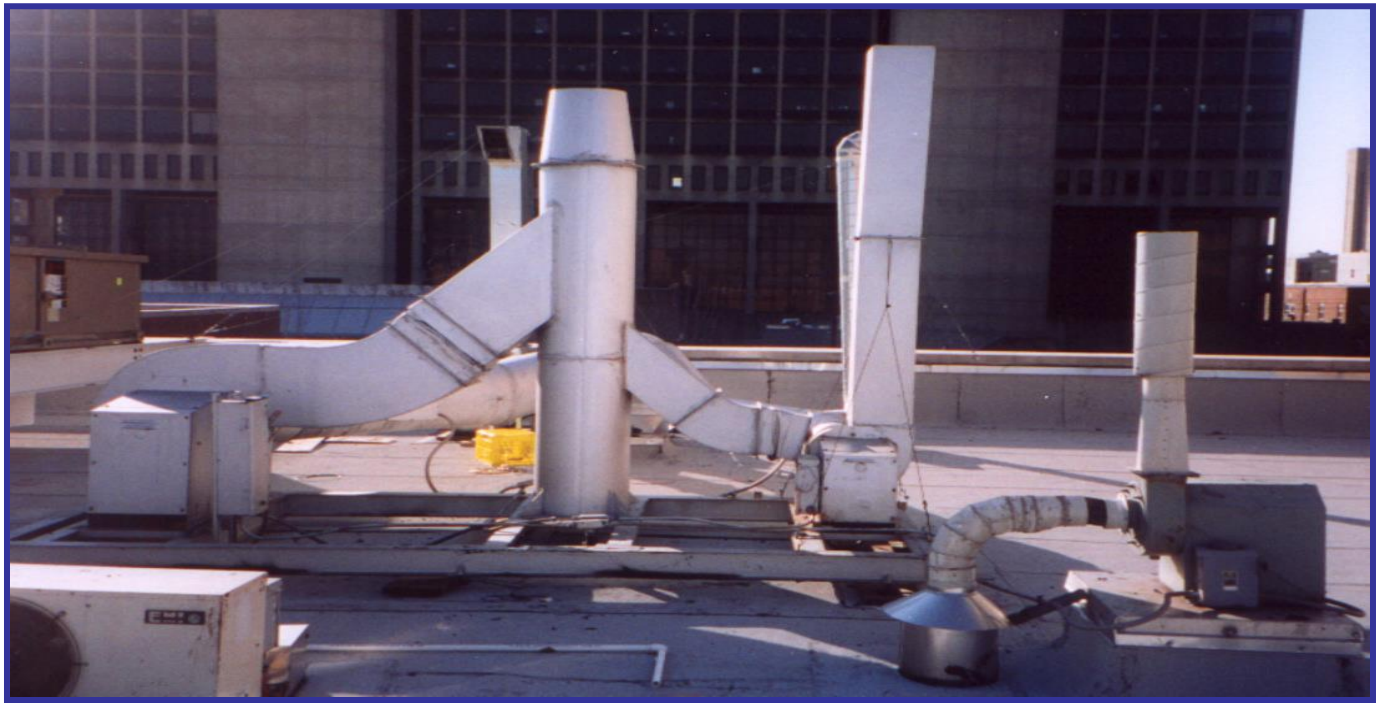
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The Main Objectives of a Laboratory Exhaust System

- Remove hazardous or noxious fumes from a laboratory
- Dilute the fumes as much as possible
- Expel them from the lab building so that the fumes do not contaminate the roof area
- Prevent re-entrainment into building make-up air systems

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Unfortunately, there are potential safety disasters!



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Laboratory Ventilation Standards

- **ANSI/AIHA Z9.5** - American National Standard for Laboratory Ventilation
- **NFPA 45** - Fire Protection for Laboratories Using Chemicals
- **NFPA 91** - Exhaust Systems for Air Conveying of Materials
- **NFPA 90A** - Installation of Air Conditioning and Ventilating Systems
- **OSHA 29 CFR Part 1910** - Occupational Exposure to Hazardous Chemicals in Laboratories
- **ANSI/ASHRAE 110** - Method of Testing Performance of Laboratory Fume Hoods

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"NOT" Standards... but *important* references to know!!

- *CRC Handbook of Laboratory Safety* (Specifically for Perchloric Acid Exhausts)
- *Industrial Ventilation, a Manual of Recommended Practice*; American Conference of Governmental Industrial Hygienists
- *ASHRAE Fundamentals Handbook*; Chapter 16, Airflow Around Buildings
- *ASHRAE Applications Handbook*; Chapter 45, Building Air Intake and Exhaust Design
- *Laboratory Fume Hoods, A User's Manual*, G. Thomas Saunders

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Chapter 45, 2015 ASHRAE Applications Handbook

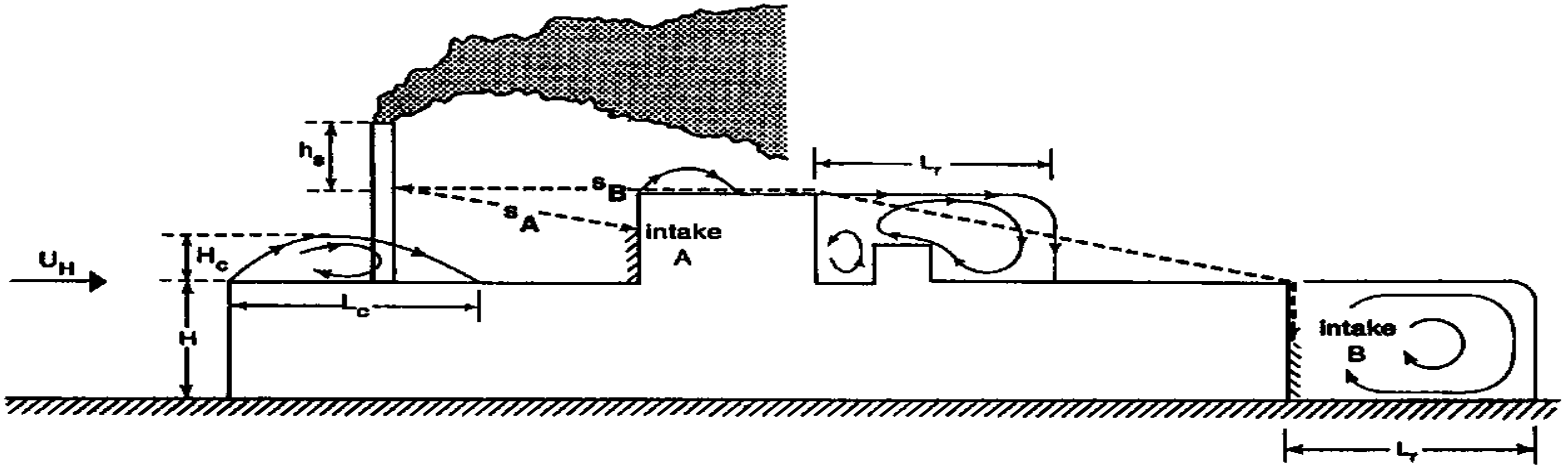


Fig. 3 Flow Recirculation Regions and Exhaust to Intake Stretched String Distances (Wilson 1982)

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ANSI Z9.5 and NFPA 45 Standards



1. Minimum stack discharge velocity shall be 15.2 m/s (3000 ft/min).

2. Stack height shall not be less than 3m (or 10 ft) above roof line.

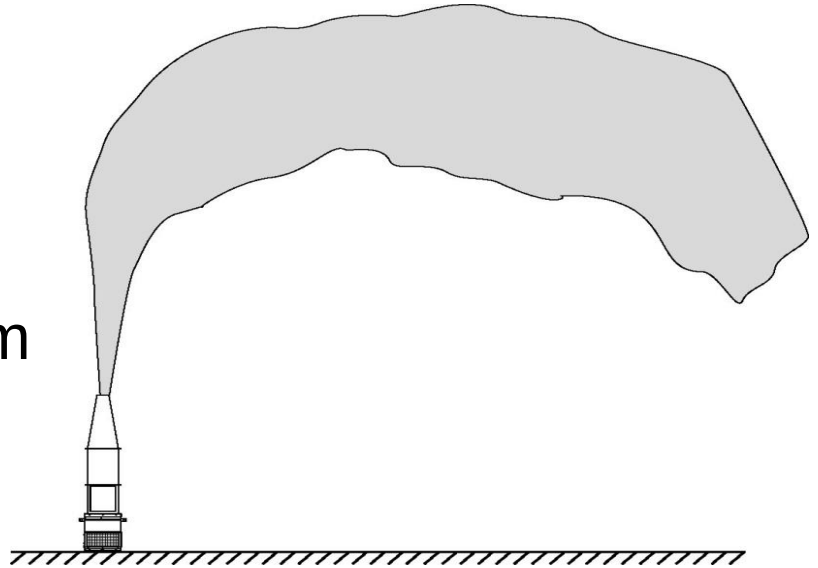
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Maximizing Plume Rise

$$h_r = \frac{3Vd}{U}$$

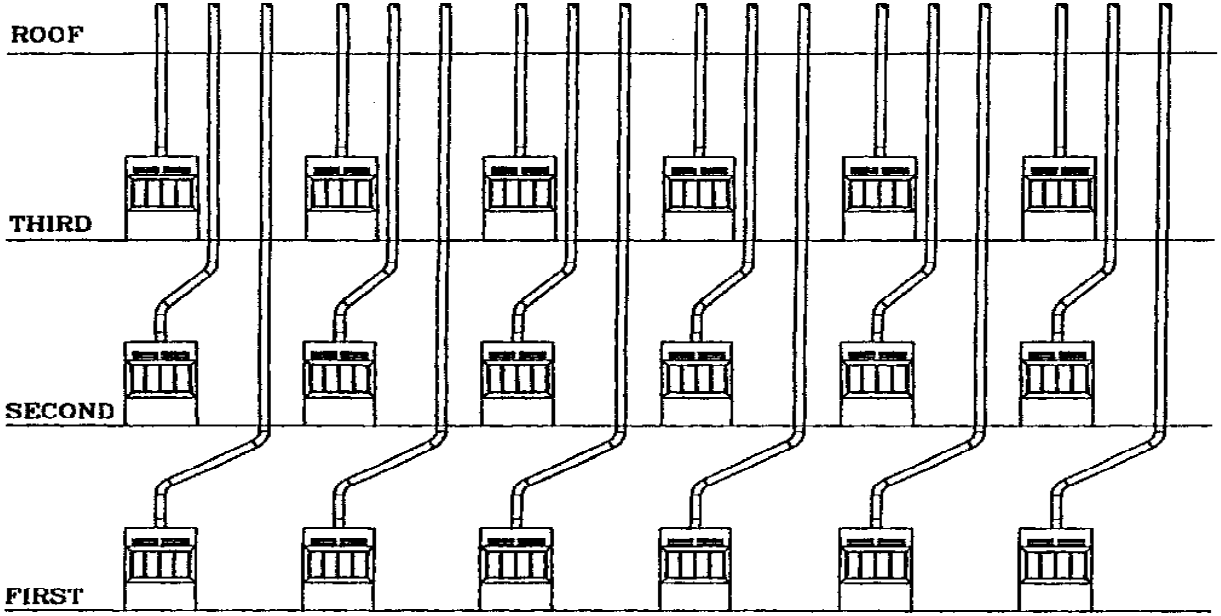
where: h_r = plume rise, feet
V = discharge velocity, fpm
d = nozzle diameter, feet
U = wind speed, ft/min



Plume Rise, h_r, equation (Briggs)

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Individual Fan and Stack Systems..



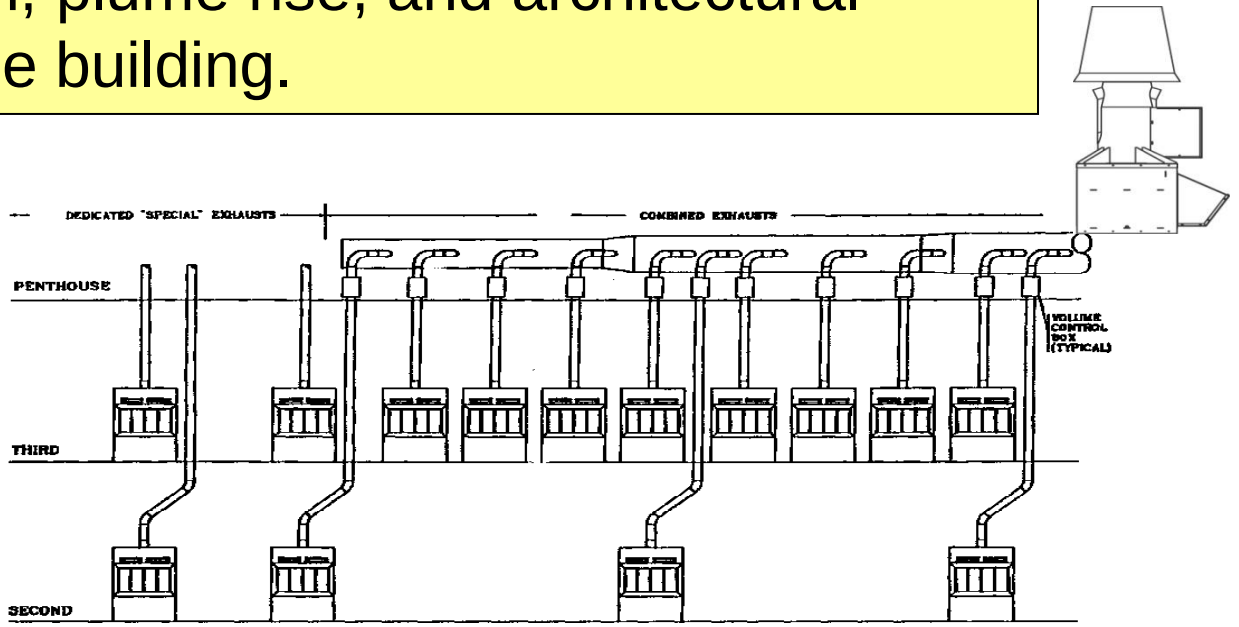
INDIVIDUAL EXHAUST RISERS and FANS

- *More maintenance*
- *More roof penetrations*
- *Lower plume rise*

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Current designs use manifolded exhaust systems to reduces the number of exhaust fans and stacks, improve dilution, plume rise, and architectural aesthetics of the building.



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Plume Rise 2015 ASHRAE Chapter 45

Plume Rise = $$h_r = \min(\beta h_x,\ \beta h_f)$$

plume rise vs. downwind distance $$h_x = \left(\frac{3F_m x}{\beta_j^2 U_H^2}\right)^{1/3}$$

where: $$F_m = V_e^2\left(\frac{d_e^2}{4}\right)$$

$$\beta_j = \frac{1}{3} + \frac{U_H}{V_e}$$

and: $$h_f = \frac{0.9\left[F_m U_H / U_*\right]^{\frac{1}{2}}}{U_H \beta_j}$$

logrithmic wind profile: $$U_H / U_* = 2.5 \ln\left(H / z_o\right)$$

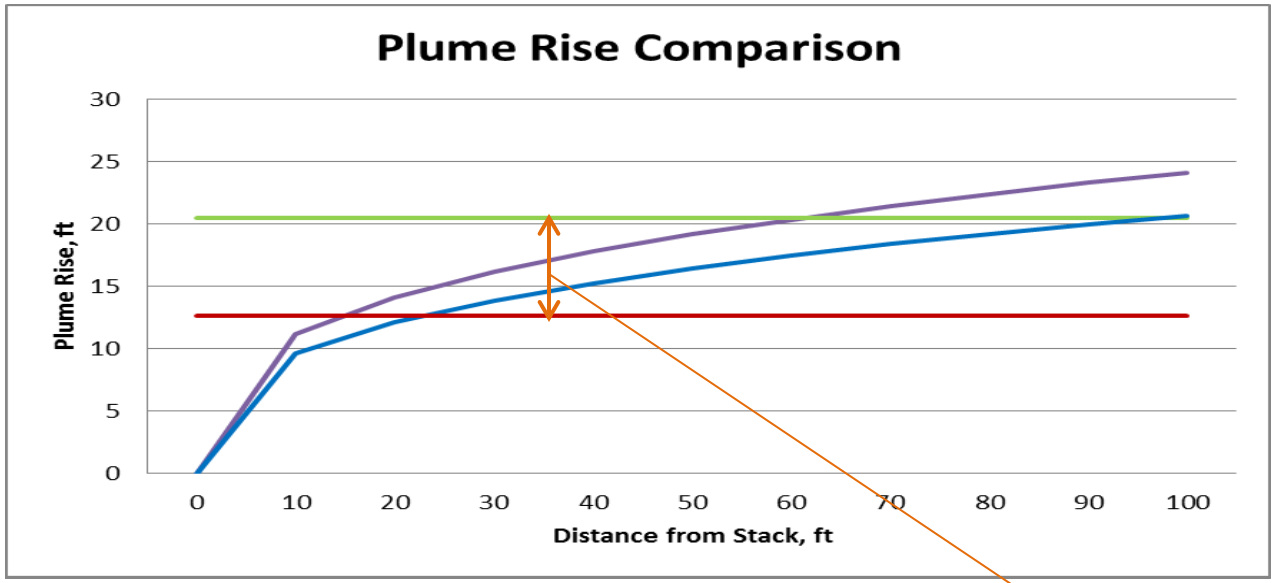
β = cap factor: 1.0 without cap, 0 with cap
x =distance downwind of stack, ft
V_e =stack exit velocity, fpm
U_H =wind speed at building top, fpm
H =building height above ground level, ft
z_o =surface roughness length, ft
d_e = stack diameter, ft

Atmospheric Boundary Layer Parameters	
Terrain Category	**z_o, ft**
Flat, water, desert	0.03
Flat, airport, grassland	0.16
Suburban	2.1
Urban	6.0

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Impact on Plume Rise

Example:
Wind speed 10 mph (16 kph)
Exh Vel 3,000 fpm (15.2 m/s)
Building height 30 ft (9.1 m)
Suburban setting
Stack diameter 2 ft, (0.6m)
uncapped



Briggs 1969 equation for jet plume rise over a distance
Briggs equation simplified to a single value (Up to 2011)
ASHRAE 2011 jet plume rise over a distance
ASHRAE 2011 final jet plume rise at breakup

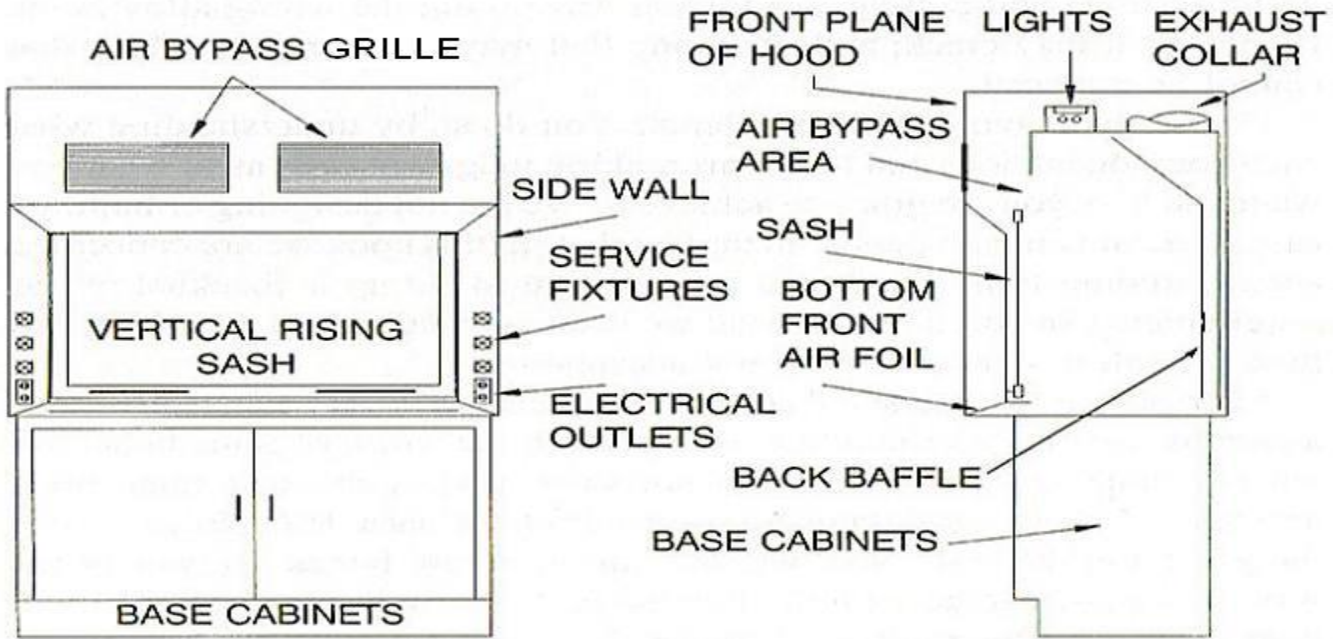
38% decrease

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Constant Volume Laboratory Exhaust Systems

