Fan Troubleshooting and System Effects

AMCA & O'Dell Associates Education Series | Session 6 | November 23, 2021

Lisa Cherney

Education Manager, AMCA International

Webinar Moderator

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

Introductions & Guidelines

- Participation Guidelines:
  - Audience will be muted during the session.
  - Questions can be submitted anytime via the Airmeet platform and will be addressed at the end of the presentation.
  - Reminder: This session is being recorded!
  - To earn PDH credit for today, please stay clicked onto the platform for the entire hour.
  - A post-program survey will be emailed to everyone within one hour of the conclusion. Your feedback is greatly appreciated, and the survey must be completed to qualify for today's PDH credit.

Q & A

To submit questions:

- From the interactive panel on the right side of the screen, select the "Q&A" option at the top.
- Type your question in the box and click "Send".
- Remember: All attendees can see all questions submitted.
- If you would like to verbally ask your question, please click the "Raised Hand" icon at the bottom of your screen.

- Questions will be answered at various points during the presentation.

AMCA International has met the standards and requirements of the Registered Continuing Education Program. Credit earned on completion of this program will be reported to RCEP at RCEP.net. A certificate of completion will be issued to each participant. As such, it does not include content that may be deemed or construed to be an approval or endorsement by the RCEP.

Attendance for the entire presentation AND a completed evaluation are required for PDH credit to be issued.

ENGINEERING
RCEP
REGISTERED CONTINUING EDUCATION PROGRAM

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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.

- Questions
  - Presentation is Broken Down Into Segments
  - Please Ask

- Special quiz question- will be asked at the end. Correct answers win a NYB & AMCA prize!
  - ➢ Which of the demonstrated systems is one of true system effect, and not a fan system effect?

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)

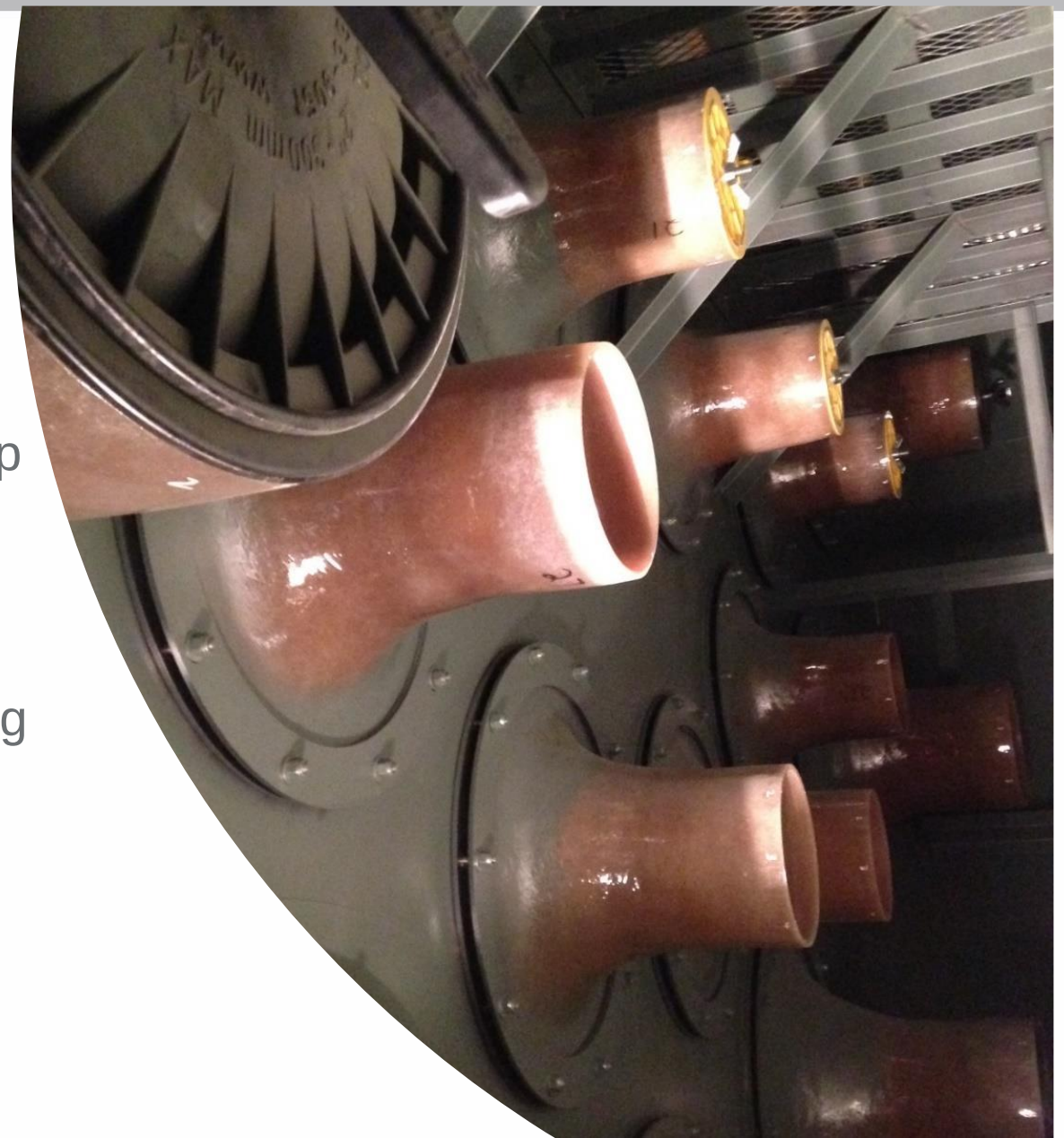
- On the other side of the bulkhead, lies the test chamber.
- The exhaust fan is used to overcome the resistance within the chamber and allow for a complete curve to be generated from closed off to wide open.

Test Lab:

AMCA Accredited Test Lab

(Test Chamber – continue)

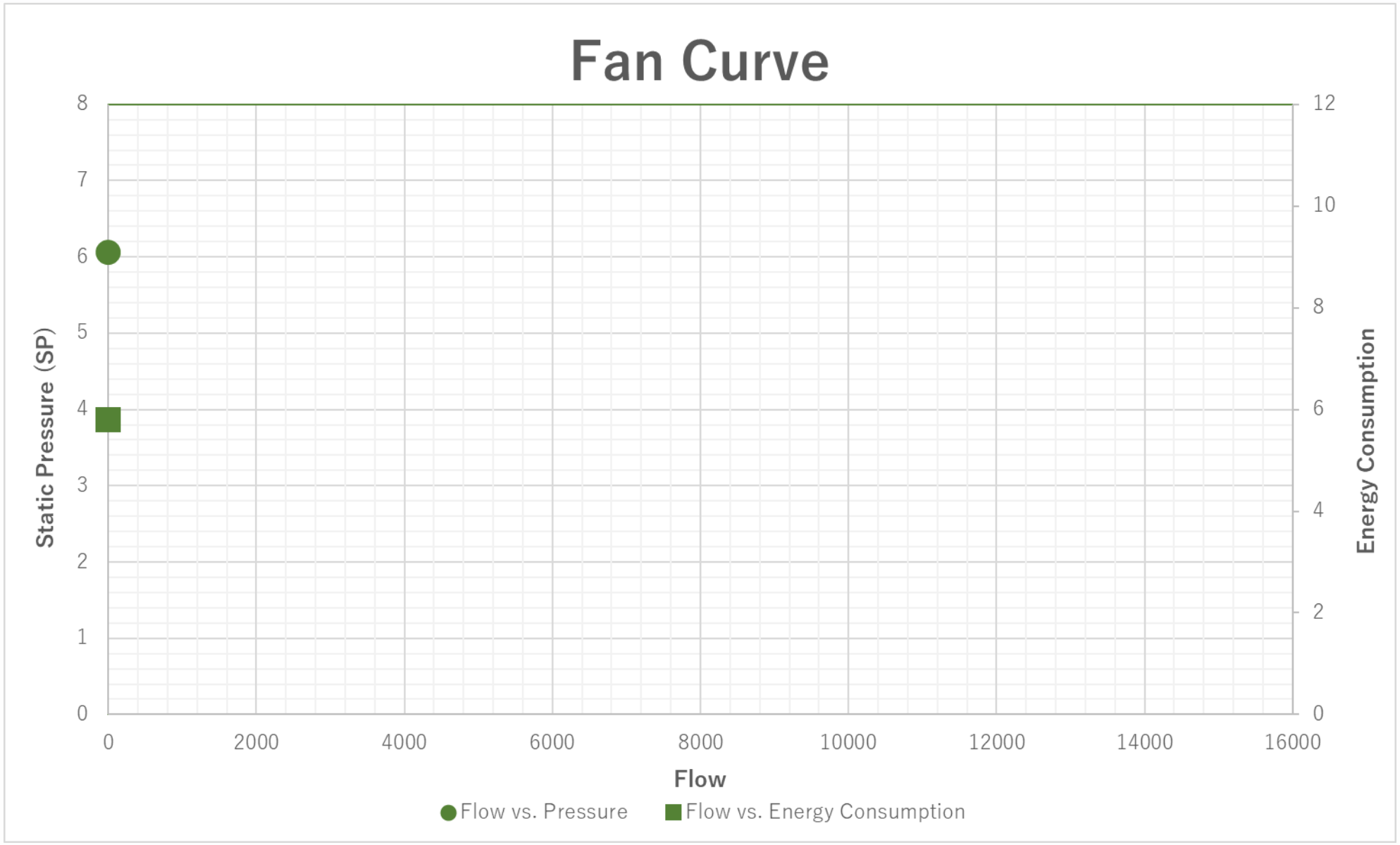
- Nozzles within the chamber are opened up or left closed depending on the air flow capabilities of the fan.
- Enough nozzles are opened to handle the theoretical wide-open flow for the fan being tested.
- Some nozzles will have to be closed to accommodate lower flow conditions being tested



Questions?

