Axial Fan Wind Turning Vane Scale Model Test Results

Prepared for ACCUG Conference
September 22-25, 2014
San Diego, California

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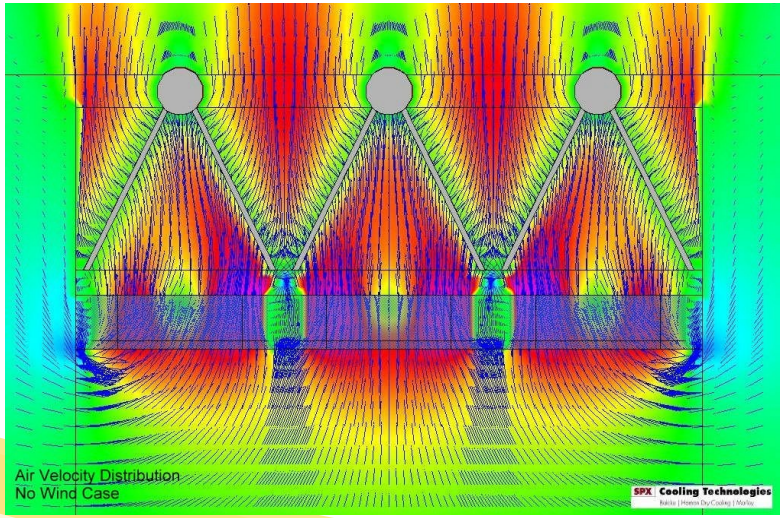
Classic Axial Fan
Flow Distortion and Asymmetry

"Distorted flows arising from upstream air-turning circumstances are, however, unavoidable in many instances. For example, a fan taking air from the free atmosphere will be subjected to varying wind conditions, which **in the most severe case will be at right angles to the fan axis**."

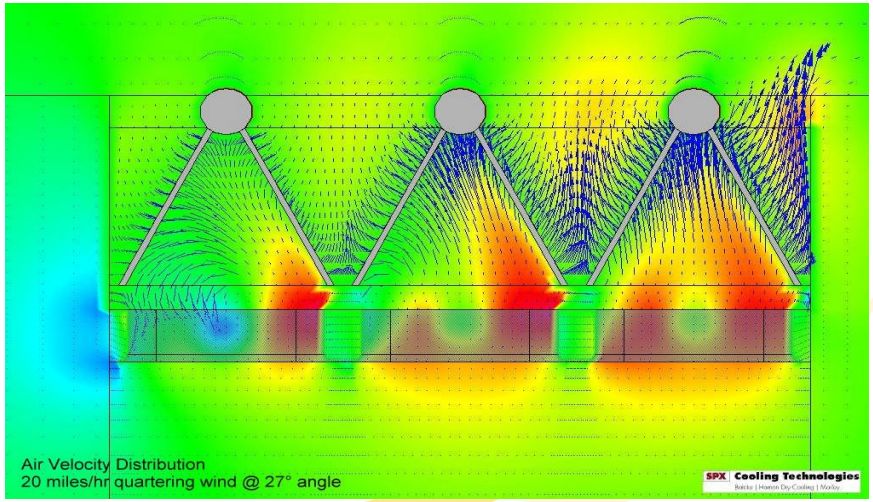
Source: Wallis, R. Allen, "Axial Flow Fans and Ducts," John Wiley & Sons, 1983,

ACC Axial Fans are inherently operating with crosswinds of the "most severe case."

ACC Axial Fan Performance – CFD Predicted Wind Related Degradation, Distortion & Asymmetry

