Seminar 51 – Why Isn't My Fan Working? The Complex World of Fan/System Interactions

SYSTEM LINE INTERACTION AND STABILITY WITH AXIAL FANS

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Learning Objectives

- Explain the difference between system resistance and system effect and describe how each impacts the performance of a fan in a system.
- Identify causes of system effect and describe how it can be minimized or compensated for in various applications.
- Describe factors that cause a change in system resistance and explain how this will affect the fan performance.
- Apply engineering judgment to select fans to minimize the risk of unstable operation.

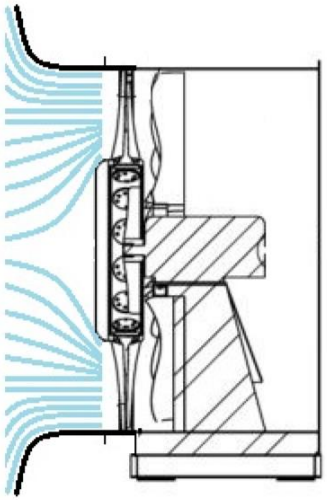
SYSTEM INTERACTION - EFFECT

- Two different types of system effects impact the performance of the fan motor units

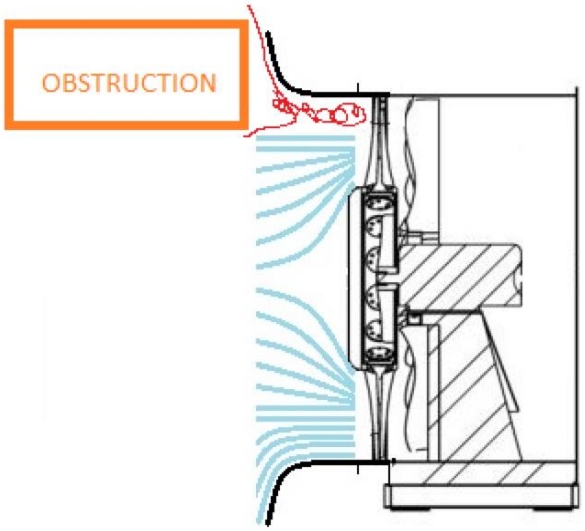
1. Installation variations that modify the flow path directly in front of or behind the rotating component.