Fan Terms & How Fans are Tested

Generating Fan Curves


Fan Curve
Static Pressure (SP)
Energy Consumption
Flow
0
1
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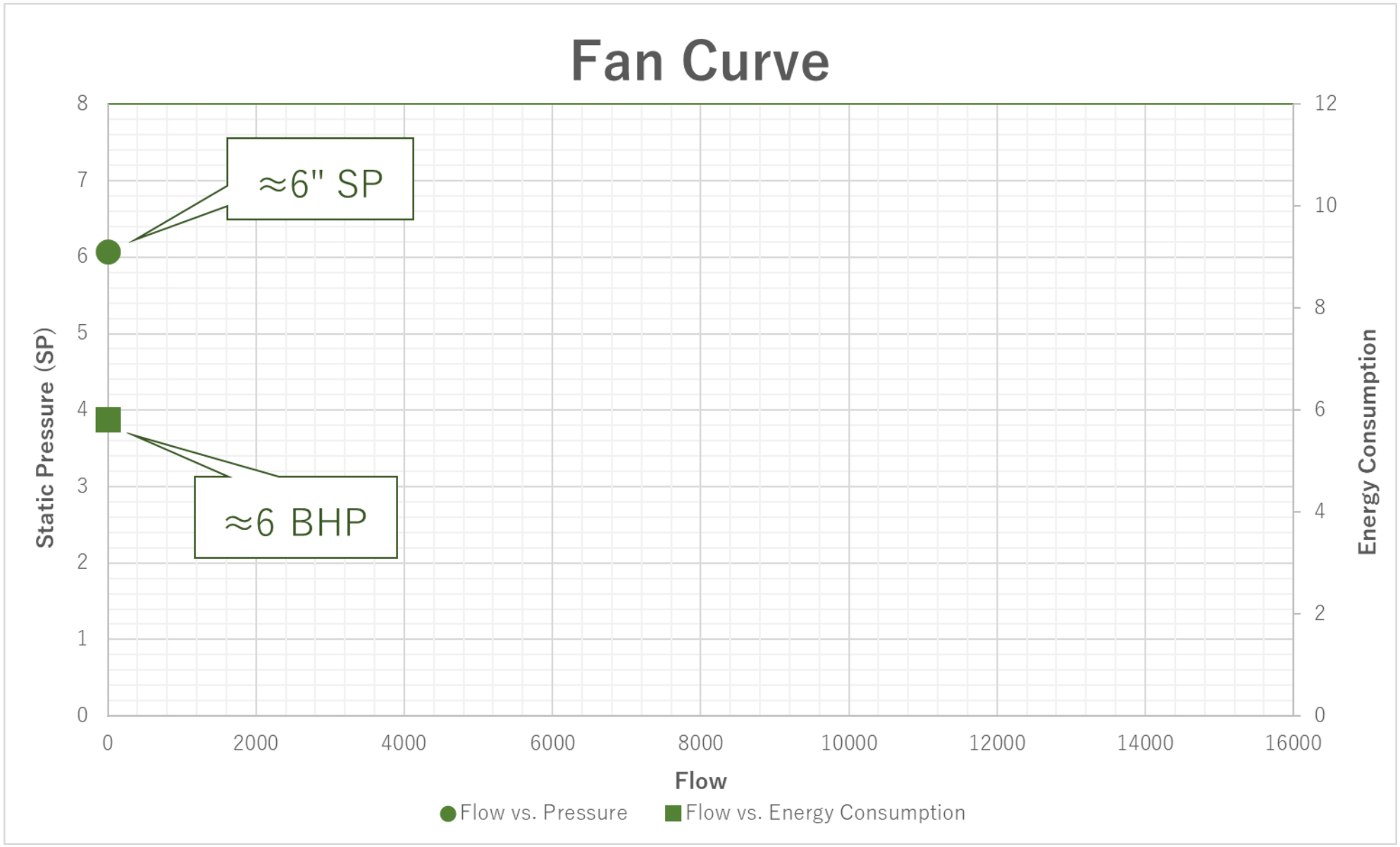
Flow vs. Pressure
Flow vs. Energy Consumption


Fan Curve
≈6" SP
≈6 BHP
Static Pressure (SP)
Energy Consumption
Flow
0
1
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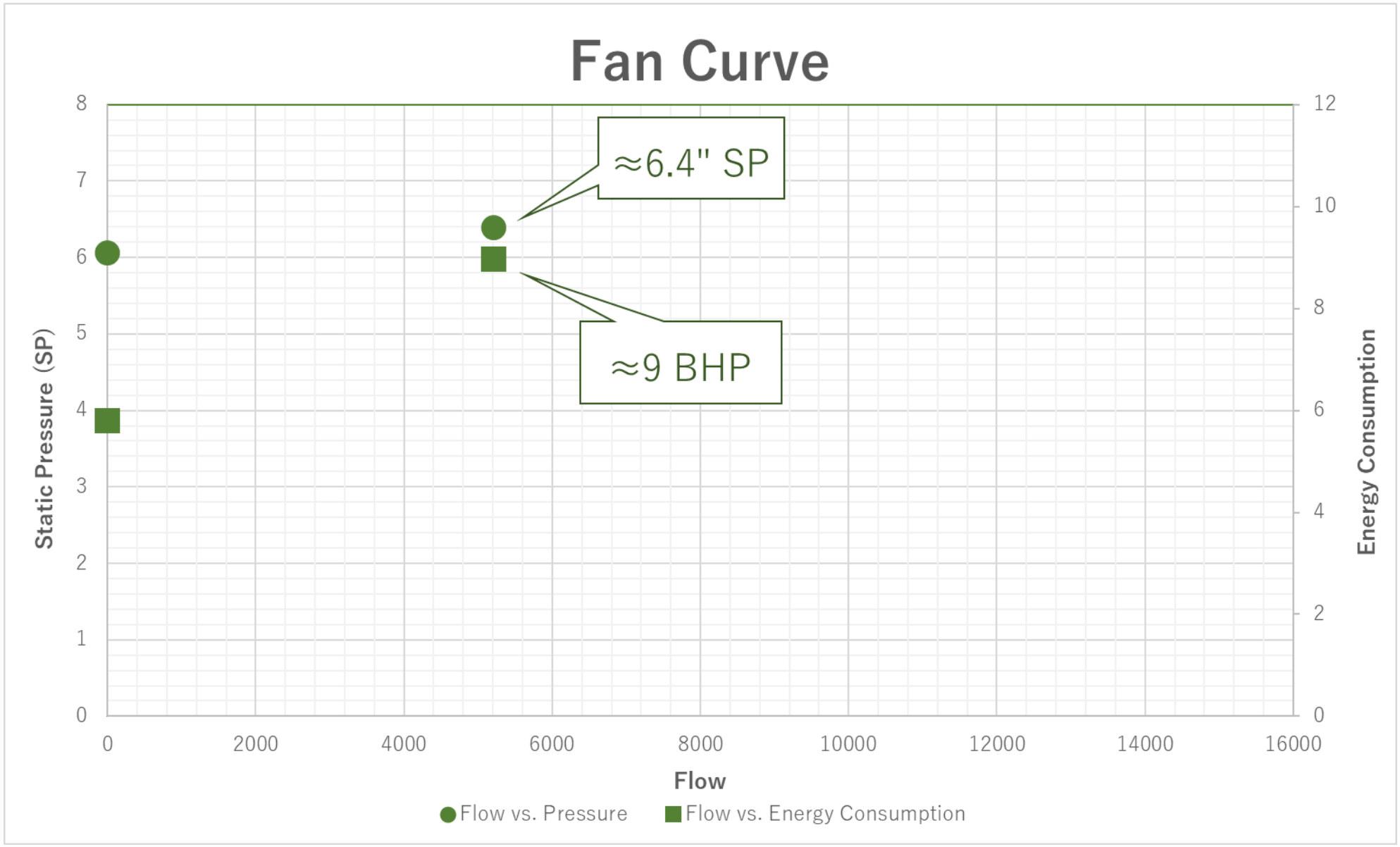
Flow vs. Pressure
Flow vs. Energy Consumption


Fan Curve
≈6.4" SP
≈9 BHP
Static Pressure (SP)
Energy Consumption
Flow
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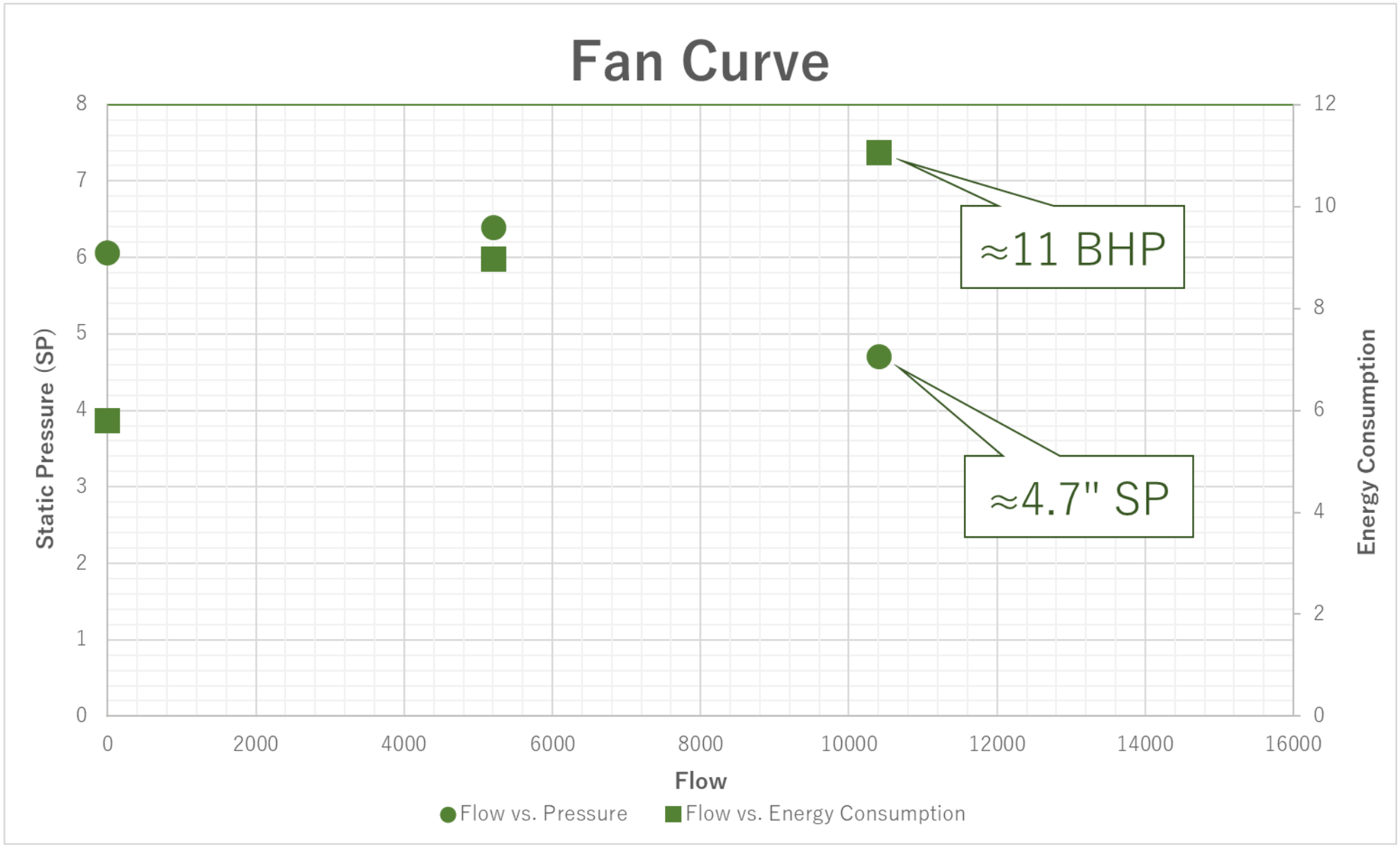
Flow vs. Pressure
Flow vs. Energy Consumption


