

Charting a Course to Energy Independence

**Providence, RI
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Using Fan Array & VFD Technology to Improve System Performance in Retrofit Applications

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Agenda

- What is a Fan Array?
- System Retrofit Questions to Solve
 - Access/Space/Weight
 - Performance
 - Acoustics & Vibration
 - Long Term Care & Maintenance
- How Can a Fan Array Benefit a Retrofit?
- Fan Array Design Considerations
- Example Project



What Is A Fan Array?

The Evolution Of Air Handling Unit Technology, Utilizing An Array Of Direct Drive Plenum Fans With Variable Frequency Drives To Improve Total System Performance



Fan Array Evolution

- Multiple Forward Curved Fans
 - Long Common Fan Shaft = Wide Unit Footprint
 - External Isolation
 - Low to Medium Pressure
 - Constant Volume
 - Low Efficiency
- Single DWDI Airfoil Fans
 - Shorter Fan Shaft = Narrower Footprint
 - Internal Isolation
 - Medium & High Pressure
 - Constant & Variable Volume
 - Improved Efficiency & Non-overloading BHP Curve



Fan Array Evolution

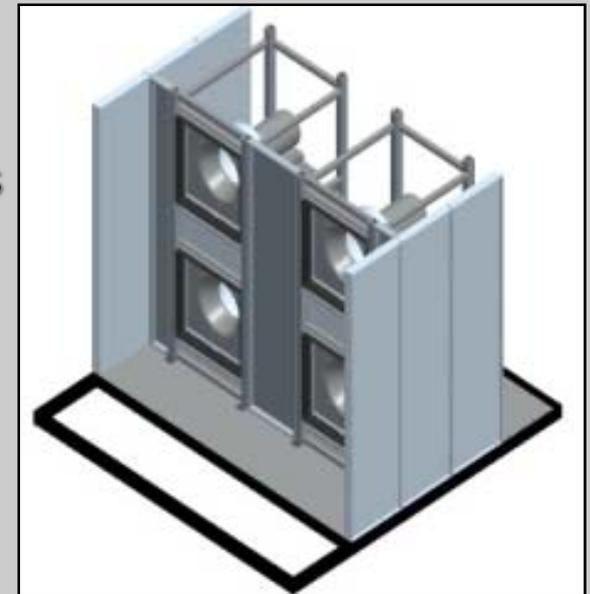
- Single Belt Drive SWSI Airfoil “Plenum” Fans
 - Reduced Unit Length
 - Increased Flexibility
 - Improved Sound Profile
 - Constant & Variable Volume
 - 12 Blade Designs Further Improve Sound Performance
- Single Direct Drive Airfoil “Plenum” Fans
 - Smaller Fan Footprint = Better Placement
 - Less Complexity: No Belt Drives, No Fan Bearings
 - Benefits Offset by Physically Larger Motors & Less Efficient, Trimmed Wheels
- Plenum Fans With VFDs Now 80-90% of Usage



Fan Array Evolution

- Fan Array
 - An Array of Smaller Direct Drive Plenum Fans
 - Uses the Ever Present VFD to Set Design Fan RPM
 - No Wheel Trimming = Higher Efficiency
 - Further Reduction in Unit Length
 - Improved Sound Profile
 - Reduced Maintenance & Service Costs

All Of The Benefits Of Direct Drive!
Without The Disadvantages!





Retrofit Questions

- With My Access, Space and Weight Constraints, How Will I Ever Replace This Old Air Handling Unit?
- How Am I Going To Update My System's IAQ Capability And Energy Performance?
- How Can I Improve My System's Acoustic & Vibration Performance For A Better Tenant Environment?
- What Are My Options For Reducing The Long Term Cost Of Maintenance And Service





Fan Array = Smaller Footprint

- Fan Section Length Dictated by Fan Size & Type
 - 54" Plenum Fan Requires 90"
 - Fan Array Requires Maximum of 48"
- Clearance Dictated by Fan Diameter and Service
 - 54" Plenum Fan Requires 54" Upstream Clearance
 - 24" Plenum Fan Requires 24" Upstream Clearance
 - Technician Requires No Less Than 24" Clearance
- Potential 72" Overall Length Savings
- Plenum Fans Do Not Require Diffuser Section
- Savings Can Be Used For Added Coil, Added Filtration, Air Mixers, etc.