2. Installation variations that change the pressure rise of the overall flow path.

AIR PATH BY ROTATING COMPONENT



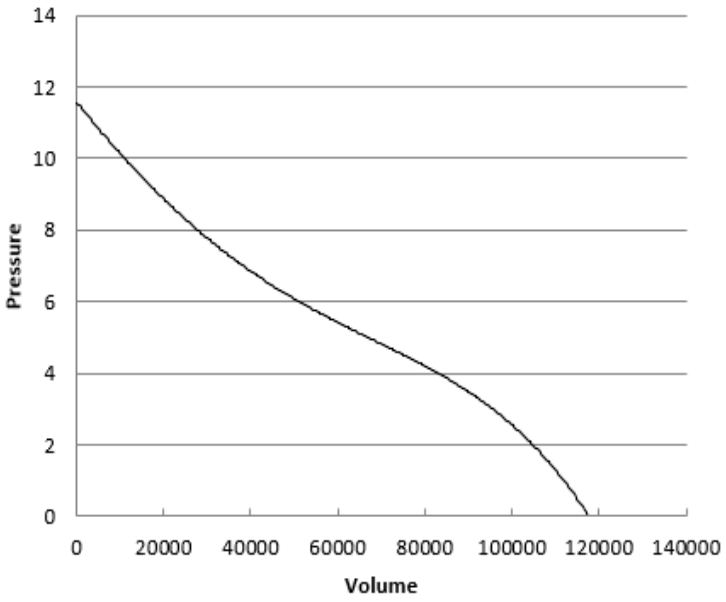
Normal
Airflow



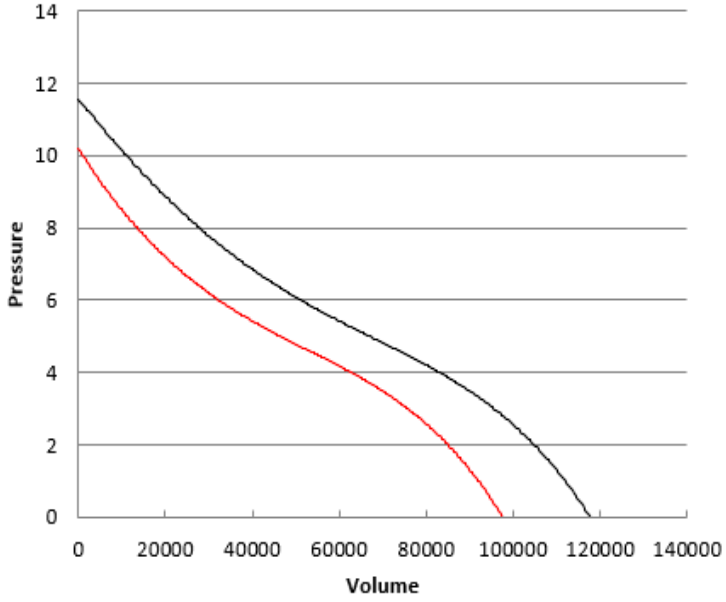
Obstructed
Airflow

FAN CURVES

Typical Performance Curve
Tested with Normal Airflow



Red Line is indicative of a
REDUCED performance based on
OBSTRUCTED inlet airflow



UNKNOWN EFFECT

- A Fan with an obstruction **will not** operate on its known fan curve.

Usefulness of the System Resistance Line

- The fundamental use of the System Resistance line is to understand how the fan and system will operate under different conditions.

Creation of the System Resistance Line

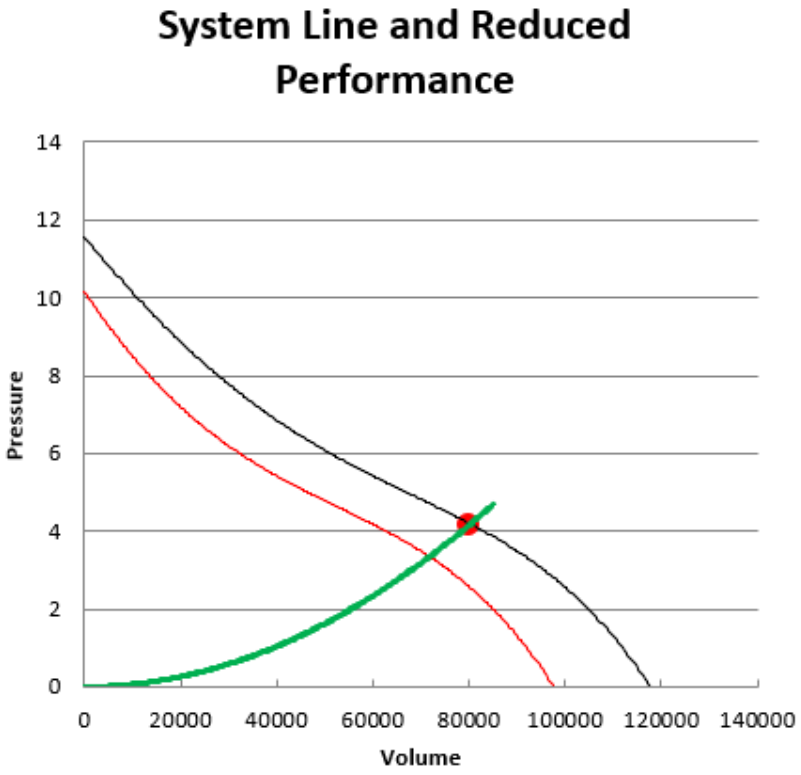
- The Equation for the system resistance line is:

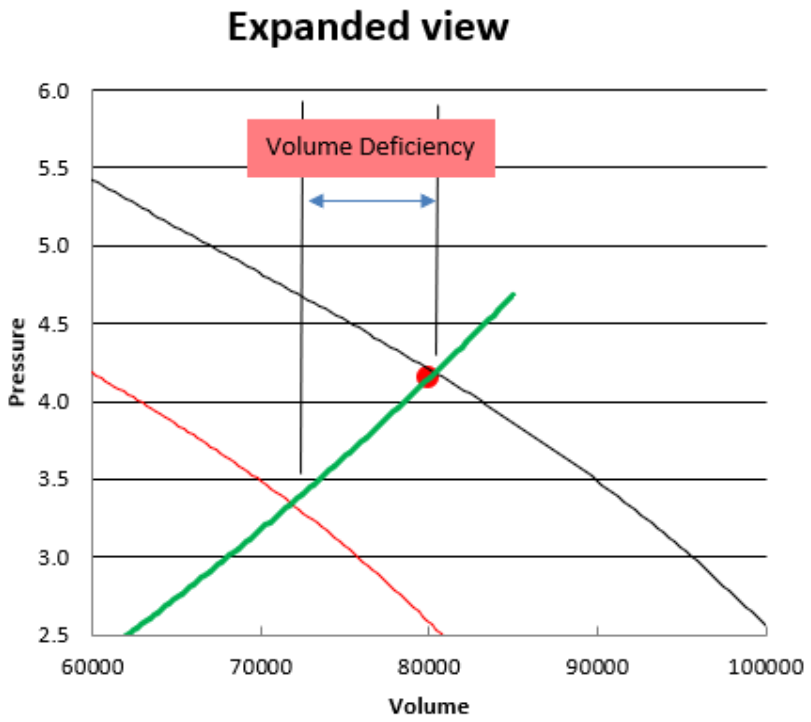
$$y = mx^2$$

y = the required pressure at the known volume
x = the volume flowrate required
m = a constant defining the shape of the curve (based on components in system providing resistance to flow)

- Each pressure differential throughout the system is based on the actual volume (velocity) of the air passing through that section. As the volume decreases so does the differential pressure requirement.

Deficiency due to obstruction





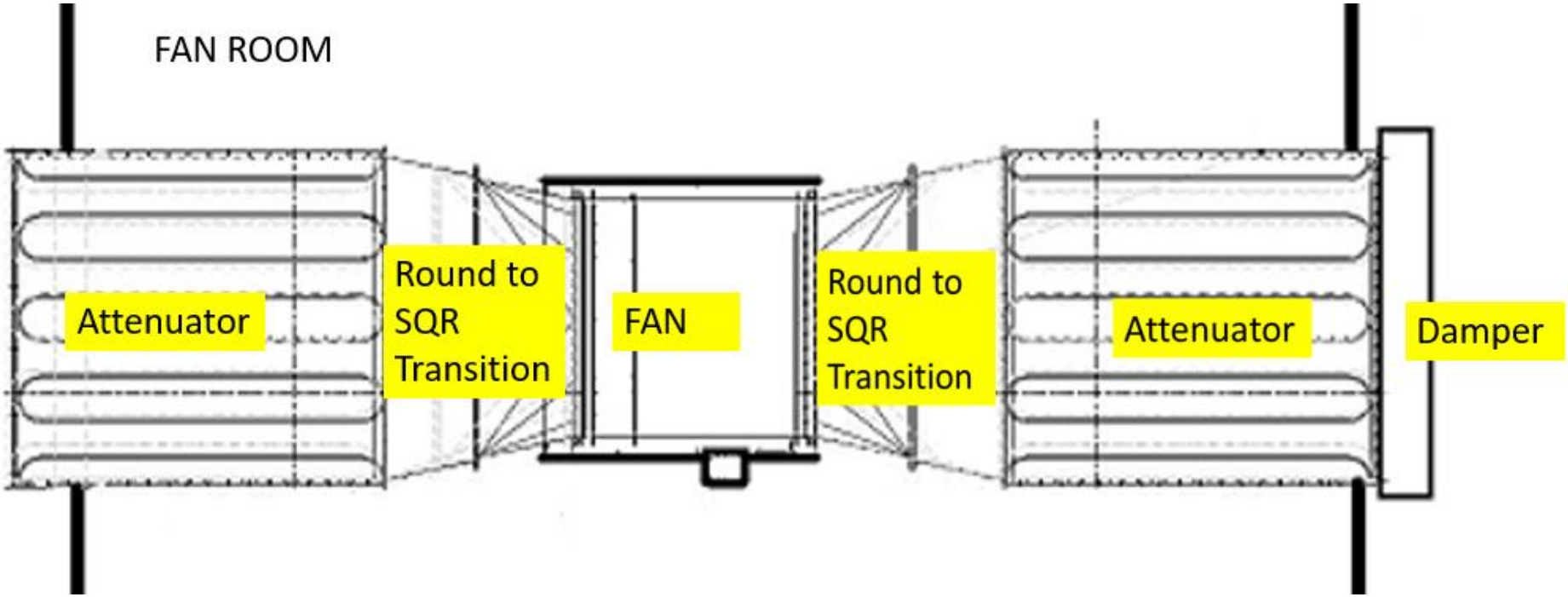
Correction Method

- Modify the installation
- Modify the rotating component
- Increase the unit's speed
  Confirm new volume and absorbed power – Trial and Error