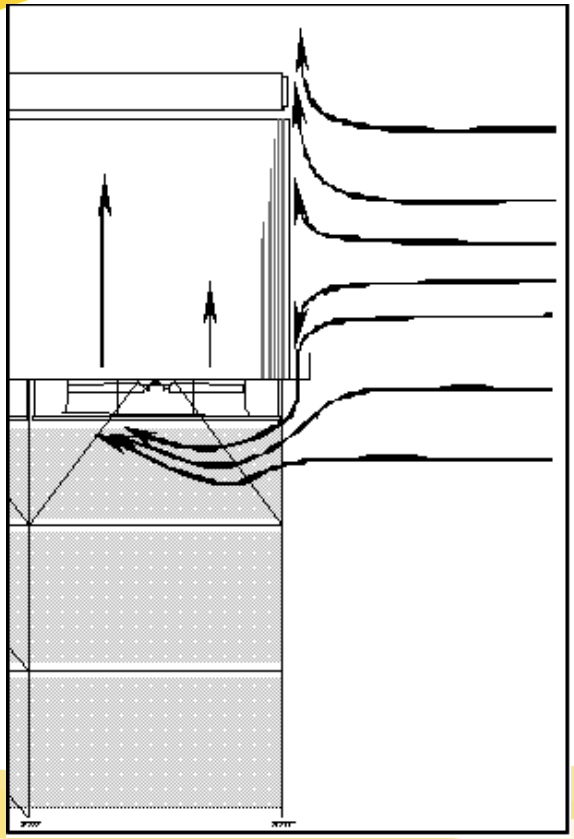


Calm Winds

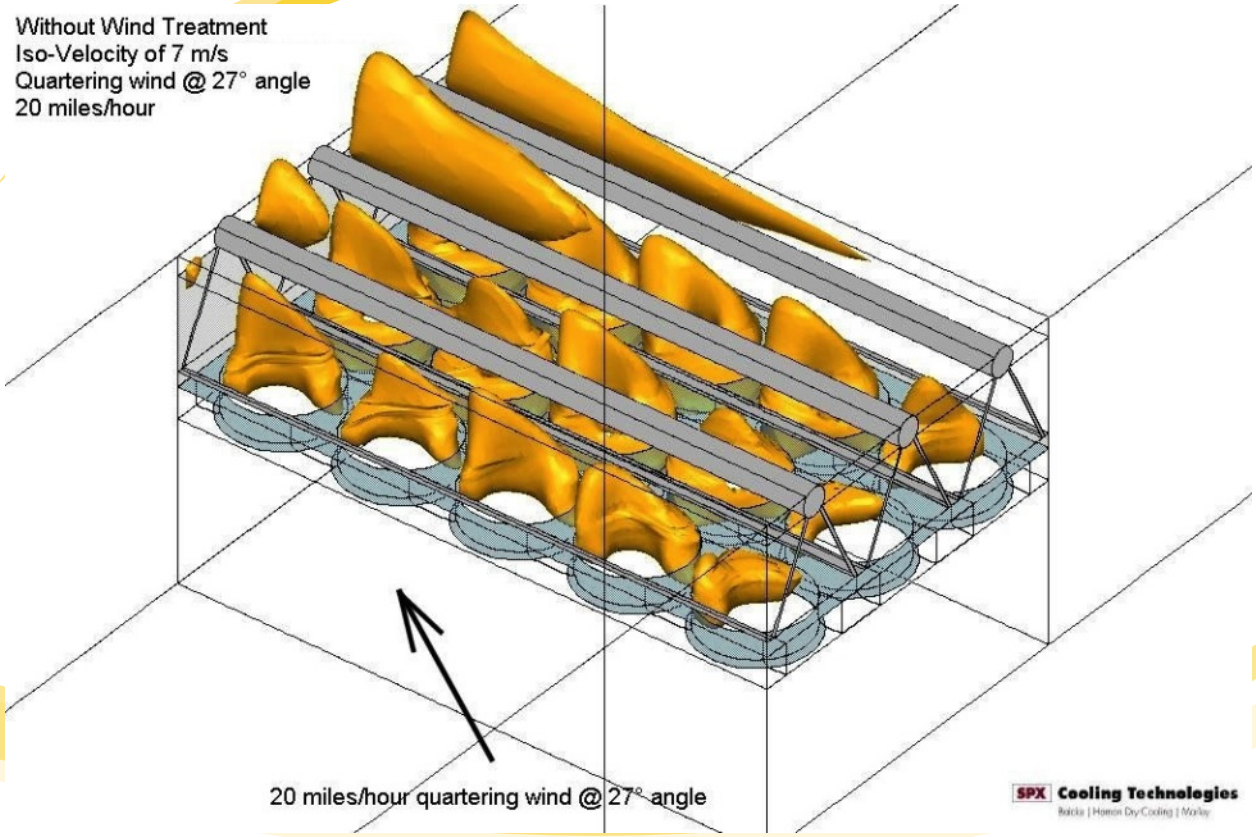


20 MPH Winds

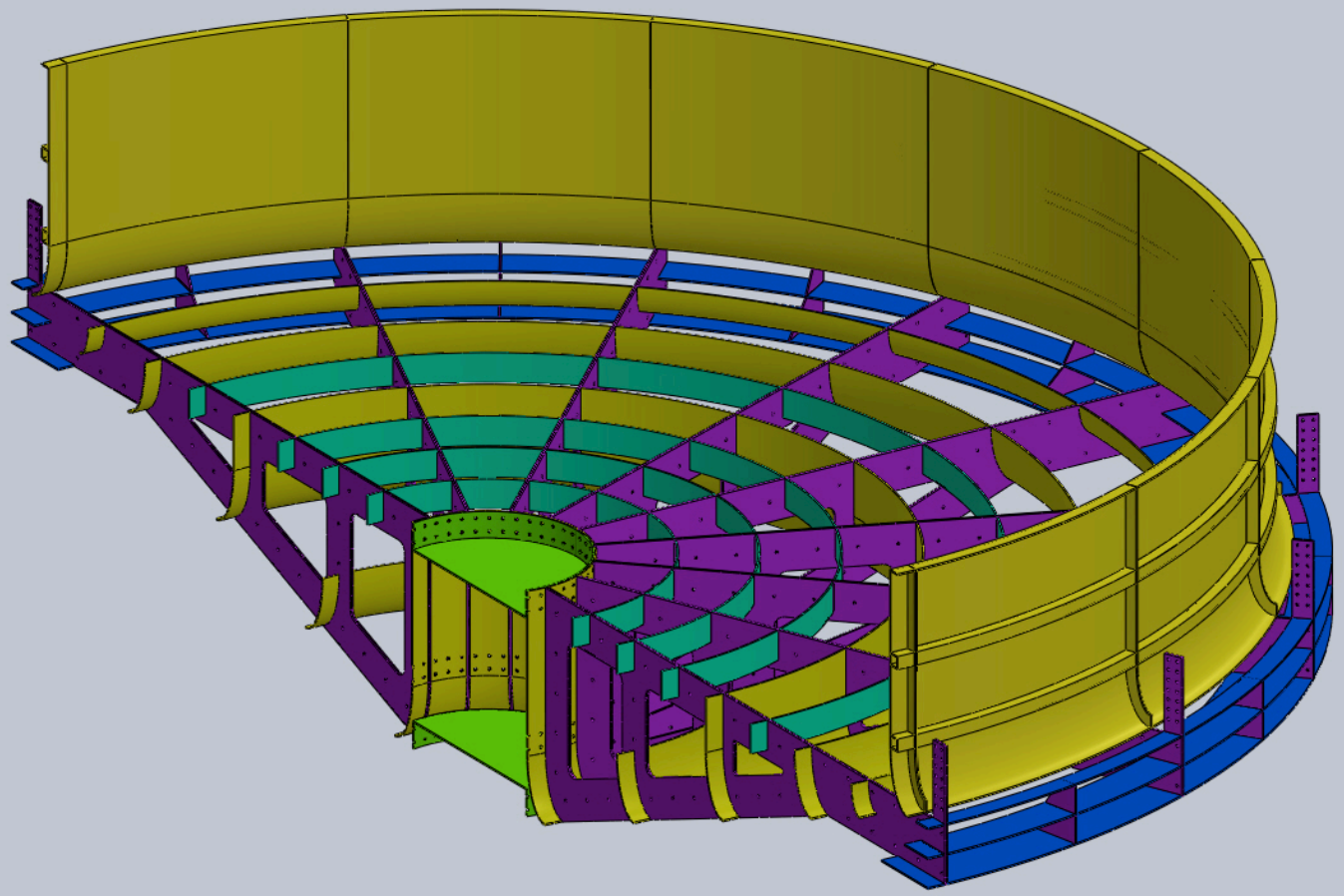
Source: **Improved Performance of an Air Cooled Condenser (ACC) Using SPX Wind Guide Technology at Coal-Based Thermoelectric Power Plants** [DEFC2606NT06549], Final Report 3/31/2011, **DOE Funding Opportunity, DE-PS26-08NT00233-01,** Principal Investigator: Ken Mortensen.