Fan Curve
Static Pressure (SP)
Energy Consumption
Flow
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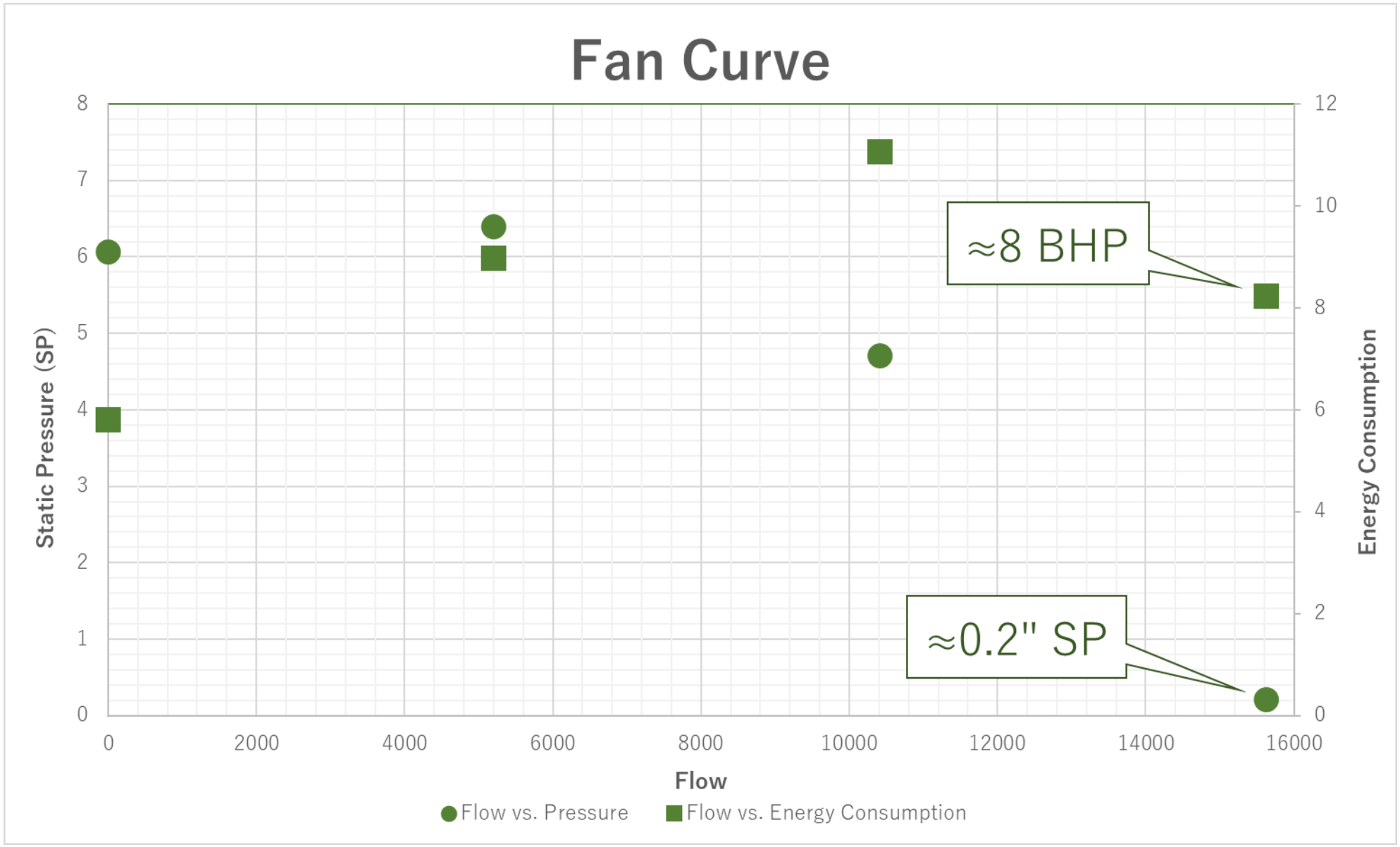
≈11 BHP
≈4.7" SP
Flow vs. Pressure
Flow vs. Energy Consumption


Fan Curve
Static Pressure (SP)
Energy Consumption
Flow
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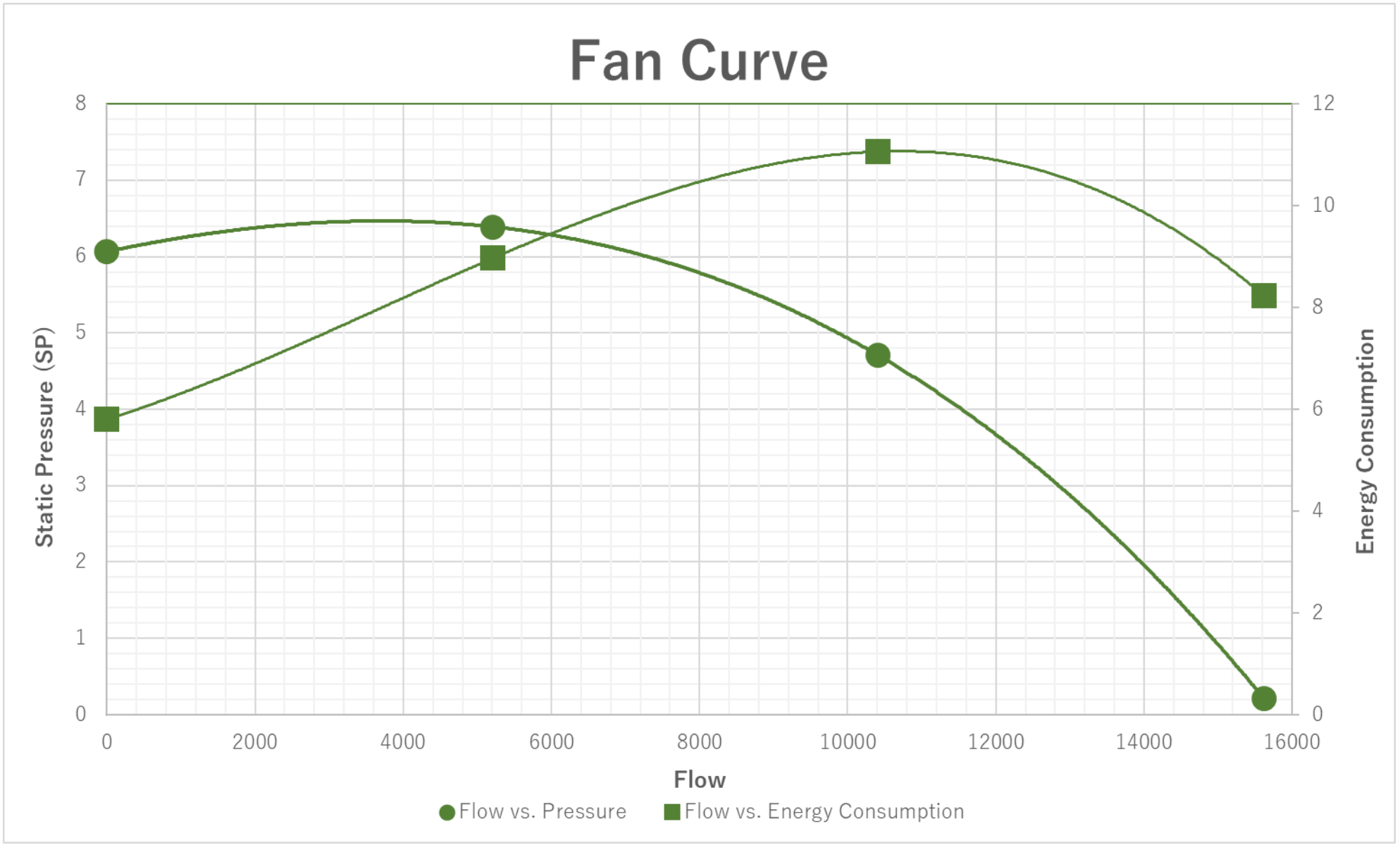
≈8 BHP
≈0.2" SP
Flow vs. Pressure
Flow vs. Energy Consumption