Fan Array = Greater Efficiency

A Fan Array Will Deliver System Efficiencies That Are \geq A Belt Drive Selection!

- Fan Static Efficiencies Equal Those of Belt Drive
 - Compare To What Is Being Replaced
- No Drive Losses
 - Belt Losses Can Be 3% To 8% Of The Fan BHP
 - Belts Stretch As They Wear And Need To Be Adjusted Continuously To Keep Losses At A Minimum
- No Inlet Obstructions
 - Inlet Bearing Losses Can Be 2% Of The Fan BHP
- No Losses From Isolation Dampers
- VFD Control Versus Old Systems Still Using VIV's



Fan Array = Even Air Distribution

- Fans Located Horizontally And Vertically In The Cabinet!
- Better Flow Distribution Than One Or Two Large Fans:
 - Eliminate “Hot Spots”
 - Better Filter Utilization





Fan Array = Improved Acoustics

- Smaller Fans Driven At Higher Speeds Elevate Peak Noise Generation To The 3rd, 4th Or Even 5th Octave Band Instead Of In The 1st or 2nd
- Cabinet Attenuation Is Much Greater In The Higher Octave Bands
- Minimize or Eliminate Attenuators
 - Lower Pressure Drop Further Improves System Performance
- Basic Acoustic Principles Still Apply; Review Sound Claims Carefully



Fan Array = Improved Vibration

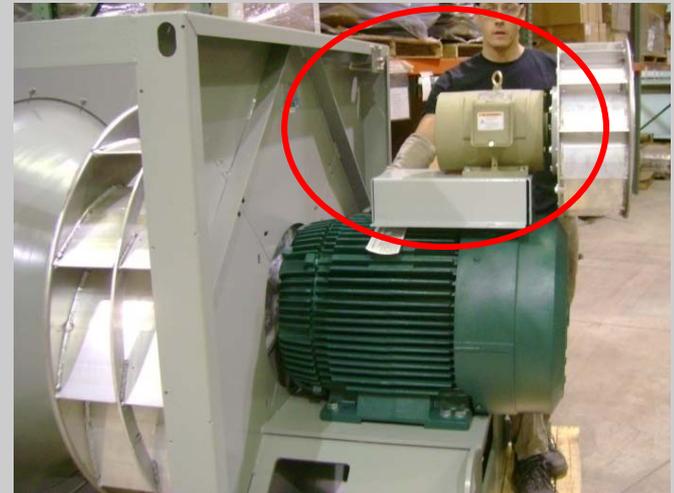
- Avoid Destructive Resonant Frequencies Within The Fan Operating Speed Range
 - Multiple, Smaller Fans Help Provide The Solution
 - Avoid “Water Glasses” in the Air Handler
- Use New FEA Design Tools To Eliminate Problem Natural Frequencies
- Tighter Fan Balance Specification





Fan Array = Lower Cost Service

- Smaller Individual Motor Sizes
 - Motor Range 3 to 30 HP
 - Typically 10 to 25 HP & Weigh <150 Lbs; Max. 250 Lbs
 - 2 - 3 Hour Motor Replacement
 - Compare To A 1500 Lb Motor With 6 V-Belt Sheave – 2 - 3 Days?
- Motors 1800 or 3600 RPM
 - Smaller Wheels Operate At Higher Speeds
- Motors Locally Available
- No Belts To Align, Adjust Or Replace
- No Fan Bearings To Tighten, Lubricate Or Replace
- 5 Year Manufacturer's Fan & Motor Warranty





Fan Array = System Redundancy

- Multiple Fans Reduce The Impact of a Failure
- Service Interruptions Can Be Eliminated if the System Can Still Perform With A Failure
 - 2 Fan System = 60-70% Flow, w/Back Draft Damper
 - 6 Fan System = 80% Flow Without Back Draft Damper
 - With Sufficient Motor HP, 100% Flow Is Achievable
 - N+1 or N-1
 - Always Look at the Cost/Benefit to the User
- Repairs Are Scheduled To Minimize Disruption
- Avoid Multiple Large Belt Drive Fans w/Dampers



