Minimizing and Troubleshooting Fan System Effect

David Maletich, vice president of engineering,
The New York Blower Co.

amca insite

Participation Guidelines

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- You must be present for the entire session and complete a post-course online evaluation.
- Credit cannot be issued to anyone who does not complete the evaluation.
- A link to the evaluation will be provided at the end of the session and e-mailed in the weeks following the 2024 AHR Expo.

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David Maletich

Vice President, Marketing
The New York Blower Company

- Over 30 years in the fan industry
- Current ASME Nuclear Air and Gas Treatment “Conagt” committee member and member of various AMCA committees
- Presents fan-related seminars for AMCA, ASHRAE, OSHA, ACGIH, universities and engineering firms

Fan Troubleshooting and System Effects

Purpose and Learning Objectives

The purpose of this presentation is to inform industry professionals on the causes of system effect, and how to recognize and minimize these effects.

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

1. Outline how fans are tested and rated in accordance with AMCA Standards 210 & 211.
2. Describe how ductwork configurations are affected by the placement of inlet & outlet elbows.
3. Compare system effect (in-situ) performance vs. catalog fan performance.

Test Lab:

AMCA Accredited Test Lab

(Fan Set-up for Testing)

Ideal Conditions

- Open inlet
- Straight run of ductwork from the outlet
- Run of Outlet duct allows the velocity profile to even out before entering the chamber.
- Fan catalog performance is tested in this manor.

Test Lab:

AMCA Accredited Test Lab

(Drive Side View of Test Set-up)

- Torque measuring device to calculate BHP *(or kW)* consumption.

Test Lab:

AMCA Accredited Test Lab

(Chamber)

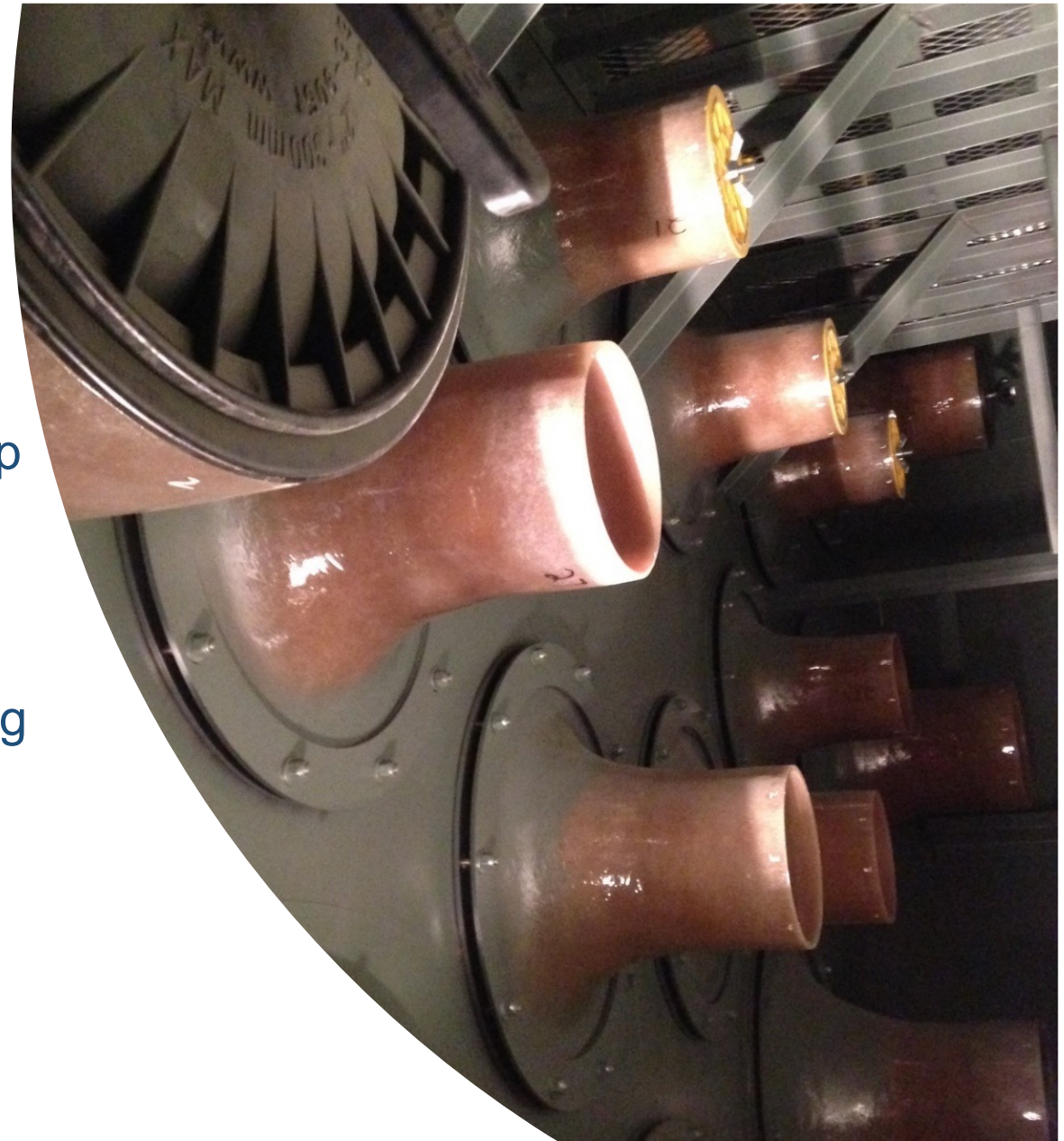
- On the other side of the bulkhead, lies the test chamber.
- The exhaust fan is used to overcome the resistance within the chamber and allow for a complete curve to be generated from closed off to wide open.

Test Lab:

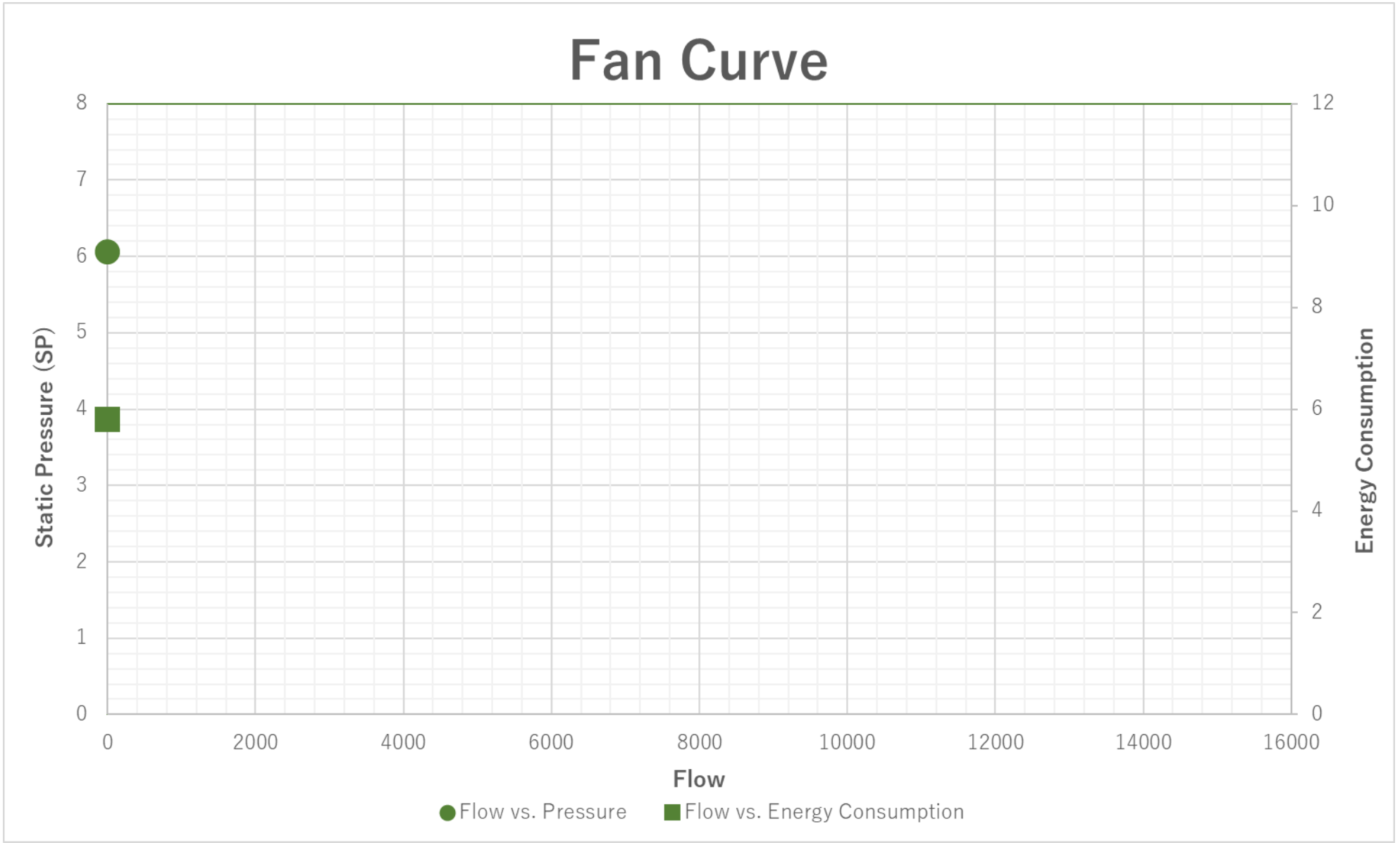
AMCA Accredited Test Lab

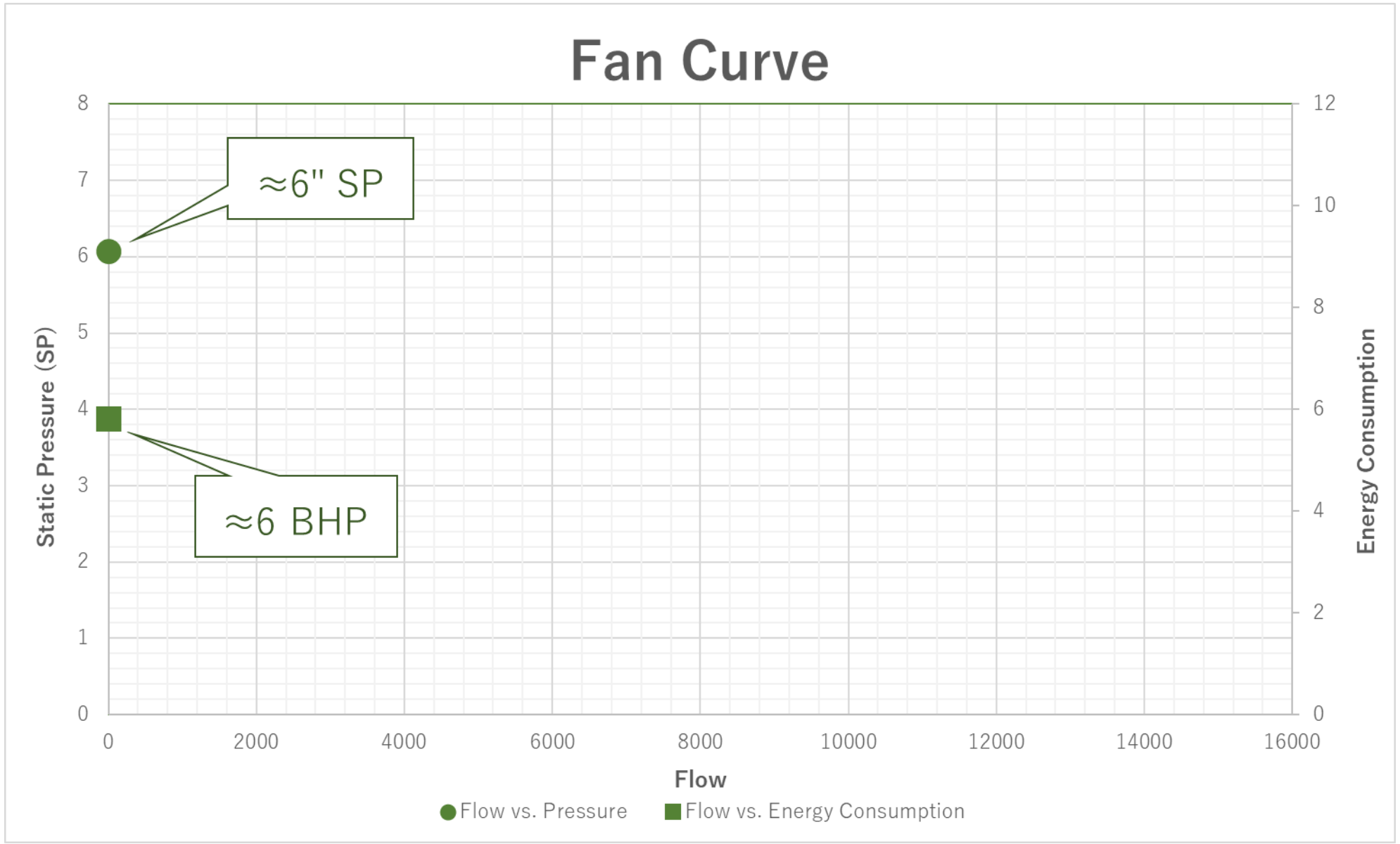
(Test Chamber – continue)