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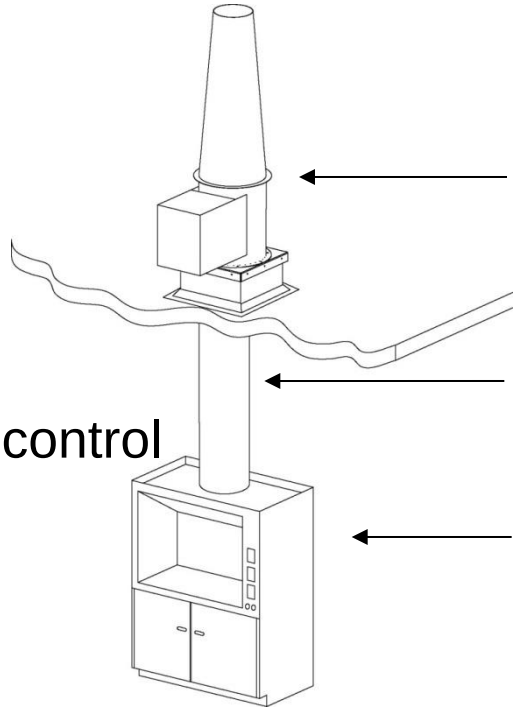
Constant Volume Fume Hood



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Constant Volume Fume Hood

- Pros
  - Easy to install
  - Low cost
- Cons
  - Poor face velocity control
  - Poor containment
  - Unsafe

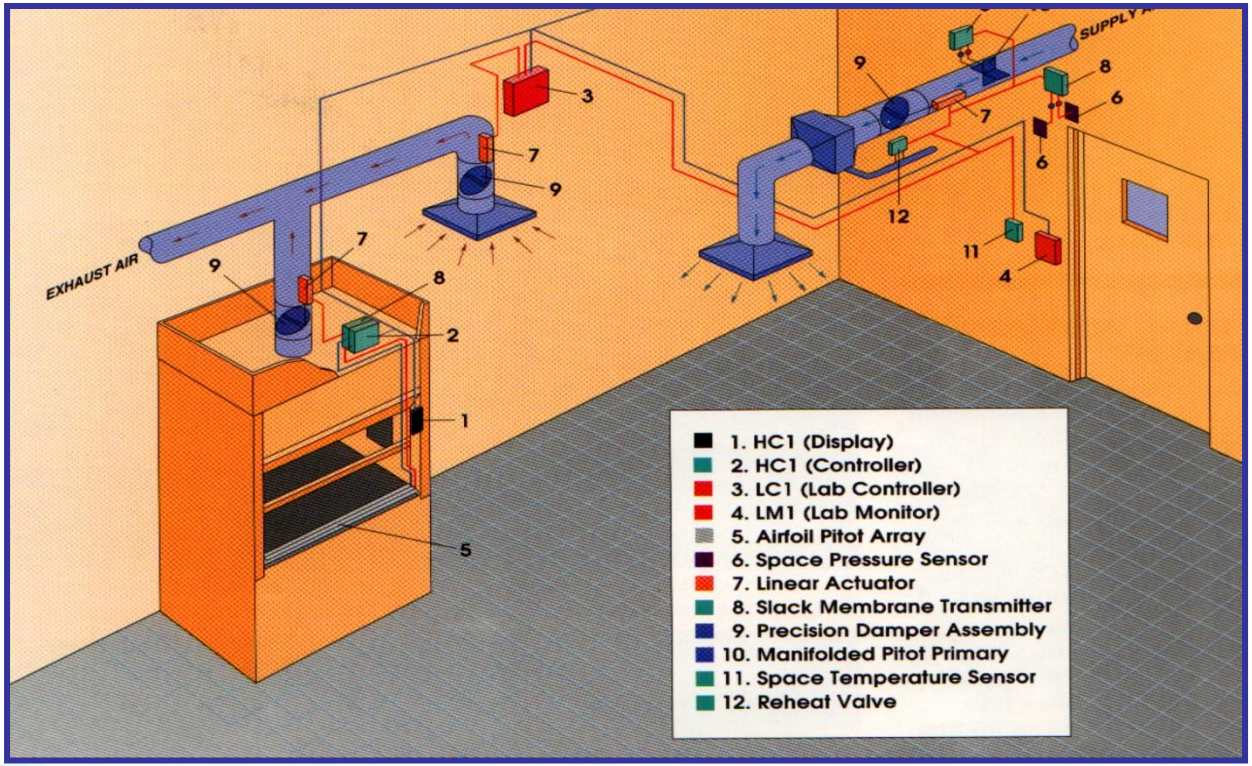


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Variable Volume Laboratory Exhaust Systems

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Variable Volume Laboratory

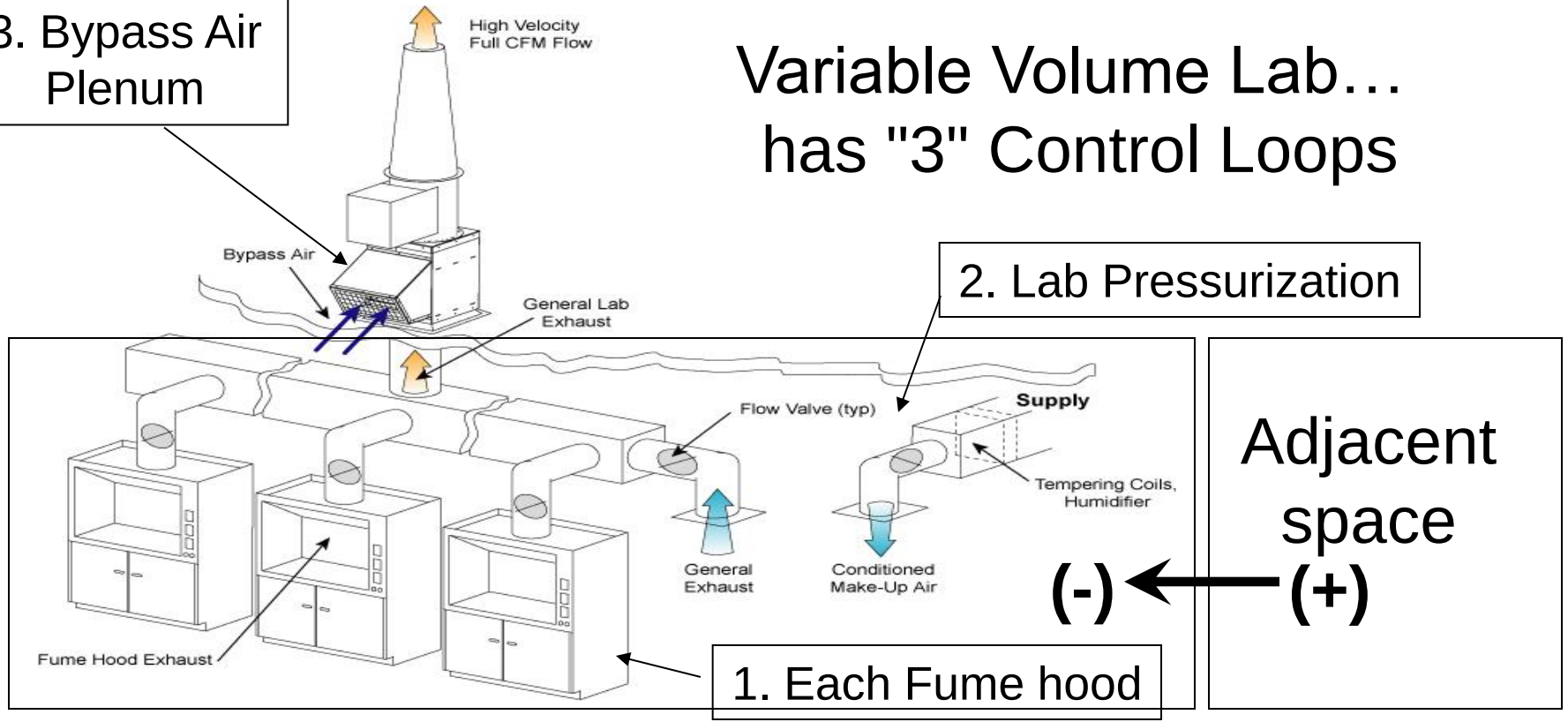


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Variable Volume Lab… has "3" Control Loops

3. Bypass Air Plenum



2. Lab Pressurization

Adjacent space

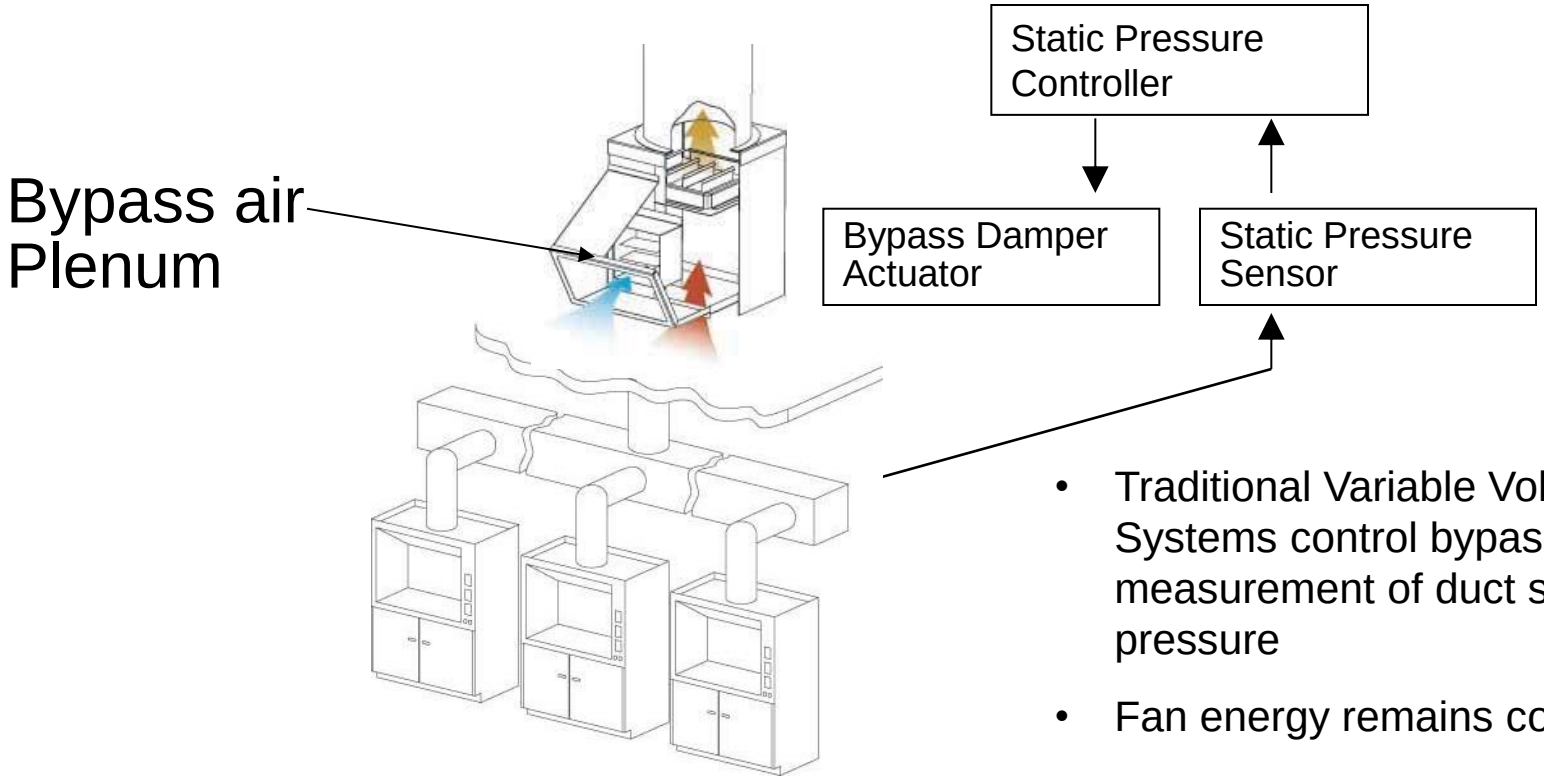
(-) ← (+)

1. Each Fume hood

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GREENHECK Building Value in Air.

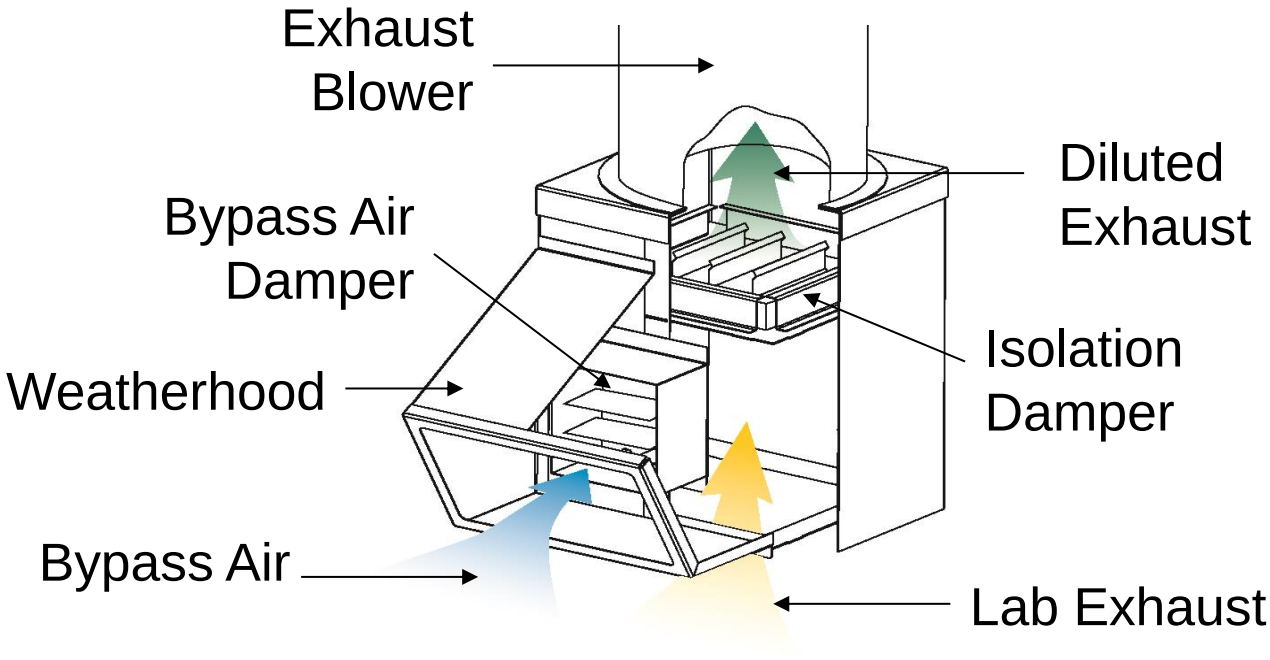
Traditional VAV System



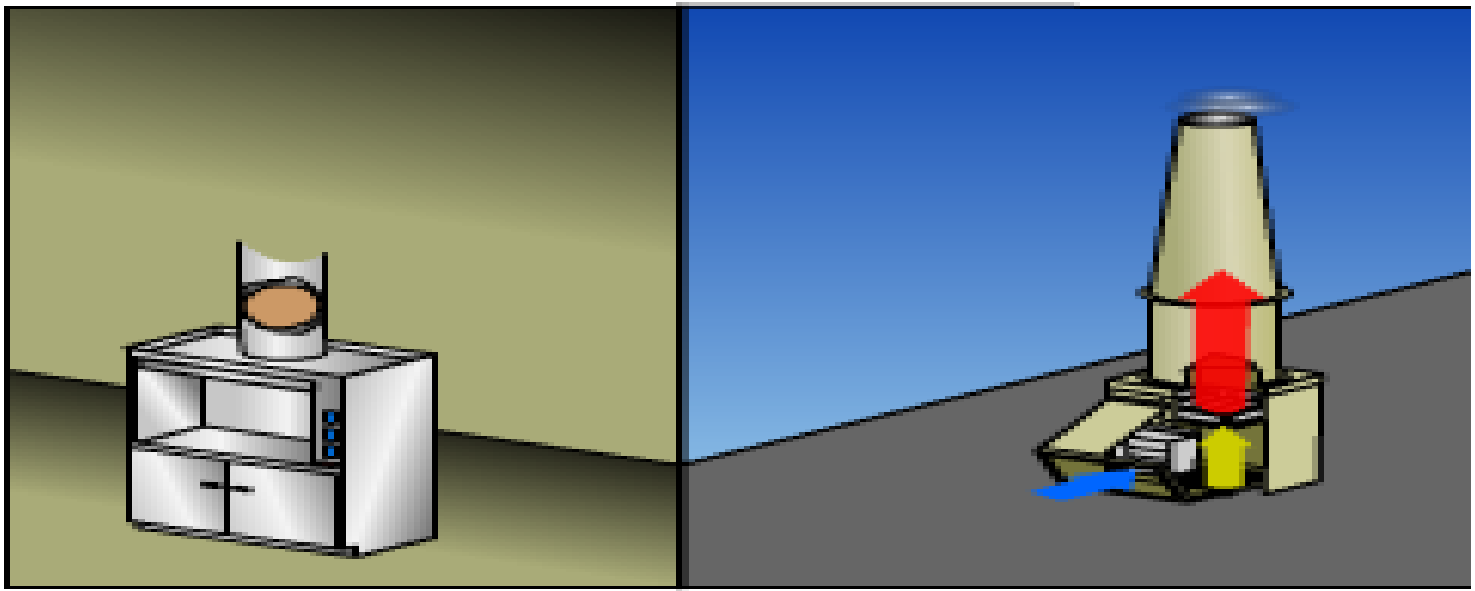
- Traditional Variable Volume Systems control bypass air by measurement of duct static pressure
- Fan energy remains constant

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Bypass a Air Plenum Works



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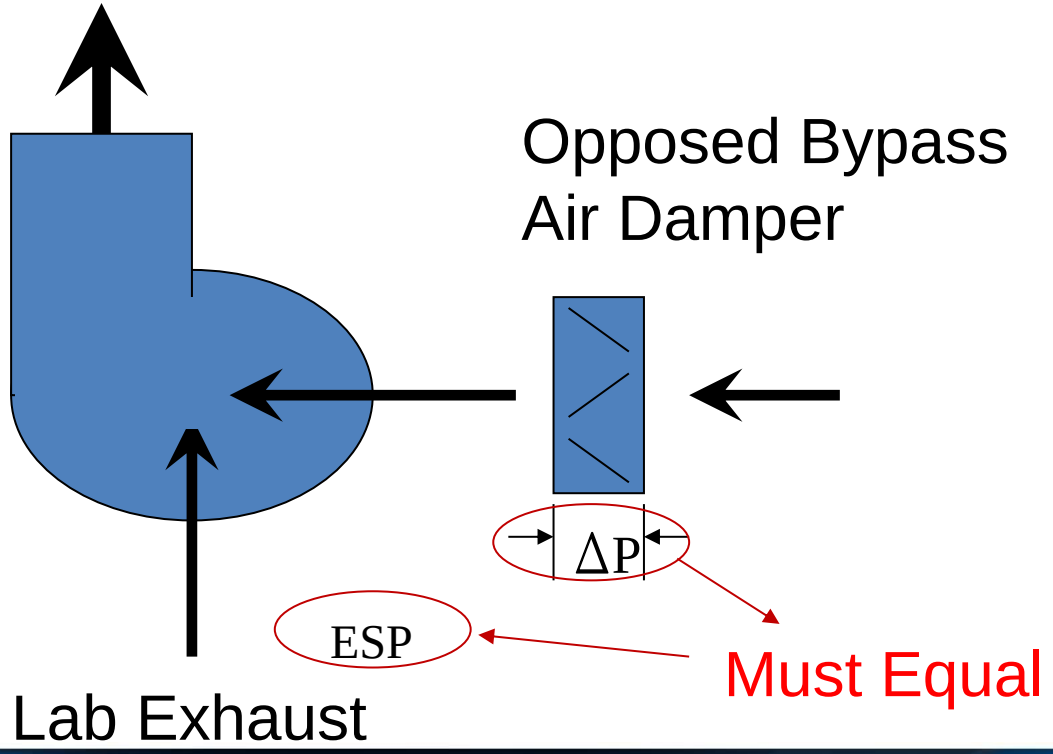