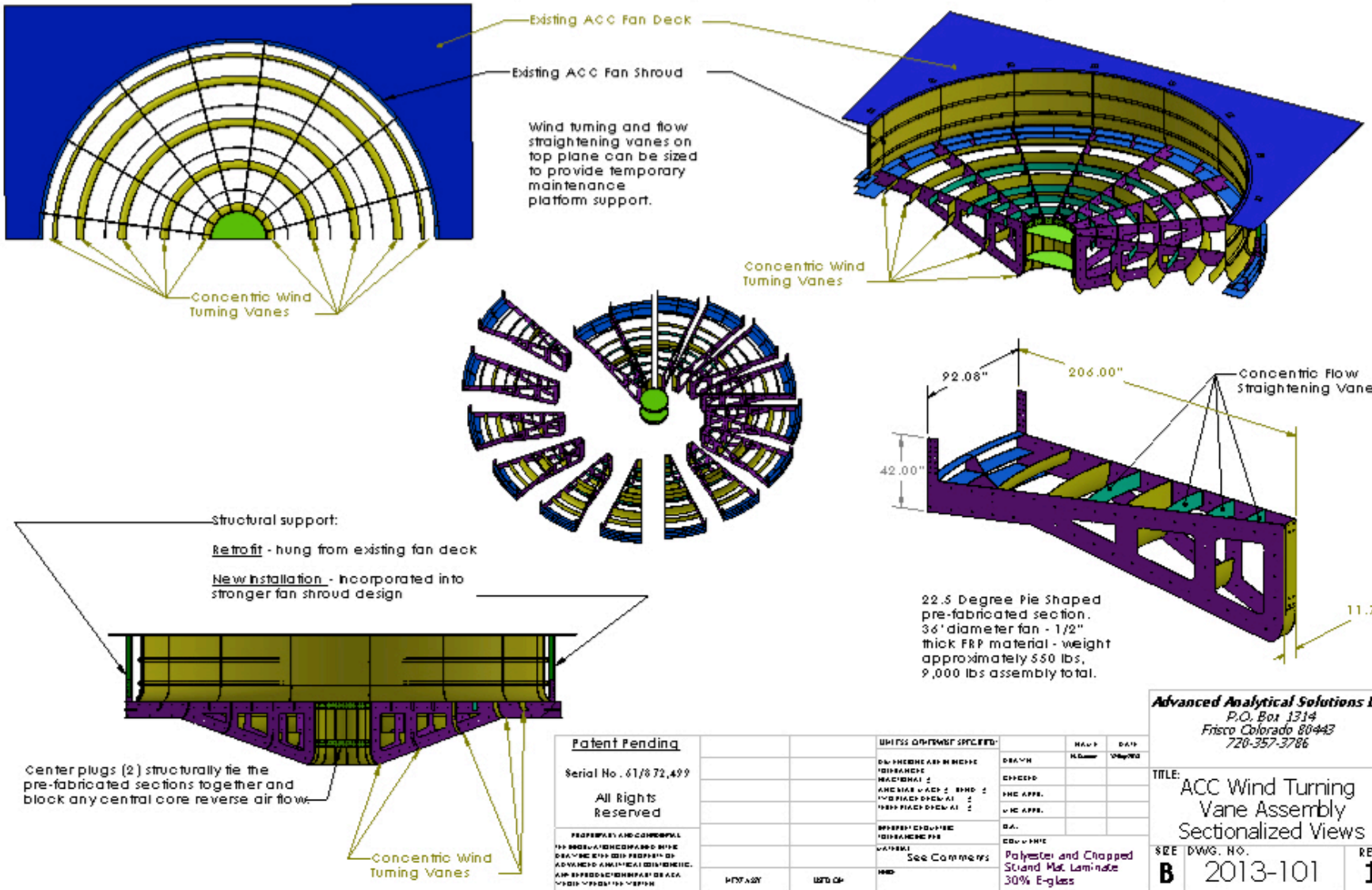


Source: Maulbetsch, John, Michael DiFilippo. 2010. ***Effect of Wind on the Performance of Air-Cooled Condensers***. California Energy Commission. Publication Number: CEC-500-2013-065

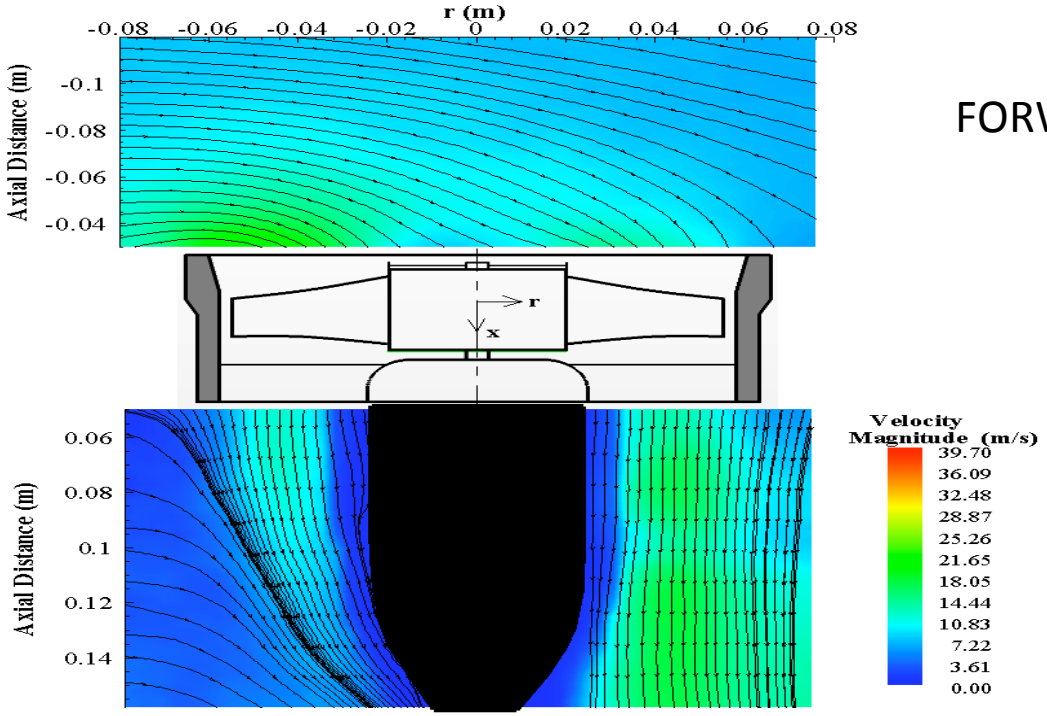


Source: "Improving Performance of ACC using SPX Wind Guide Technology", Award by National Energy Technology Laboratory, Department of Energy, October 27, 2008