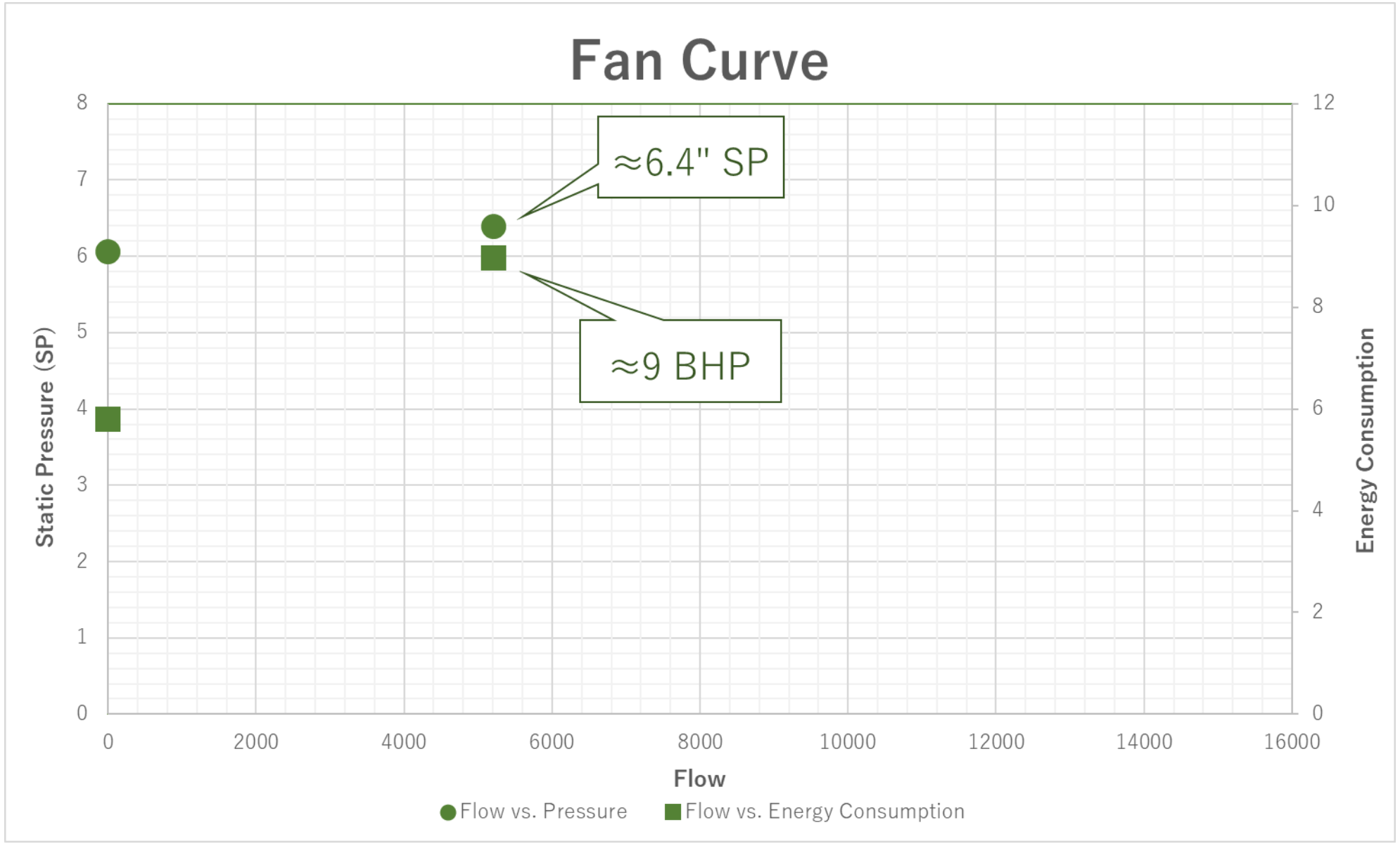
- Nozzles within the chamber are opened up or left closed depending on the air flow capabilities of the fan.
- Enough nozzles are opened to handle the theoretical wide-open flow for the fan being tested.
- Some nozzles will have to be closed to accommodate lower flow conditions being tested

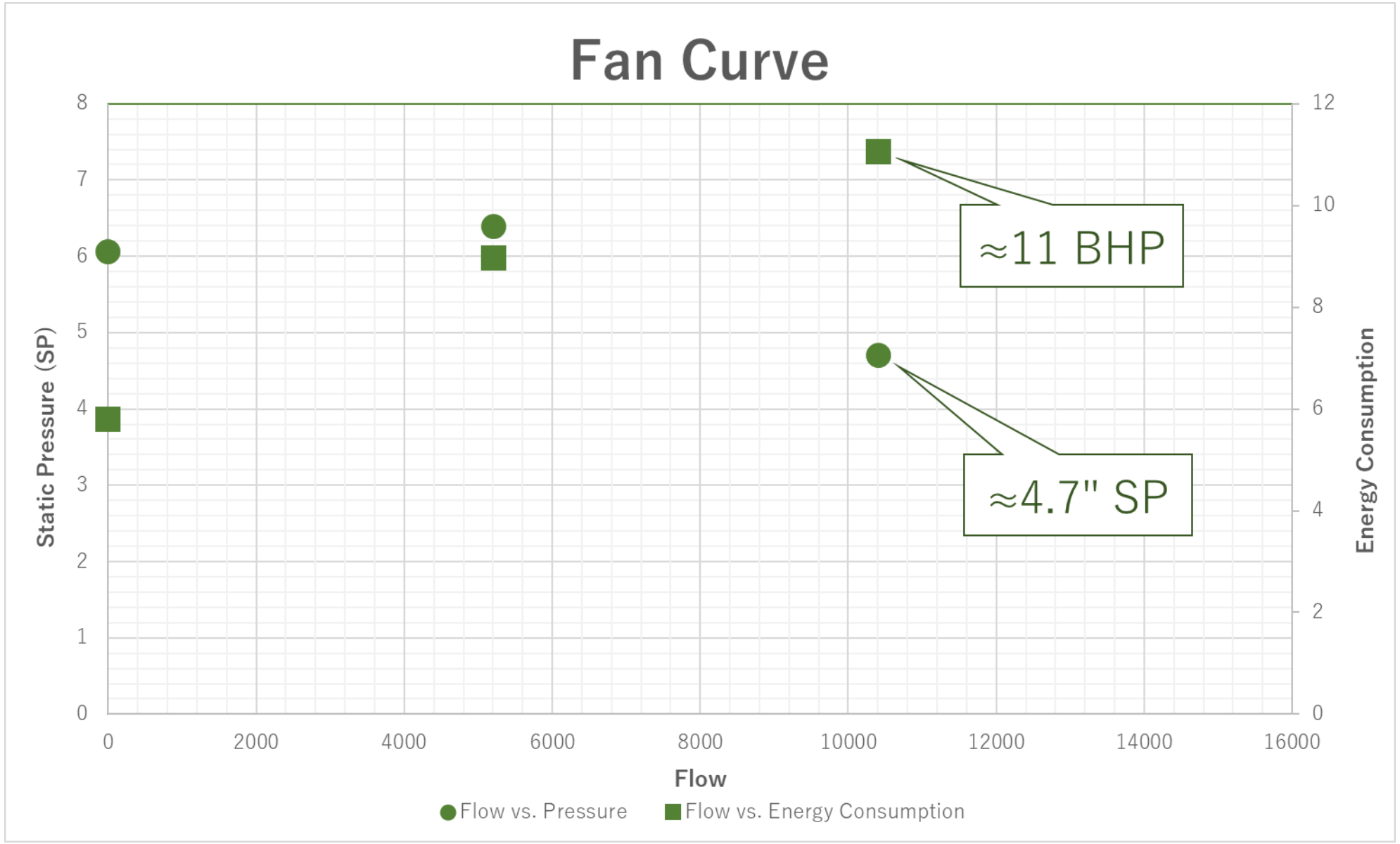


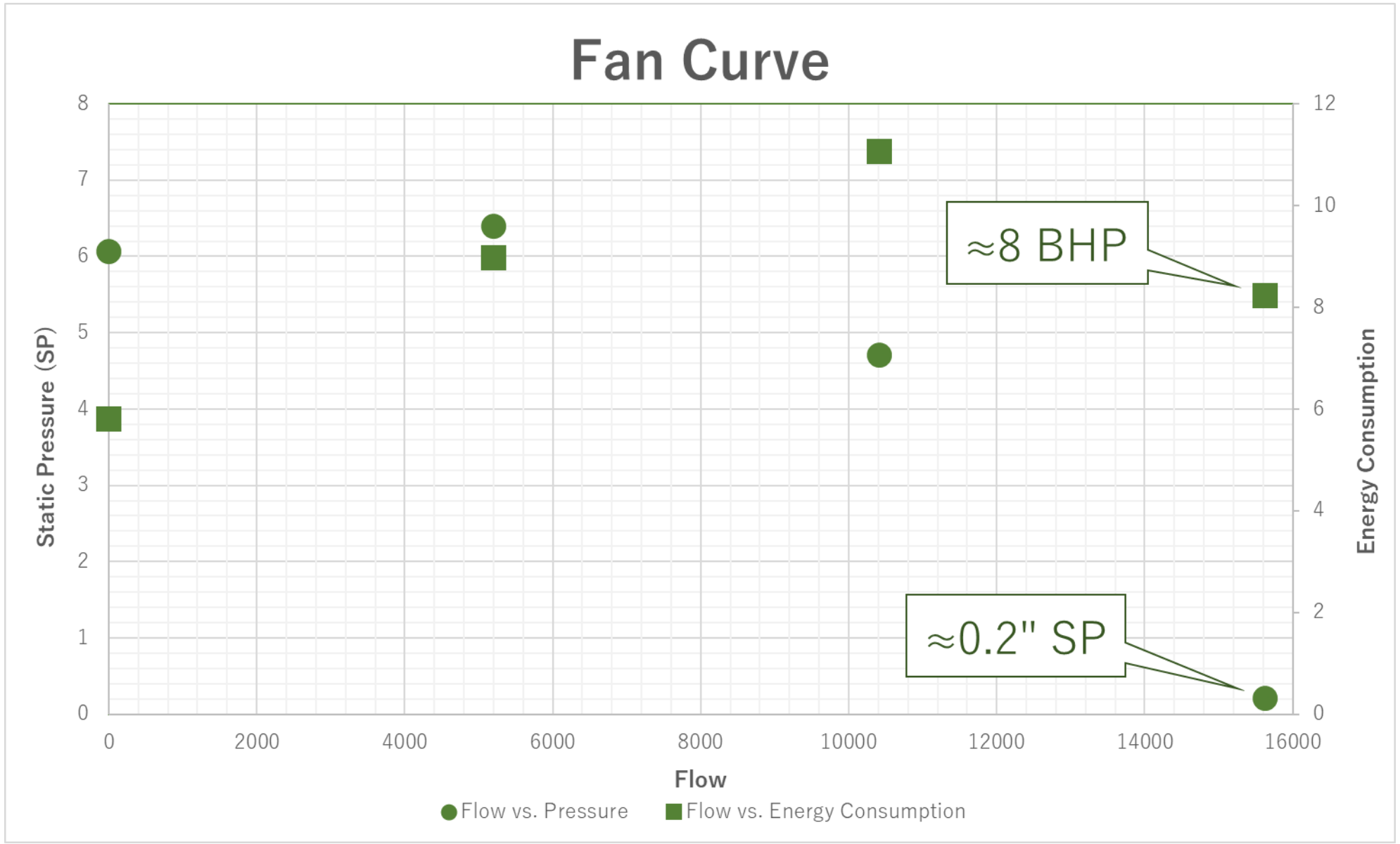
Generating Fan Curves

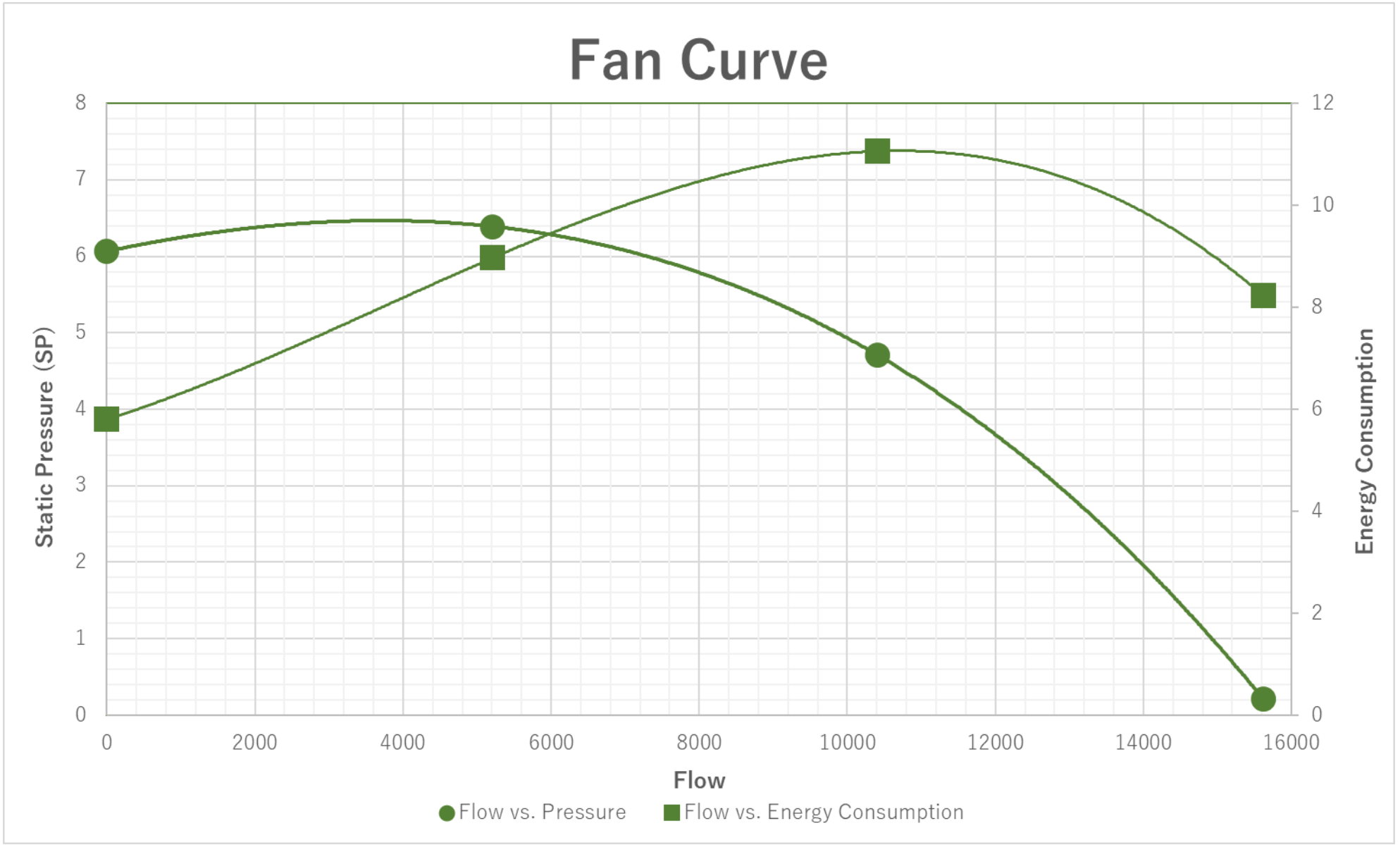

Fan Curve
Static Pressure (SP)
Energy Consumption
Flow
0
1
2
3
4
5
6
7
8
0
2
4
6
8
10
12
0
2000
4000
6000
8000
10000
12000
14000
16000
Flow vs. Pressure
Flow vs. Energy Consumption