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Bypass Air Damper Sizing

Factors

- System pressure

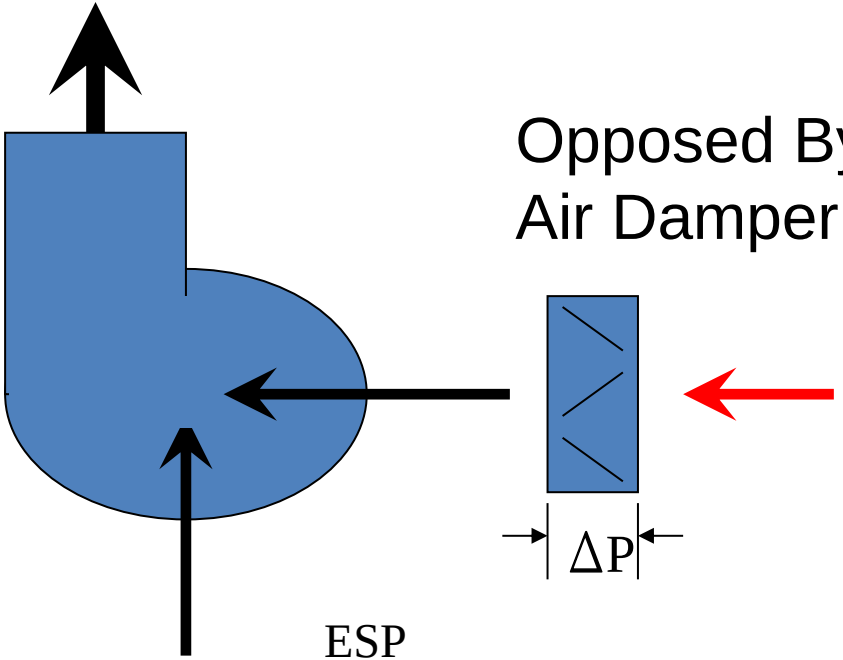


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Bypass Air Damper Sizing

Factors
- System pressure
- Bypass-air amount

50-100% of lab exhaust volume

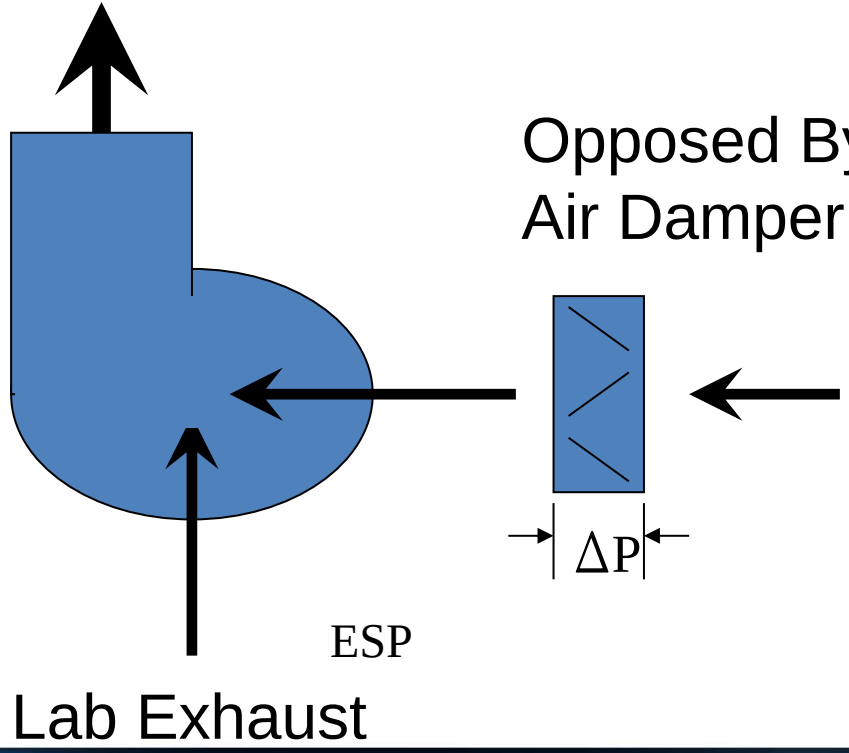


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Bypass Air Damper Sizing

Factors
- System pressure
- Bypass-air amount
- Staging controls

Typically see up to 100% of a single fan



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VAV System with Redundant Fans

Stand-by, Redundant or N+1 Fan Systems
That Improve Exhaust System Reliability also utilized for Staging Controls Systems

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Fan Technology

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Stack Technology (Non-variable)



High Plume

Dilution

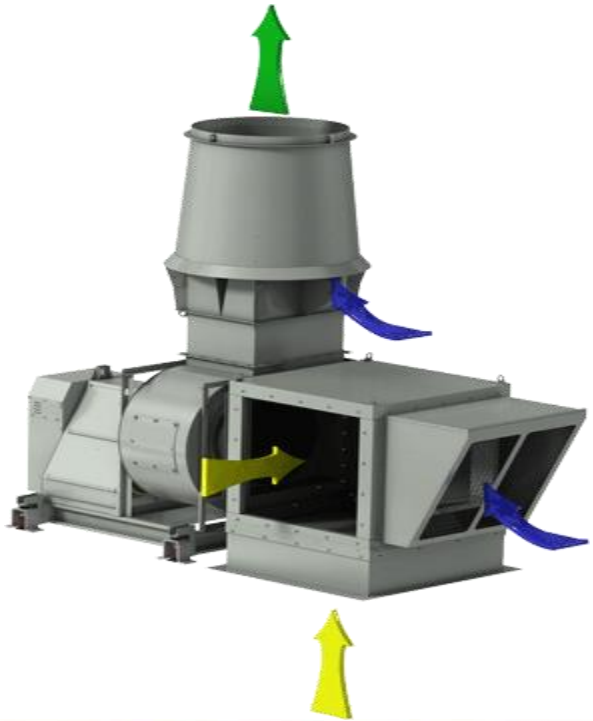


High Plume

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“High Plume Dilution” Stacks

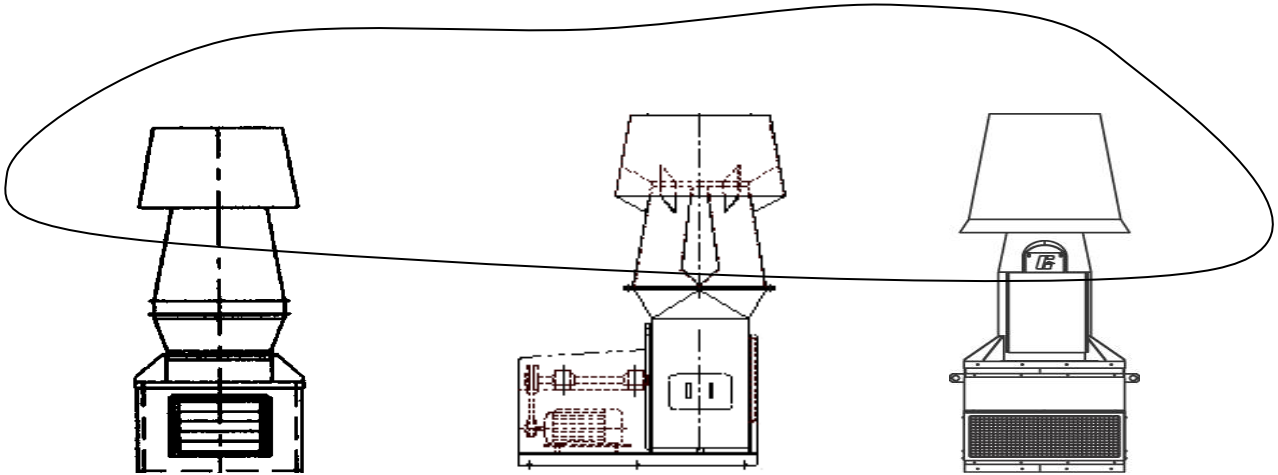




- Dilution nozzles add entrainment air to dilute the exhaust effluent
- Energy levels can increase to attain necessary nozzle exhaust levels

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Until recently, there was no AMCA Performance Certification for Dilution Fans!



$$h_r = \frac{3Vd}{U}$$

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AMCA Certification

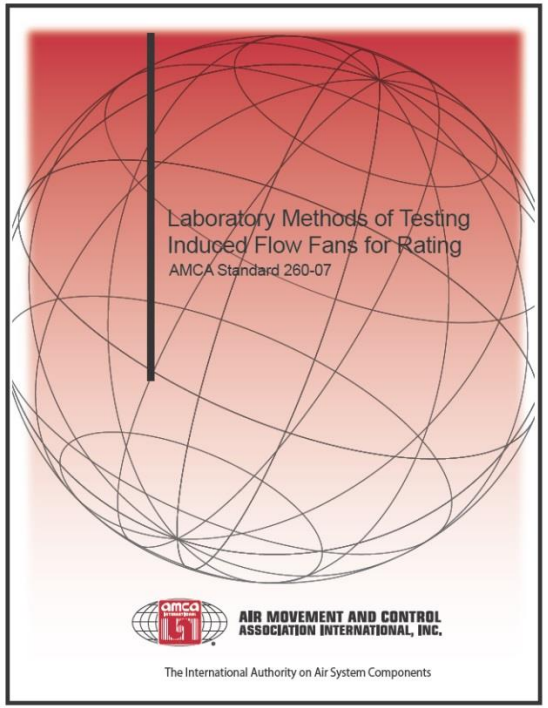


International Air Movement and Control Association, Inc.

"AMCA is an independent third party that certifies performance. Assures engineers, contractors and facility owners that air movement and control devices (fans, dampers, louvers, sound attenuators) perform as the manufacturer states."

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Laboratory Exhaust Systems



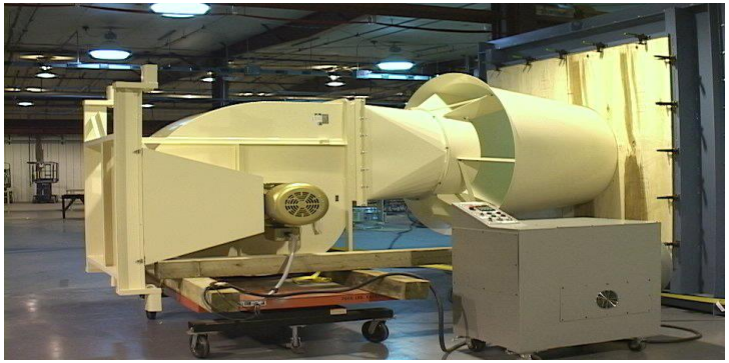
AMCA 260 Certification

amca
CERTIFIED
RATINGS
INDUCED
FLOW FAN
AIR AND SOUND
PERFORMANCE
AIR
MOVEMENT
AND CONTROL
ASSOCIATION
INTERNATIONAL, INC.®

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AMCA 260 Test Certification





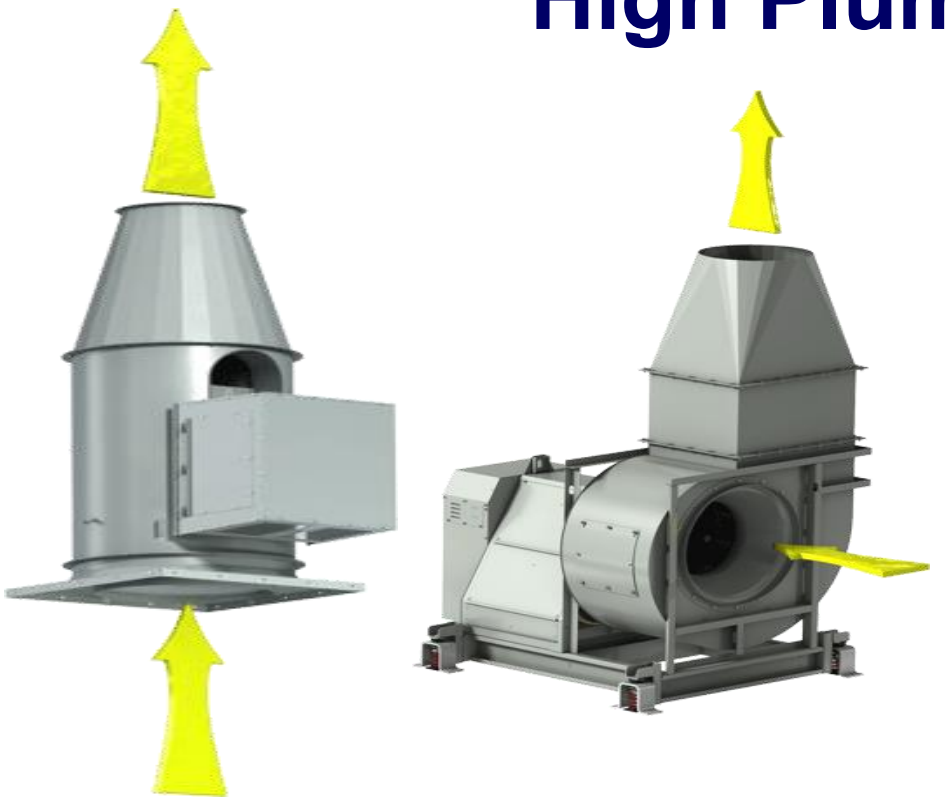




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“High Plume” Stack



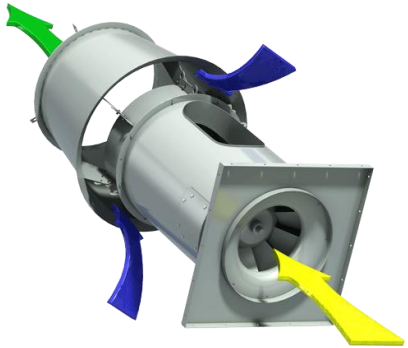
- High Plume Stacks attain plume heights without excessive pressure drop to reduce energy and sound
- There is no measureable dilution with a high plume nozzle

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Dilution versus High Plume

Dilution

- High velocity discharge nozzle and windband creates dilution
- Dilutes odor and contaminates at the fan discharge
- Air out > Air in



High Plume

- Utilizes non-dilution engineered conical nozzle
- More nozzles per fan size
- Increased efficiencies
- Air out = Air in



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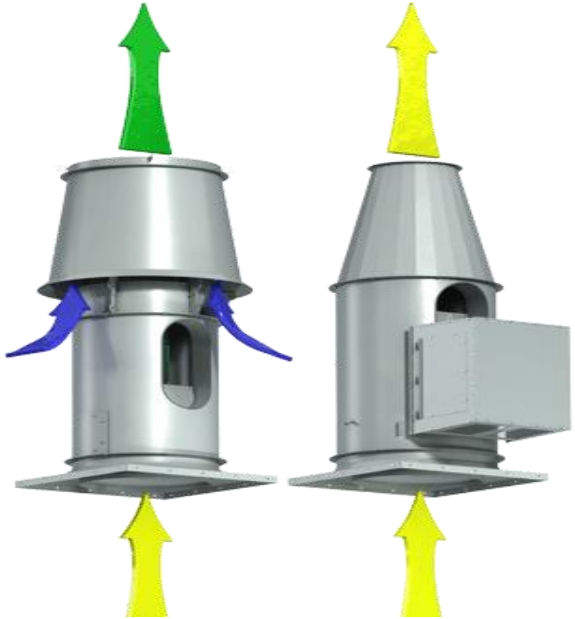
High Plume vs. Dilution Nozzle Comparison

30,000 CFM (50,970 CMH) at 5 in.wg (1.25 kPa)

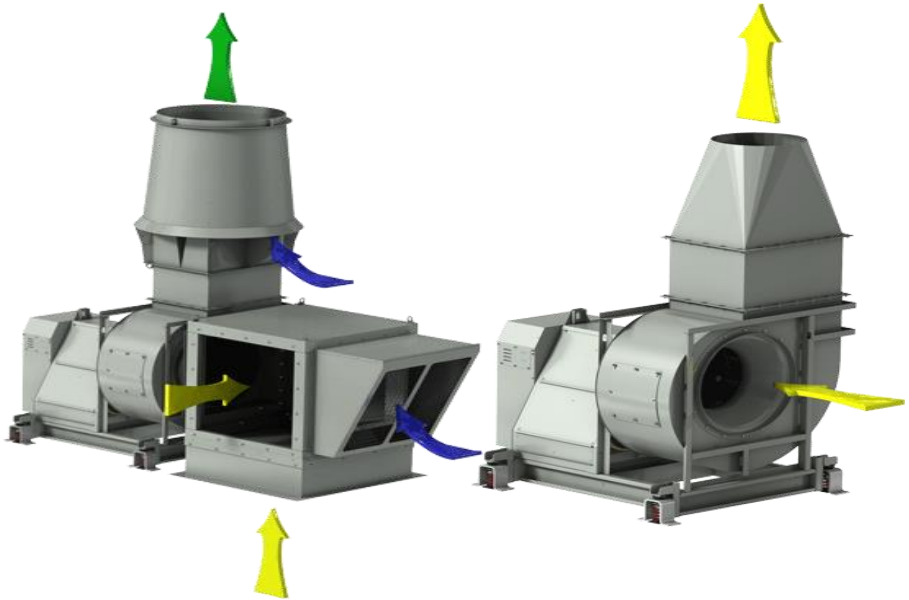
Model	Size / Nozzle	BHP	Nozzle Velocity (fpm)	Dilution (%)	Effective Plume Rise (ft)	Total Efficiency (%)	Relative Cost
Vektor®-MH (High Plume)	40-85 34	47.17	4754	N/A	45.9	64.4	1
Vektor®-MD (Dilution)	40-85-MV	53.11	5882	196	43.1	63.7	1.17

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Fan Technology



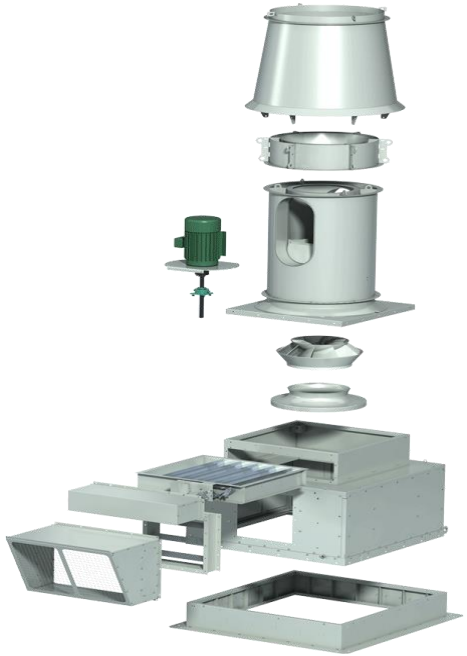
Inline Fans



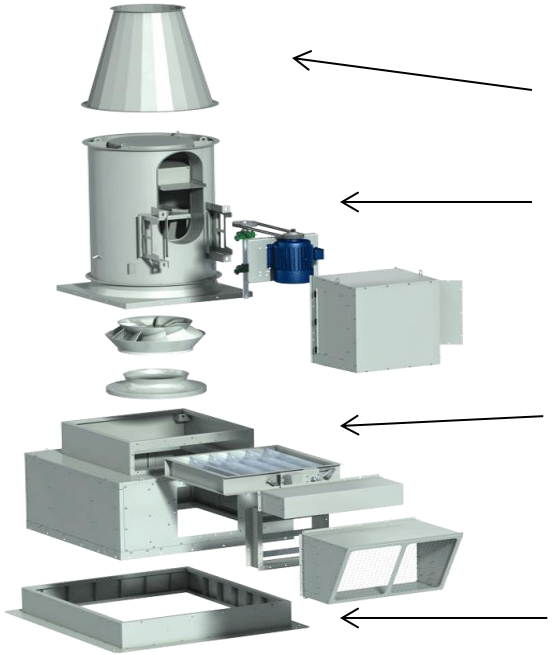
Centrifugal Fans

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High Performance Inlines



High Plume Dilution



High Plume

Nozzle

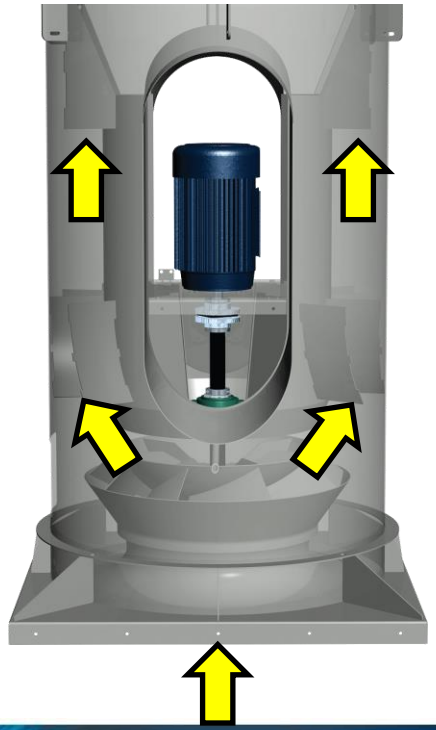
Fan Body

Bypass Plenum and Dampers

Roof Curb

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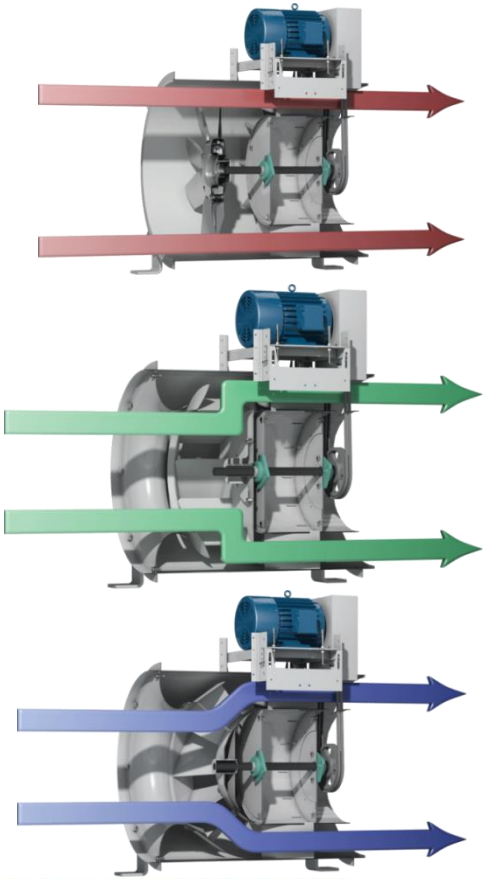
Bifurcated Fan Housings