160,000CFM Fan Array





Fan Array Design Considerations



Fan Wheel Selection

- 12 Blade Direct Drive Aluminum Plenum Fans
 - Same Components as in AMCA Certified Assemblies
 - Class 2 or Class 3 Fans - Up to 11" W.C.
 - Balanced To 0.08 in/sec (1/2 Of Belt Drive Standard)
 - Light Weight – Low Rotating Mass
 - 12 Blades Improves Acoustics
- Look For Best Combination Of Efficiency & Sound Power
 - 71 to 72% Static Efficiency





Robust Fan Motors

- Premium Efficiency
- VFD Compatible per NEMA MG1 Part 31.4.4.2
 - 1600V Insulation
- L10 – 200,000Hr Minimum Bearing Life
 - Grease Capable
- Designed To Operate at 120Hz
- Clamped Rear Bearing
- Available Shaft Grounding Kits
- 5 Year Manufacturer's Warranty





Fan Motor Speed Selection

- Modern VFD's Can Deliver Full Current At Up To 400HZ
 - The Maximum Output Frequency Is A Set Point On The Drive.
- Select Motors In The Constant Horsepower Region >60Hz
- Motors Selected At <60Hz Must Be De-rated
 - Energy Codes, i.e. ASHRAE 90.1, Do Not Recognize BHP, Just Motor HP
 - Electrical Requirements Are Based On Installed Motor HP
 - Lower Shaft Currents Above 60Hz
- Design Operating Frequency Affects Bypass Options





How Many Fans To Use?

- Design To The Requirements Of The Job
 - Degree Of Redundancy Required
 - Single Stage Of Redundancy
 - N + 1 or N – 1 Capability
 - Space Requirements
 - Understand The Impact of More Fans
- Fewer Fans Equals:
 - Lower Cost
 - Improved Efficiency
 - 3Hp Premium Efficiency Motor – 89.5%
 - 15HP Premium Efficiency Motor – 93.0%
- Do Not Overlook The Impact On The VFD
 - (4) 5Hp Motors Have > Amps Than (1) 20Hp Motor





Utilize Internal Spring Fan Isolation

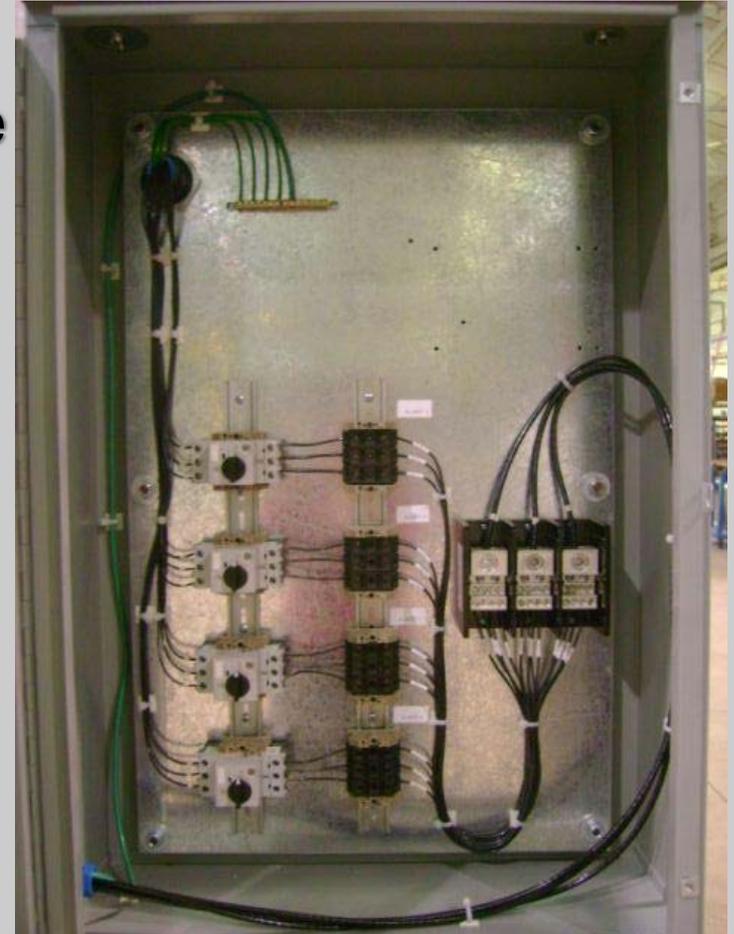
- Is It Necessary?
 - Yes, According To The ASHRAE Handbook. Chapter 47 Table 48 Recommends A Minimum Of 0.75" Deflection Spring Isolators For Centrifugal Fans Consuming Less Than 40 HP With Operating Speeds Greater Than 500 RPM
 - To Avoid Possible Interaction Between Multiple Fans In The Array