Fan Curve
≈6" SP
≈6 BHP
Static Pressure (SP)
Energy Consumption
Flow
0
1
2
3
4
5
6
7
8
0
2
4
6
8
10
12
0
2000
4000
6000
8000
10000
12000
14000
16000
Flow vs. Pressure
Flow vs. Energy Consumption


Fan Curve
≈6.4" SP
≈9 BHP
Static Pressure (SP)
Energy Consumption
Flow
0
1
2
3
4
5
6
7
8
0
2
4
6
8
10
12
0
2000
4000
6000
8000
10000
12000
14000
16000
Flow vs. Pressure
Flow vs. Energy Consumption

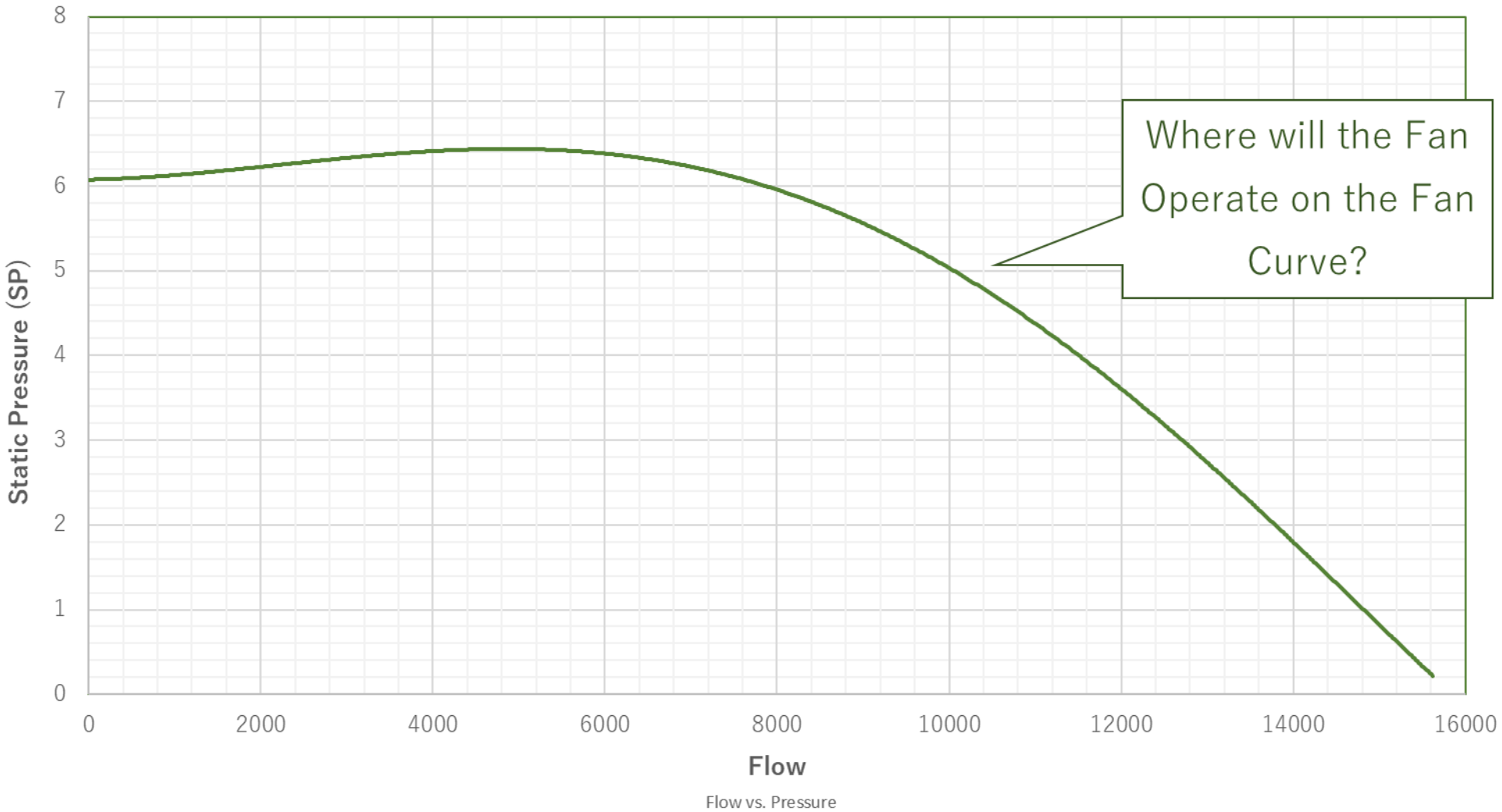

Fan Curve
Static Pressure (SP)
Energy Consumption
Flow
0
1
2
3
4
5
6
7
8
0
2
4
6
8
10
12
0
2000
4000
6000
8000
10000
12000
14000
16000
≈11 BHP
≈4.7" SP
Flow vs. Pressure
Flow vs. Energy Consumption


Fan Curve
Static Pressure (SP)
Energy Consumption
Flow
0
1
2
3
4
5
6
7
8
0
2
4
6
8
10
12
0
2000
4000
6000
8000
10000
12000
14000
16000
≈8 BHP
≈0.2" SP
Flow vs. Pressure
Flow vs. Energy Consumption

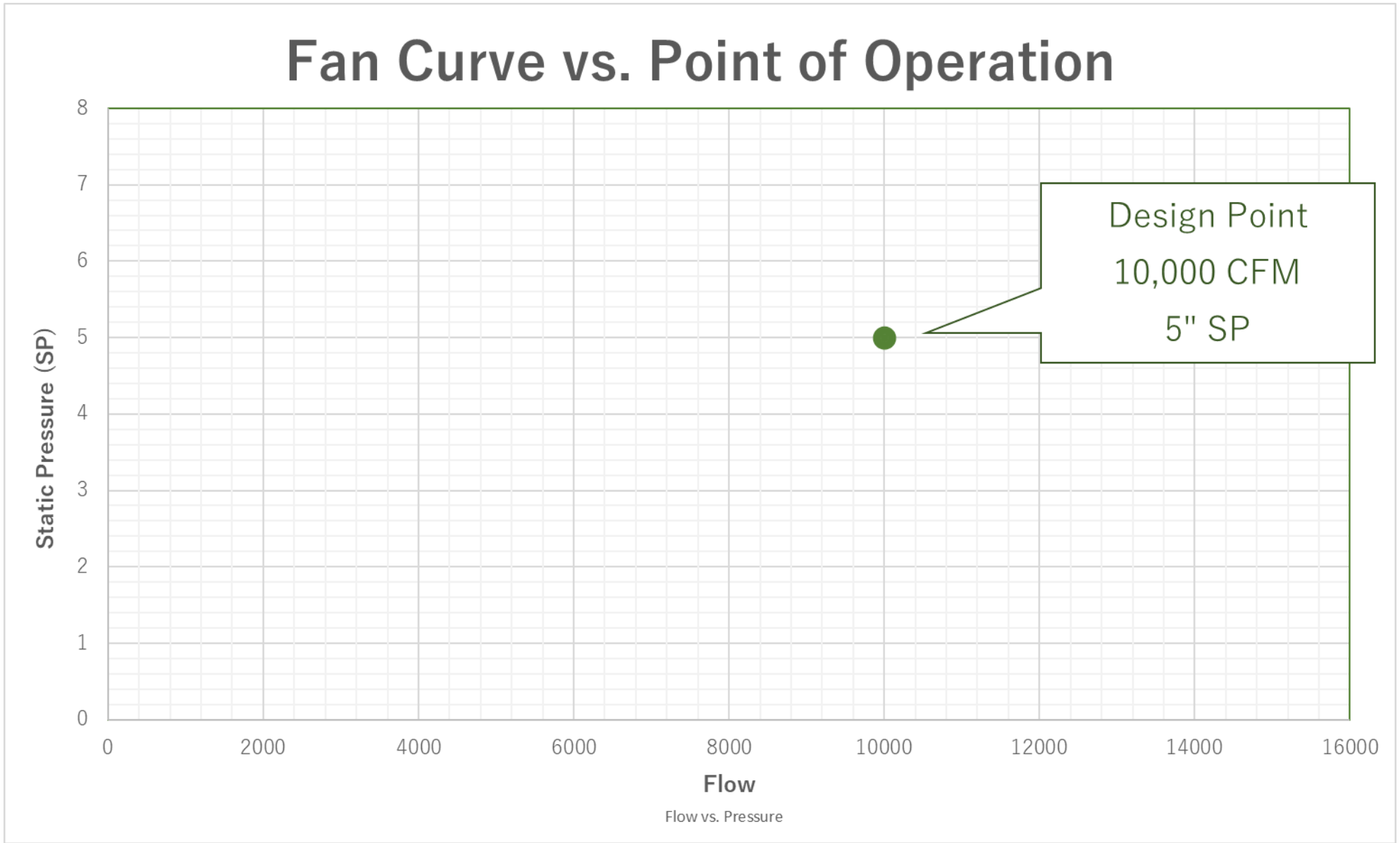

Fan Curve
Static Pressure (SP)
Energy Consumption
Flow
0
1
2
3
4
5
6
7
8
0
2
4
6
8
10
12
0
2000
4000
6000
8000
10000
12000
14000
16000
Flow vs. Pressure
Flow vs. Energy Consumption