Air splits around the motor and drive compartment

All drives are completely isolated from the contaminated airstream

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Inlines Utilize Mixed Flow Impellers

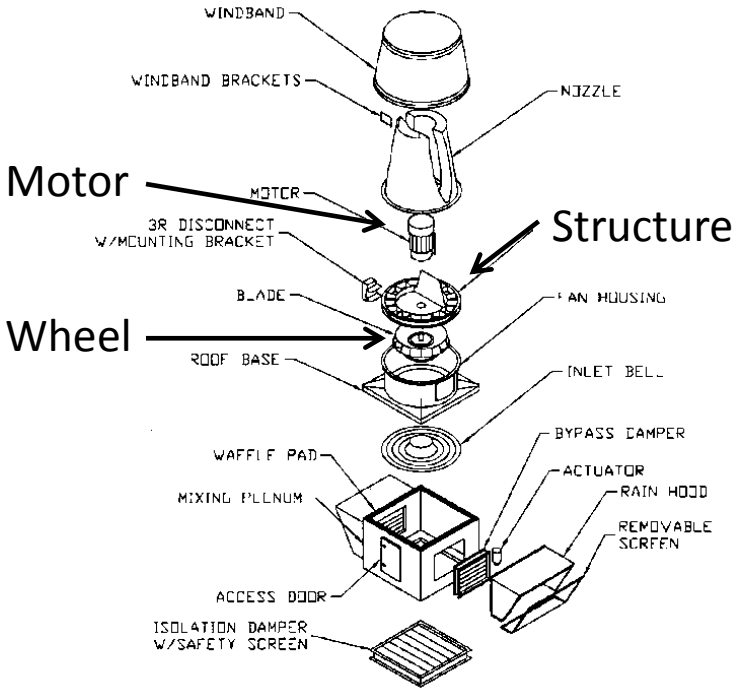
- A mixed flow wheel has a hybrid impeller with performance characteristics between an axial an centrifugal



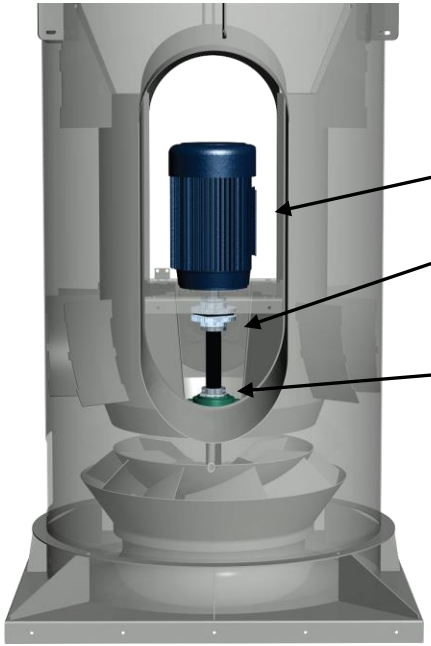


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Arrangement 2 Direct Drive



Direct Drive Arr #4



Direct Drive Arr #2

Serviced from outside contaminated airstream

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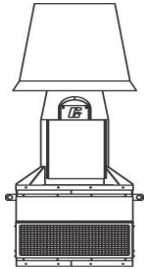
Inline Fans

- Advantages
  - Low to medium pressure capabilities
  - Pre-engineered tested with appurtenances
  - Small footprint on roof deck
  - Excellent for Tight Space Areas

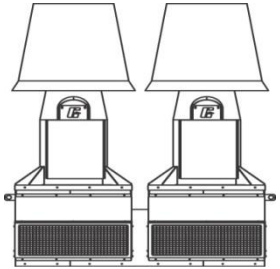


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Multiple Configurations



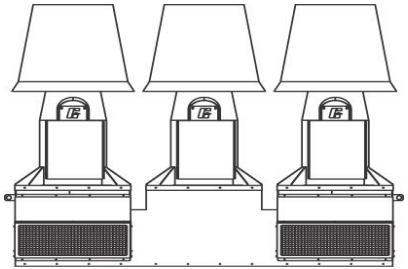
1x1 Single



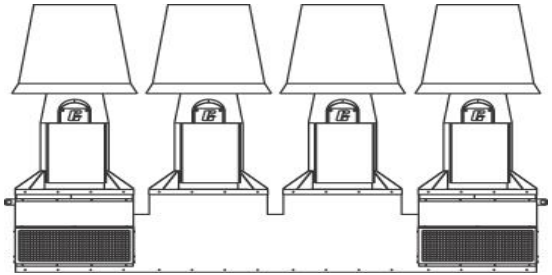
2x1 Dual



2x2 “Quad”



3x1 Triple



4x1 Four

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Inline Fans

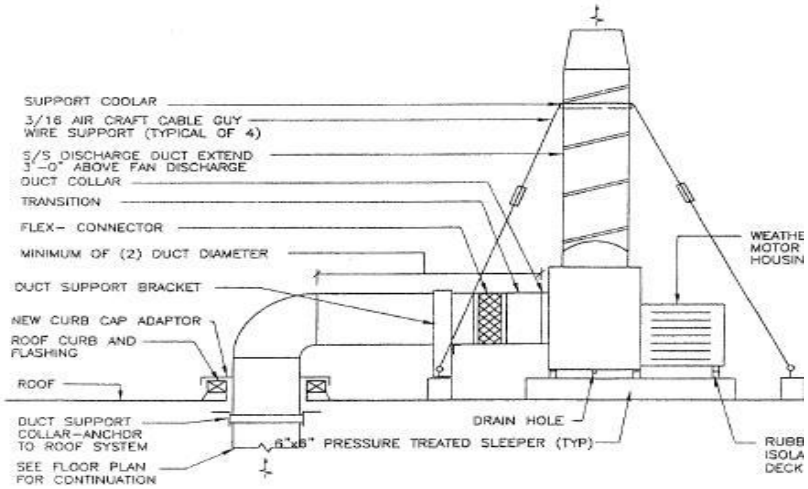
- Disadvantages
  - Taller finished heights
  - Elevated motor access
  - Lower efficiencies versus scrolled centrifugal fans



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Centrifugal Fans

- Field built-up system
  - Standard centrifugal turned into a lab exhaust fan





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Centrifugal Fans

- Built-up systems
  - Low purchase price (fan)
  - High installed cost
  - Fan performance tested only



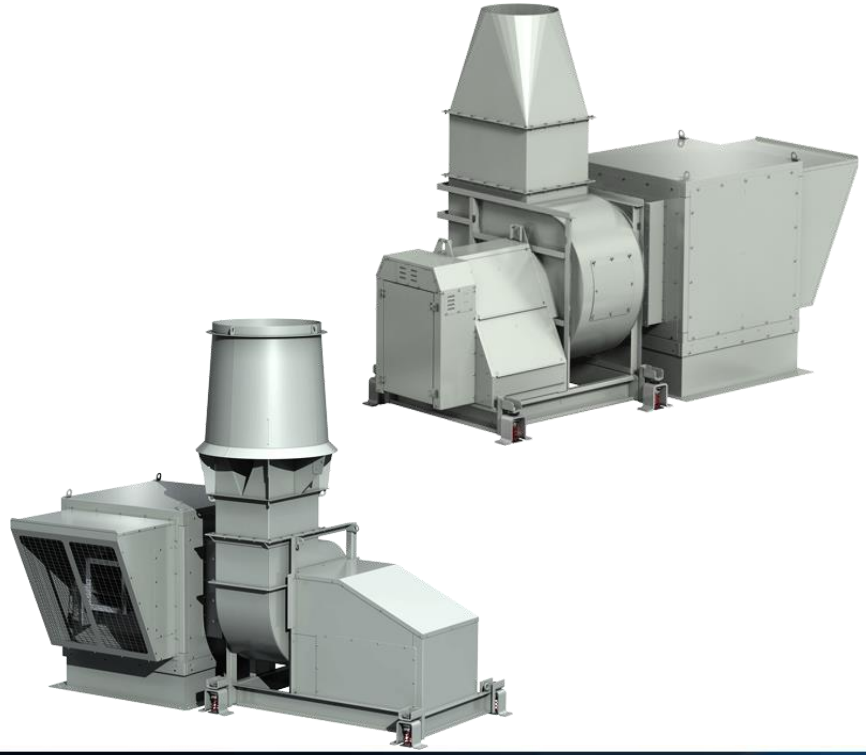
- Pre-engineered systems
  - Higher purchase price (fan)
  - Lower installed cost
  - Fan tested with appurtenances
  - Known nozzle velocity and plume rises



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Pre-Engineered Centrifugal Systems

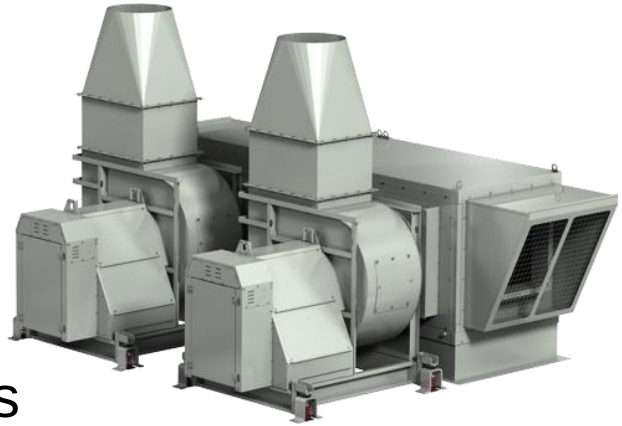
- Scrolled housing, free duct turn
- Efficient backward inclined or airfoil wheels
- Belt drive or direct drive
- Constant or variable volume applications

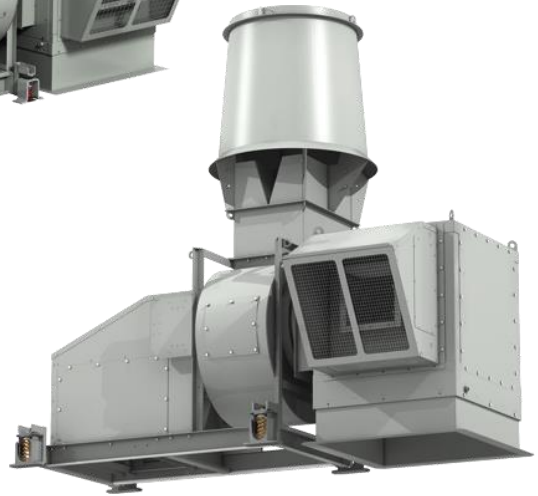


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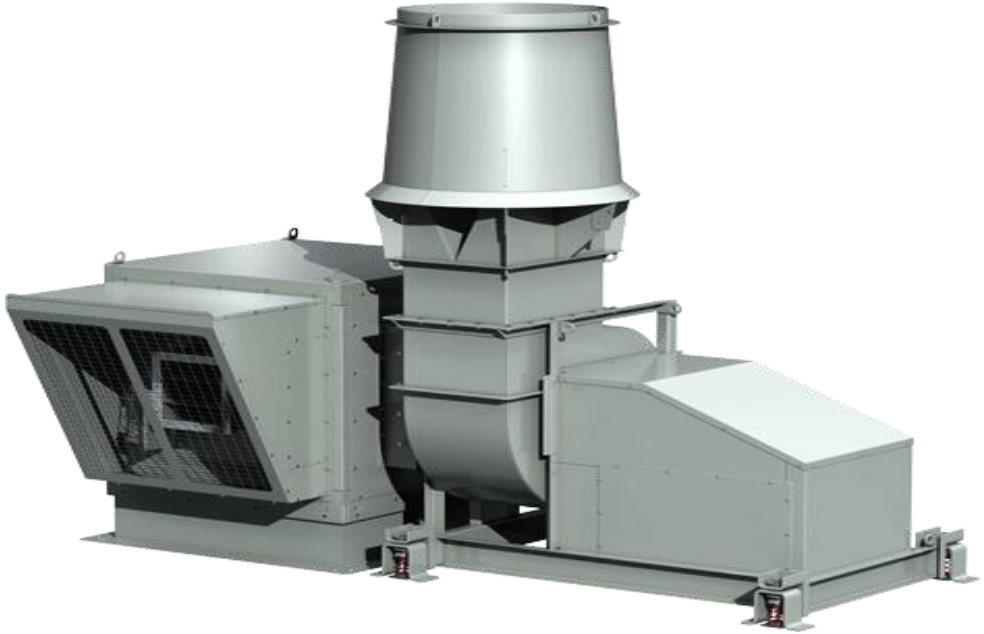
Pre-Engineered Centrifugal Systems

- Advantages
  - Efficient
  - High pressure capabilities
  - Large air volumes
  - Ground level motor access
  - Indoor mounting applications
  - Vibration isolation options
  - Lower finished heights





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Centrifugal systems are easier to service, but tend to take up more roof space

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51

Multiple Configurations

Single Fan System





Dual Fan System



Triple Fan System

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Inline and Centrifugal Applications

Applications

- Hospital labs or isolation rooms
- High school and university labs
- Forensic labs
- Pharmaceutical companies
- Bio-tech companies
- Research laboratories
- Grease exhaust
- Generator Exhaust (Centrifugal)





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Key Features – 200km/hr (125 mph) Rating



- Easy to install
- No guy-wires
- Less opportunity for system effects

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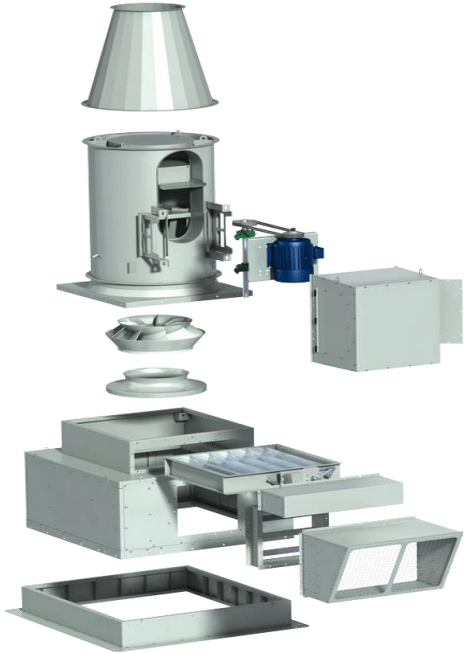
Key Features - Spark Resistant Construction

Spark proof construction…a necessity for laboratories that exhaust solvent vapors that are flammable or explosive!

AMCA spark resistant construction "Classes" AMCA Standard 99

Copyright © 2015 Greenheck Fan Corp.

Spark Resistant Construction

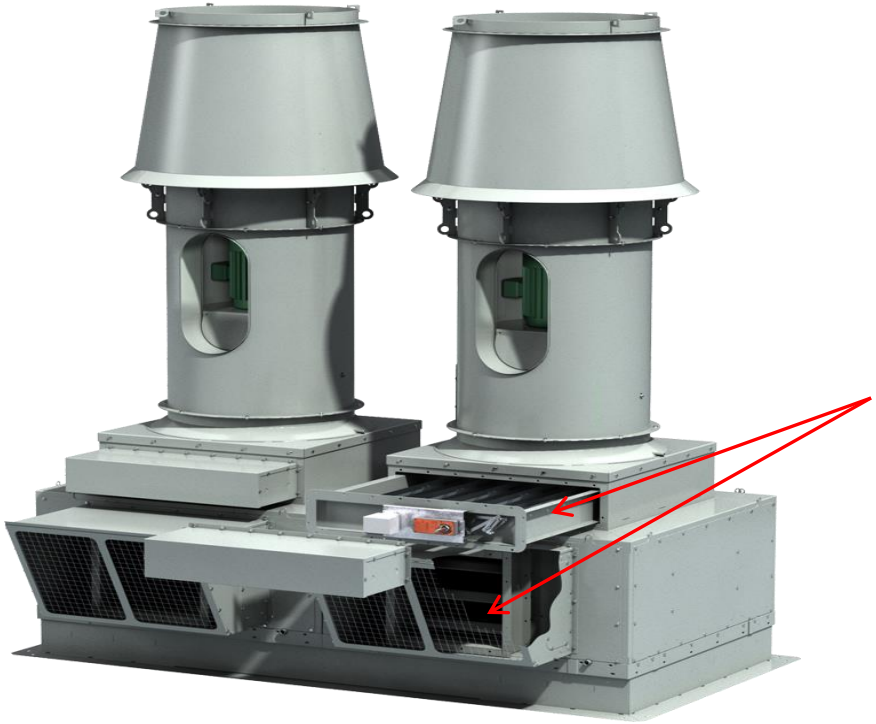


- ***Class A:*** Entire fan in contact with the air stream is nonferrous
- ***Class B:*** Nonferrous wheel and rub ring for the shaft
- ***Class C:*** Nonferrous inlet venture and rub ring for shaft will not permit two ferrous part to rub

Motor does not need to be explosion resistant!

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Reliability and Service – Damper Access

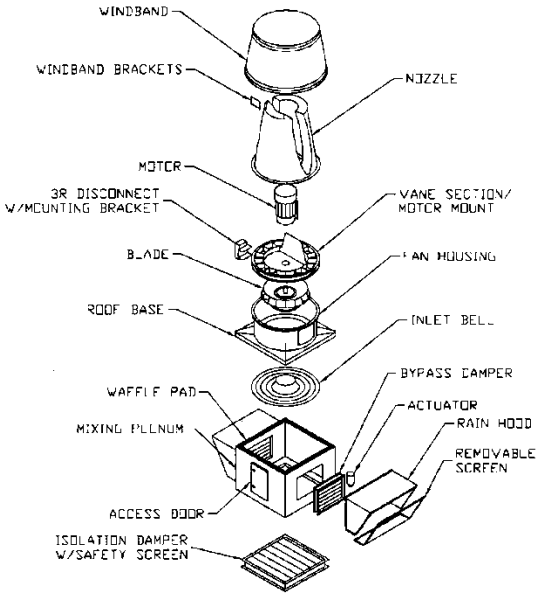


Isolation and bypass dampers are completely accessible from outside of the contaminated airstream

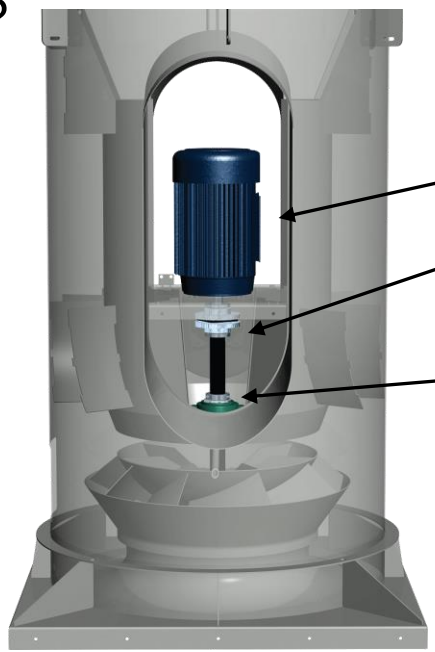
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Reliability and Service – Motor Access

- Which motor is easier to change?



Direct Drive Arr #4



Motor

Ridged coupling

L10-200,000 hr bearing

Direct Drive Arr #2

Serviced from outside contaminated airstream

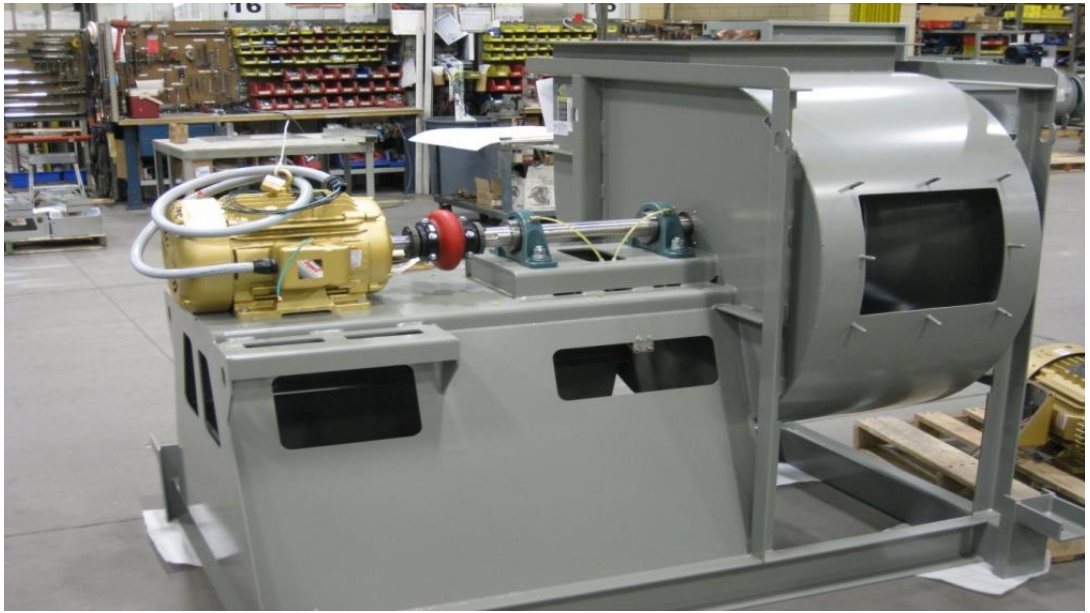
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Reliability and Service - Direct Drive

Arr. 8 utilizes a coupling to connect the fan shaft to the motor for easy motor removal

L(10) 80,000 or 200,000 hr bearings



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Reliability - Concentric Mount Bearings



- True concentric mounting eliminated inner ring distortion and 2x fan RPM vibration.
- No shaft marring for easy bearing removal.