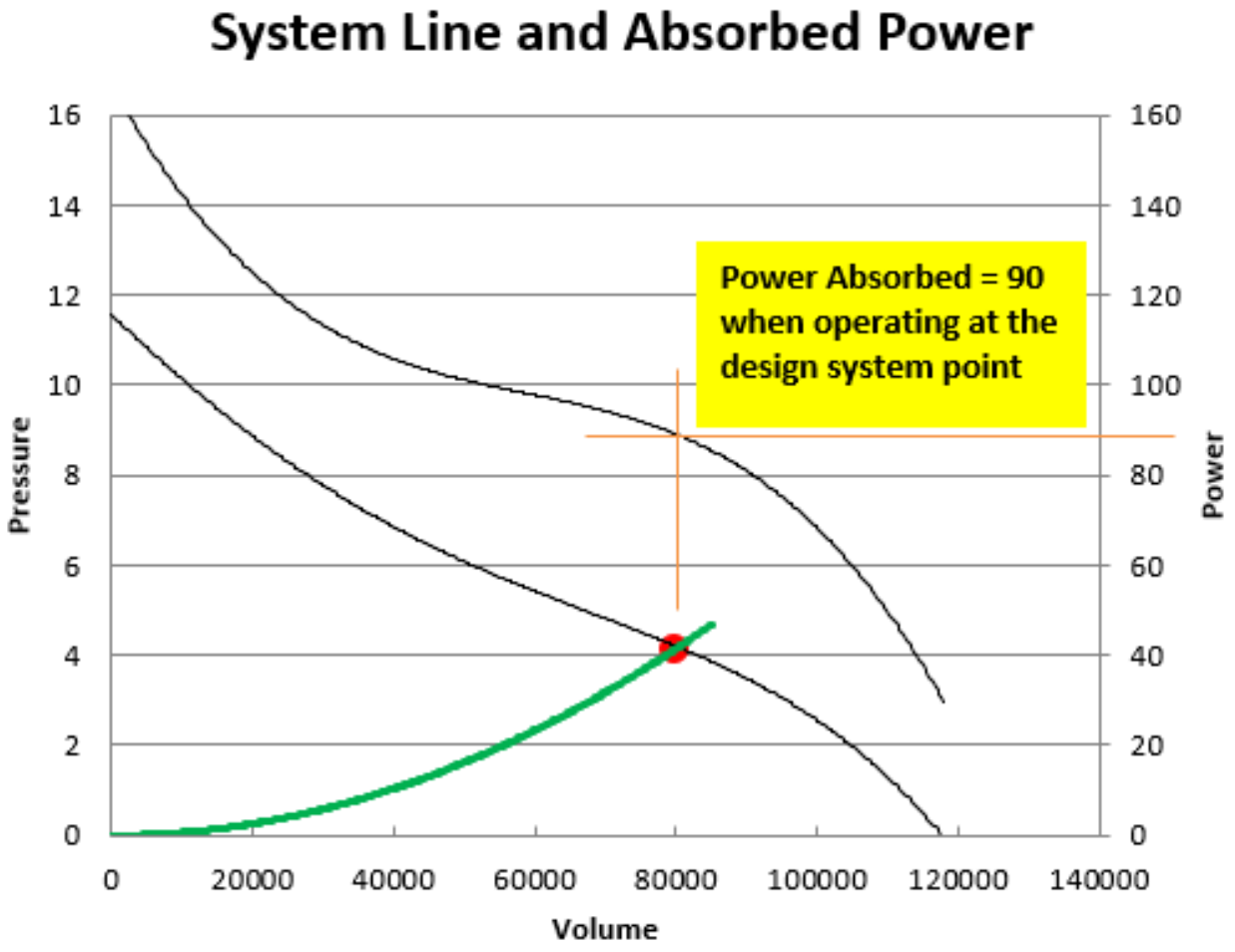
NORMAL AIRFLOW PERFORMANCE

A Fan with normal airflow
MUST
operate on its fan curve!

Typical Fan Train



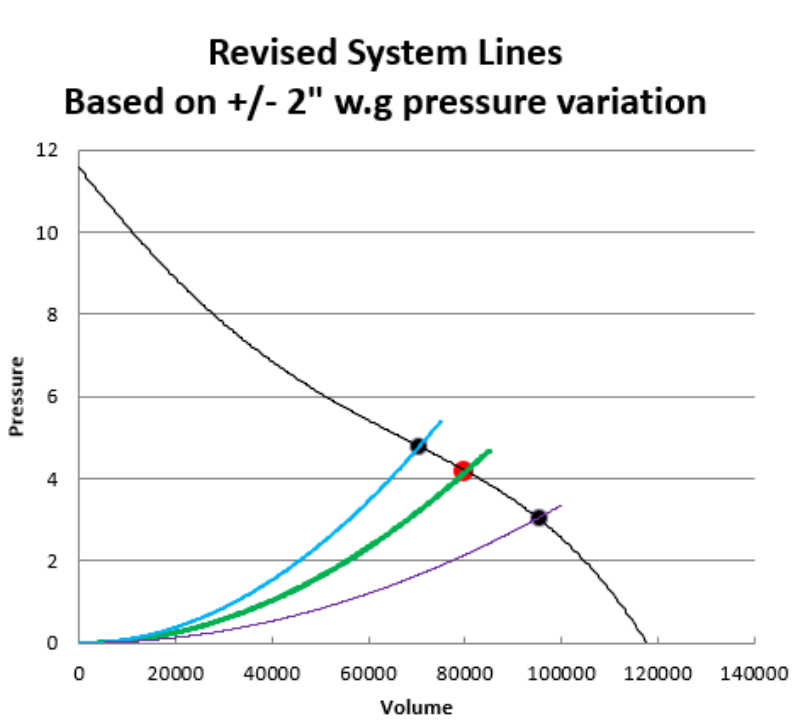
TYPICAL AXIAL FAN PRESSURE & POWER CURVE