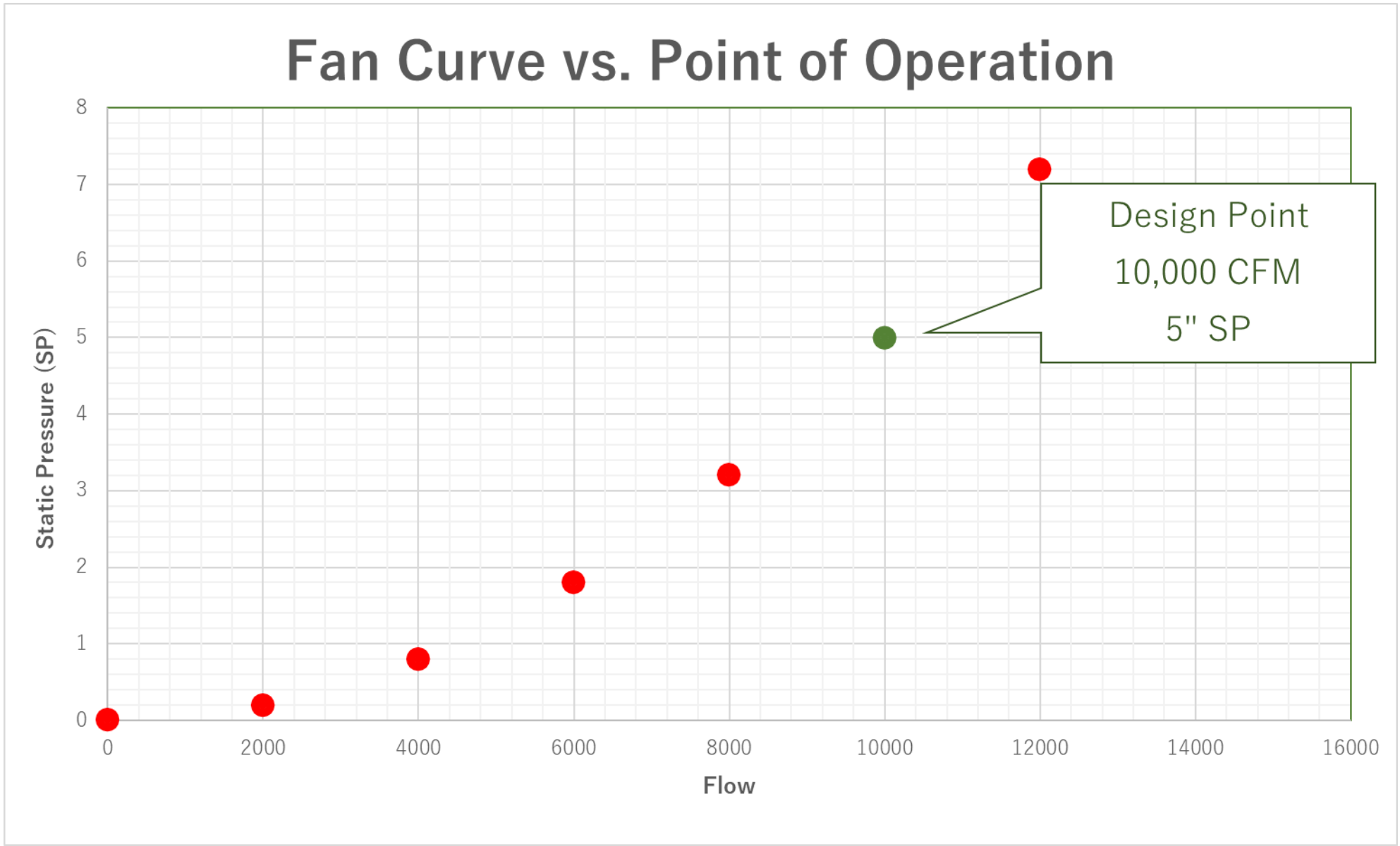
Fan Curves-Operating Point

Fan Curve vs. Point of Operation

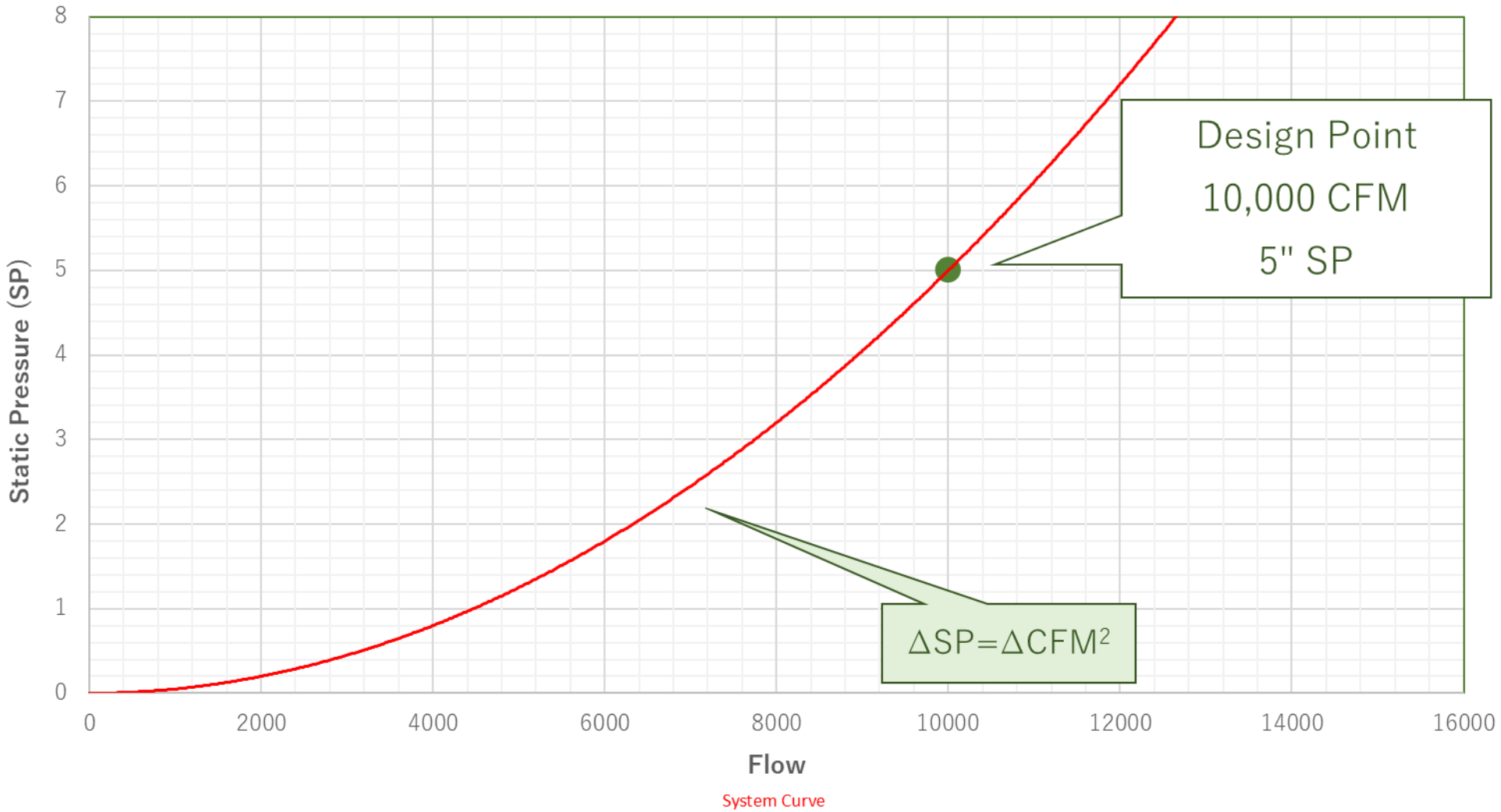


Fan Curve vs. Point of Operation

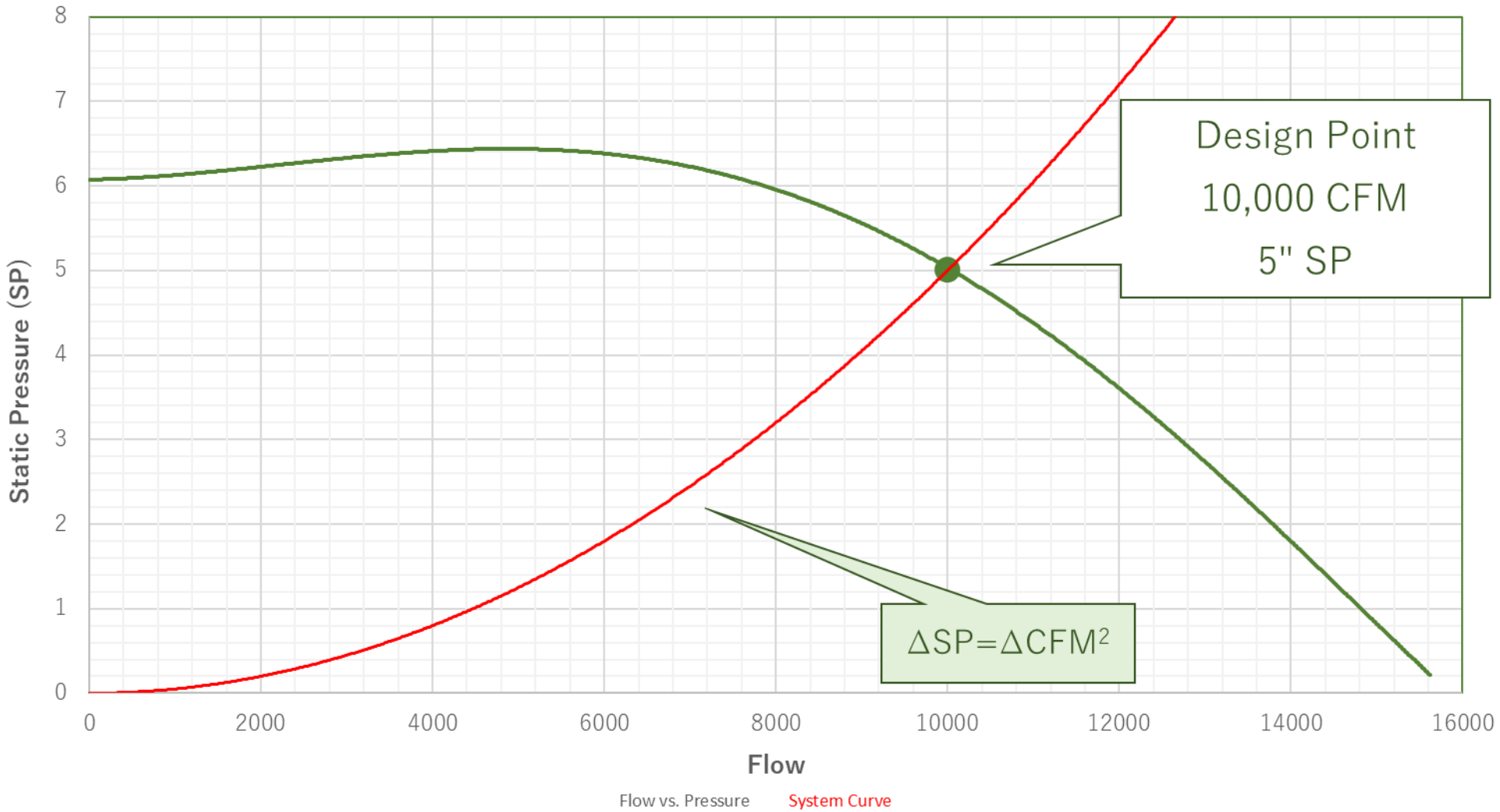



Fan Curve vs. Point of Operation
Static Pressure (SP)
0
1
2
3
4
5
6
7
8
0
2000
4000
6000
8000
10000
12000
14000
16000
Flow
Design Point
10,000 CFM
5" SP

Fan Curve vs. Point of Operation



Fan Curve vs. Point of Operation

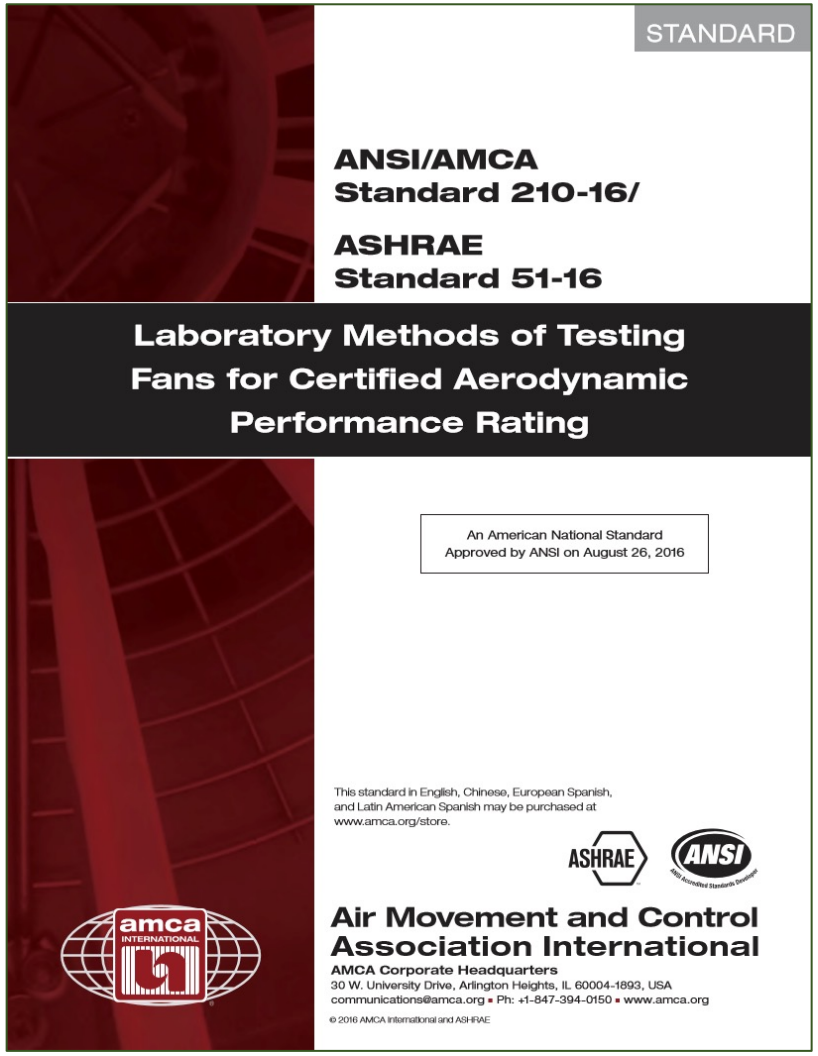


Testing and Rating

Testing and Rating:

Tested:

- In Accordance with AMCA Standard 210 (ASHRAE 51)



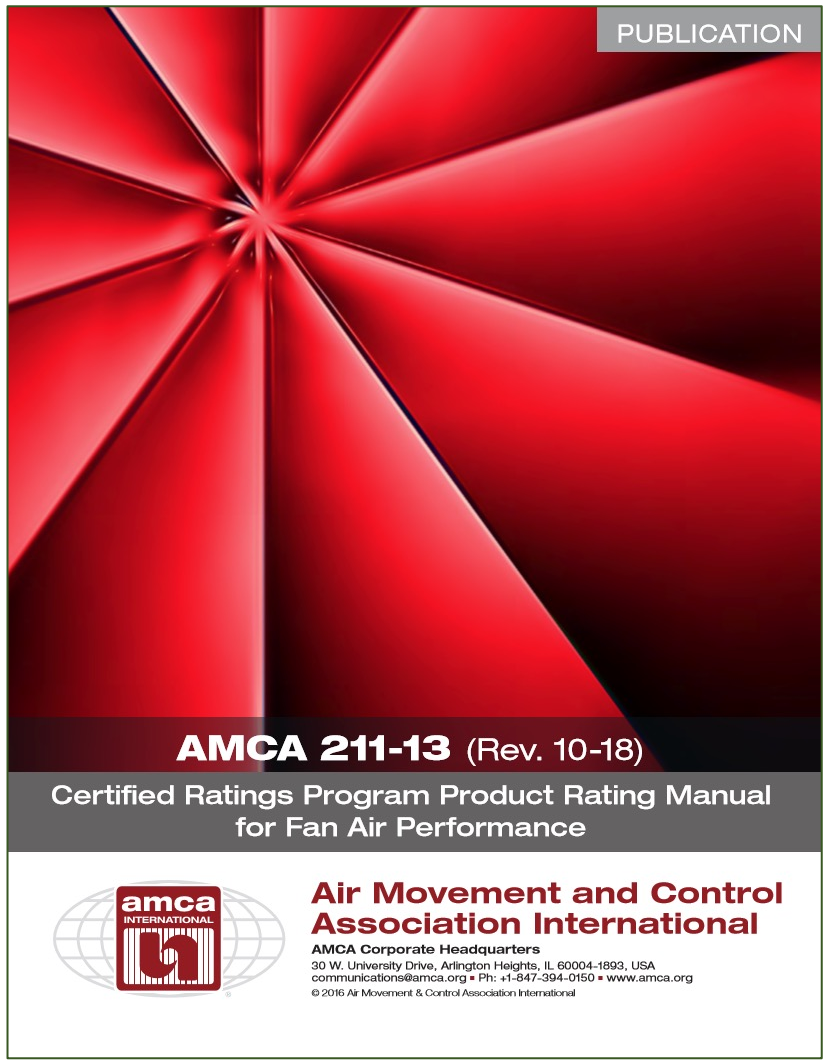
Testing and Rating:

Tested:

- In Accordance with AMCA Standard 210 (ASHRAE 51-07)

Rated:

- In Accordance with AMCA Publication 211

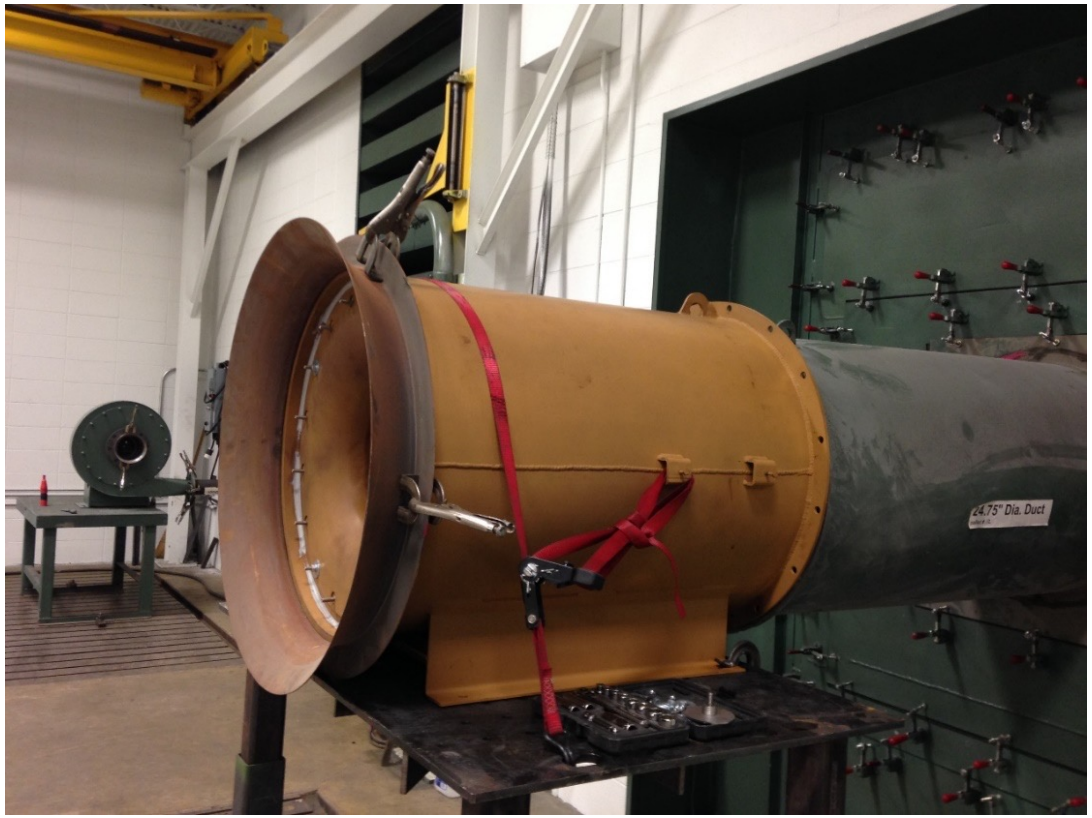


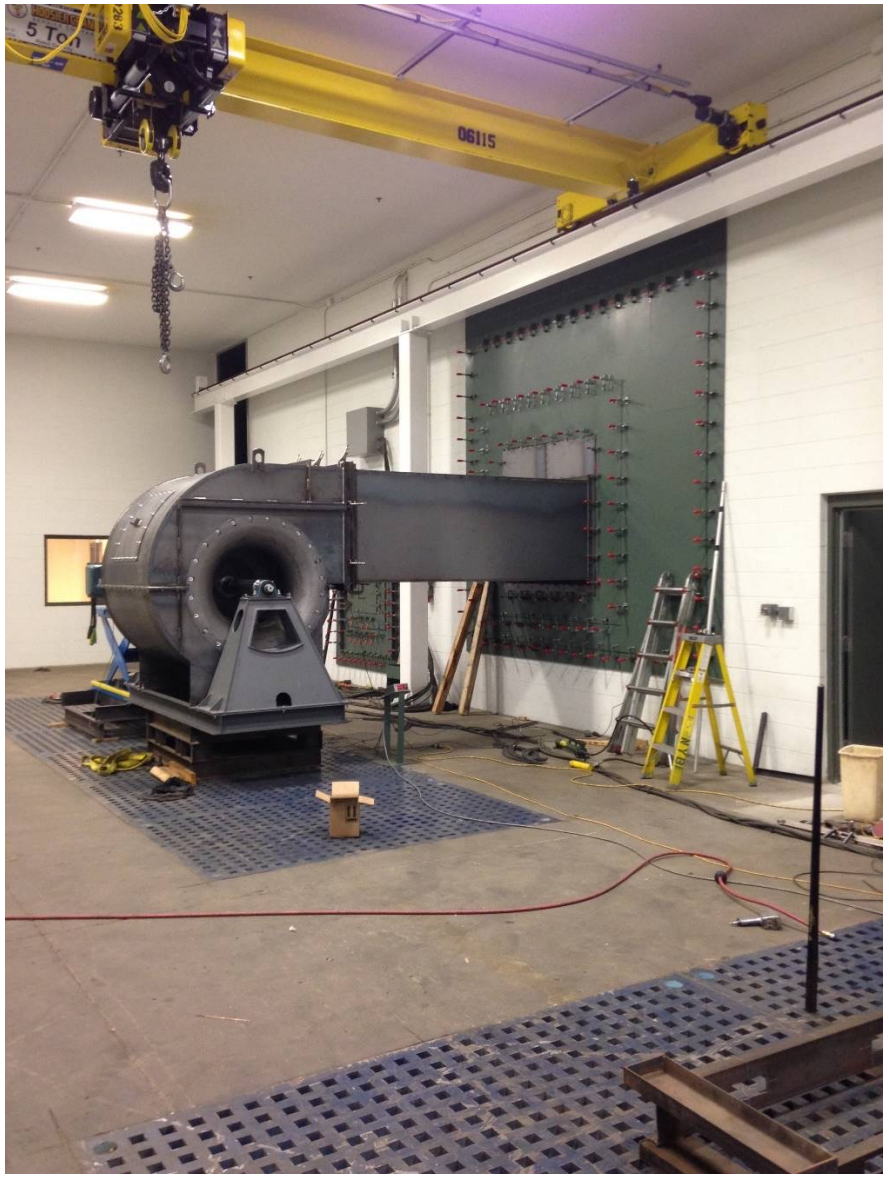
Testing and Rating:

Check Test (AMCA Standard 211):

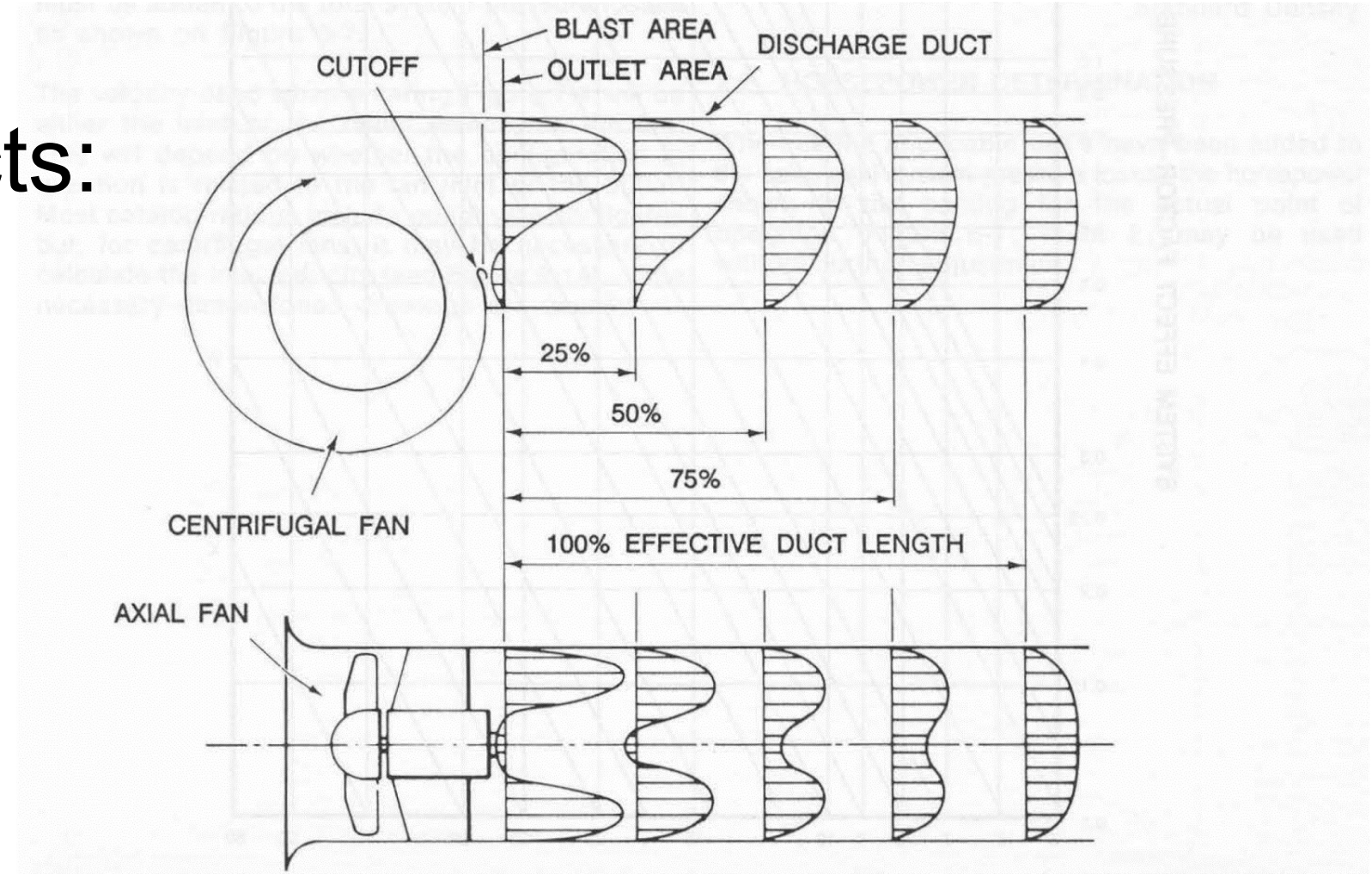
System Effects

System Effects:





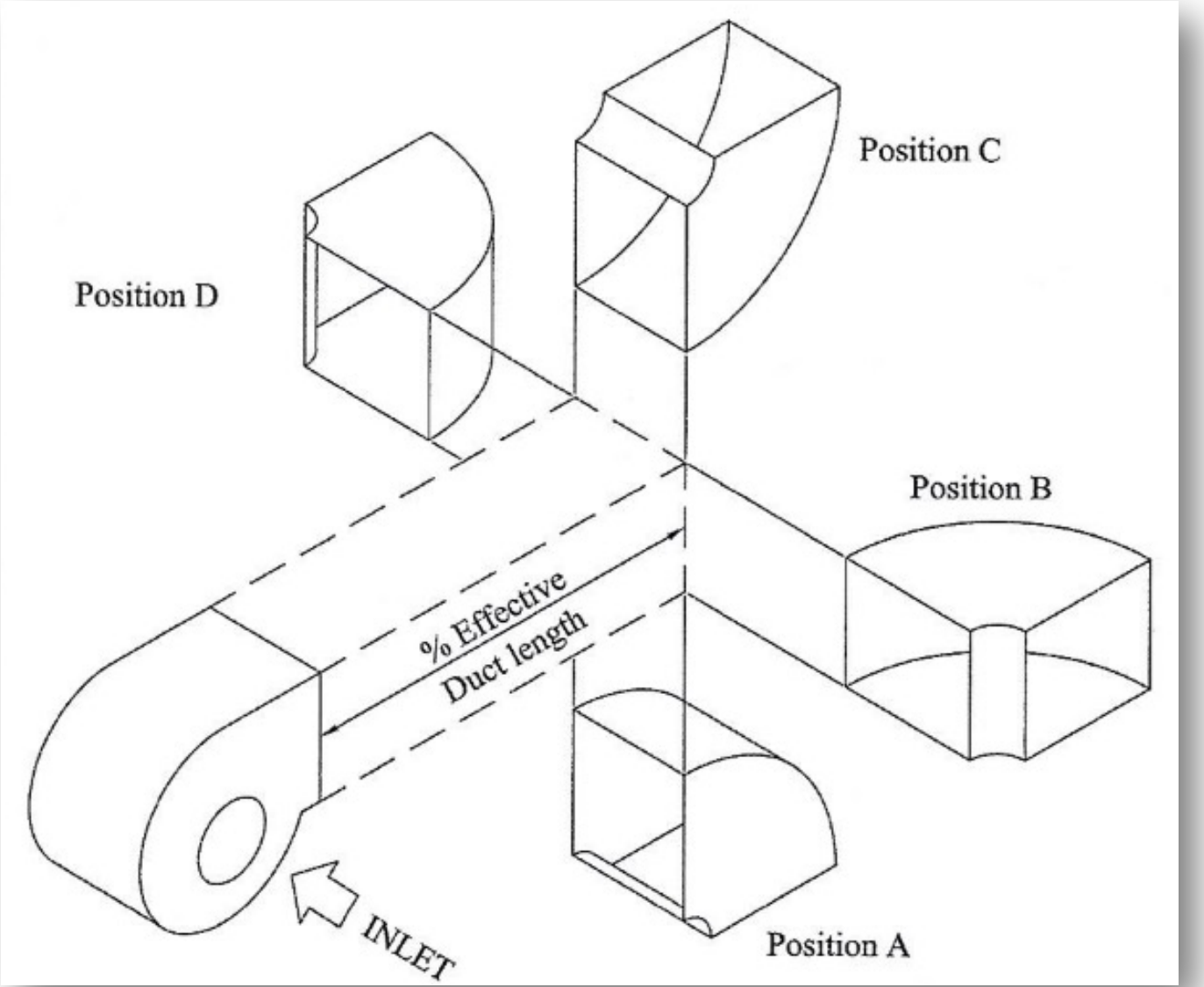
System Effects:



TO CALCULATE 100% EFFECTIVE DUCT LENGTH, ASSUME A MINIMUM OF 2-1/2 DUCT DIAMETERS FOR 2500 FPM OR LESS. ADD 1 DUCT DIAMETER FOR EACH ADDITIONAL 1000 FPM.