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Bearing Life

- Basic Rating Life, L_{10} - the bearing life associated with a 90% reliability when operating under conventional conditions.

- Average Life, L_{50} - the bearing life associated with a 50% reliability when operating under conventional conditions.

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Bearing Life Comparisons

Required L_{10} Life	Equivalent L_{50} Life
20,000	100,000
40,000	200,000
80,000	400,000
100,000	500,000
200,000	1,000,000

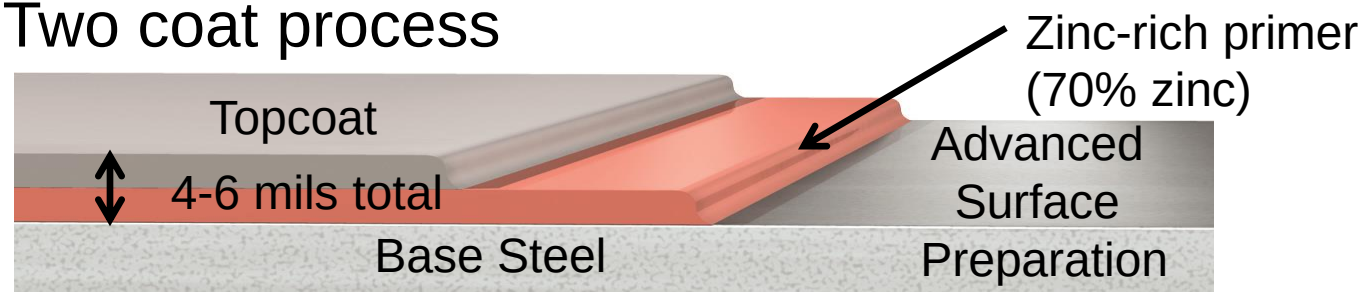
$$L_{50} = 5 \times L_{10}$$

Note: The correct way to specify bearing life per the ABMA is L_{10}

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Reliability - Greenheck's LabCoat™

- Two coat process



Salt Spray ASTM B117

Hours	1000	2000	3000	4000
Permatector™				
Hi-Pro™ Poly				
Perma-Z™				
LabCoat™				

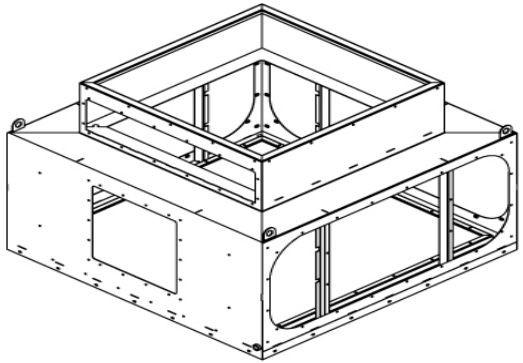
Durability

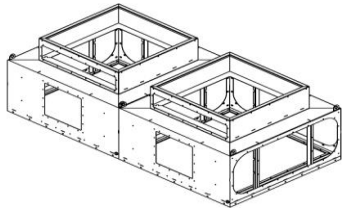
Pencil Hardness ASTM D3363	Cross-Hatch Adhesion ASTM D3359-B
3H	No Failure
2H	No Failure
3H	No Failure
2H	No Failure

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Modular Plenum

- LabCoat™, inside and out
- Welded construction
- Separate access points for dampers
- Silicone gasket between plenum sections and access points
- Lab exhaust duct to have a maximum velocity of 1500 fpm when entering plenum

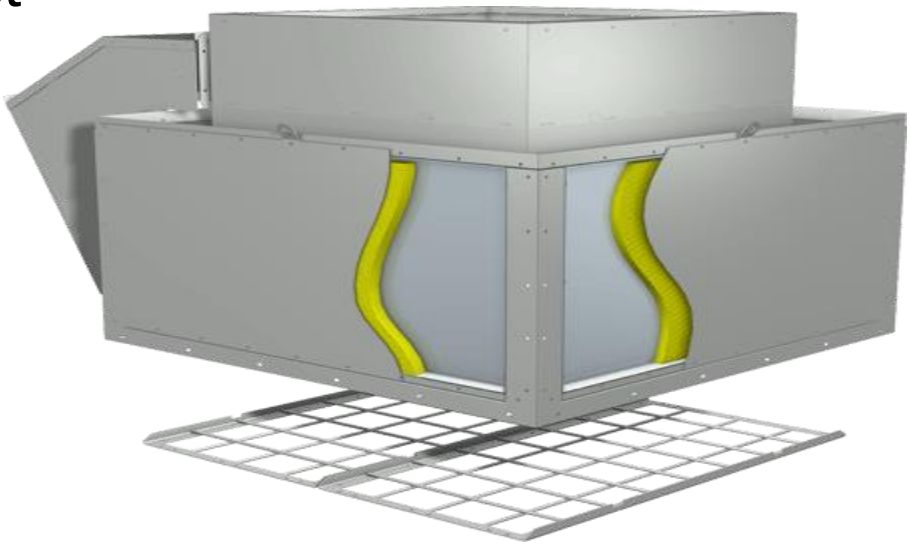




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Double Wall Plenum

- Used to insulate the exhaust airstream to prevent condensation
- Welded construction
- LabCoat™, inside and out
- Optional SS inner liner



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Greenheck Damper Offering



- Industrial, airfoil blade, corrosion resistant steel
- Sized for each application for a maximum of 15 in. wg (3.74 kPa)

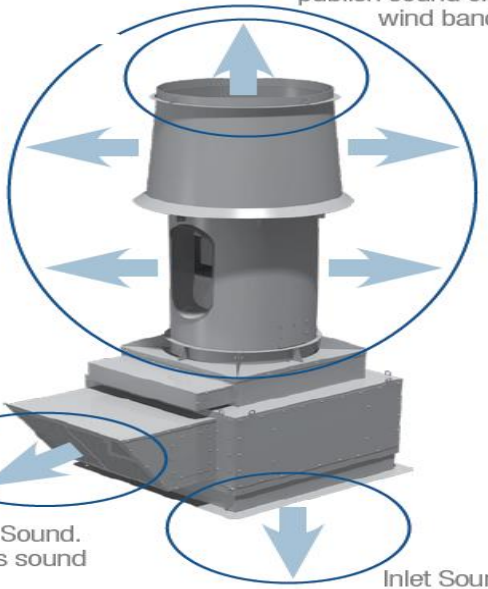
	HCD-130	HCD-230
Pressure (sp)	Up to 7”	Up to 15”
Velocity (fpm)	2000 – 4000	4000 - 5000
Blade Thickness	20 ga.	16 ga.

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Acoustic Considerations

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Potential Sound Sources



Outlet Sound —
Some manufacturers publish sound exiting the wind band.

Greenheck Total Outlet Sound includes fan outlet sound, motor sound, drive sound (belt drive models), and casing radiated sound

Bypass damper sound is not included in Total Outlet Sound. Greenheck can supply bypass sound based on damper sizes and airflow velocities.

Inlet Sound -
Some manufacturers base outlet sound on the inlet sound levels.

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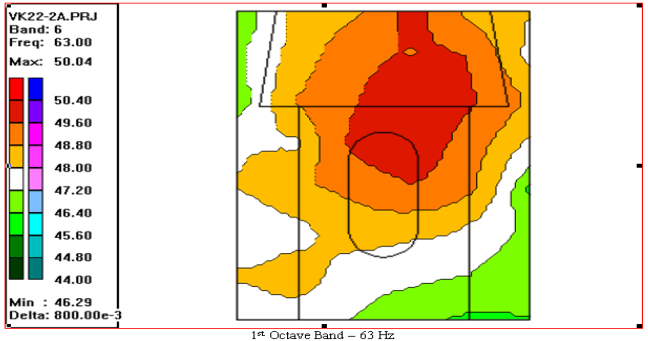
Radiated Sound Mapping

- Vektor sound mapping
- Visual image of sound intensity levels per octave band

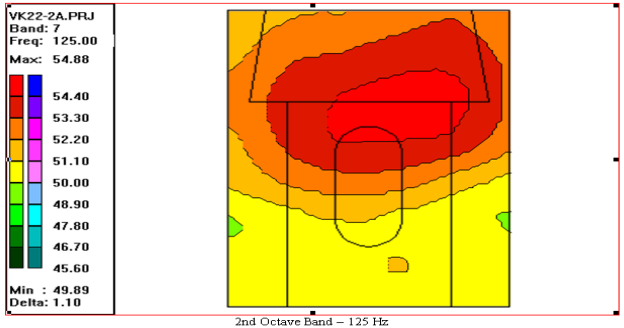








1st Octave Band – 63 Hz
(with Standard Windband)



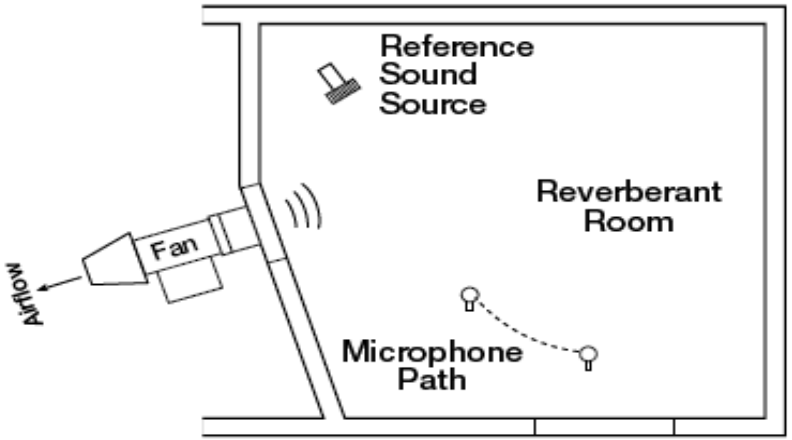
2nd Octave Band – 125 Hz
(with Standard Windband)

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AMCA 300

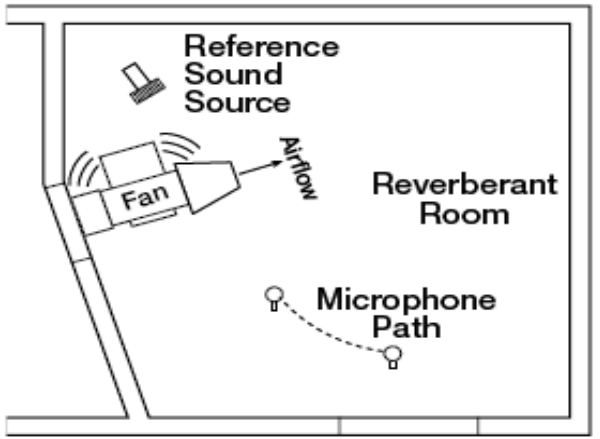
Inlet Sound



AMCA 300 Figure 2: Fan Inlet Testing

(Installation Type A: Free Inlet, Free Outlet)

Outlet Sound



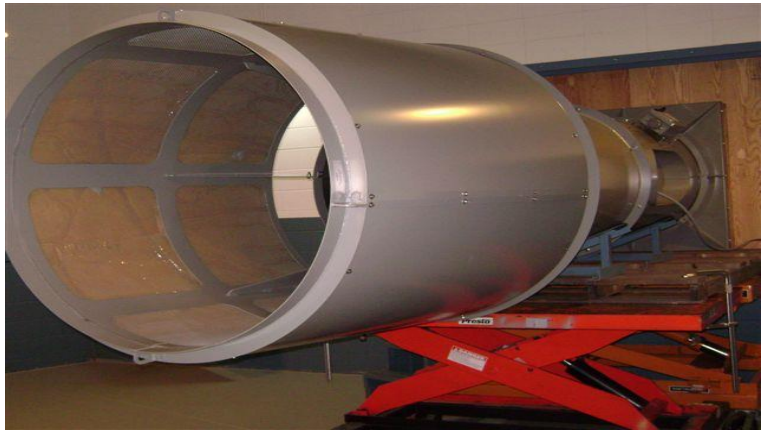
AMCA 300 Figure 3: Fan Outlet Testing

(Installation Type A: Free Inlet, Free Outlet)

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AMCA 300 – Total Outlet Sound

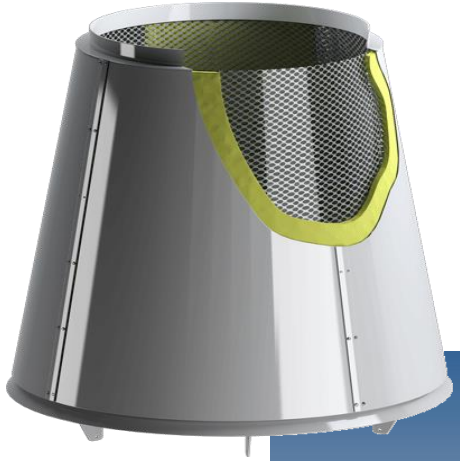


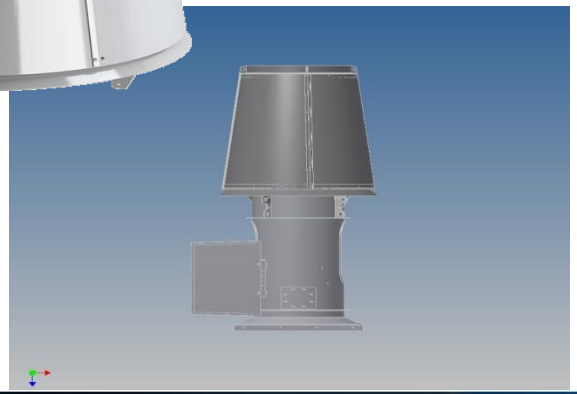


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Key Options - Attenuated Windbands

- Double wall windband construction
- Insulated with perforated stainless steel liner
- Reduces outlet radiated sound by 3-4 dB





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Key Options - Attenuated Wind Wraps

- Double wall extensions hanging from windband
- Insulated with perforated stainless steel liner
- Reduces outlet radiated sound by additional 3-4 dB
- Can be field installed



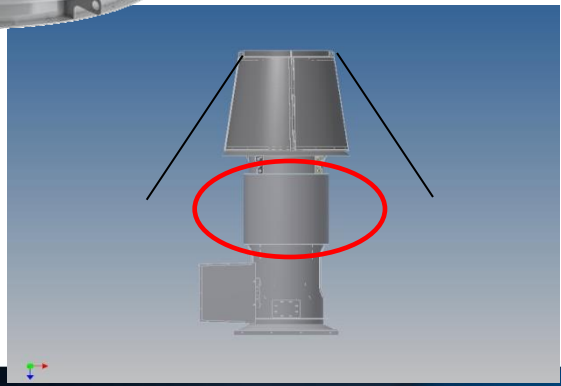


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Key Options - Inline Attenuators

- Reduces outlet sound by 5-10+ dB or more depending on length
- Exterior casing is coated to match fan color
- Guy wires are required



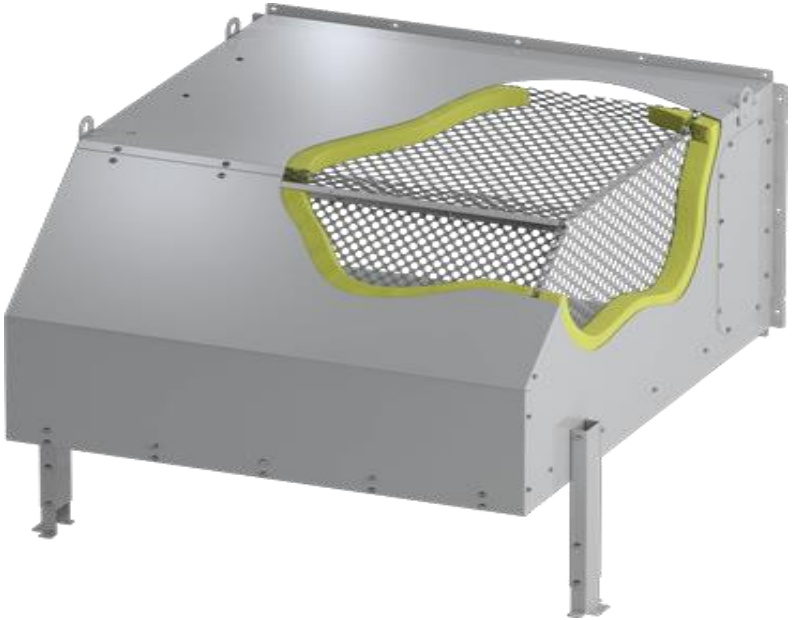


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Key Options - Bypass Damper Silencer

- Used to reduce sound coming through the bypass damper
- Internal baffles
- Sized for bypass flows
- SS construction option



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Greenheck CAPS Provides All Details

Job 2013-02-28 09.06.50 - Mark 1

Model: VEKTOR-MD-33-9-85-LV-HF QD / Stock

Model | Selection | Fan Curves | Configuration | Drawings | SDRs / Notes | AMCA

Design Conditions | Performance | Sound Attenuation

Operating Fan Qty: 1

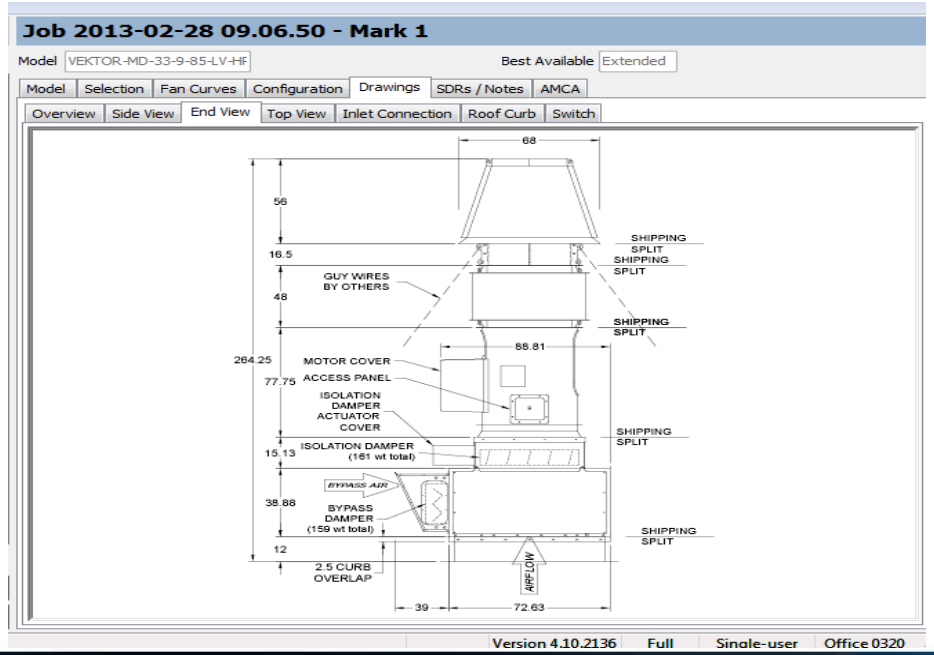
Distance Correction (ft): 10

Attenuating Windband: Yes

Inline Silencer: 3 feet

	62.5 Hz (dB)	125 Hz (dB)	250 Hz (dB)	500 Hz (dB)	1000 Hz (dB)	2000 Hz (dB)	4000 Hz (dB)	8000 Hz (dB)	LwA (dB)	dBA At 5 feet	dBA At 10 feet
Individual Fan - Inlet	100	97	104	97	96	92	88	80	101	90	N/A
Individual Fan - Outlet	93	96	102	102	98	94	91	85	103	92	86
Attenuated Fan - Outlet	91	93	93	91	85	85	85	79	93	82	76
All Fans (TOTAL) - Outlet	91	93	93	91	85	85	85	79	93	82	76

Version 4.10.2136 | Full | Single-user | Office 0320



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Additional Attenuation Considerations

- Initial fan selection significantly improves ability to have a successful facility
- Avoiding direct line of site is a key to preventing sound issues
- Avoid putting high volume fans directly over occupied office space

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Impact of Distance on Sound

Sound decreases by 6 dB every time distance is doubled

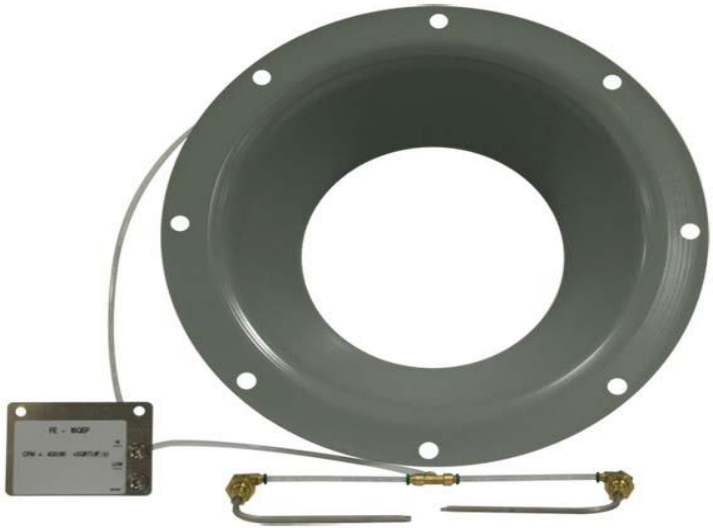
LwA (Outlet)	Distance (ft)	Distance (m)
80	5	1.5
74	10	3
68	20	6.1
62	40	12.1