Fan Curve
Static Pressure (SP)
Energy Consumption
Flow
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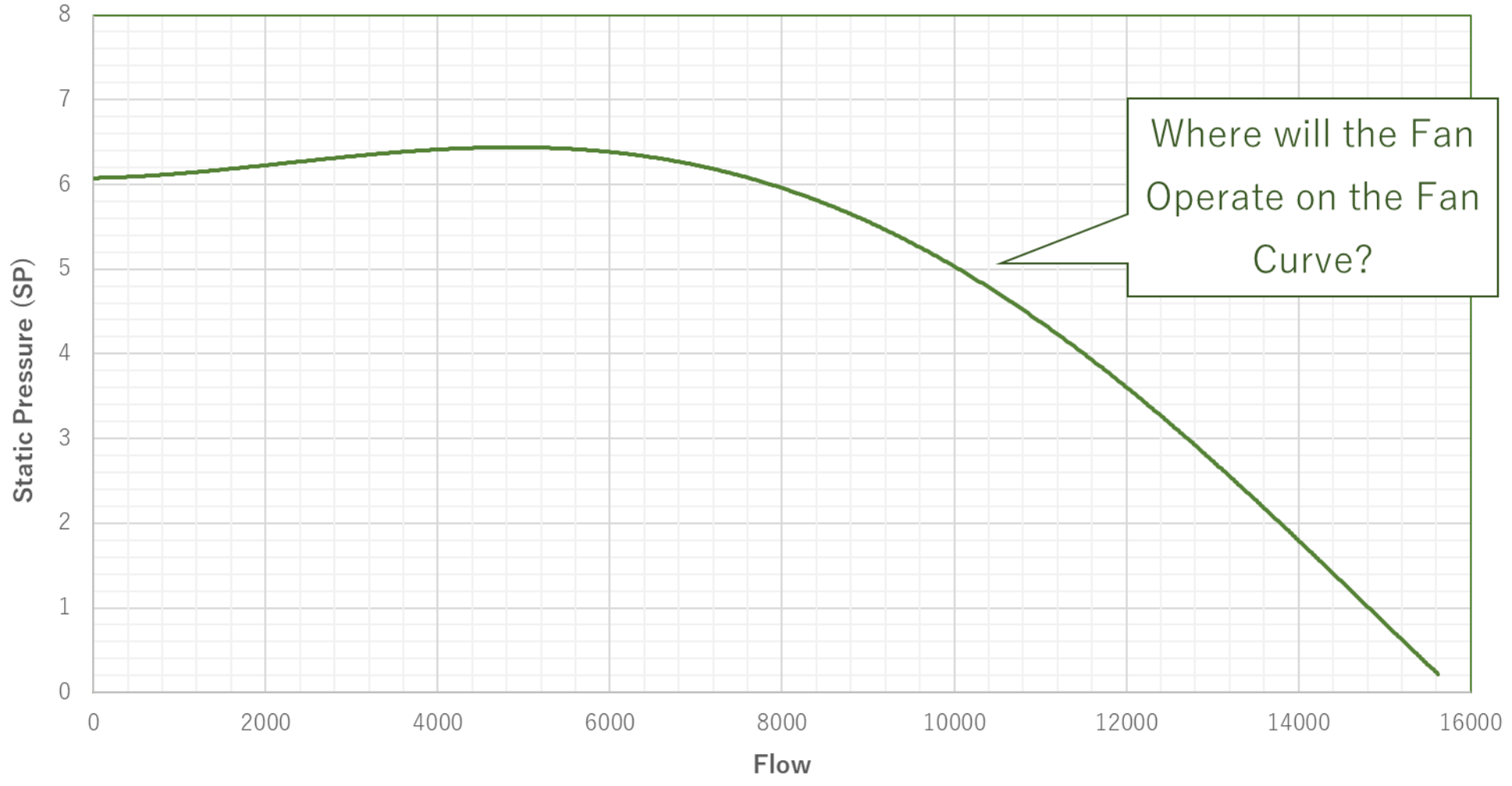
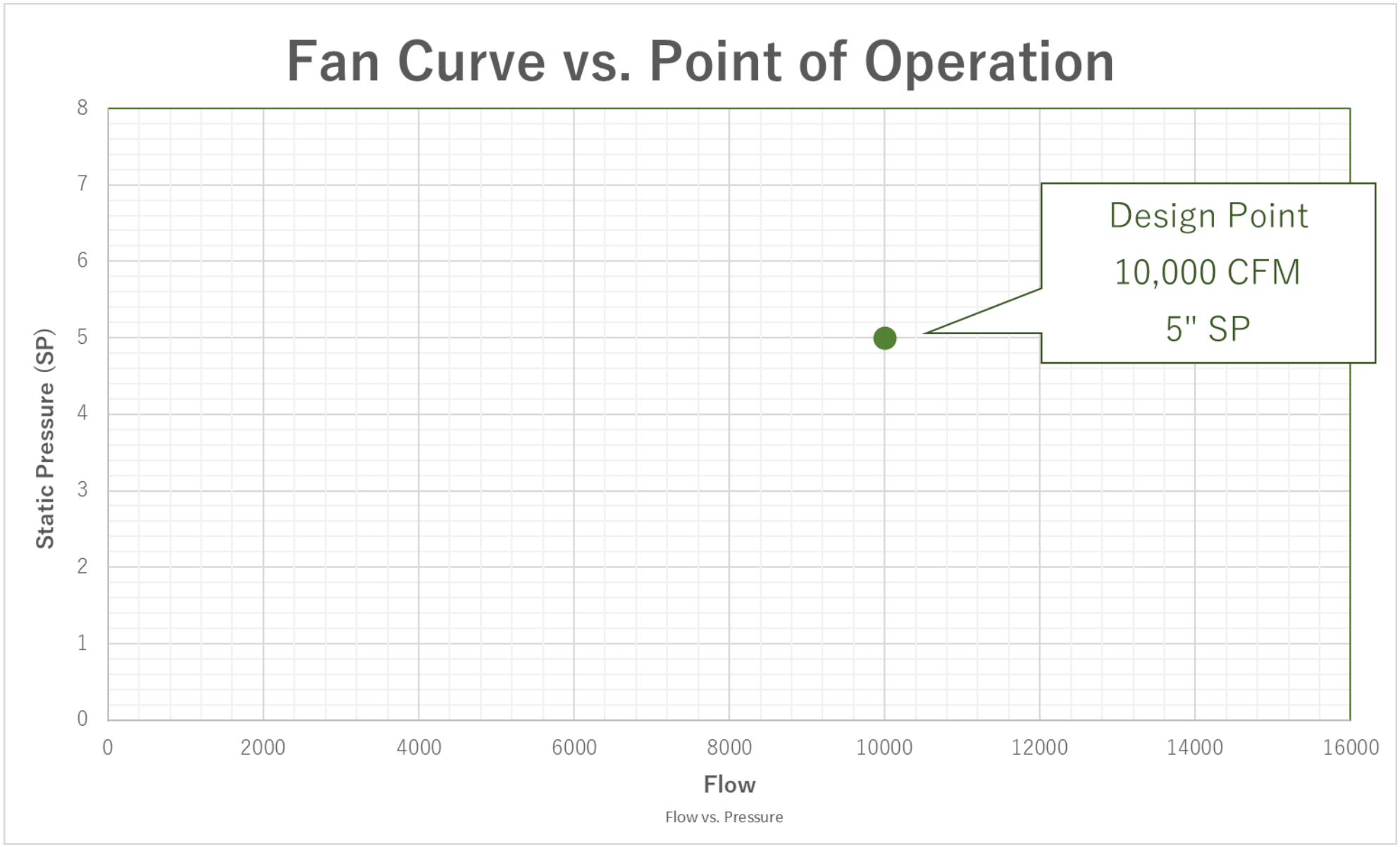
Flow vs. Pressure
Flow vs. Energy Consumption

Fan Curves-Operating Point

Fan Curve vs. Point of Operation



Flow vs. Pressure


Fan Curve vs. Point of Operation
Static Pressure (SP)
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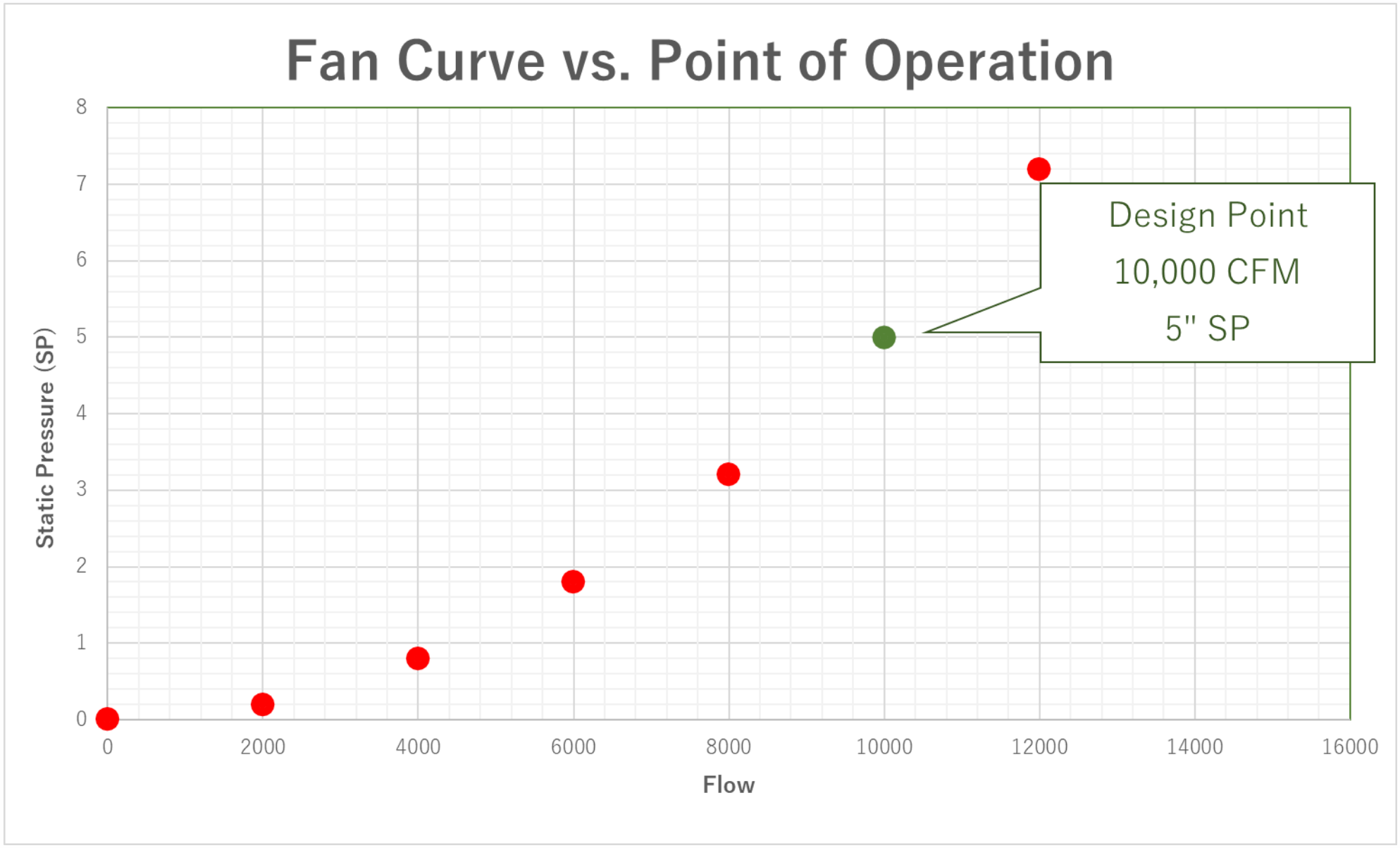
14000
16000
Flow
Design Point
10,000 CFM
5" SP
Flow vs. Pressure


Fan Curve vs. Point of Operation
Static Pressure (SP)
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12000
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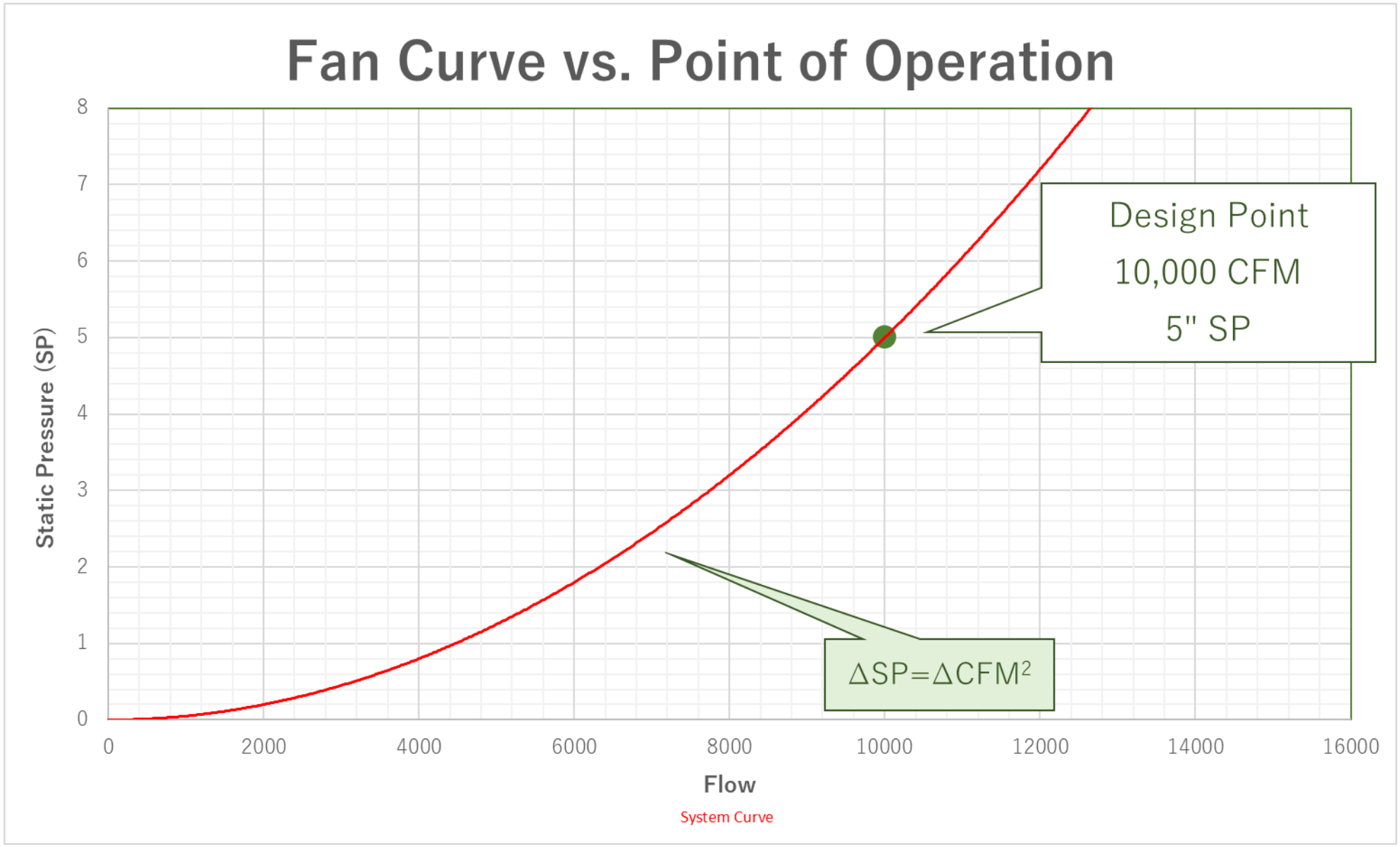
16000
Flow
Design Point
10,000 CFM
5" SP