EXAMPLE: 5000 FPM = 5 EQUIVALENT DUCT DIAMETERS. IF THE DUCT IS RECTANGULAR WITH SIDE DIMENSIONS a AND b, THE EQUIVALENT DUCT DIAMETER IS EQUAL TO $(4ab/\pi)^{0.5}$

System Effects:



System Effects:

Turned Outlet Away From Neighbors to Reduce Nuisance Noise

- **Unfavorable conditions**:
  - Abrupt 90-degree elbow at inlet
  - Less than half of surface area of inlet seeing air
  - Outlet turned against the rotation of the area
- **Better solution**:
  - CW fan
  - TH discharge
  - Improve inlet condition (larger duct diameter, increased number or gores)

System Effects:

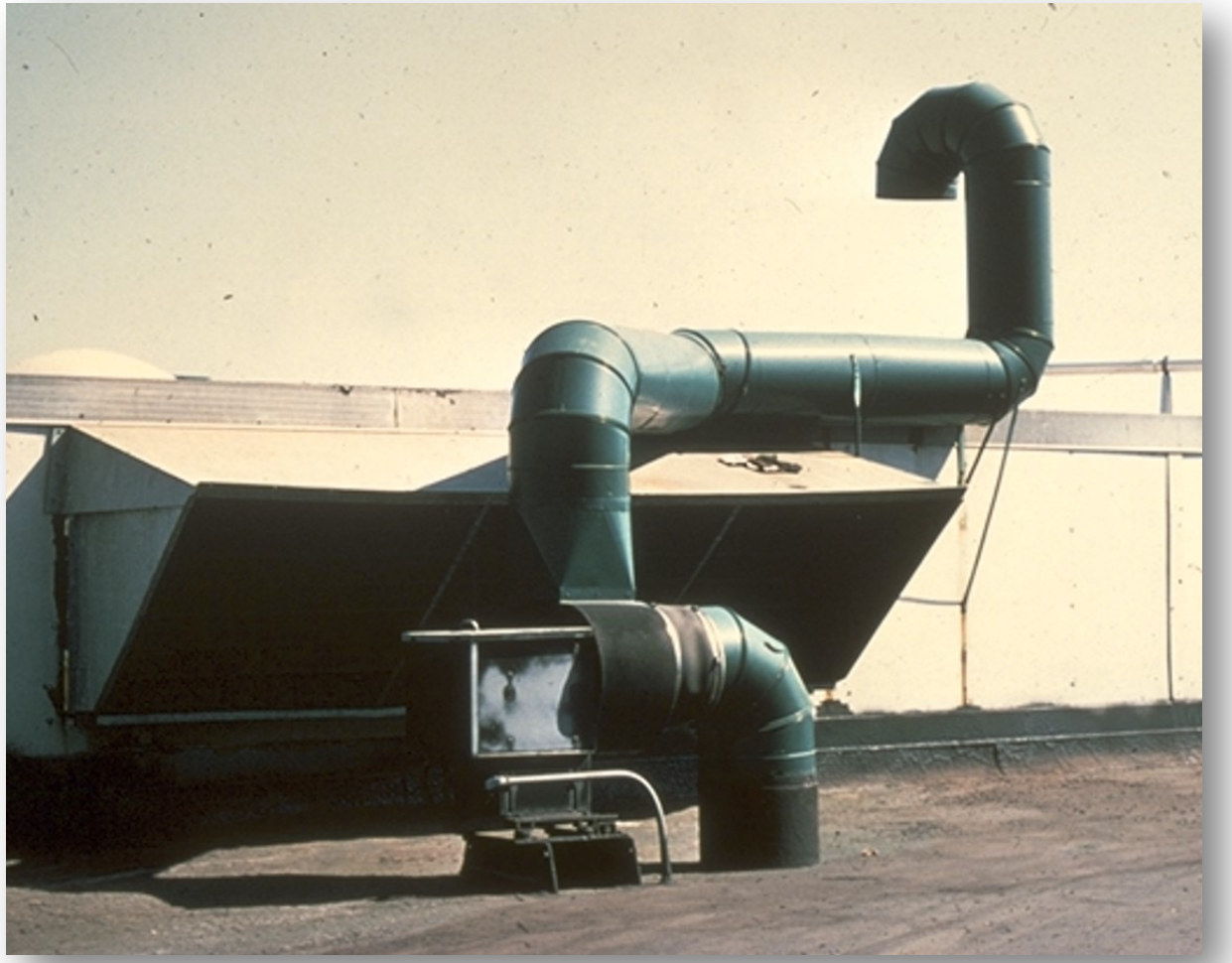
- **Unfavorable conditions**:
  - 90-degree turn directly at outlet
  - Air turned against rotation of fan
  - Rain cover acts as outlet damper directly at outlet of ductwork
- **Better solution**:
  - UB fan discharge
  - No-loss rain stack

System Effects:

- **Unfavorable conditions**:
  - Poorly designed inlet box
  - No outlet ductwork
  - No flexible connector on fan inlet
- **Better solution**:
  - Factory designed inlet box
  - Add for outlet duct
  - Add for a flexible inlet connector

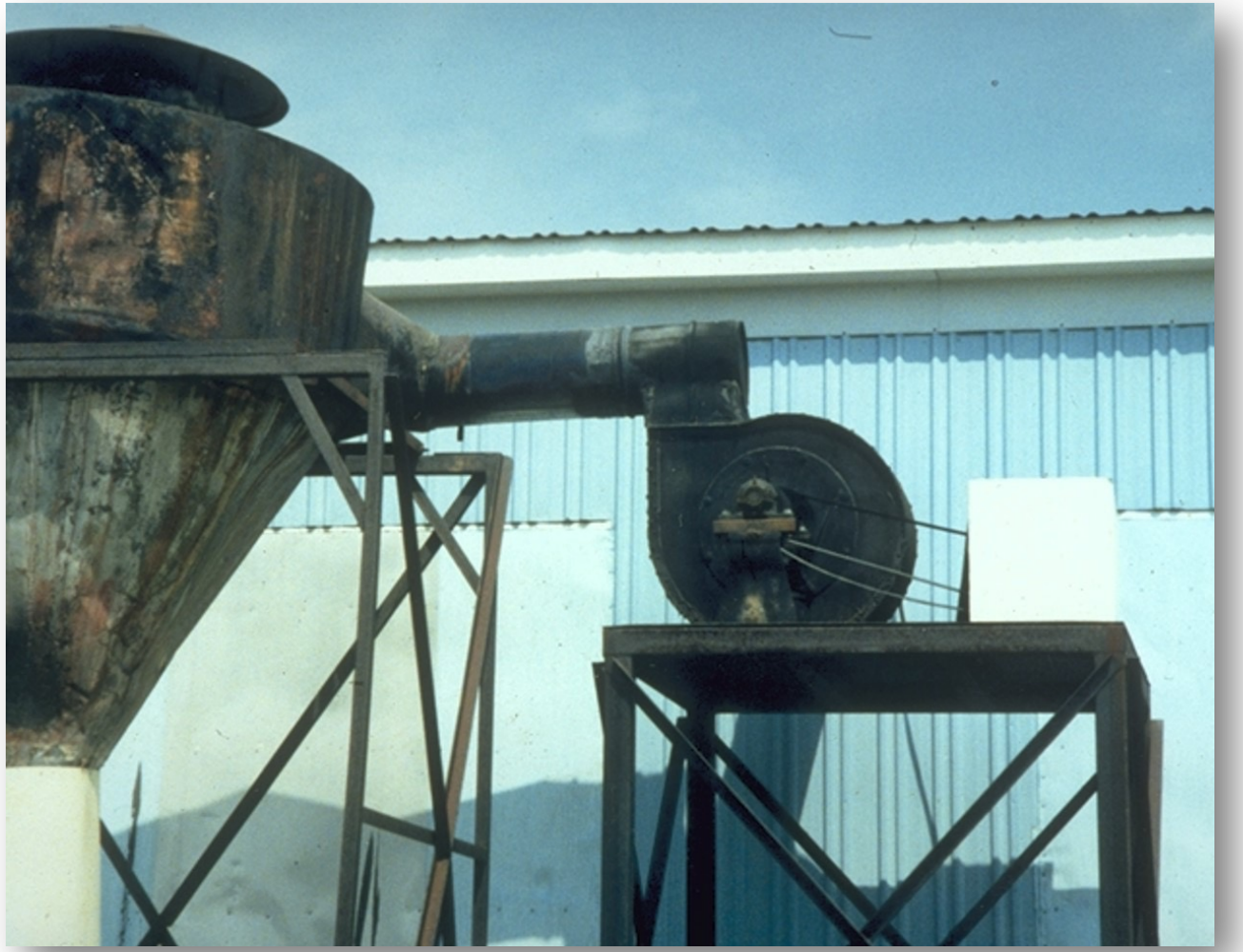
System Effects:

- **System Modification**
- **Unfavorable conditions**:
  - Exhaust air discharge moved to avoid fresh air intake
  - 90-degree elbow at inlet
  - Quick change of direction after fan outlet
- **Better solution**:
  - Transition with no-loss stack



System Effects:

- **Unfavorable conditions**:
  - Flimsy mezzanine doubles as flimsy unitary base
  - Fan deadheads into a 90-degree round elbow
- **Better solution**:
  - Change to CCW TH fan
  - Ensure mezzanine is stout and then mount fan on proper unitary base onto mezzanine



System Effects (not actually):

- Material Handling Fan
- Fan Operating Backwards

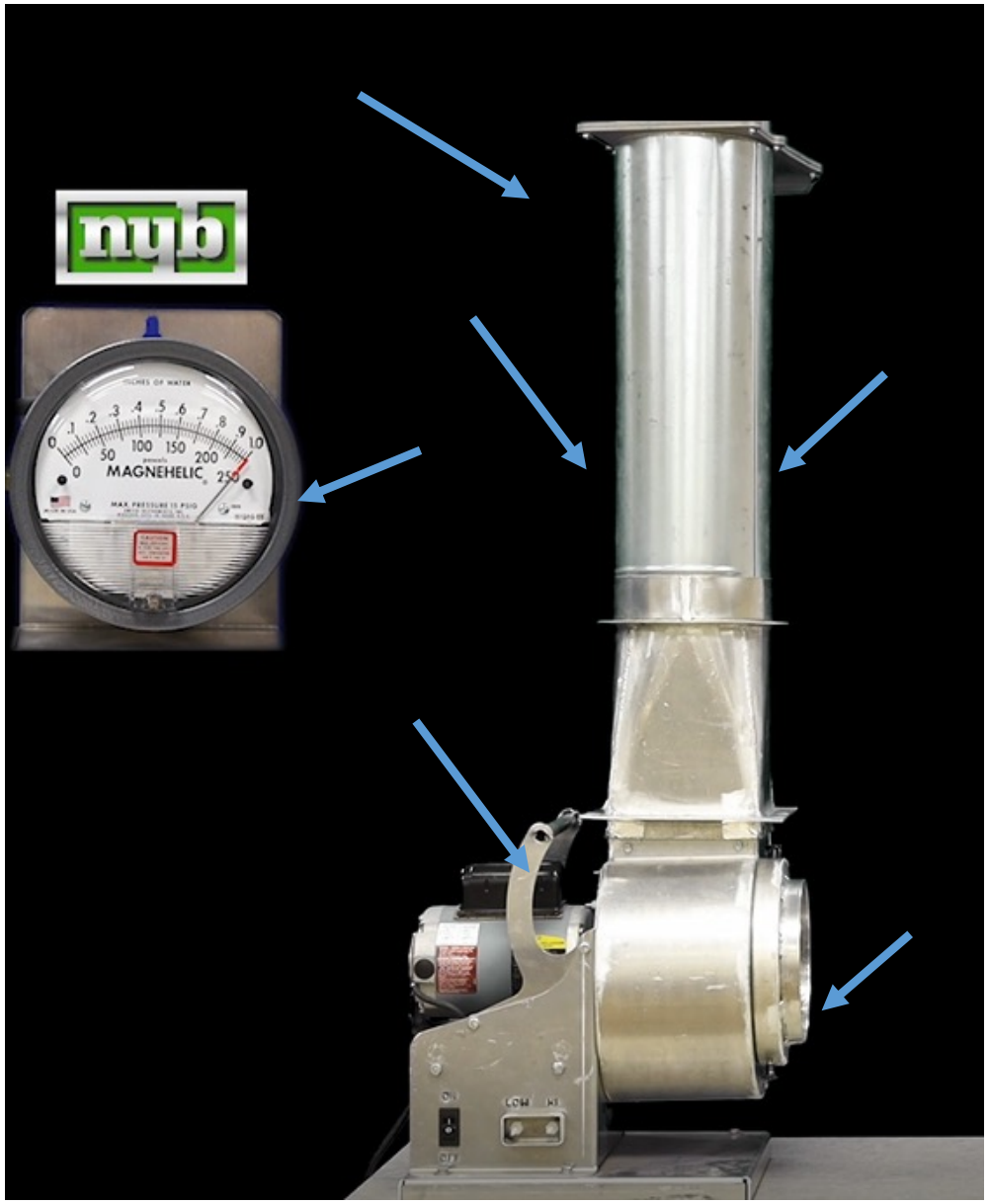
System Effects:

- Silencer at the fan inlet reduces transmitting of sound into factory
- Rectangular to round transition
- No loss rainhood

System Effect Demonstration

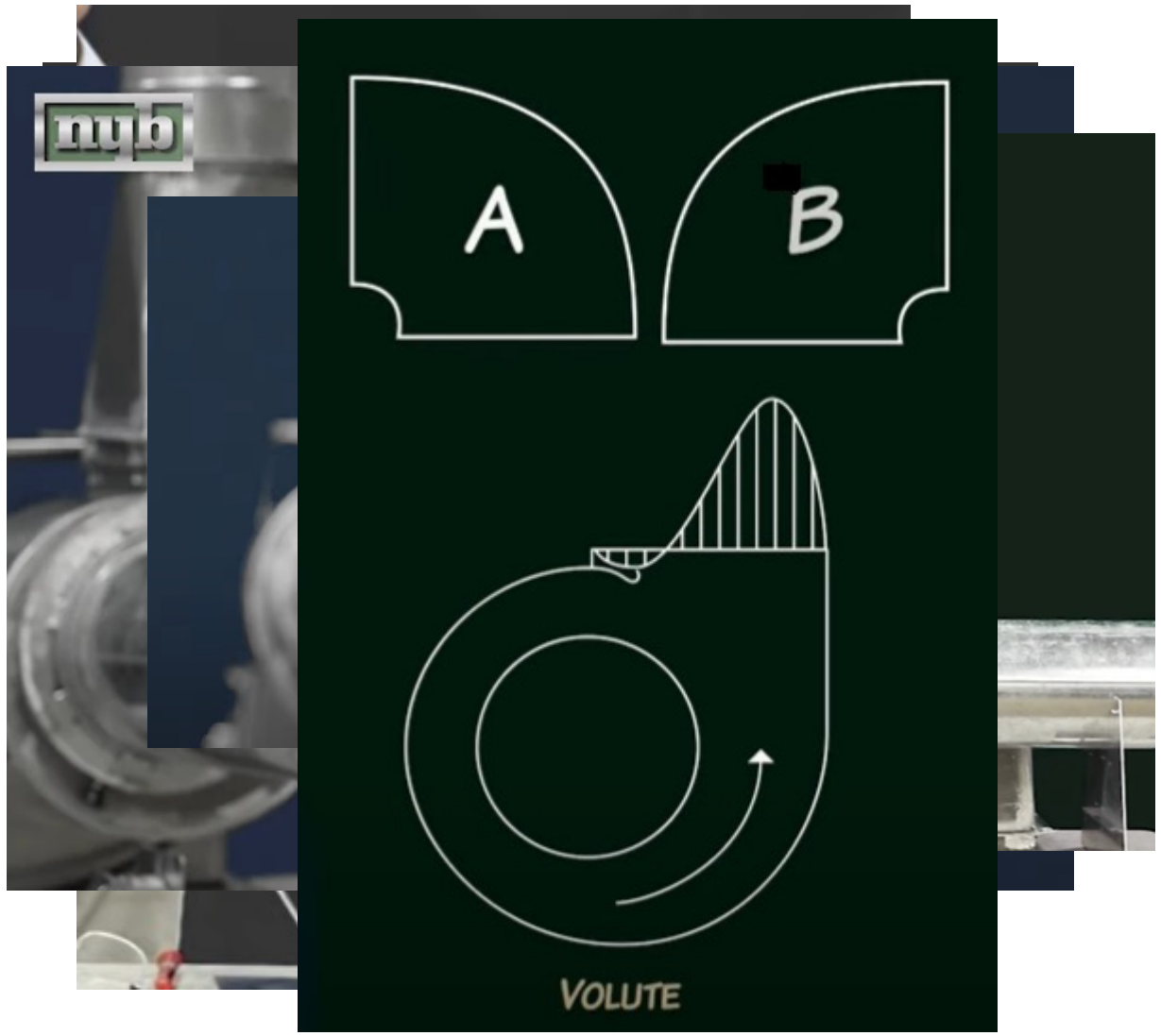
System Effects Video:

- Fan
- Open Inlet
- Ducted Outlet
- Pitot Tube (can’t see)
- Damper
- Magnehelic



Topics:

- 90˚ Elbow
- Corkscrews
- Inlet Boxes
- Straight Runs of Ductwork
- Discharge Ductwork (straight runs)
- Discharge Elbows



System Effect
90˚ Elbow

Review

Non-Vaned Elbows vs. Vaned Elbows

System Effect Corkscrews

Review

Corkscrews

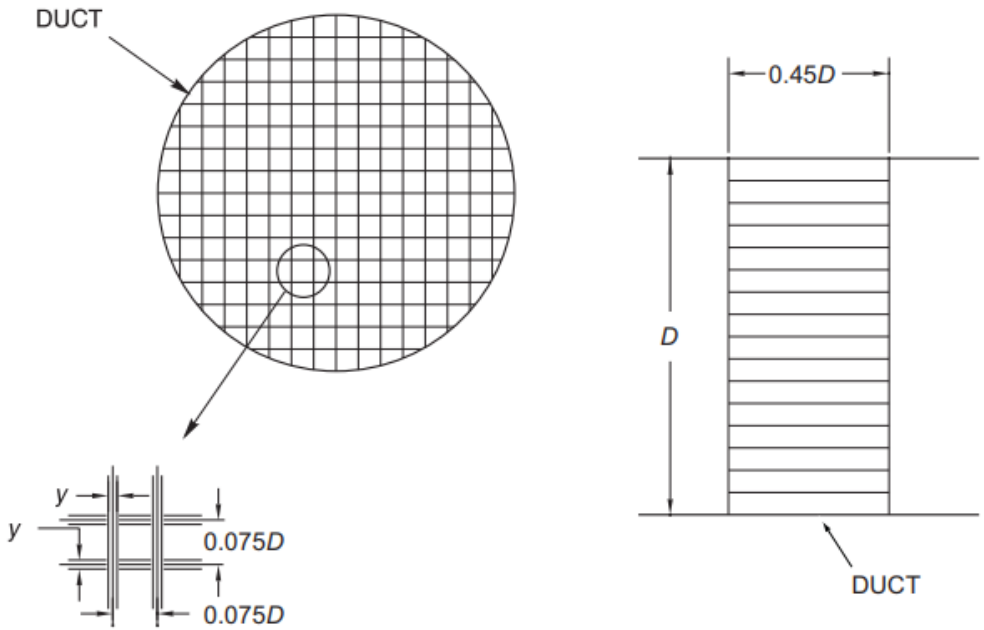


Figure 9.10A - ANSI/AMCA Standard 210 Egg-Crate Straightener

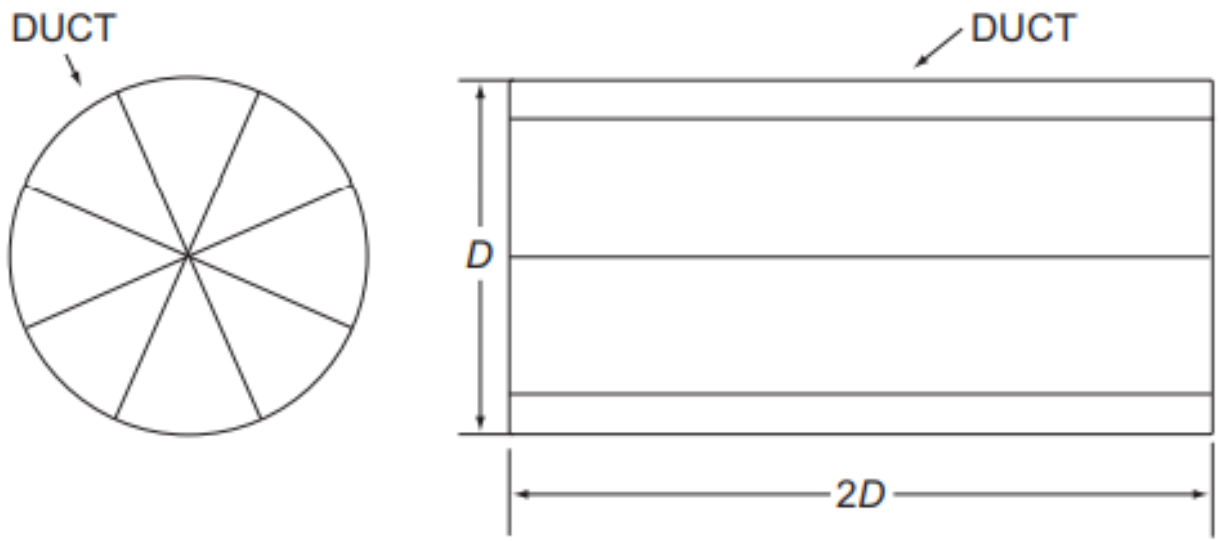
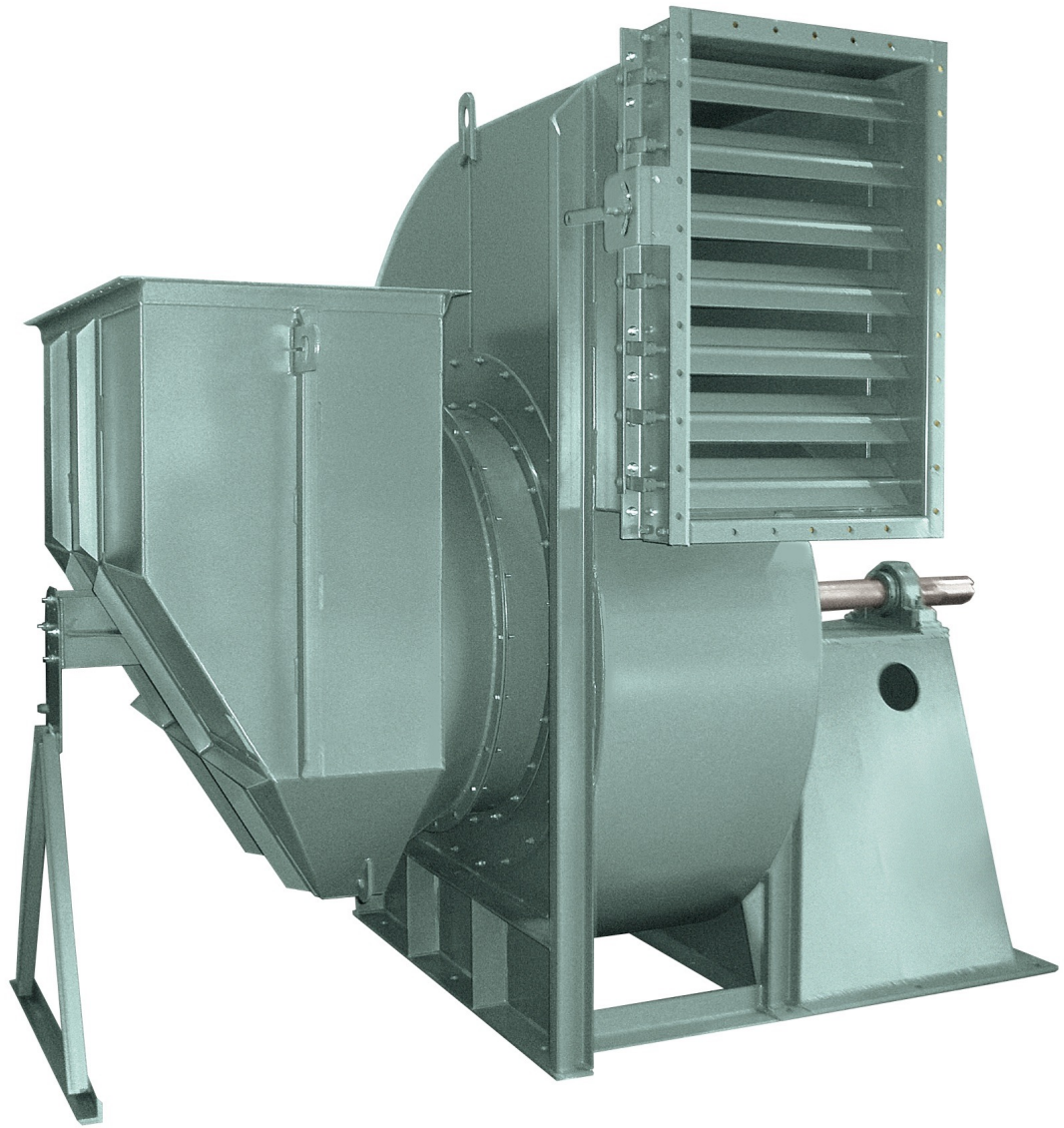