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Flow Monitoring

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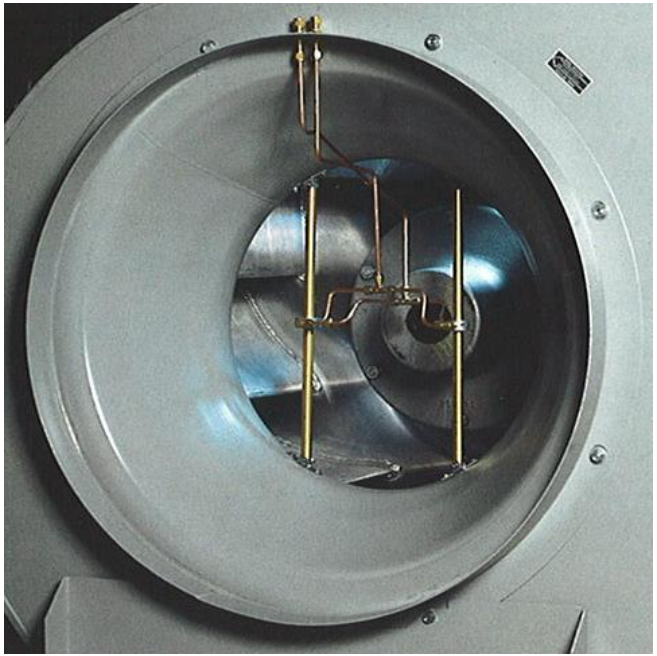
Key Options – “Sure-Aire” Piezometer Rings



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Avoid Fan Inlet "Invasive" Mounted Probes

- Mounted into the smallest diameter of the fan inlet venturi
- Use tubing that is designed to measure total and static pressure components of airflow



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System Effect (in. wg) for Typical Invasive Probes

SWSI Size	Max Class I	Max Class II	Max Class III
20	1.2” (300 Pa)	2.0” (500 Pa)	3.2” (800 Pa)
36	0.8” (200 Pa)	1.3” (325 Pa)	2.1” (525 Pa)
73	0.4” (100 Pa)	0.7” (175 Pa)	1.1” (275 Pa)

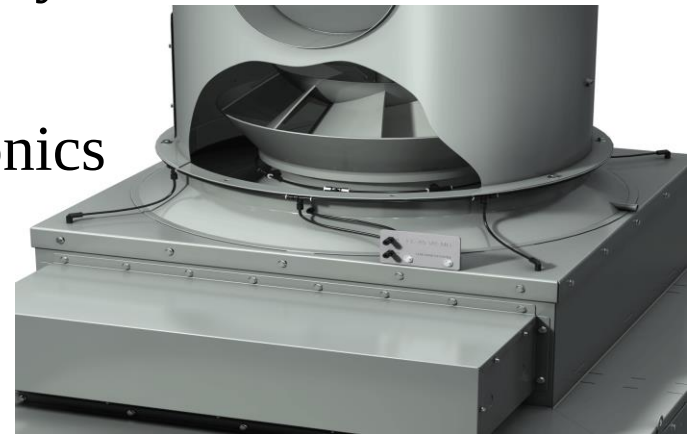
Performance taken at 70% WOV and at max class RPM
All measured using AMCA accredited test chamber

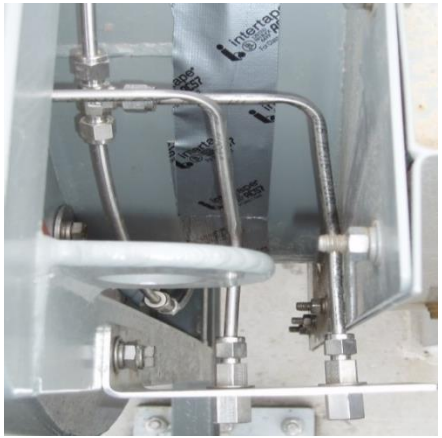
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Sure-Aire™ Flow Measurement

- Used to measure air flows moving through the fan inlet
- High degree of accuracy ±3%
- Non-invasive
- Available with electronics





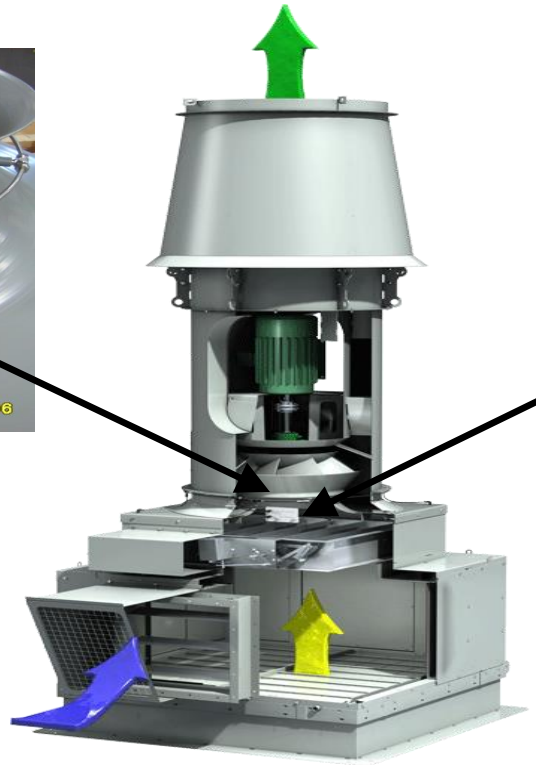


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“Sure-Aire” Piezometer Rings







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Laboratory Control Methods for Fan Energy Savings

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Fan Staging Controls

Alternative means to reduce energy for variable airflow systems

- Uses a greater quantity of fans
- Uses smaller fans
- Uses bypass air dampers
- Typically provided by controls contractor

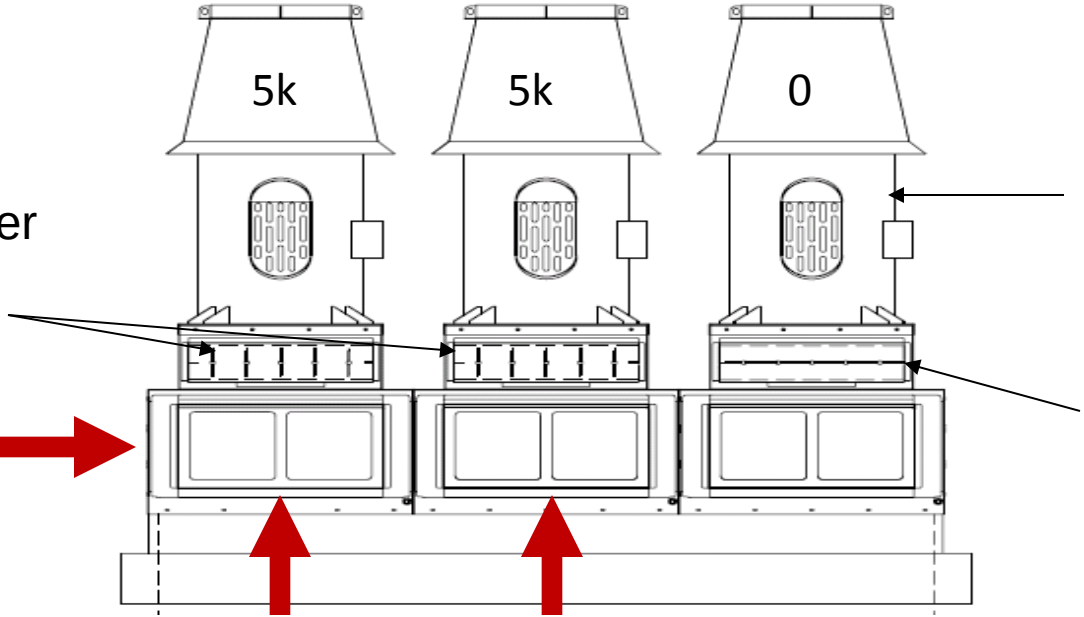
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Variable Volume Staging Example

- Variable Air Volume Chemical Hoods
- 3x1 High Plume Dilution Exhausters
- 1 Fan on Stand-By
- 10,000 CFM (16,990 CMH) Max Capacity

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Max Lab Output – 10,000 CFM



Isolation Damper (Open)

Bypass Air Dampers

0 CFM

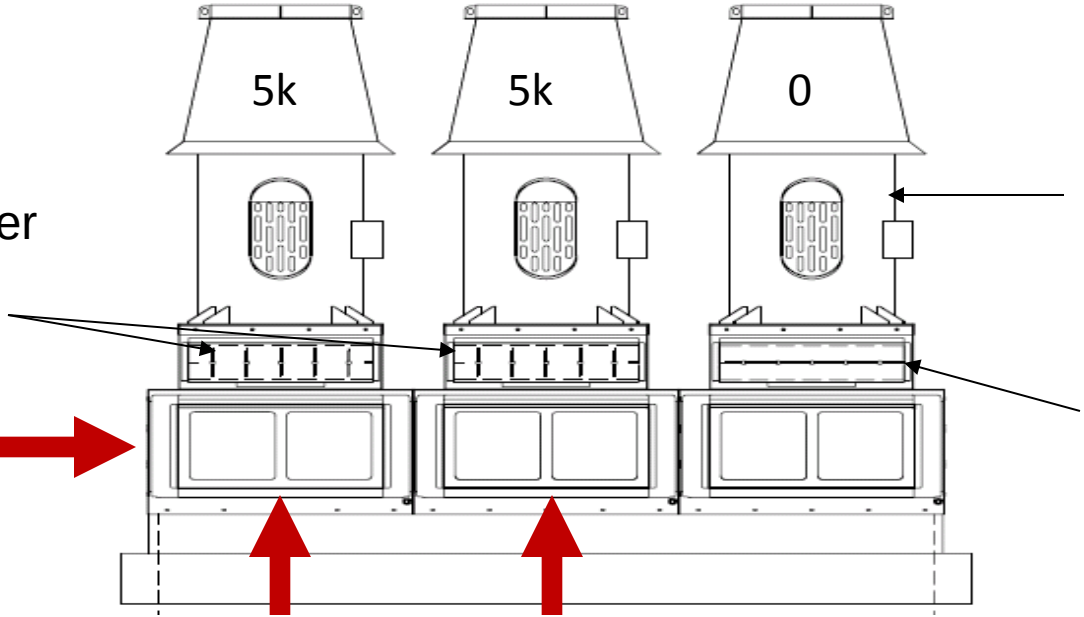
Standby Fan

Isolation Damper (Closed)

10,000 CFM Exhaust Plenum

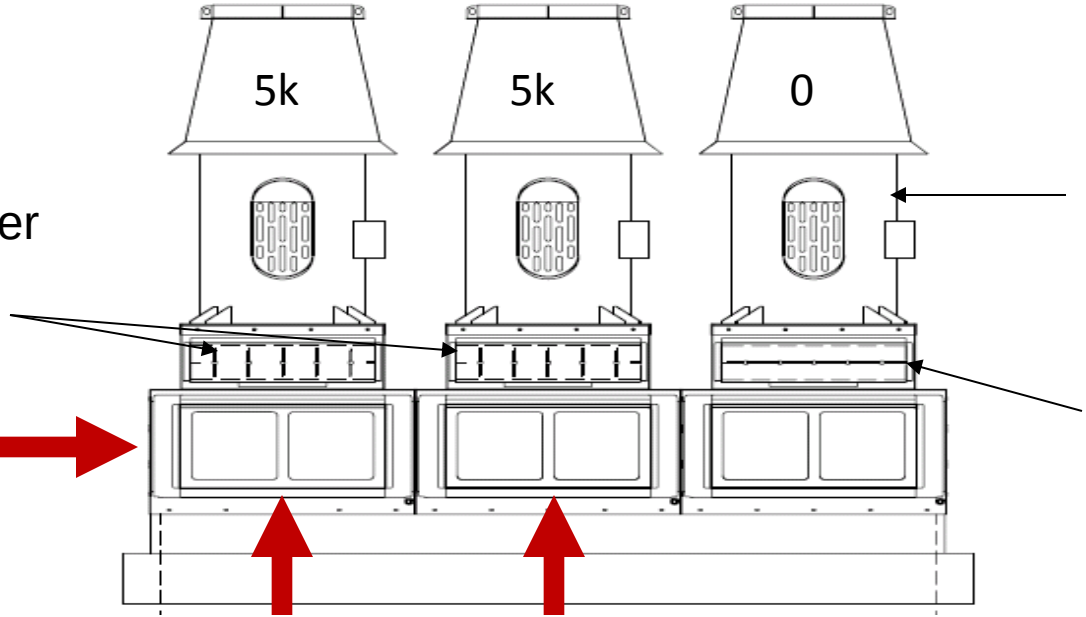
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25% Bypass



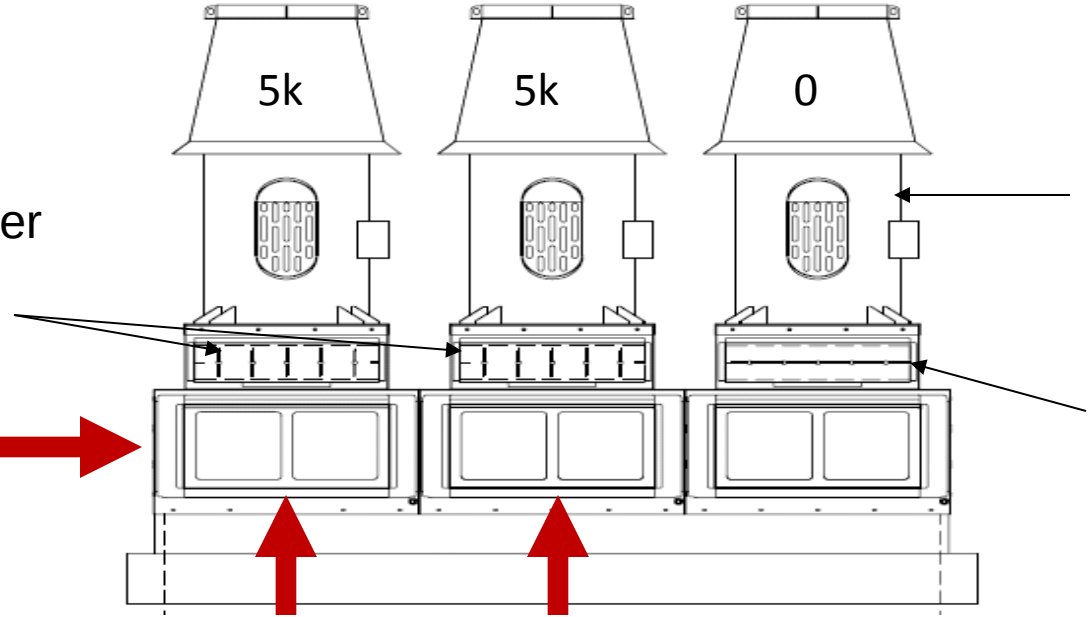
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50% Bypass



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Bypass > 50%



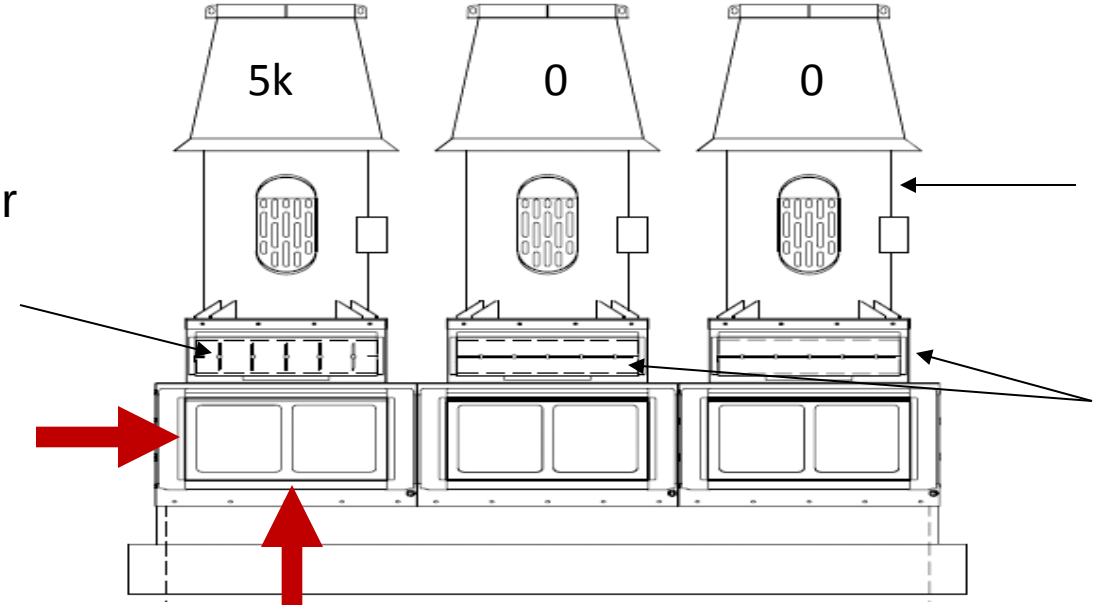
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Bypass > 50% with Staging

Isolation Damper (Open)

Bypass Air Dampers

1,000 CFM



Standby Fan

Isolation Dampers (Closed)

4,000 CFM

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Fan Staging Results

Up to 10k 2 Fans	12.5% (6 Hours)						25% (12 Hours Total)	
Up to 5k 1 Fan								
	12 a.m.	3	6	9	12 p.m.	3	6	9-12

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Additional Advantages

- Maintains stack discharge flow and velocity
- Allows selection of fans to maximize efficiency
- Allow use of smaller fans with smaller motors
- Can be programmed to alternate the standby by fans
- Will help reduce sound levels during low usage periods

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Safe Use of Variable Speed Drives for VAV Systems



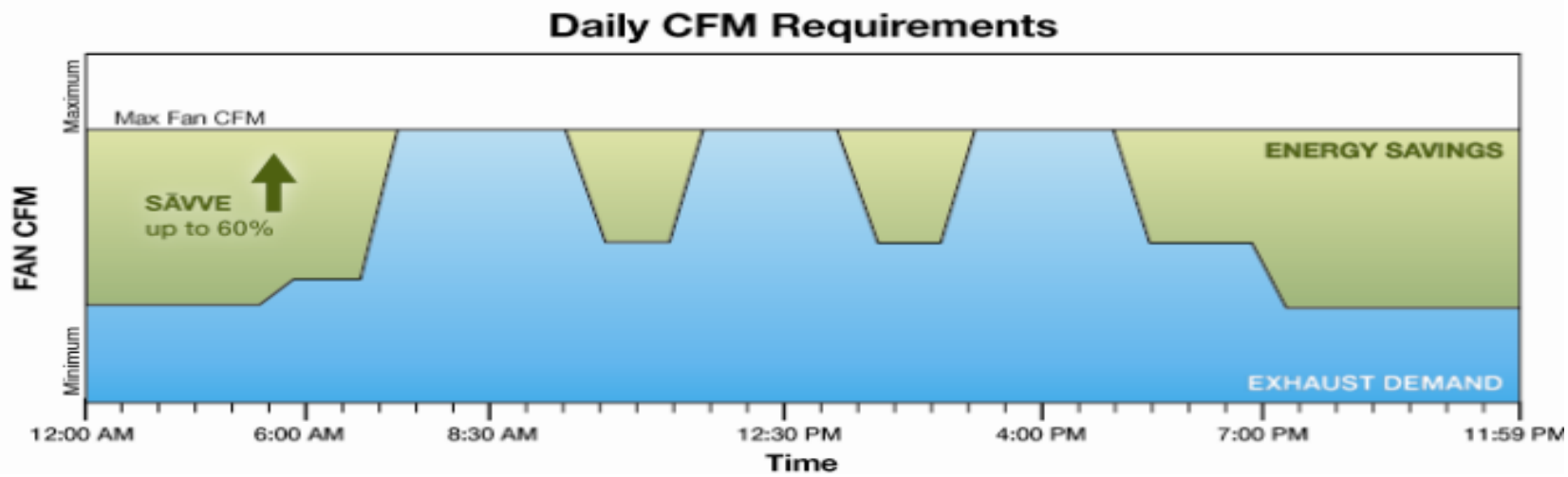


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Typical “Peaks & Valleys”



Rarely is a lab 100% utilized – this results in wasted energy through use of a bypass air plenum.

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Can't We Use VFDs in Labs?