Fan Curve vs. Point of Operation
Static Pressure (SP)
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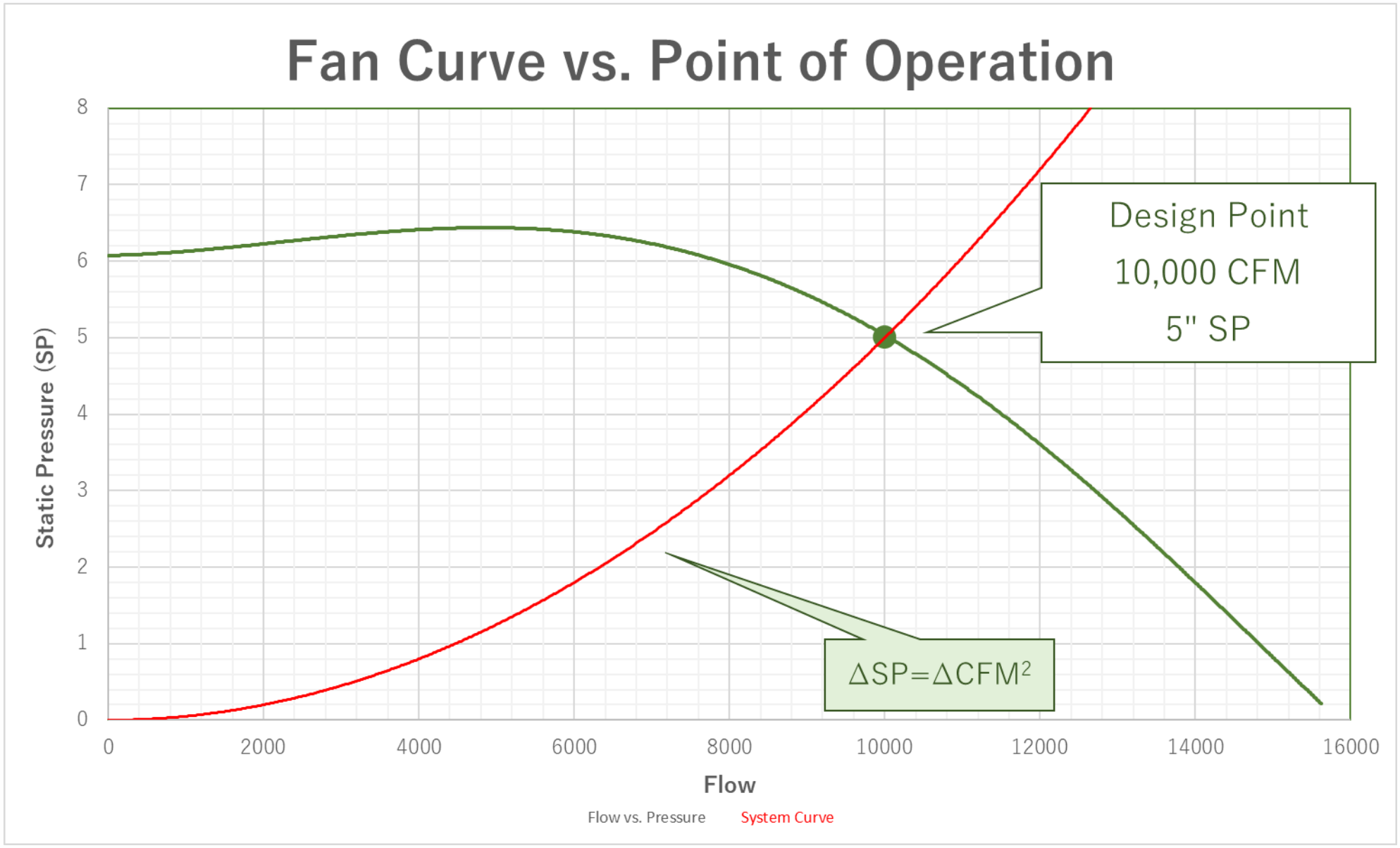
14000
16000
Flow
Design Point
10,000 CFM
5" SP
ΔSP=ΔCFM²
System Curve


Fan Curve vs. Point of Operation
Static Pressure (SP)
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4000
6000
8000
10000
12000
14000
16000
Flow
Design Point
10,000 CFM
5" SP
ΔSP=ΔCFM²
Flow vs. Pressure
System Curve

Questions?

Generating Fan Curve,

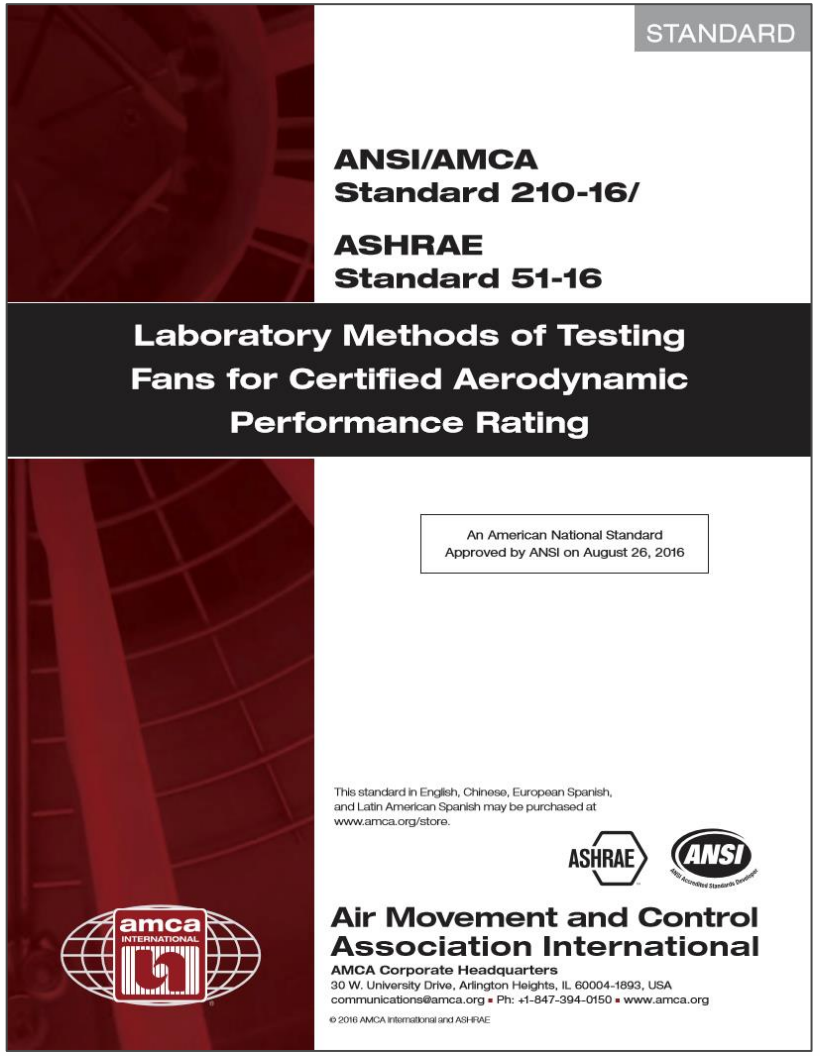
Where a Fan Operates on the Fan Curve

Testing and Rating

Testing and Rating:

Tested:

- In Accordance with AMCA Standard 210 (ASHRAE 51)



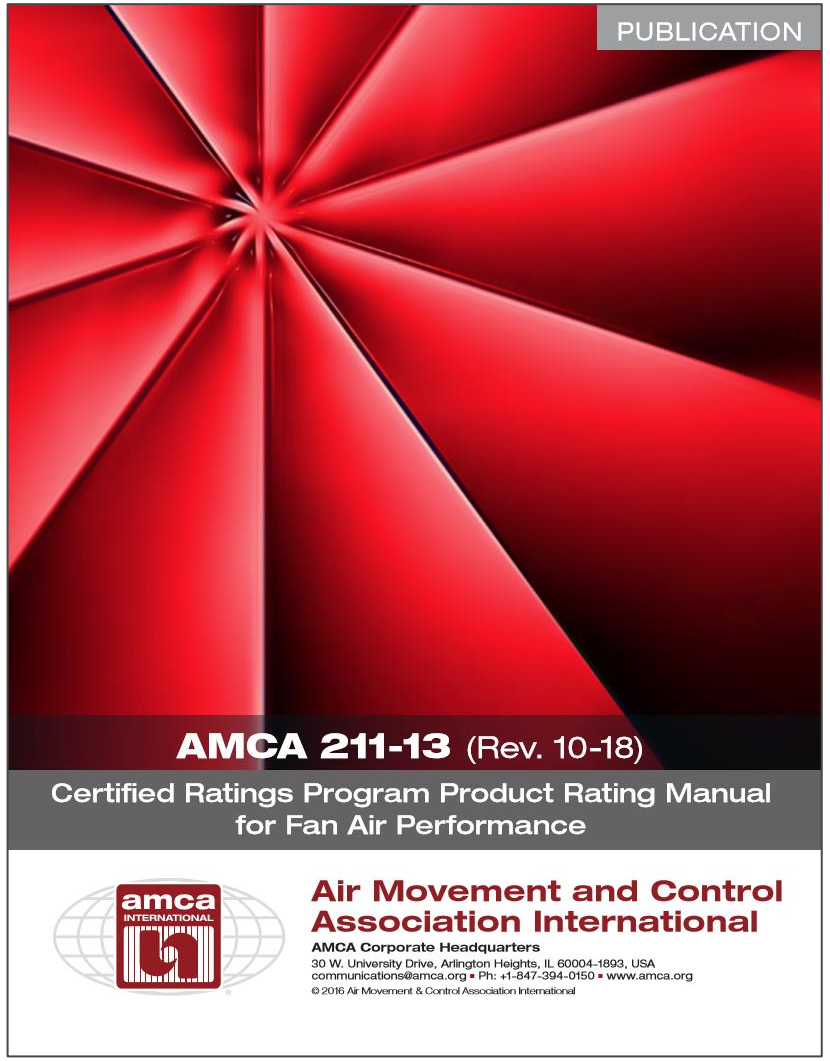
Testing and Rating:

Tested:

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

Rated:

- In Accordance with AMCA Publication 211



Testing and Rating:

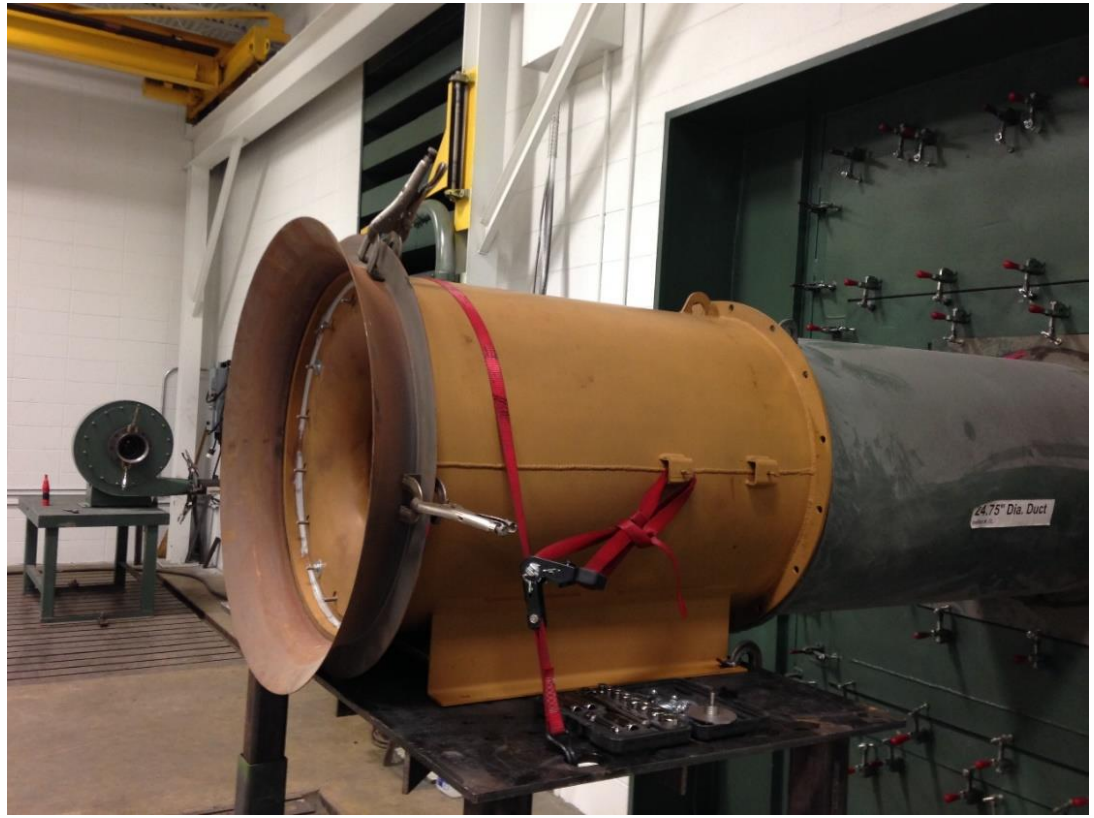
Check Test (AMCA Standard 211):

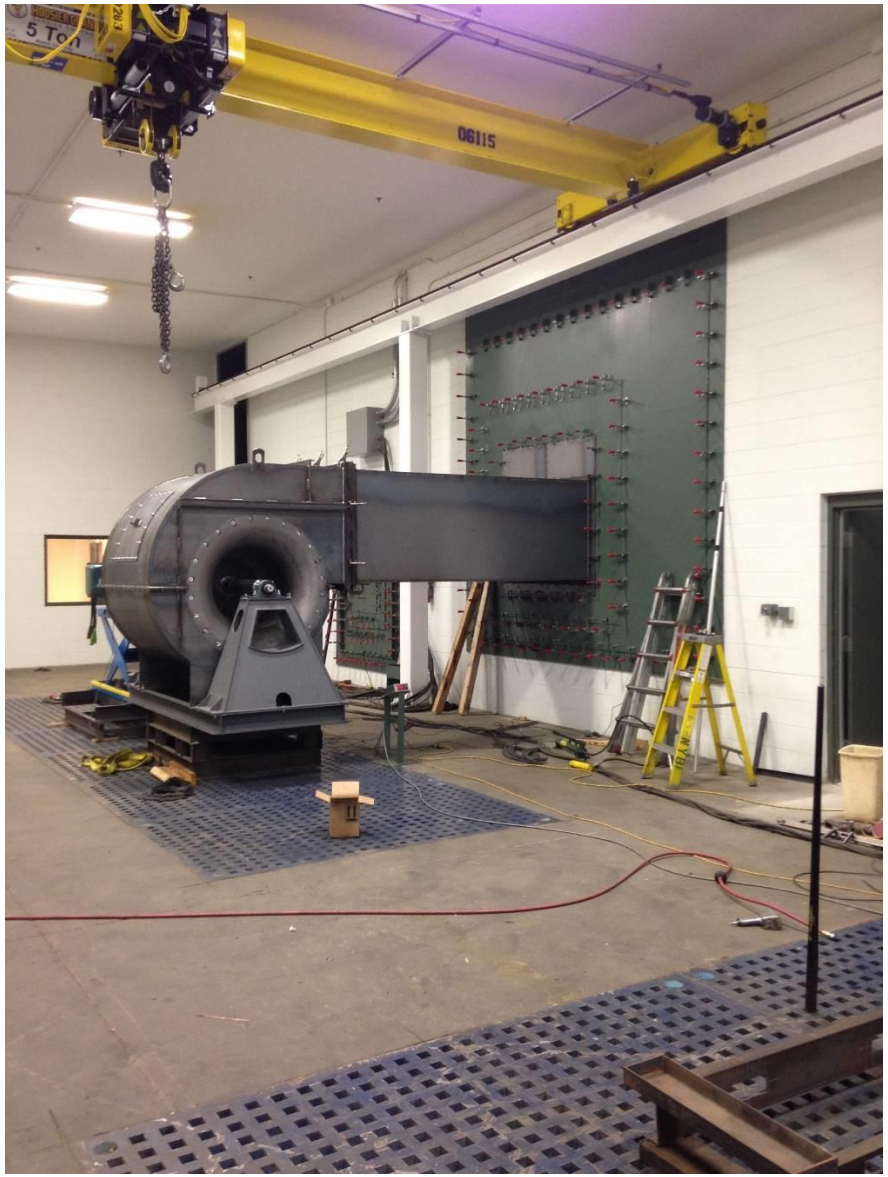
Questions?

Fan Testing/Rating & AMCA Certification

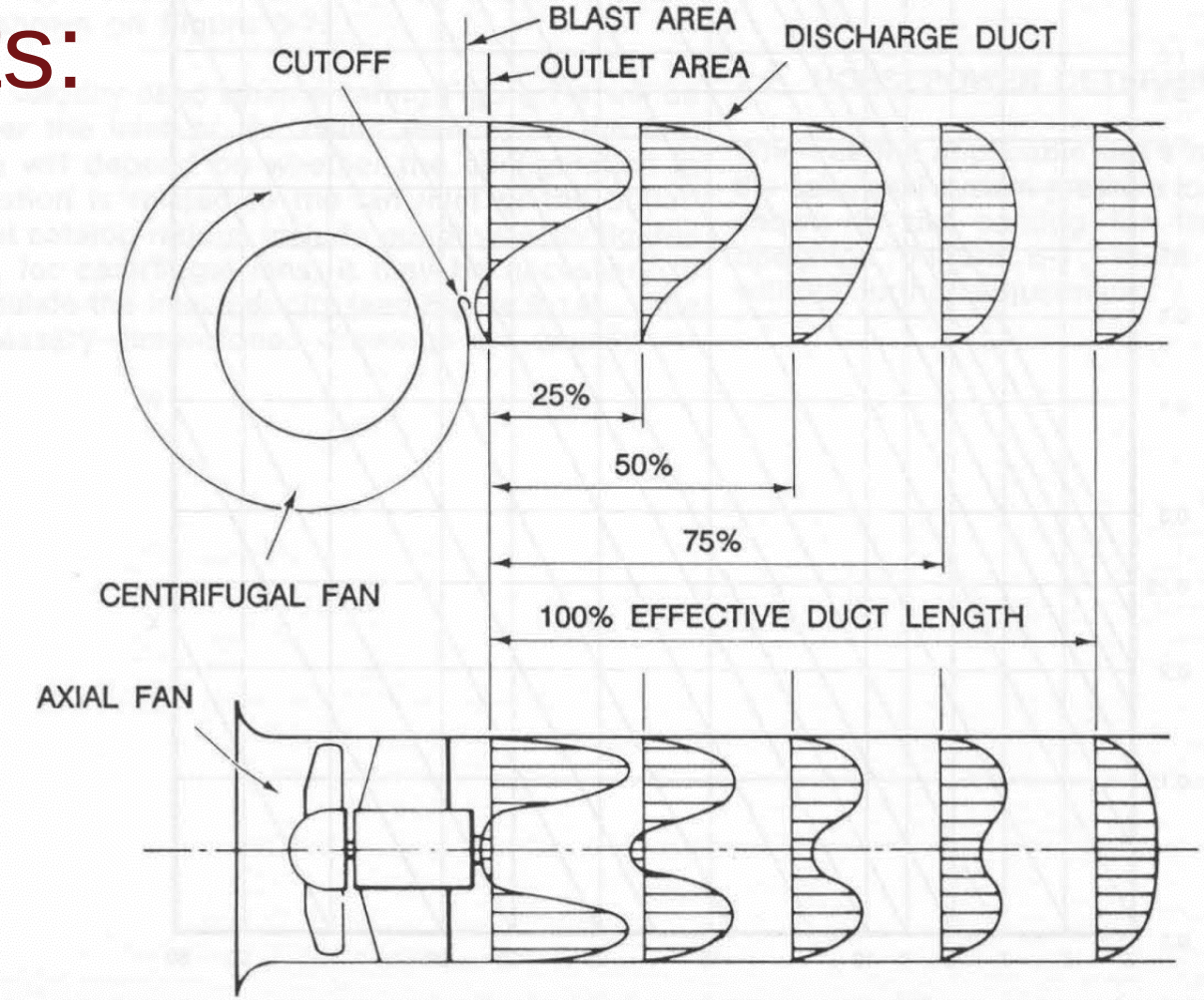
System Effects

System Effects:





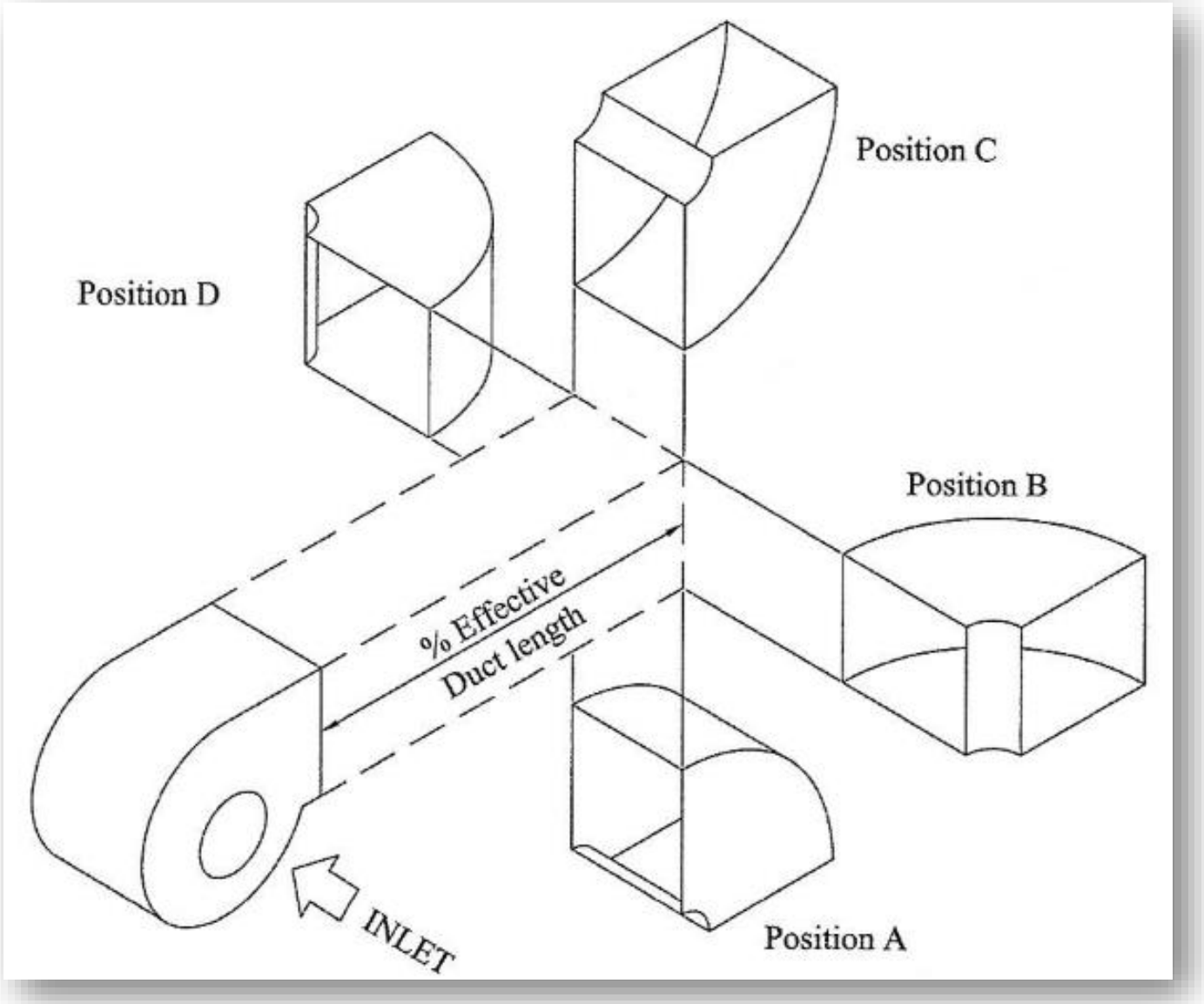
System Effects:



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:

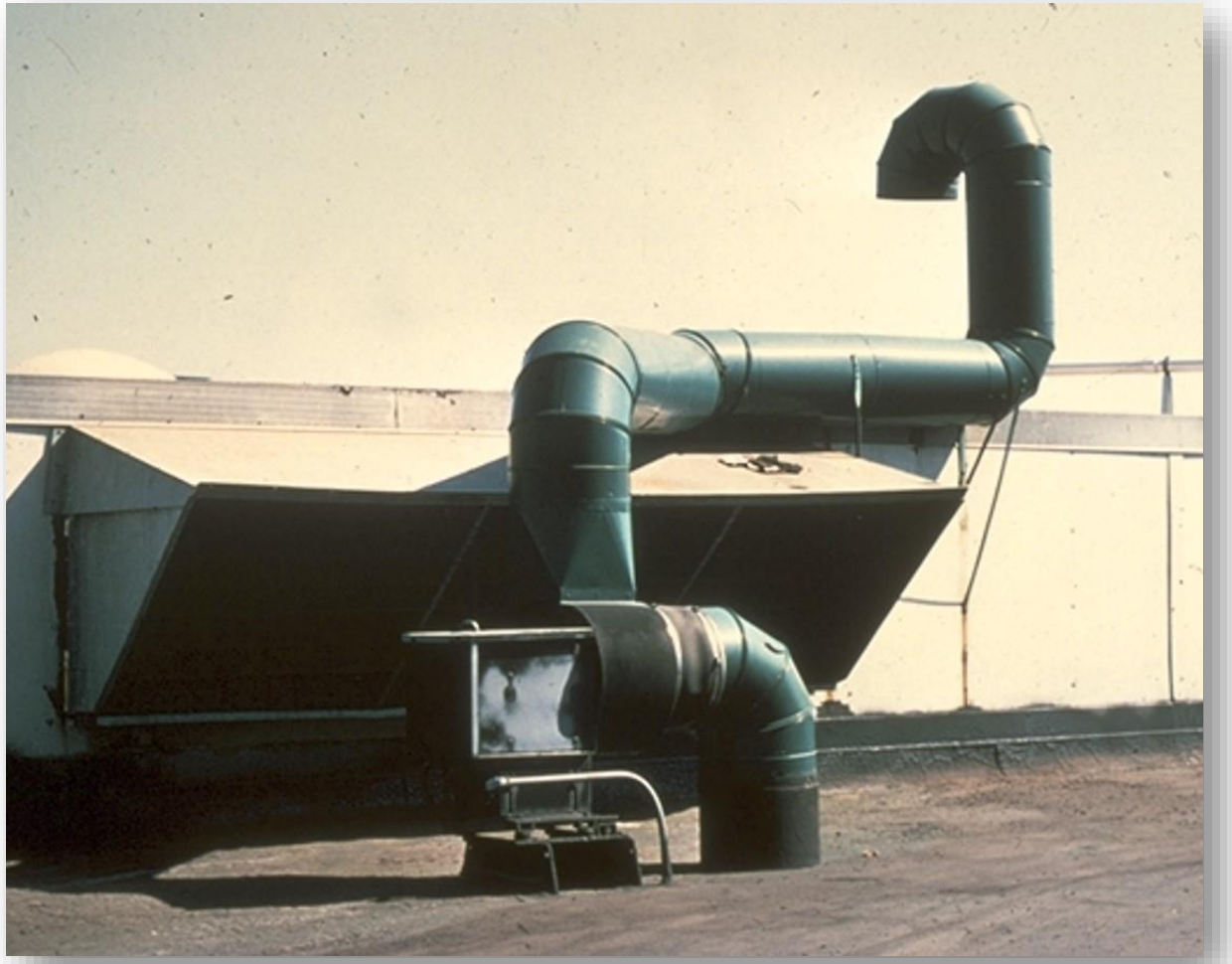
- **Unfavorable conditions**:
  - Air turned against rotation of the fan
  - Damper placed too close to elbow; laminar flow not yet achieved
- **Better solution**:
  - UB fan discharge
  - Move damper further from outlet to allow for evening of velocity profile

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

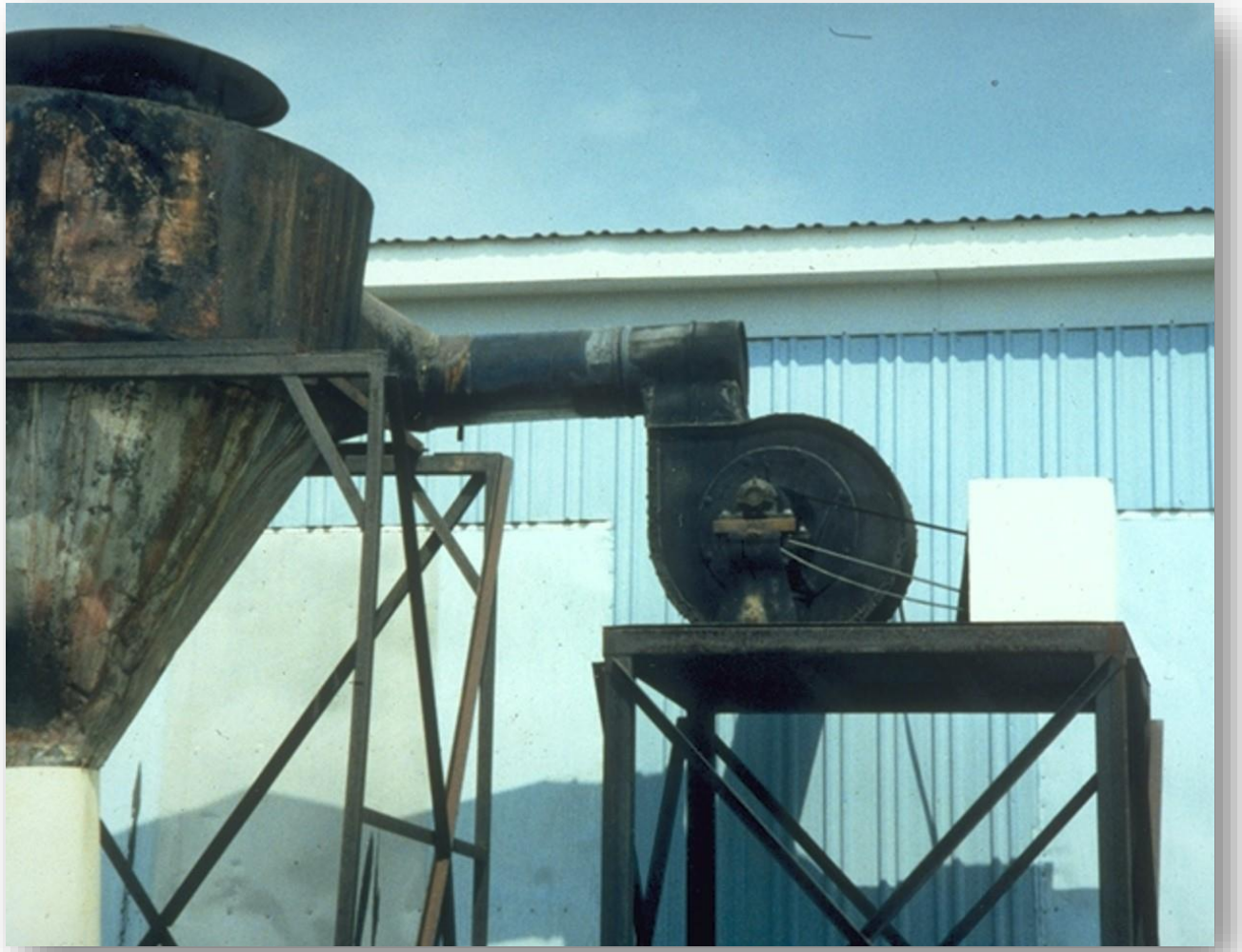
System Effects:

- **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

Questions?