Existing ACC Fan Deck
Existing ACC Fan Shroud
Wind turning and flow straightening vanes on top plane can be sized to provide temporary maintenance platform support.
Concentric Wind Turning Vanes
Concentric Wind Turning Vanes
92.08"
206.00"
Concentric Flow Straightening Vanes
42.00"
11.70"
Structural support:
Retrofit - hung from existing fan deck
New Installation - incorporated into stronger fan shroud design
22.5 Degree Pie Shaped pre-fabricated section. 36' diameter fan - 1/2" thick FRP material - weight approximately 550 lbs, 9,000 lbs assembly total.
Center plugs (2) structurally tie the pre-fabricated sections together and block any central core reverse air flow.
Concentric Wind Turning Vanes
Patent Pending
Serial No. 61/872,499
All Rights Reserved
See Comments
Polyester and Chopped Strand Mat Laminate 30% E-glass
Advanced Analytical Solutions LLC
P.O. Box 1314
Frisco Colorado 80443
720-357-3786
TITLE:
ACC Wind Turning Vane Assembly Sectionalized Views
SIZE B
DWG. NO. 2013-101
REV 1
SCALE: 1/6 WEIGHT:
SHEET 1 OF 1

ACC Axial Fan Performance – Wind Related Degradation, Distortion & Asymmetry Not Limited To Large Diameter Fans



FORWARD FLIGHT
6 m/s

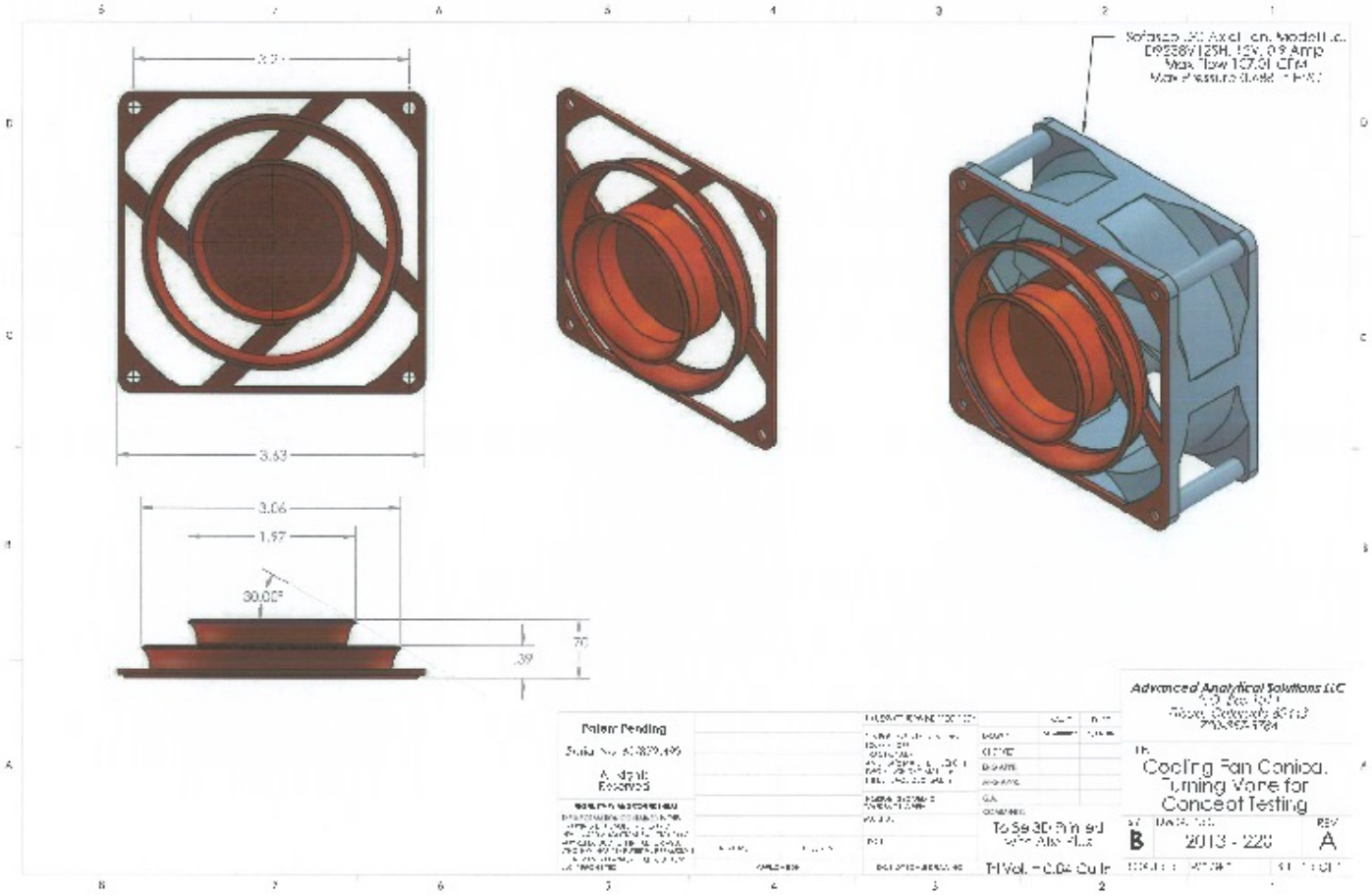
Source: Ali Akturk, Akamol Shavalikul and *Cengiz Camci, "***PIV Measurements and Computational Study of a 5-Inch Ducted Fan for V/STOL UAV Applications", AIAA 2009-332, 47th AIAA Aerospace Sciences Meeting and Exhibit, 5-8 January 2009, Orlando, Florida**