- **Pros**
  - Soft start and performance balancing capabilities
  - Rebates for application of VFDs on HVAC equipment
  - Building power factor correction
  - Ability to realize motor energy savings via demand based ventilation
- **Cons**
  - Potential for loss of design exit velocity
  - Potential for re-entrainment of lab of exhaust air into buildings
  - Oversizing nozzle velocity costs money in increased horsepower

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Variable Geometry Nozzle Technology



Patent Pending

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Variable Geometry Nozzles



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How VGN Nozzles Work



Occupied / Open Sash

- VFD max. speed
- 100% fully open nozzle
- Bypass damper closed



Occupied / Sash Closing

- VFD speed reduced
- Partially closed nozzle
- Bypass damper closed

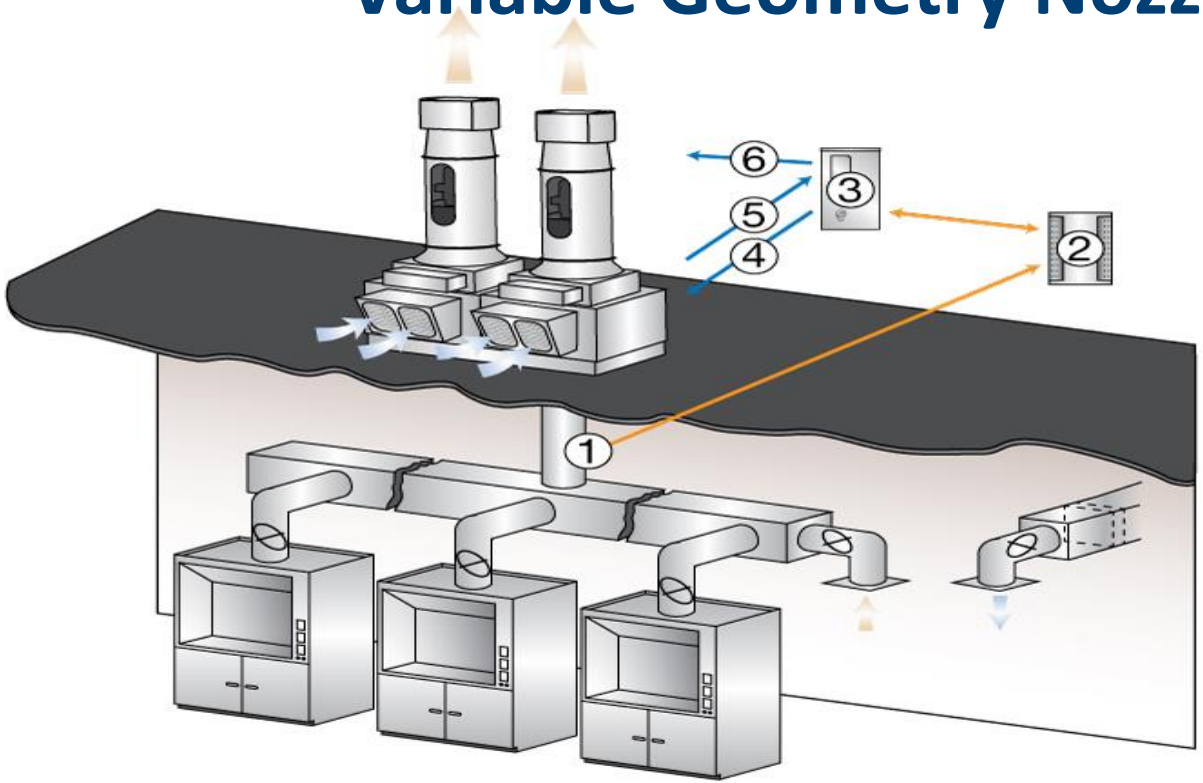


Unoccupied

- VFD min. speed
- Minimum nozzle position
- Bypass damper may open

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Variable Geometry Nozzle System

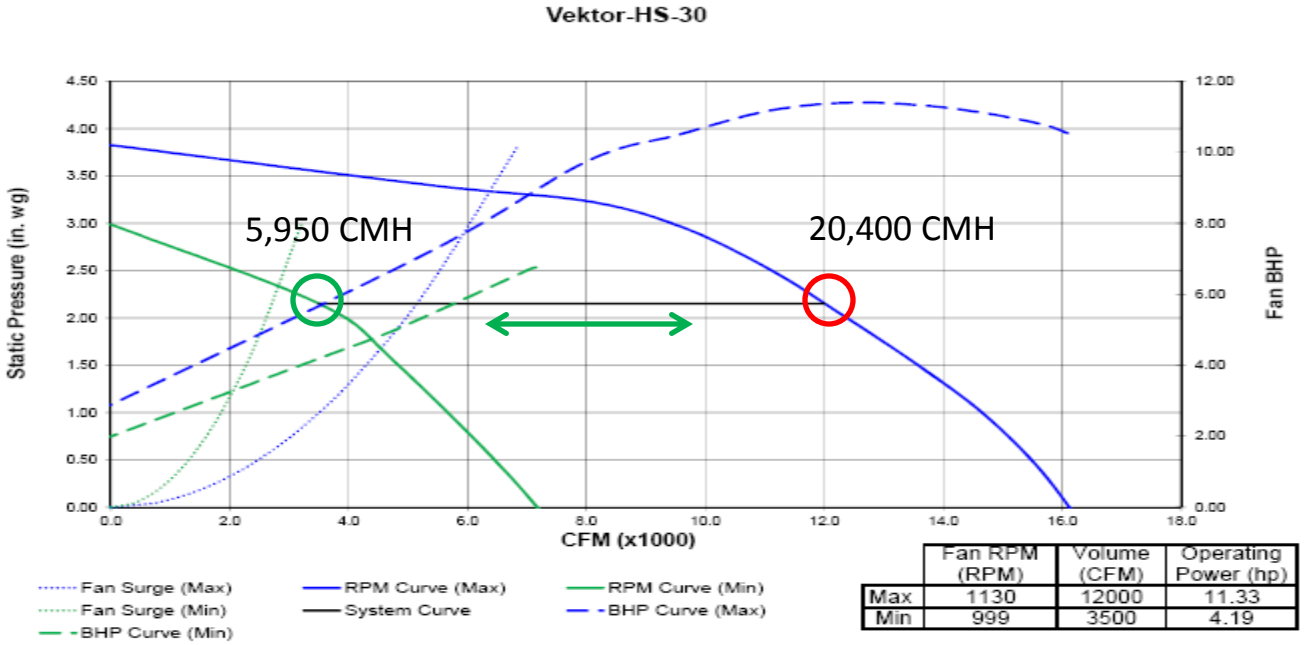


1. Static pressure measurement
2. Building Management System
3. Variable frequency drive and fan controller
4. Signal to fan motor
5. Sure-Aire flow measurement
6. Signal to SAVVE nozzle actuators

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Typical VGN Fan Curve



	Fan RPM (RPM)	Volume (CFM)	Operating Power (hp)
Max	1130	12000	11.33
Min	999	3500	4.19

* The "RPM Curve (Max)" is the fan curve for when the system is running at design conditions with the nozzle fully open.
* The "RPM Curve (Min)" is the fan curve for when the nozzle is fully closed.
* The min and max fan surge curves, and BHP curves, correspond to the min and max RPM curves respectively.

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VGN Performance Testing



- 4x1 Vektor-HS
- Size 18
- 5 HP motors
- 1725 RPM motors
- 8,000 to 20,000 CFM (13,590 to 33,908 CMH)

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Energy Savings Summary

Control Method	Energy Used (5 Day Operation)	% Energy Savings Versus Variable Volume System
Traditional Variable Volume System	$21,430	-
Traditional Staged System	$17,144	20%
SAVVE System Float Control	$11,700	45.4%
SAVVE System Float Control and Staging	$10,600	50.5%

- All systems ran the same demand profile
- Float control ramps all fans up and down together
- Float control with staging ramps up and down individual fans, stages on and off fans as required

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Variable Geometry Nozzle Energy Savings Analysis

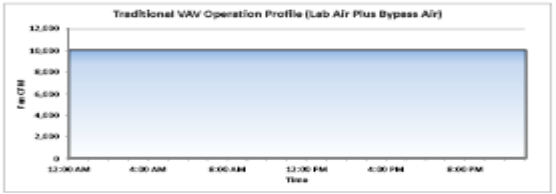
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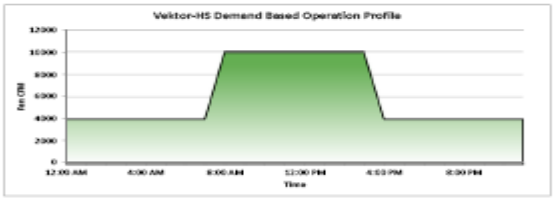
Printed Date: 10/13/2011
Job: SAVVE
Product Type: Fan
Mark: Mark 1

Energy Savings Analysis

Operating Costs (Per Year)					
Traditional VAV System	Vektor-HS	Energy Savings (Per Year)		Payback (Years)	
$5,973.93	$2,827.64	$3,146.29	52.67%	1.25	Based On 5 Day A Week Lab Occupancy
$5,973.93	$3,969.58	$2,004.35	33.55%	1.97	Based On 7 Day A Week Lab Occupancy

*Energy cost used for energy analysis: 0.1 $/kWhr
*This energy analysis compares the cost of operating a Vektor-HS system to the cost of operating a traditional variable volume exhaust system.
*Energy savings for 5 day a week operation assumes standard operation (per Vektor-HS Demand Based Operation Profile) during the work week and operation at minimum design exhaust volume during the weekend.
*Energy savings for 7 day a week operation assumes standard operation (per Vektor-HS Demand Based Operation Profile) 7 days a week.
*Payback analysis assumes that a standard VFD or soft start would have been purchased with a traditional variable air volume system.





*Fan CFM in the above graphs is equal to the building cfm plus any bypass cfm required to maintain 3000 fpm outlet velocity.

For more information about rebates, tax credits and other funds available for improving the efficiency of buildings on a state and federal level, visit http://www.dsireusa.org

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Variable Geometry Nozzle Endurance Testing

- Damper and actuator cycling
- Winter testing for ice and snow
- Easy access for actuator maintenance

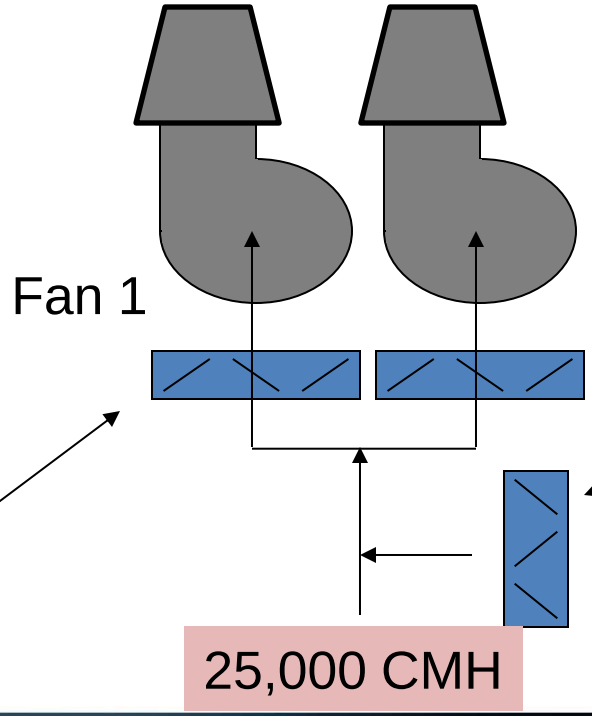


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Hot Standby Applications (Standard)

2 Fan VAV System



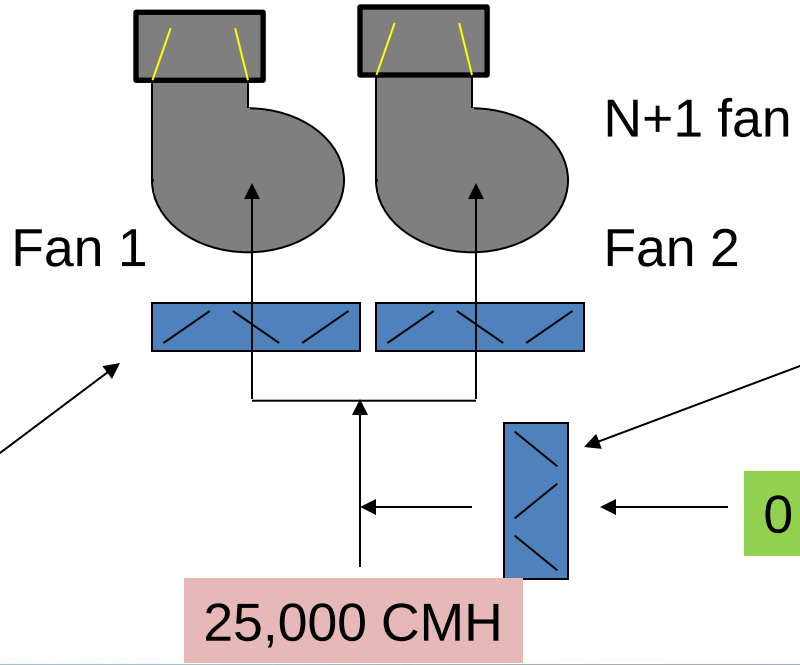
50,000 cmh @ 1250 Pa exhausted by fans

25,000 cmh each fan

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Hot Standby – Variable Geometry

2 Fan VAV System



25,000 cmh @ 1250 Pa exhausted by fans

12,500 cmh each fan @ 50% load

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Variable Speed Drive by GFC

- Factory installed terminals
- Factory programmed parameters
- VFD houses all controls
- NEMA 3R enclosure
- Voltage up to 600 VAC
- Auto transfer to bypass
- BACnet MS/TP or LonWorks communication protocol to BMS





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Variable Speed Drive by Others

- Greenheck provides control to monitor airflow and control nozzle
- Variable Speed Drive by others
- Analog (0-10VDC) or digital communication



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Benefits of SAVVE Technology

- Reduced fan energy consumption
- Lower acoustics at unoccupied modes
- Maintain discharge velocity to meet ANSI Z9.5
- Single-source responsibility
- Real time system monitoring with BMS
- LEED credit opportunities



Patent Pending

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Variable Geometry Nozzle Installations

- University Illinois, Chicago
- University of Delaware
- Siemens
- Duke University (Gross Hall)
- Wayne State University
- University of California, Santa Barbara
- Schreiber Foods
- Bay State Health
- Texas A&M Rehab
- Royal Alberta Museum
- Celerion Labs
- Yale University
- Upper Chesapeake Hospital
- Penn State University
- Chevron Phillips
- Bringham Young University
- Mount Union University
- Arizona State University

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University of Illinois - Chicago



- Complete retrofit of field built centrifugal fans
- Added manifolded VAV system
- Variable geometry nozzles were added for additional savings

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University of Illinois - Chicago



- 5 year payback guarantee on the system
- Received added credits from the local power company

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Critical Equipment Monitoring

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Common Field Issues

Insufficient / Poor Maintenance





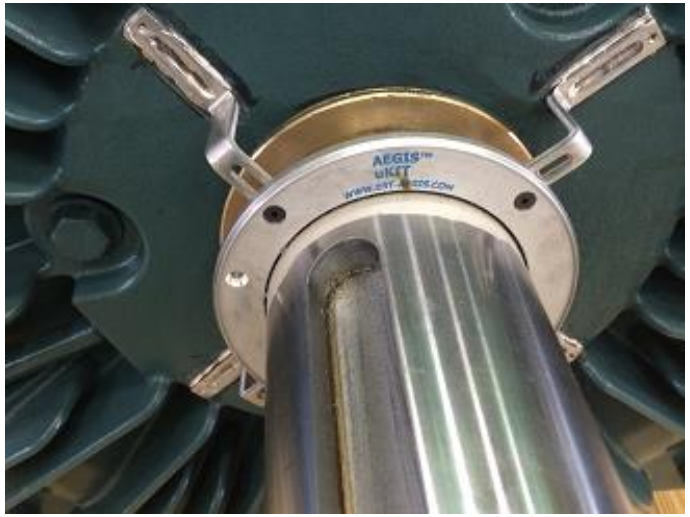


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Common Field Issues

Shaft Grounding – VFD Usage





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Common Field Issues

System Effects







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FMS *– Fan Monitoring System*

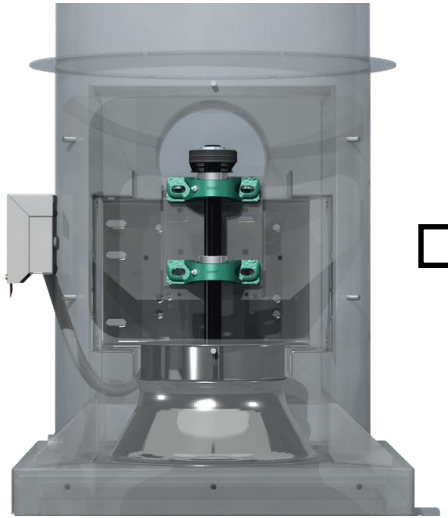
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Greenheck Fan Monitoring Systems



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Available Sensors



Vibration

Current

Pressure

Bearing Temp

Airstream Temp

RPM



To BMS

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Sensor Kit Packages

- Single/Dual Vibration Sensors
  - Monitors single plane vibration on two bearings or one bearing and one motor (two locations)



- Current Sensor
  - Monitors amp draw/run time



- Current and Vibration Sensors
  - Monitors amp draw and single plane vibration in one location





- Dual Pressure Sensors
  - Dirty filter indicator



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Sensor Kit Packages

- Bearing Temperature Sensor(s)
  - Monitors bearing temperature



- RPM and Current Sensors
  - Monitors amp draw and fan RPM for power consumption and run time





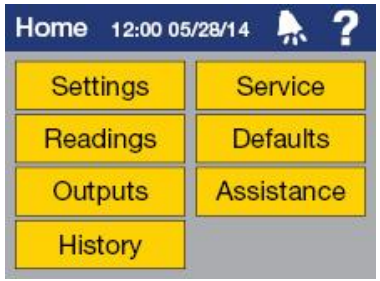




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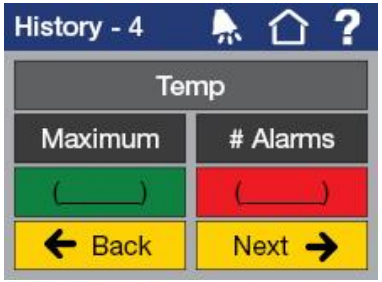
LCD Touch Screen

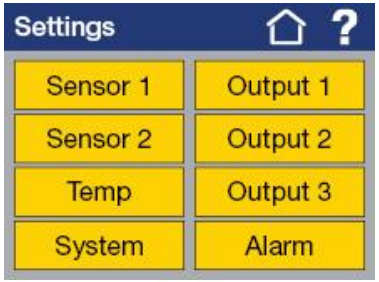
- Real time LCD display
- Intuitive menu and screen structure

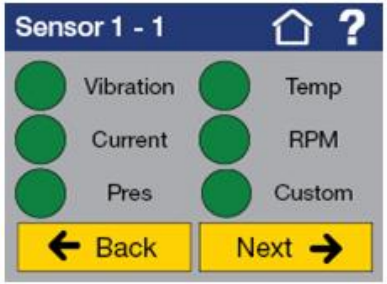








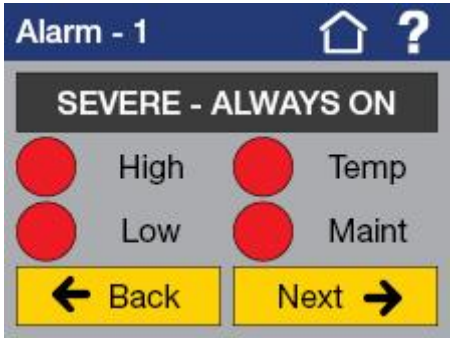


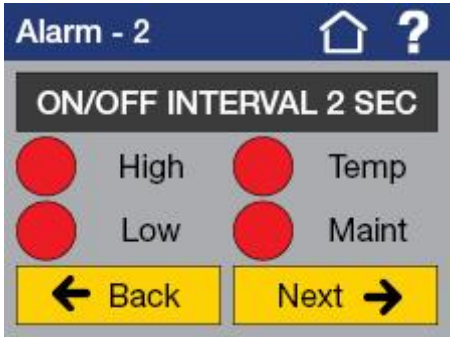


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Alarms

- Four user defined alarm points can be sent to BMS via analog outputs
  - High alarm
  - Low alarm
  - Temp alarm
  - Maintenance alarm





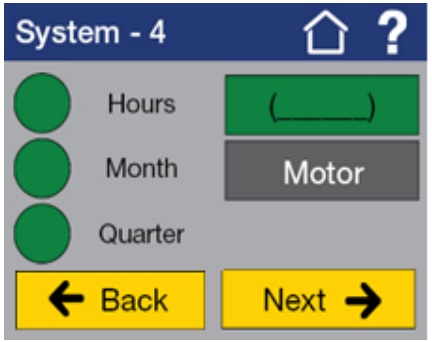
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Maintenance Features

- Five system maintenance features
  - Recordable run time with amp sensor (with current sensor)
  - Motor information
  - Bearing lubrication reminder (user defined interval)
  - Motor lubrication reminder (user defined interval)
  - Belt check reminder (user defined interval)