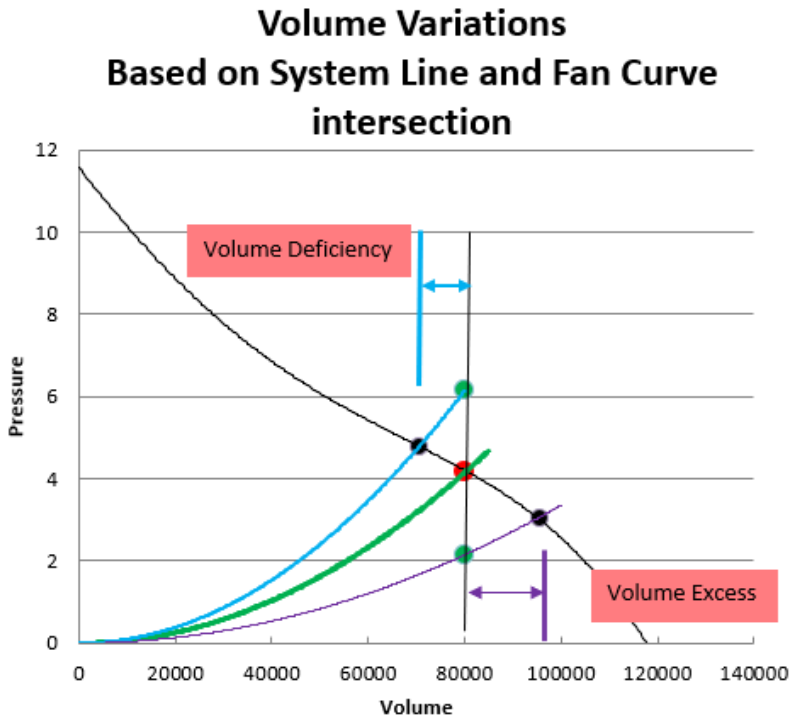


Effects of Pressure Changes on Units with Normal Airflow Performance

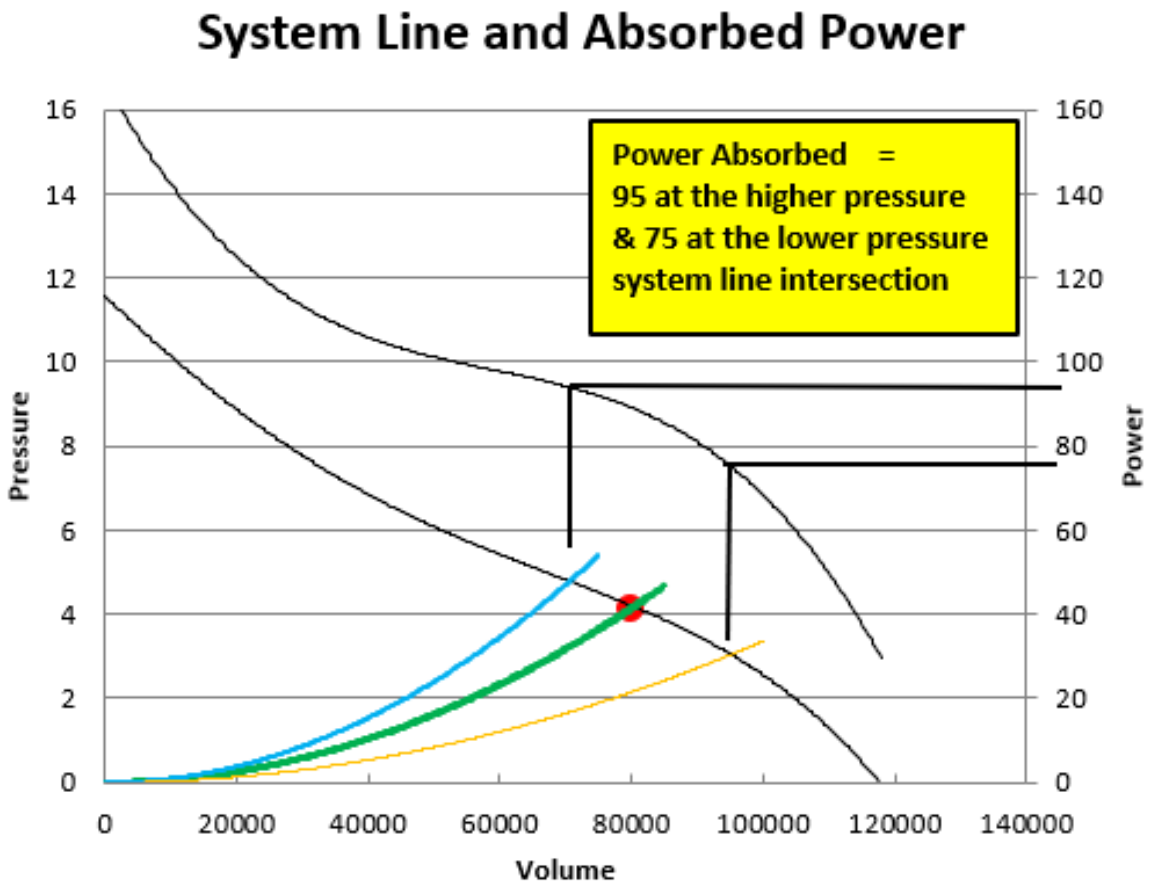
- When the air moving equipment is presented with a change in the required pressure the fan can only operate on the fan curve.
- What is impacted is the system resistance line and the intersection point on the fan curve.

Volume variation due to Pressure variation