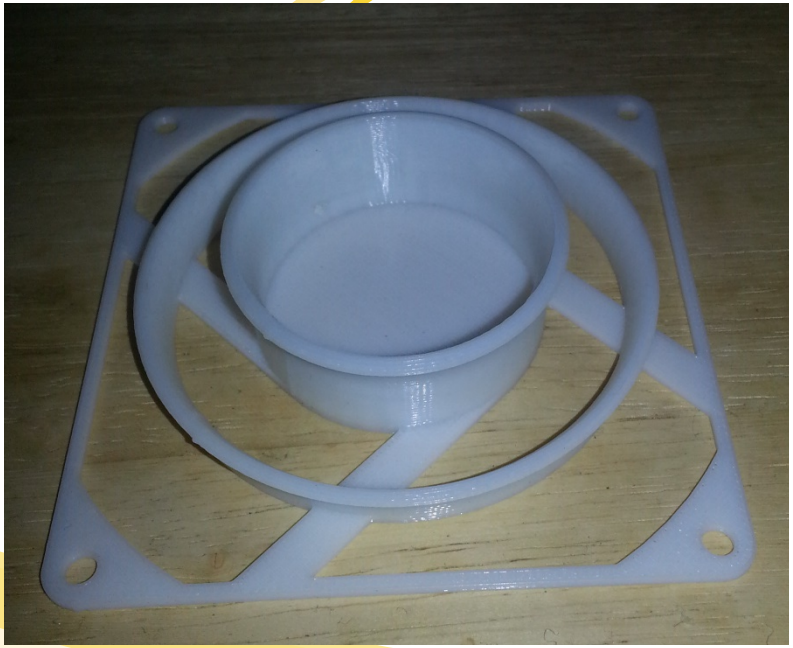
Conclusions:

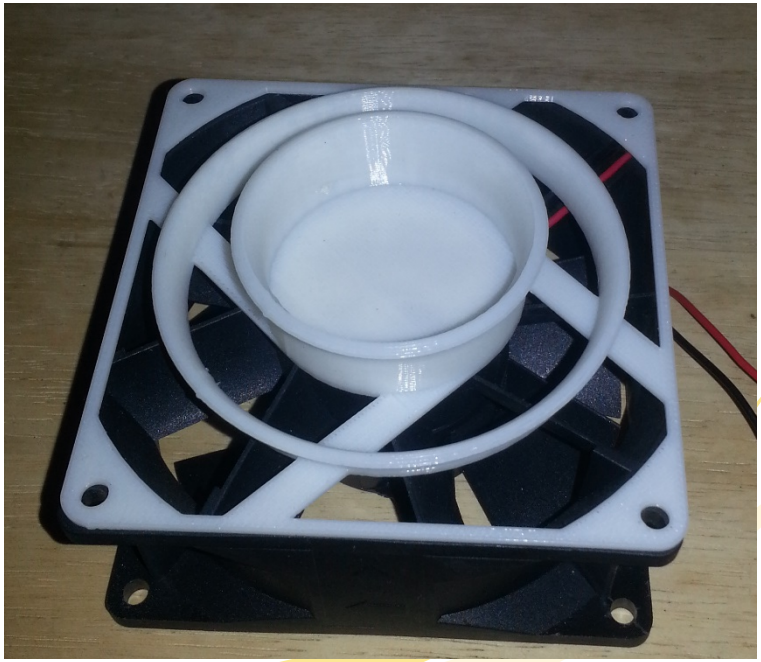
1. Non-Axisymmetric Axial Fan Output Airflow is the result of Non-Axisymmetric Inlet Flow.
2. Non-Axisymmetric Axial Fan Inlet Flow in ACC's is caused by crosswinds.
3. Axial Fan Inlet/Outlet Asymmetry is independent of the Fan Diameter.
4. A small diameter axial fan should be sufficient to test the Wind Turning Vane Concept, i.e., will the wind turning vane operating in a cross wind condition result in axisymmetric axial fan outlet airflow?

Wind Turning Vane Scale Model Test

Step 1: Create a Scale Model Wind Turning Vane


3.63
3.06
1.97
30.00°
.39
.70
Patent Pending
To Be 3D Printed
Tri Vol. = 0.04 Cu In
Advanced Analytical Solutions LLC
Cooling Fan Conical Turning Vane for Concept Testing
B
2013 - 220
A





Scale Model Turning Vane created by 3D Printing a SolidWorks® CAD Model.

Wind Turning Vane Scale Model Test

Step 1: Create a Scale Model Wind Turning Vane

Step 2: Build a Scale Model Test Apparatus


Channel 1
VDC
Channel 2
VDC
Power Supply
On/Off
12
3.3
0
12
3.3
0

Wind Turning Vane Scale Model Test

Step 1: Create a Scale Model Wind Turning Vane
Step 2: Build a Scale Model Test Apparatus
Step 3: Test Fan Without Crosswind & No Turning Vane