Power Distribution Panel

- Required To Operate Multiple Motors From A Common VFD
- Manual Motor Protectors
- Allows Identification of a Failed Motor Via Auxiliary Contact On The MMP
- Disconnect Switches





Optional Features To Consider

- Back Draft Dampers or Blank Off Plates
- Inlet Screens
- Outlet Screens
- Shaft Grounding Kits
- Airflow Measurement
- Acoustic Baffles
- Motor Removal Winch





Application Comparison

- 160,000 CFM
- 6.5" TSP
- Laboratory Facility
- Conventional 2 Fan Layout

VS

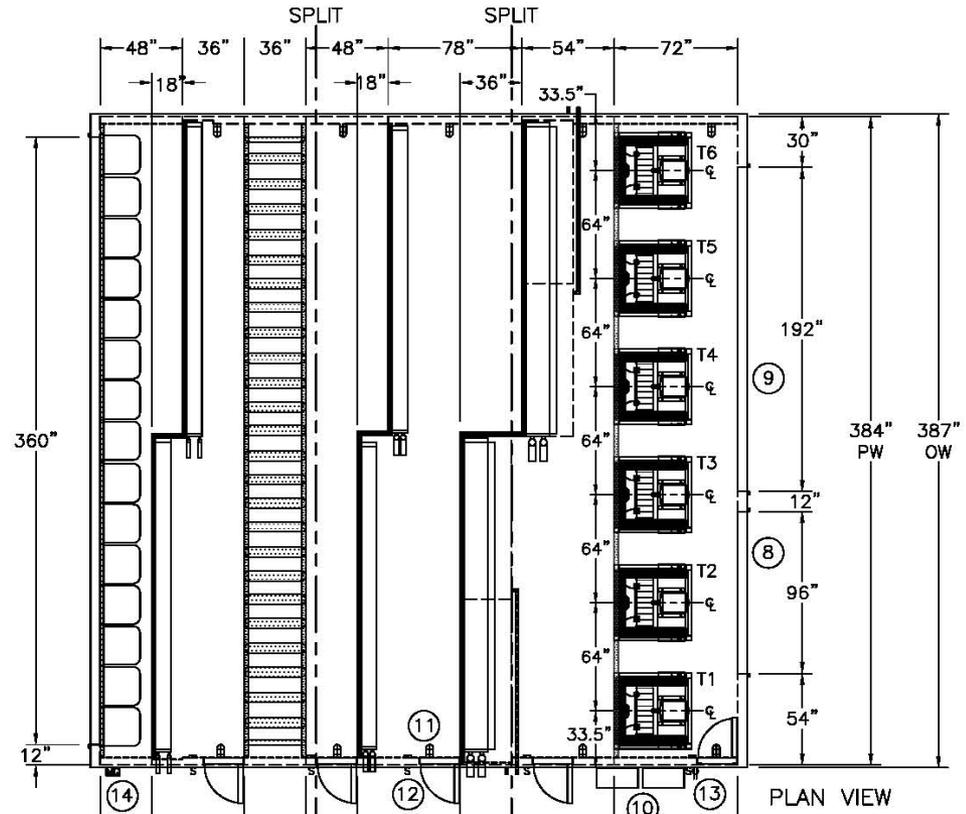
12 Fan Matrix Layout – 2H x 6W

OKLAHOMA CITY, OK 73101-1538
 PHONE (405) 415-9230 - FAX (405) 415-9231

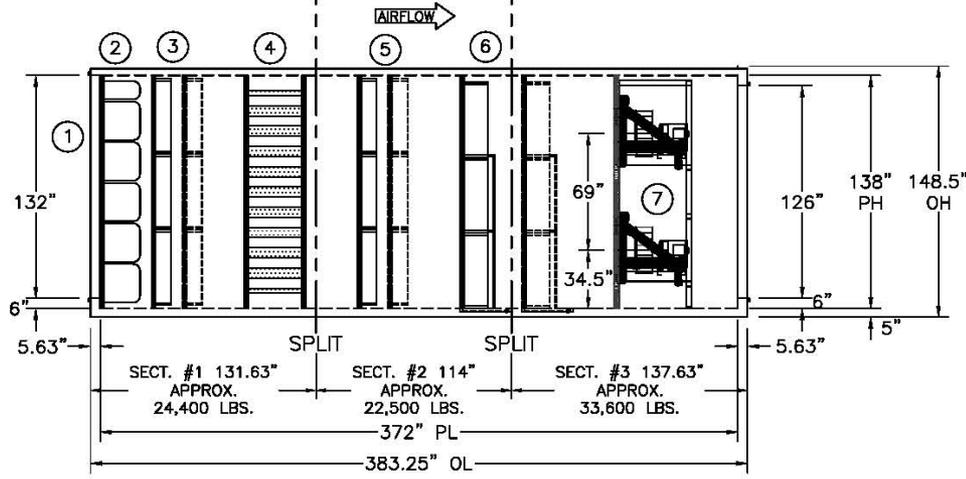


1. INTAKE OPENING
2. FILTERS, 2" - 30% & 12" - 95%
3. HEAT RECOVERY COIL
4. SOUND ATTENUATOR
48HX45W - 16 MODULES
24HX45W - 8 MODULES
5. H.W. COIL
6. C.W. COIL
7. PLENUM SUPPLY FANS
(TYP. OF 12)
8. S.A. OPENING 126"H X 96"W
9. S.A. OPENING 126"H X 192"W
10. ELECTRICAL DISTRIBUTION PANEL
WITH DISCONNECT - 6 FANS
(TYP OF 2)
11. SERVICE LIGHT (TYP OF 10)
12. LIGHT SWITCH (TYP OF 5)