Absorbed power will coincide with the new pressure requirement



Correction Method

- Modify the rotating component – Change the Angle of Attack of Blades
- Increase or decrease the unit's speed Confirm new volume and absorbed power – Follows the Fan Laws

Definition of *stability*

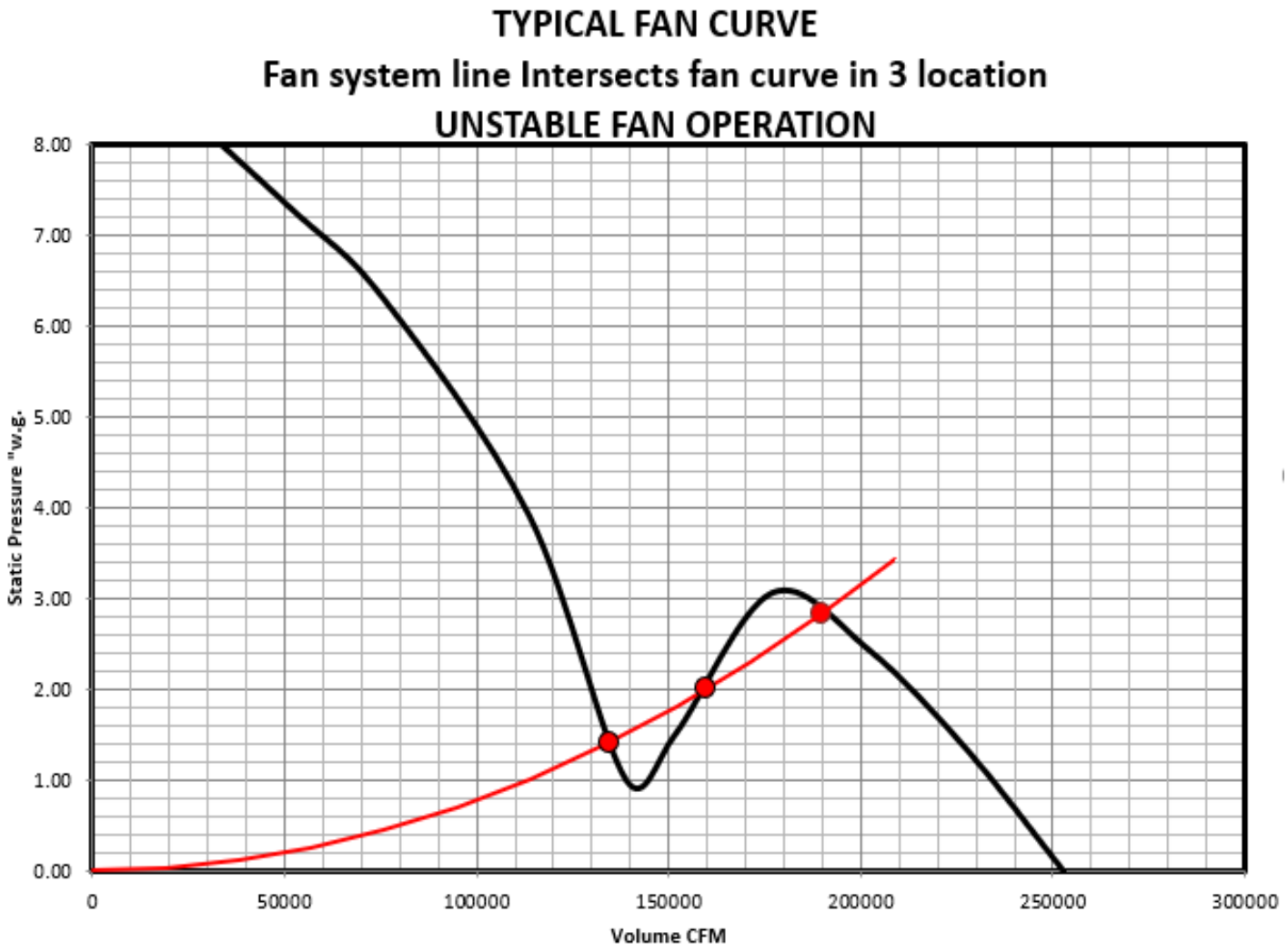
1 : the quality, state, or degree of being stable: such as