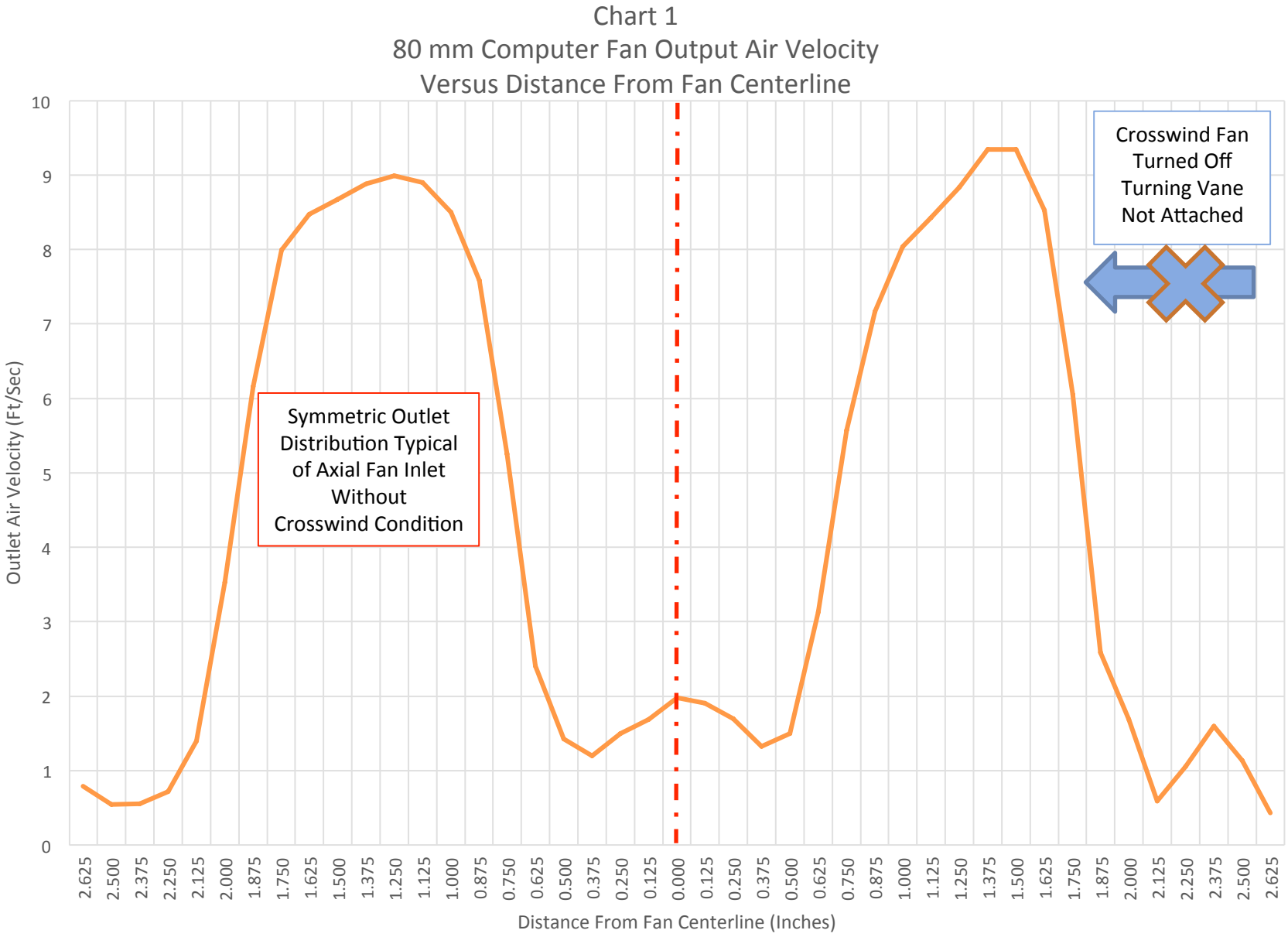
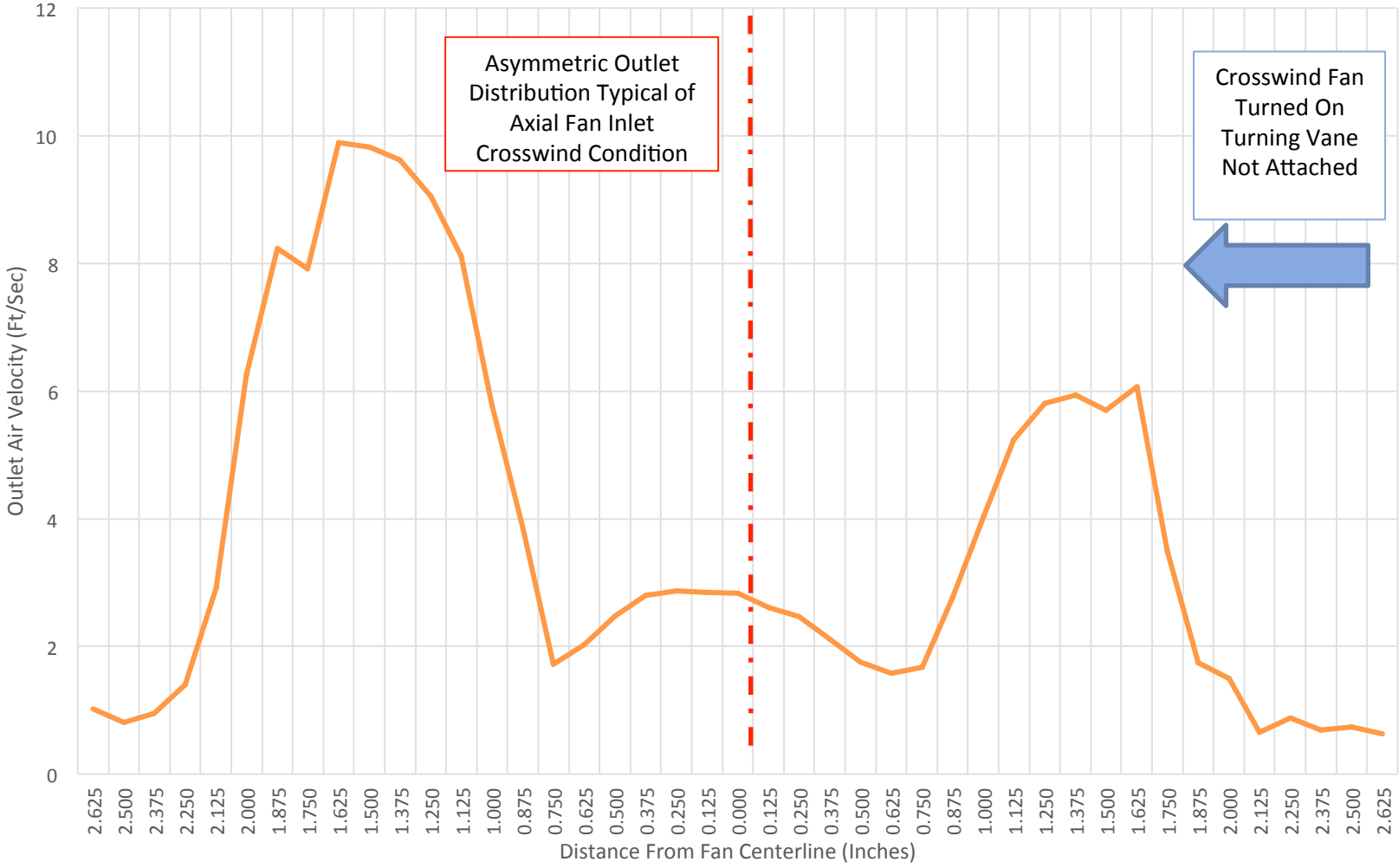