Figure 9.10B - ISO 5801 Star Straightener

System Effect Inlet Boxes

Review

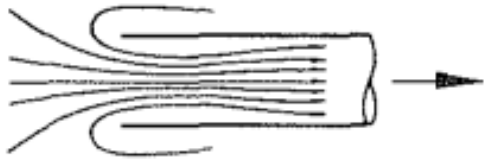
Inlet Boxes



System Effect
Straight Runs of Ductwork

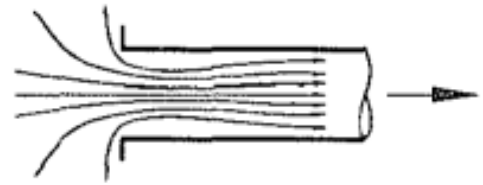
Review

Straight Runs of Ductwork



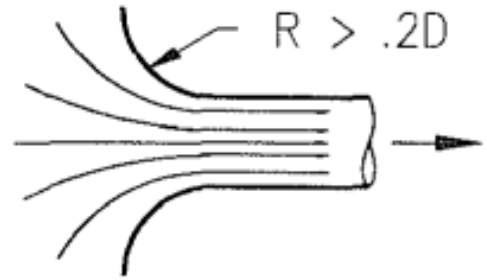
$h_e = 0.93\ VP_d$

PLAIN DUCT END



$h_e = 0.49\ VP_d$

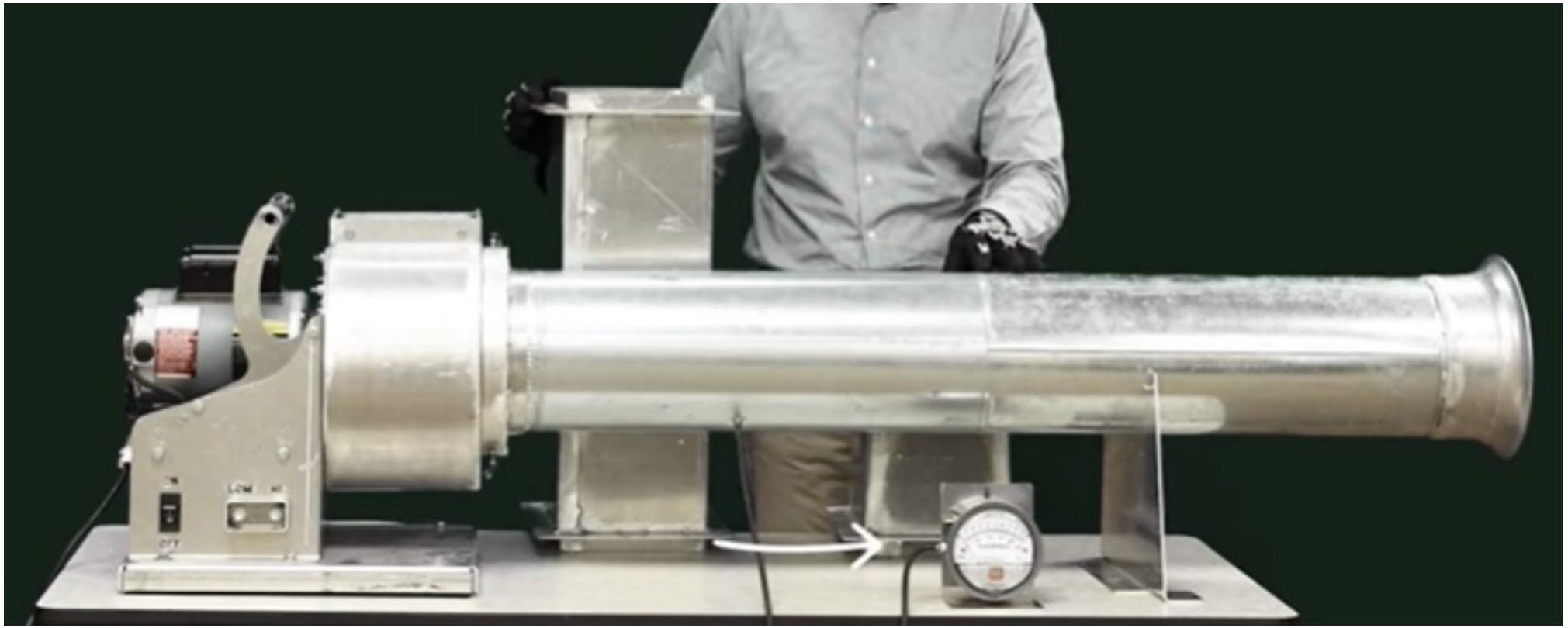
FLANGED DUCT END



$h_e = 0.04\ VP_d$

BELLMOUTH ENTRY

System Effects Video:

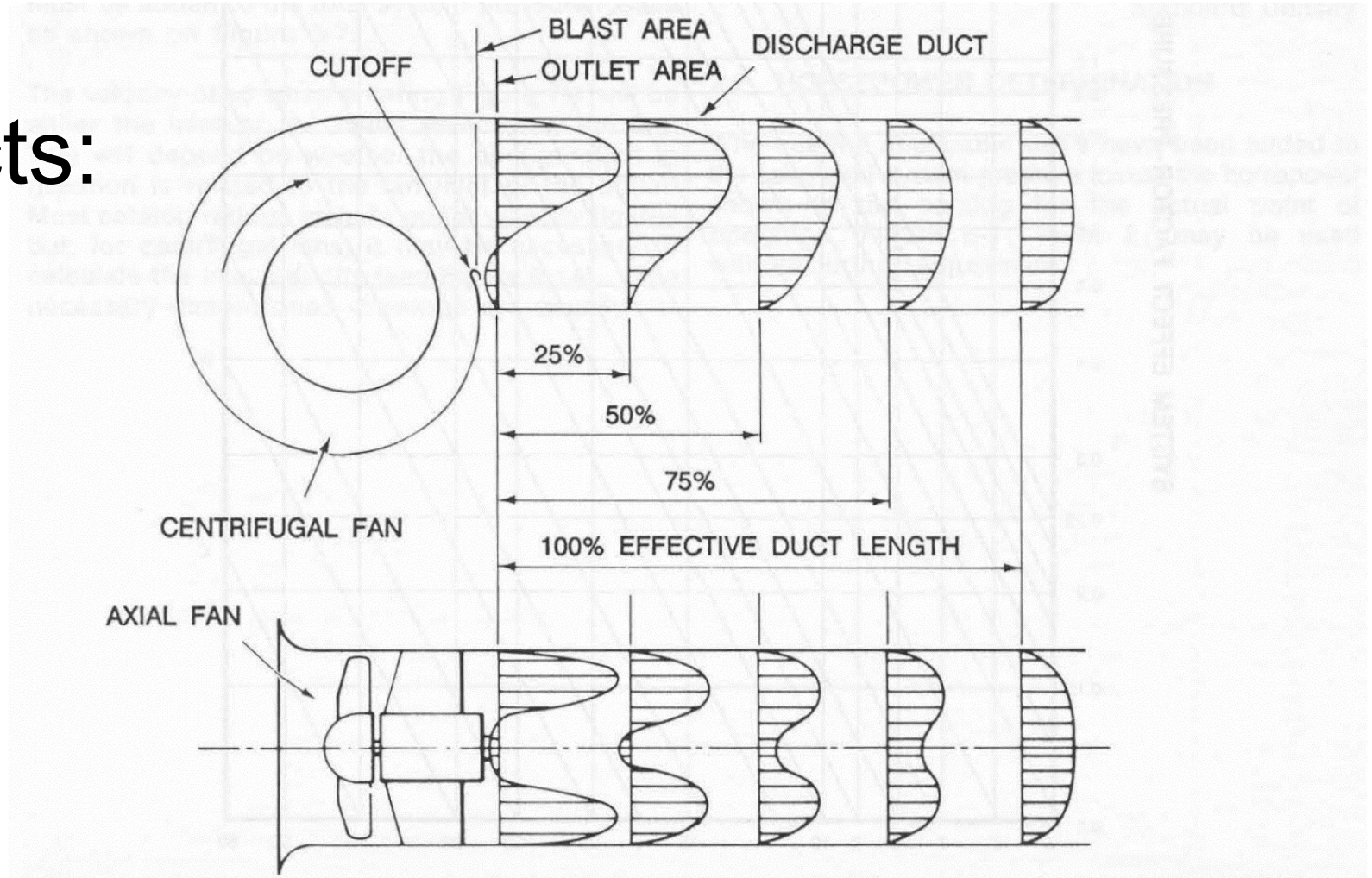


System Effect Discharge Duct

Review

Discharge Ductwork (straight runs)

System Effects:



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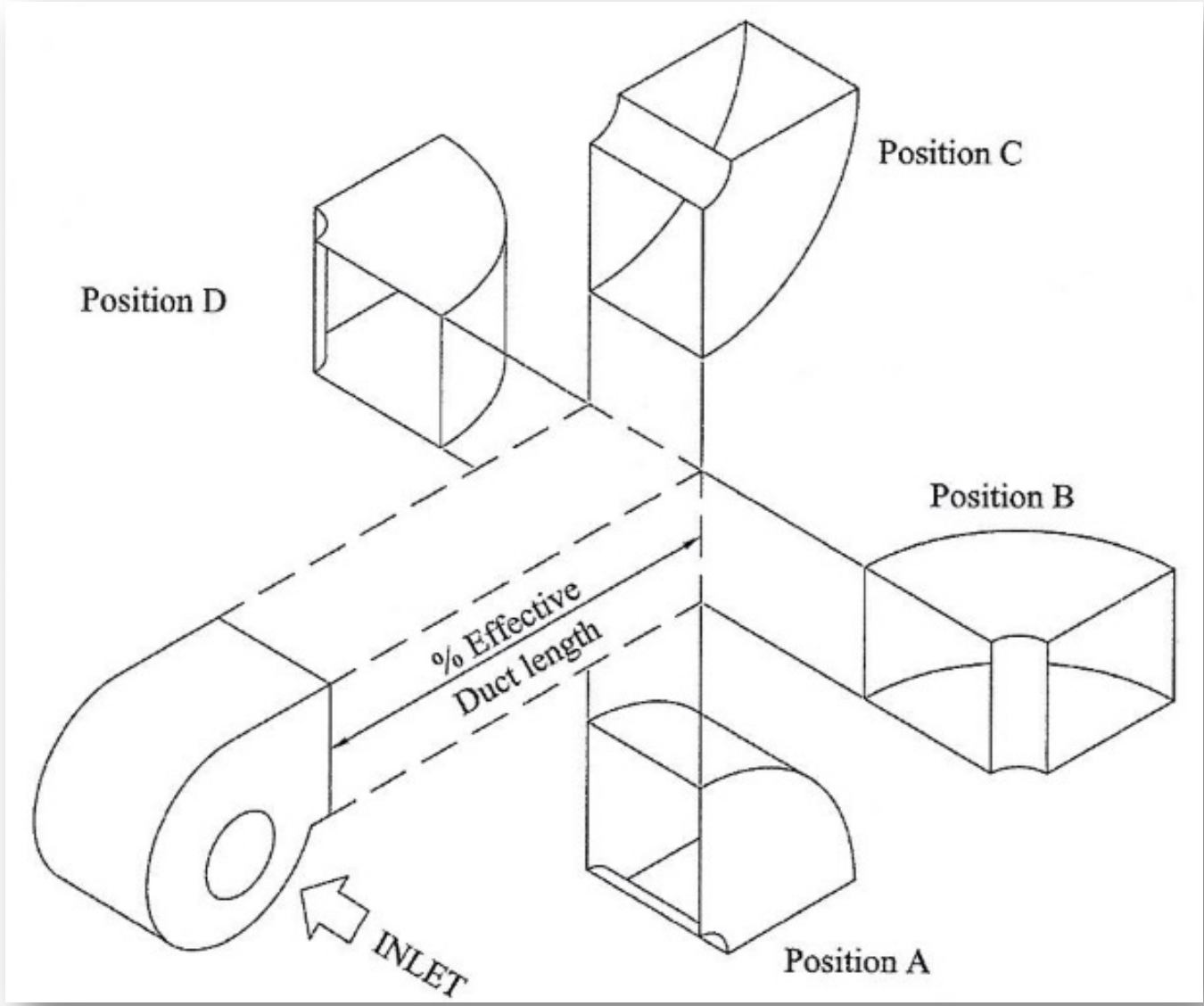
8289

System Effect Discharge Elbows

Review

Discharge Elbows


Position C
Position D
Position B
% Effective
Duct length
INLET
Position A

Fonts of System Information

26,000 CFM ≈ 1 ton/minute

4,000 ft/min ≈ 45 mph

Straight Duct vs. Curved Duct

(straight road vs. curvy roads)

1 BHP Costs ≈ $600-$800/year

Resources

- **AMCA International**: *www.amca.org*
- **AMCA Publication 201:** *www.amca.org/store*
  - Fans and Systems (available for purchase)
- **ANSI/AMCA Standard 210 / ASHRAE 51-16**: *www.amca.org/store*
  - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating (available for purchase)
- **AMCA Publications**: *www.amca.org/store*
  - **211-13:** Certified Ratings Program — Product Rating Manual for Fan Air Performance (Free PDF download available)
- **AMCA Presentations:** *AMCA Fan System test module demonstration - AMCA International (wistia.com)*
  - **System Effect** – A brief explanatory video outlining the system effect phenomena

Resources

- **Nyb Videos**:
  - *The New York Blower Company – YouTube*
- **Nyb Engineering Letters:**
  - *Engineering Letters for Industrial Fans | New York Blower*
- **Fan Fundamentals:**
  - *New to Fans? Start Here. | New York Blower Company (nyb.com)*
- **Fan Selection Software:**
  - *New York Blower - Fan-to-Size On the Web*

Final Questions?

To receive PDH credit, you must complete the post-course evaluation