a : the strength to stand or endure : FIRMNESS

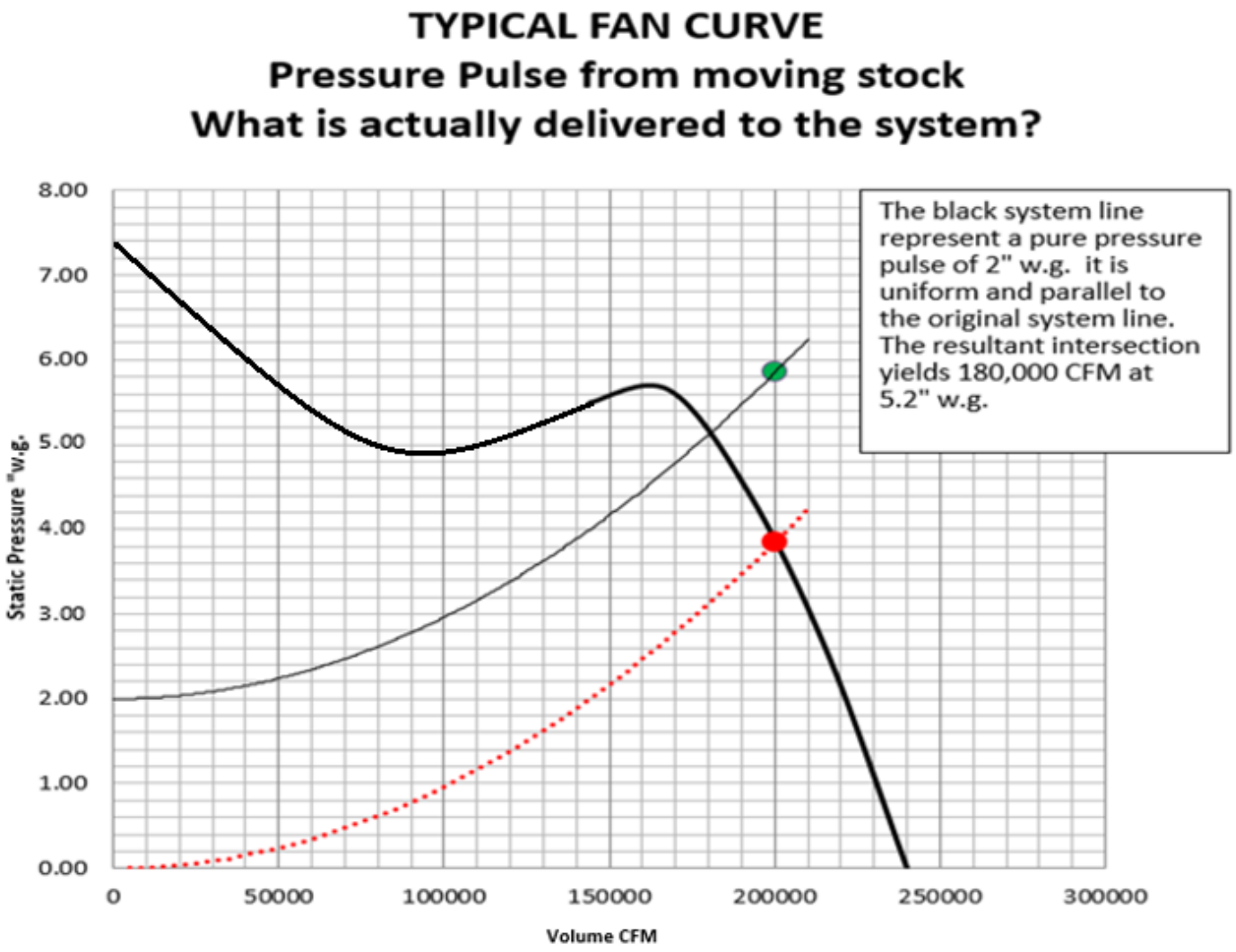
b : the property of a body that causes it when disturbed from a condition of equilibrium or steady motion to develop forces or moments that restore the original condition