Chart 1
80 mm Computer Fan Output Air Velocity
Versus Distance From Fan Centerline
Outlet Air Velocity (Ft/Sec)
10
9
8
7
6
5
4
3
2
1
0
Symmetric Outlet Distribution Typical of Axial Fan Inlet Without Crosswind Condition
Crosswind Fan Turned Off Turning Vane Not Attached
2.625
2.500
2.375
2.250
2.125
2.000
1.875
1.750
1.625
1.500
1.375
1.250
1.125
1.000
0.875
0.750
0.625
0.500
0.375
0.250
0.125
0.000
0.125
0.250
0.375
0.500
0.625
0.750
0.875
1.000
1.125
1.250
1.375
1.500
1.625
1.750
1.875
2.000
2.125
2.250
2.375
2.500
2.625
Distance From Fan Centerline (Inches)

Wind Turning Vane Scale Model Test

Step 1: Create a Scale Model Wind Turning Vane
Step 2: Build a Scale Model Test Apparatus
Step 3: Test Fan Without Crosswind & No Turning Vane
Step 4: Test Fan With Crosswind & No Turning Vane

Chart 2
80 mm Computer Fan Output Air Velocity
Versus Distance From Fan Centerline



Wind Turning Vane Scale Model Test

Step 1: Create a Scale Model Wind Turning Vane
Step 2: Build a Scale Model Test Apparatus
Step 3: Test Fan Without Crosswind & No Turning Vane
Step 4: Test Fan With Crosswind & No Turning Vane
Step 5: Test Fan Without Crosswind & With Turning Vane

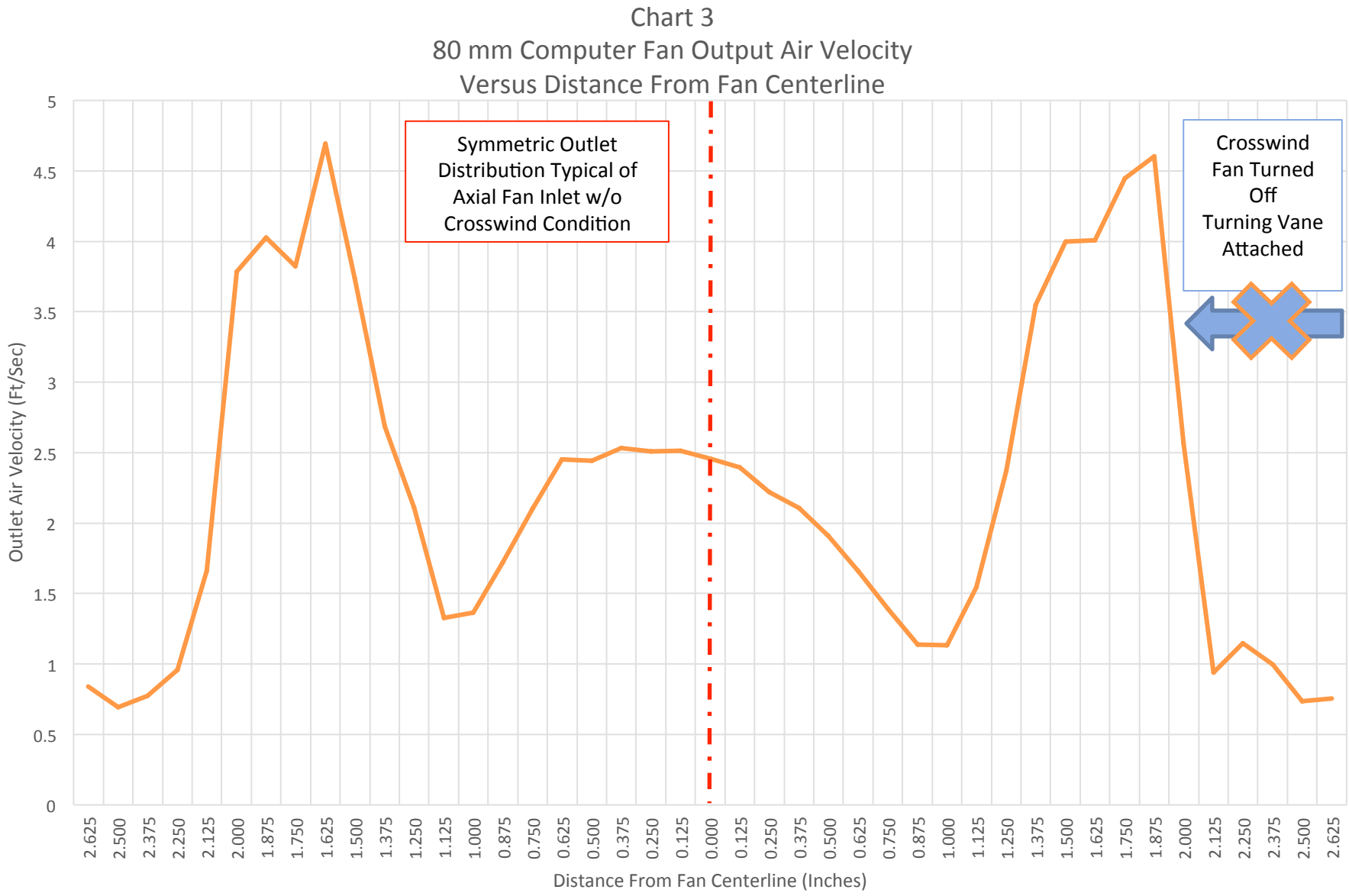
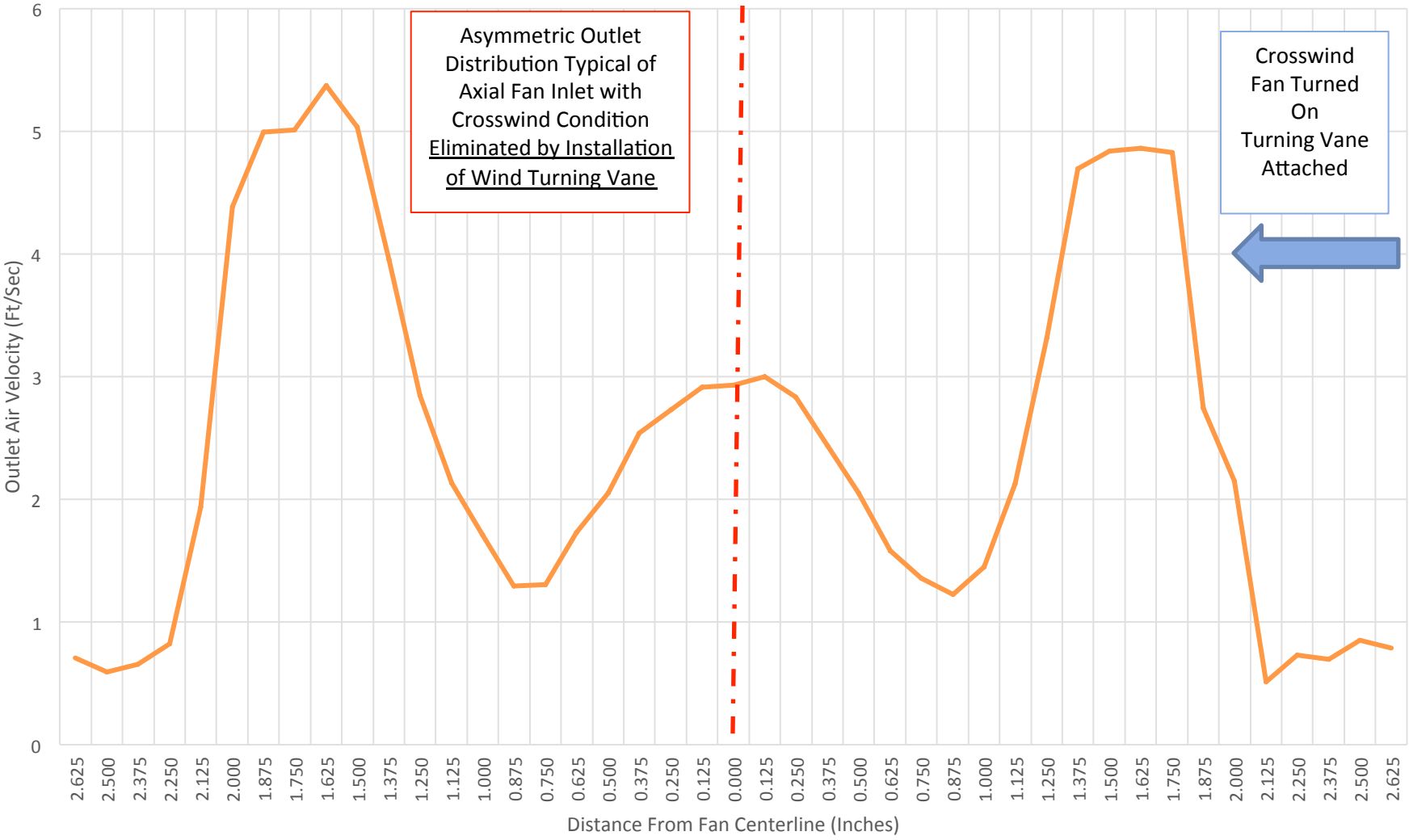