System Effects

System Effects Video:

The following video was done in conjunction with AMCA for the 2020 AHR show in Orlando and shows how various configurations of ductwork effect fan performance.

Poll Question for Prize!

Which of the demonstrated systems is one of true system effect, and not a fan system effect?

System Effects: 90˚ Elbow

Questions?

90˚Elbow

System Effects: Corkscrew Elbow

Questions?

Corkscrew Elbow

System Effects: Inlet Boxes

Questions?

Inlet Box

System Effects: Straight Run Inlet of Ductwork

Questions?

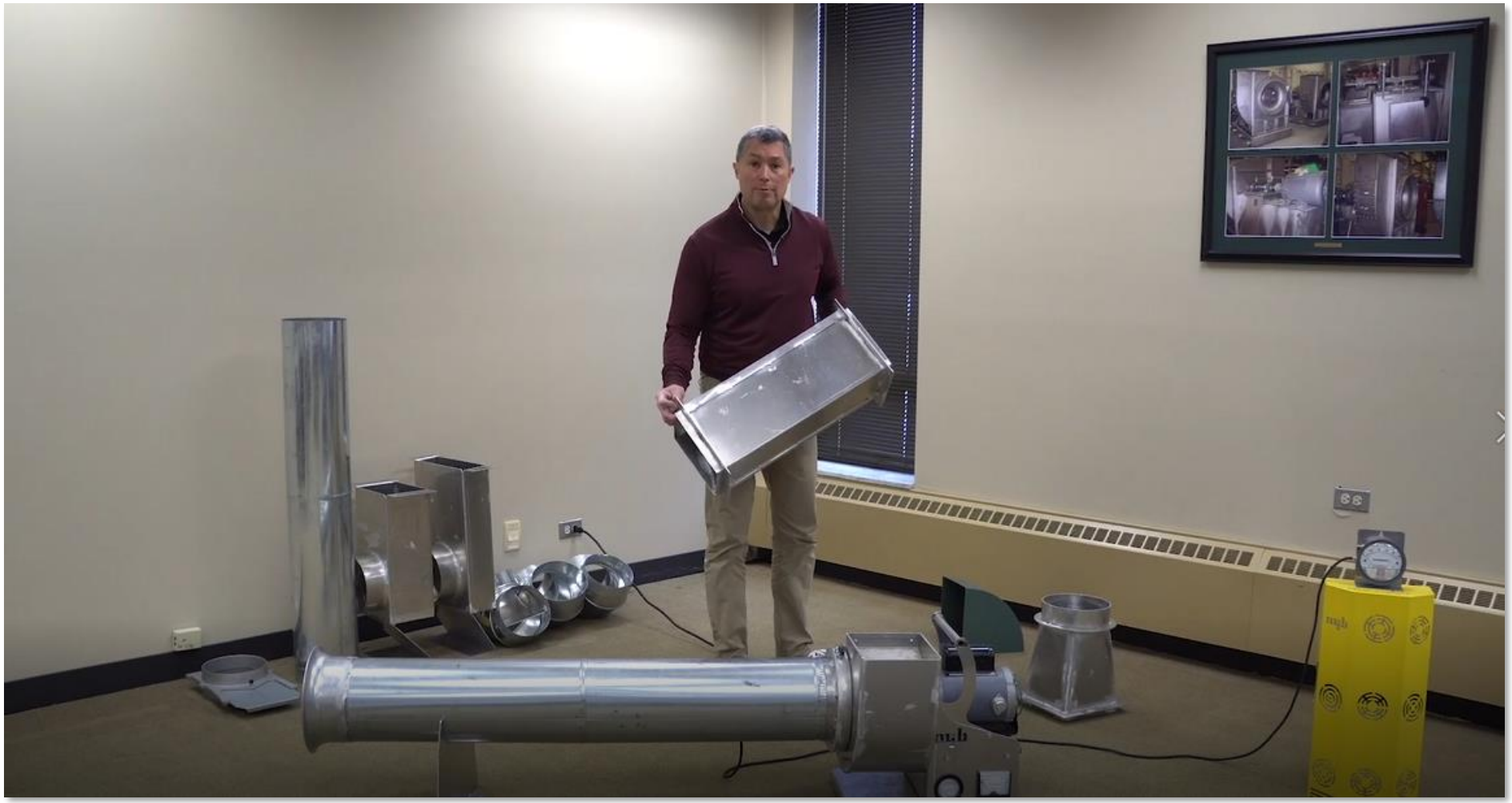
Straight Run of Inlet Ductwork

System Effects: Straight Duct/Corkscrew

Questions?

Straight Duct/Corkscrew

System Effects: Straight Discharge Ductwork



Questions?

Straight Discharge Ductwork

System Effects: Discharge Elbows

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)

27.7” WG ≈ 1 psi

≈ 900” wg to fill car tire

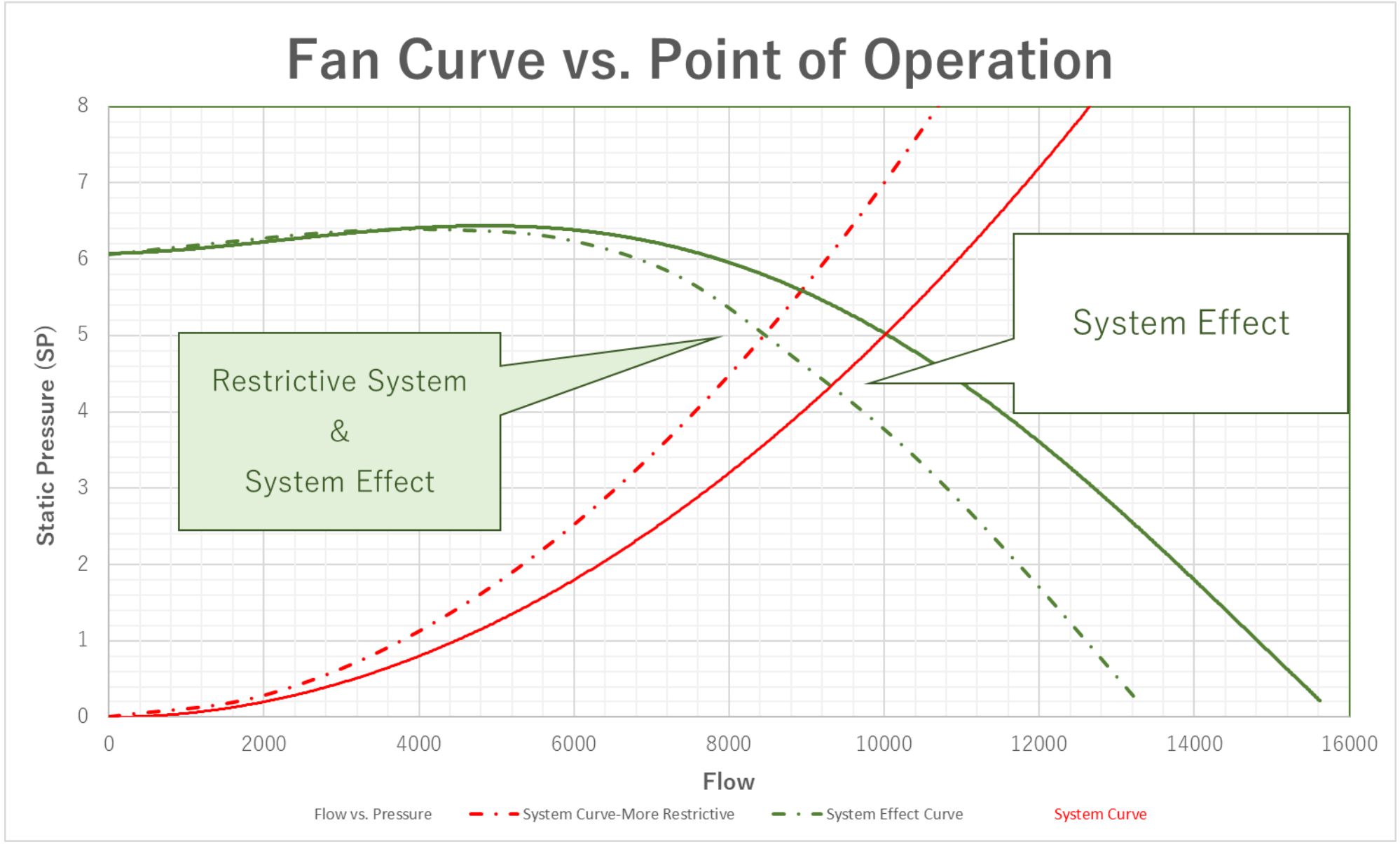
1 BHP Costs ≈ $600-$800/year

Poll Question

Answer:

Video #4…Straight Run of Inlet Ductwork

Operation


Fan Curve vs. Point of Operation
Static Pressure (SP)
0
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10000
12000
14000
16000
Flow
Restrictive System
&
System Effect
System Effect
Flow vs. Pressure
System Curve-More Restrictive
System Effect Curve
System Curve

Resources

- **AMCA International**: *www.amca.org*
- **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:** *https://www.amca.org/educate/#videos*

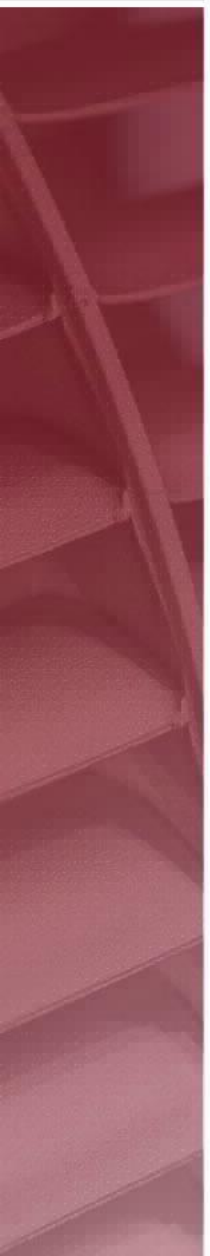
  > System Effect – A brief explanatory video outlining the system effect phenomena

Thank you for your time!

*To receive PDH credit for today's program, you **must** complete the online evaluation, which will be sent via email 1 hour after the conclusion of this session.*

PDH credits and participation certificates will be issued electronically within 30 days, once all attendance records are checked and online evaluations are received.

Attendees will receive an email at the address provided on your registration, listing the credit hours awarded and a link to a printable certificate of completion.



Final Questions?

NEXT PROGRAM

Join us for our next AMCA & O'Dell Associates Education Session:

- Thursday, December 9
- 10:00-11:00am ET
- ***Topic: Stall Detection and Control in Commercial and Industrial Fans***
- Presenter: Dr. Geoff Sheard, President, AGS Consulting

>> For additional session details please contact Sarah Johnson, Marketing Manager, O'Dell Associates (sjohnson@odellassoc.com)