13. GFI OUTLET
14. MAGNEHELIC GAUGE

NOTE:
 UNLESS OTHERWISE
 SPECIFIED ALL DOORS
 ARE 66" X 24"



PLAN VIEW



ELEVATION VIEW

APPROXIMATE UNIT SHIPPING WEIGHT 80,500 LBS.

JOB	DePaul University - Science II
TAG	AHU-P-1
Sheet	1 OF 11
DATE	08/20/07
SN	22264
MODEL NO.	CAH138X384
REV	OR
BY	PJ



Actual Application Comparison

Benefits of The Fan Array Selection

- 11% Length And Floor Space Reduction
- 25% Reduction In Pieces To Rig
- 5,400 lbs Weight Savings
- 5% Lower cost (Including Added Electrical Distribution Cost)
- 5.3% Lower BHP/4% Less MHP
- 200 lb Motors Versus 1850 lb Motors
- Blade Pass Frequency In 4th Octave Band
- No Belt, Sheave Or Bearing Maintenance
- More Even Airflow Over Cooling Coil
- Greater Redundancy



Fan Array Retrofit Benefits

- Smaller Unit Footprint
- Improved System Performance
 - Greater Efficiency
 - Improved Air Distribution
 - Flexibility For Added Capacity And Components
- Improved Acoustics And Vibration Control
- Lower Cost Maintenance And Service
 - Fan System Redundancy
 - 5 Year Fan And Motor Warranties



Thank You