Chart 3
80 mm Computer Fan Output Air Velocity
Versus Distance From Fan Centerline
Symmetric Outlet Distribution Typical of Axial Fan Inlet w/o Crosswind Condition
Crosswind Fan Turned Off Turning Vane Attached
Outlet Air Velocity (Ft/Sec)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
2.625 2.500 2.375 2.250 2.125 2.000 1.875 1.750 1.625 1.500 1.375 1.250 1.125 1.000 0.875 0.750 0.625 0.500 0.375 0.250 0.125 0.000 0.125 0.250 0.375 0.500 0.625 0.750 0.875 1.000 1.125 1.250 1.375 1.500 1.625 1.750 1.875 2.000 2.125 2.250 2.375 2.500 2.625
Distance From Fan Centerline (Inches)

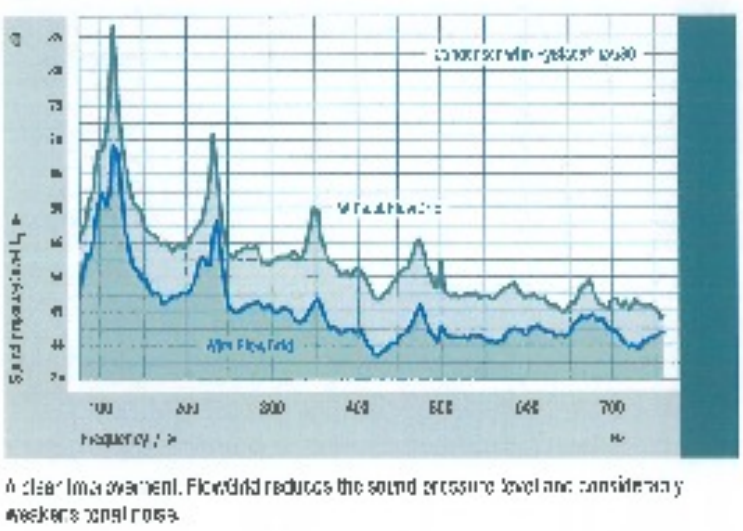
Wind Turning Vane Scale Model Test

Step 1: Create a Scale Model Wind Turning Vane
Step 2: Build a Scale Model Test Apparatus
Step 3: Test Fan Without Crosswind & No Turning Vane
Step 4: Test Fan With Crosswind & No Turning Vane
Step 5: Test Fan Without Crosswind & With Turning Vane
Step 6: Test Fan With Crosswind & With Turning Vane

Chart 4
80 mm Computer Fan Output Air Velocity
Versus Distance From Fan Centerline



European Fan OEM EBM-Papst Announced in October 2013 a new product – FlowGrid© a fan inlet noise reducer. It uses the identical principle as the Wind Turning Vane concept.



Wind Turning Vane Scale Model Test Conclusion:

The Axial Fan Wind Turning Vane Scale Model Converted a Crosswind Inlet Condition Into an Axi-Symmetric Outlet Condition.

Therefore, A Full Scale Wind Turning Vane, mounted on an Air Cooled Condenser, Should Significantly Reduce Crosswind Fan Vibrations.