c : resistance to chemical change or to physical disintegration

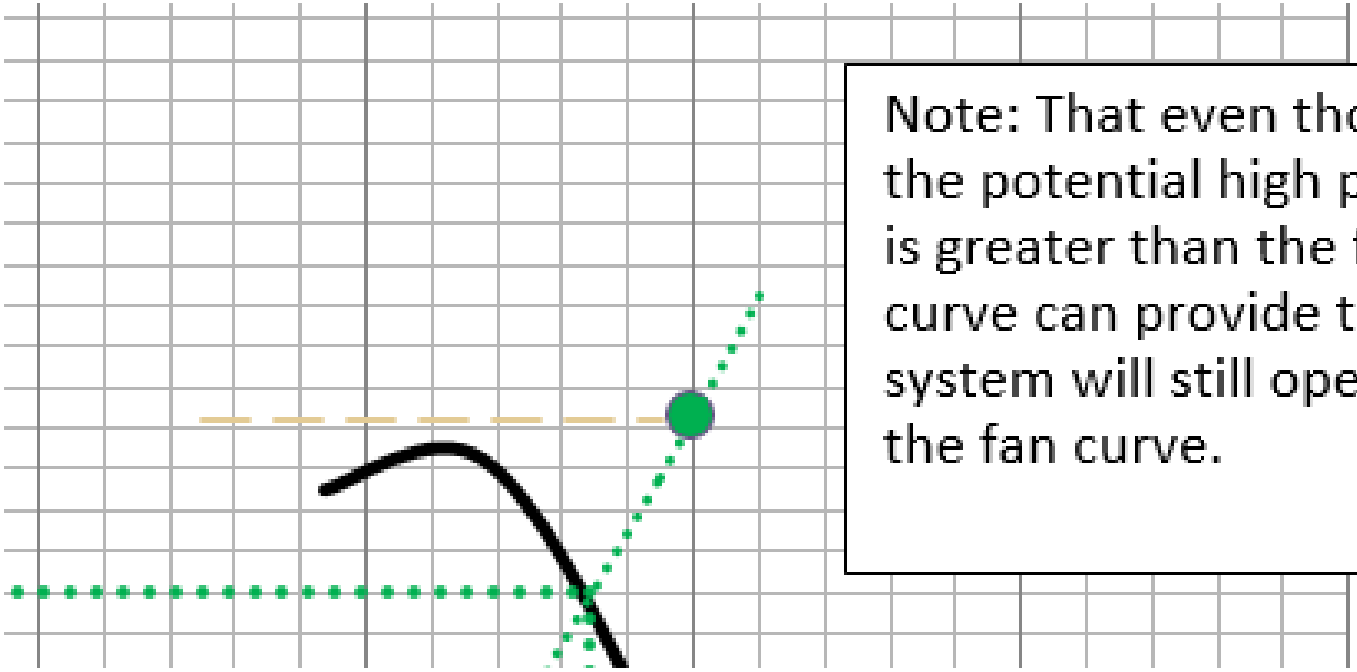
An Example with a STALL in the static pressure fan curve



An Example with a “DIP” in the static pressure fan curve



System resistance line impact



Note: That even though the potential high pressure is greater than the fan curve can provide the system will still operate on the fan curve.

Conclusion

It is crucial that the required fan volume and pressure be understood by all parties.

The equipment must be installed according to the manufacturer's recommendations – Care must be taken to avoid air path obstructions.

With properly installed fans -- the system line will aid the installer in understanding the volumes delivered.

Understanding the system line and the interaction with the fan static pressure curve will ensure stable fan operation.

Questions?

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