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Vektor Family


Vektor®-CS


Vektor®-H

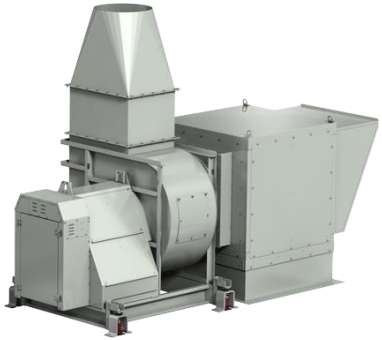

Vektor®-HS

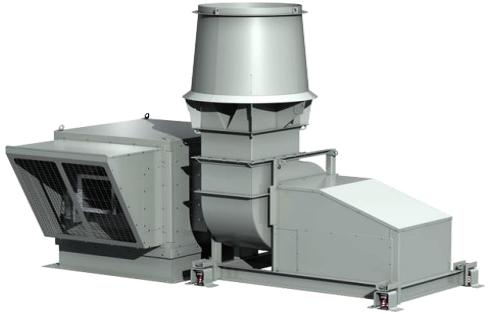

Vektor®-MD


Vektor®-MH


Vektor®-MD-ERS


Vektor®-MS


Vektor®-CH


Vektor®-CD

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High Plume Inline Vektor®-H



- Up to 24,000 CFM/fan and 3.5” w.g. {40,776 CMH and 875 Pa}
- Typically replace field built utility systems
- Best for smaller applications such as school, forensic, and isolation rooms
- UL 762 listed for restaurant exhaust

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High Plume Inline Vektor®-MH



- High plume rise, efficient mixed flow impeller
- Bifurcated housing design
- Up to 60,000 CFM/fan and 8.0” w.g. {100,000 CMH and 2,000 Pa}
- Suitable for university and pharmaceutical labs
- Suitable for industrial exhaust applications

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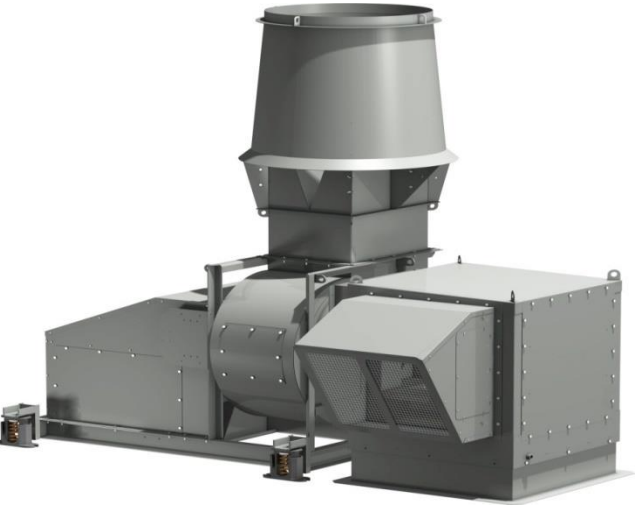
High Plume Dilution - Inline Vektor®-MD



- Up to 80,000 CFM/fan and 8.0” w.g. {135,900 CMH and 2,000 Pa}
- Dilution Air added to lab exhaust
- Bifurcated housing design
- Suitable for university and pharmaceutical labs

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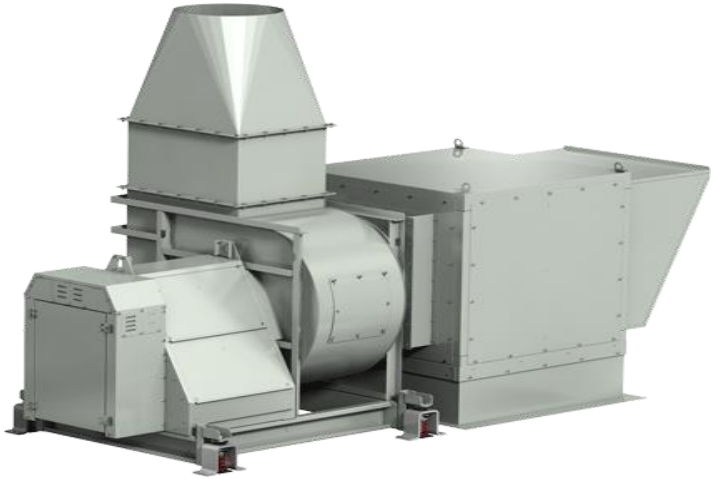
High Plume Dilution - Centrifugal Vektor®-CD



- Up to 140,000 CFM/fan and 14.0” w.g. {237,860 CMH and 3,500 Pa}
- Dilution Air added to lab exhaust
- Efficient Airfoil impeller
- Suitable for university and pharmaceutical labs

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High Plume - Centrifugal Vektor®-CH



- Up to 60,000 CFM/fan and 14.0” w.g. {100,000 CMH and 3,500 Pa}
- Engineered high plume conical nozzle
- Efficient airfoil impeller
- Suitable for university and pharmaceutical labs

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SAVVE Variable Geometry Nozzle Vektor®-HS, CS and MS

- Up to 38,400 CFM/fan and 8.0” w.g. {64,000 CMH and 2,000 Pa}
- Demand based ventilation
- Allows safe used of VFD’s
- Suitable for university and pharmaceutical labs

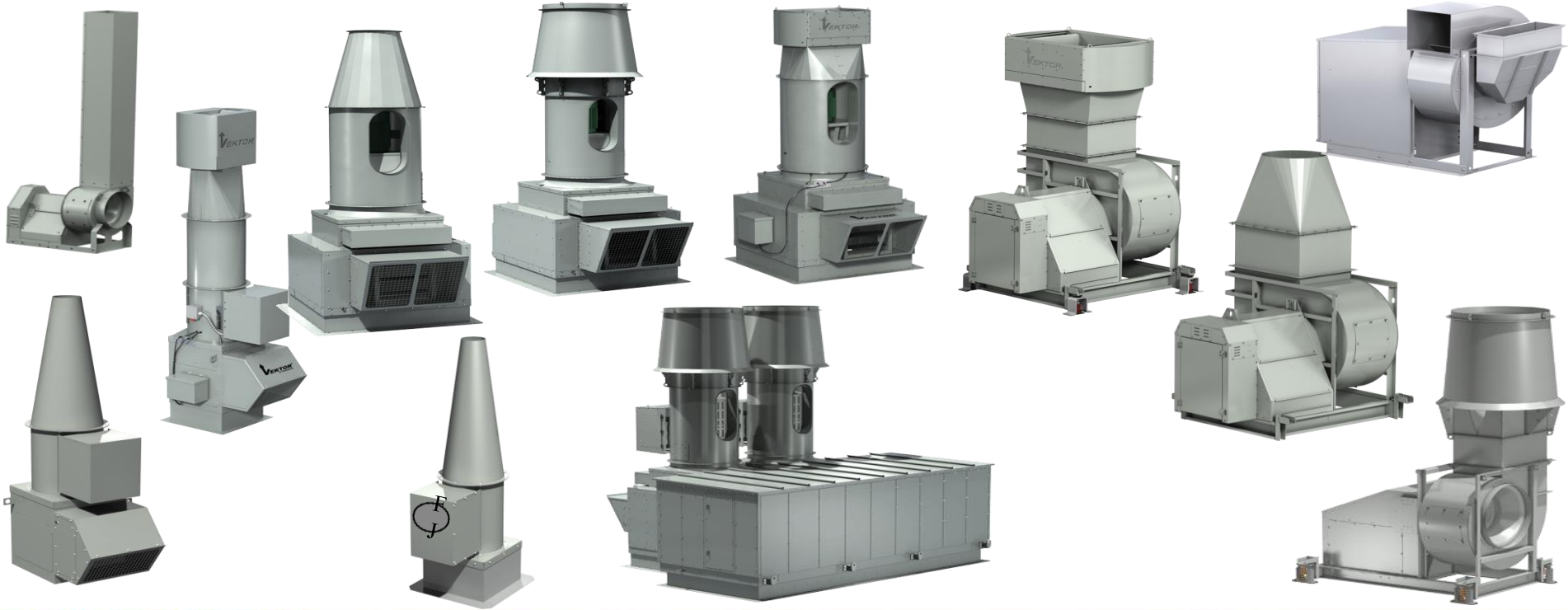






Patent Pending

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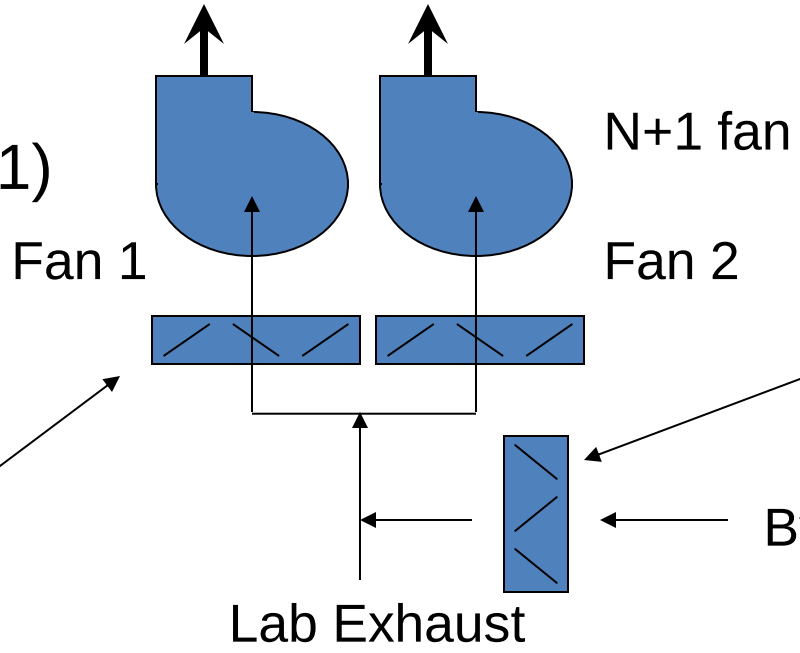


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Reducing Laboratory Energy
Exhaust Fan Energy

2 Fan VAV System (traditional N+1)



60,000 cfm exhaust @ 6-in. Ps

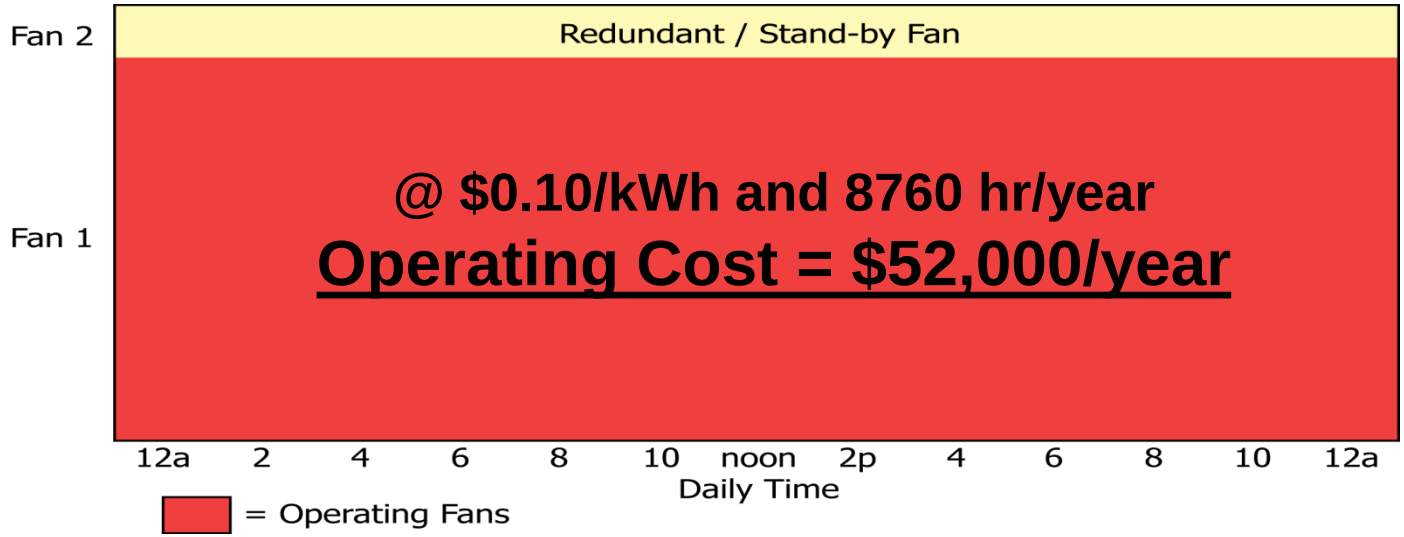
2 fans
60,000 cfm each

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Reducing Laboratory Energy
Exhaust Fan Energy

2 Fan VAV system
(traditional N+1)

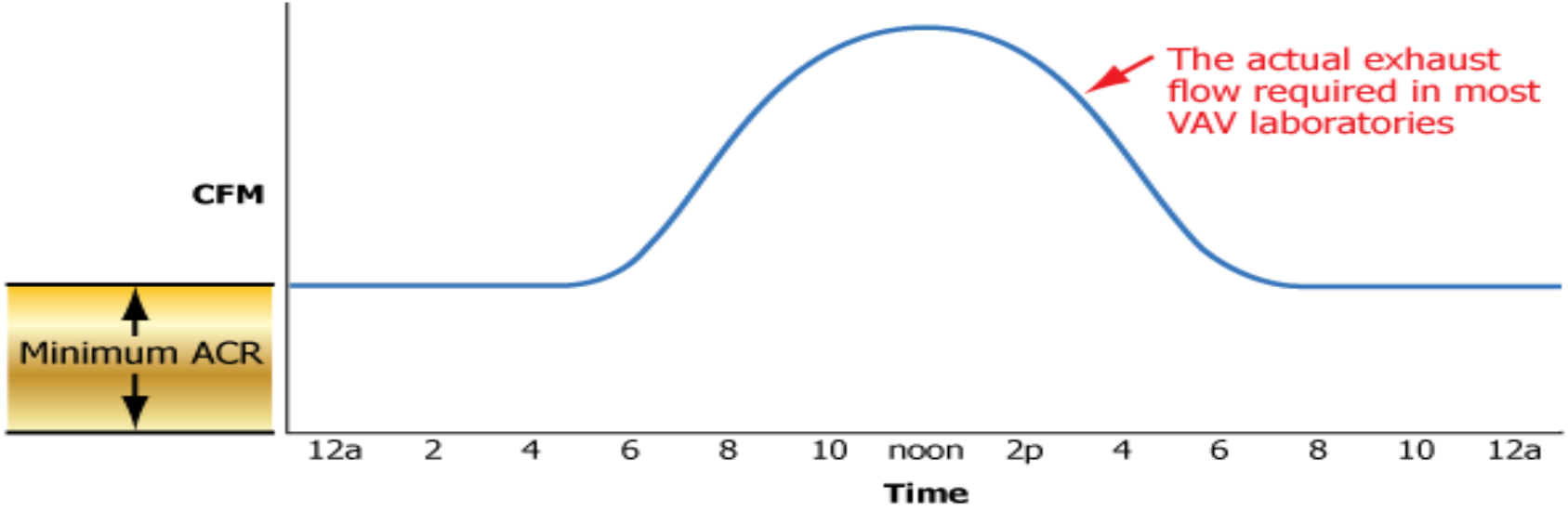
60,000 cfm exhaust @ 6-in. Ps
2 fans; 60,000 cfm each



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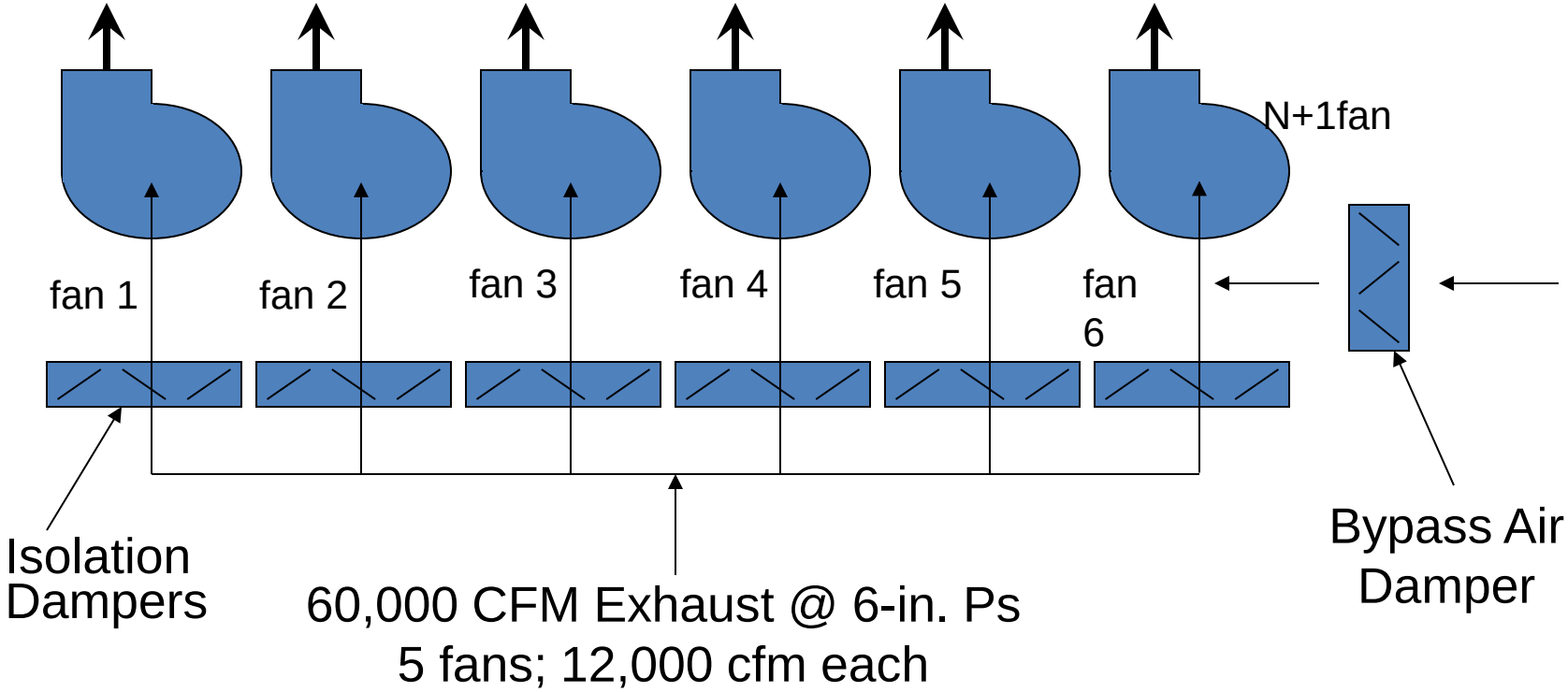
The Actual Exhaust Flow Required in Most VAV Labs



ACR = Air Change Rates

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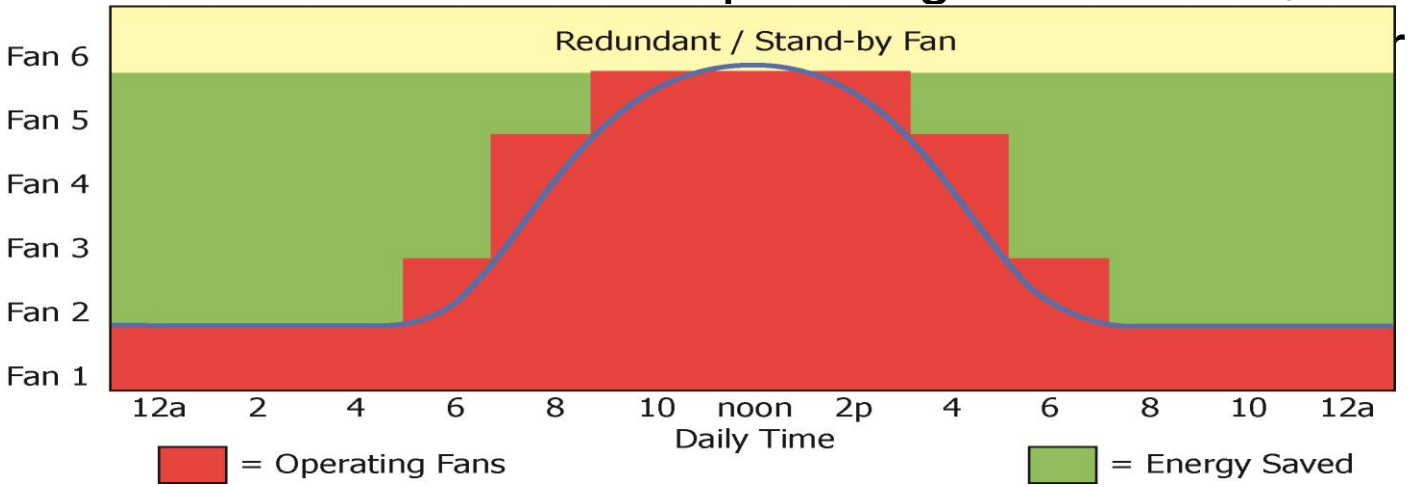
Multiple Staging Fan System



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Reducing Laboratory Energy
Exhaust Fan Energy

Operating Cost = $20,901



Energy Cost Savings: 6 Fan System = $31,111 year!

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Fan Staging Energy Savings

Fan System	BHP	Hours of Operation	$/kWh	Annual Energy Cost	Cost
N + 1	79.59	8760	0.1	$ 52,012	$105,000
Staged	Varies	8760	0.1	$ 20,901	$140,000
Annual energy saved:				$ 31,111	

1.13 years payback

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Thank you for your time.

Questions?

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