AABC Commissioning Group

AIA Provider Number 50111116

Case Study of Fan Performance

Course Number: CXENERGY1932

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Engineered Air Balance Co., Inc.

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Course Description

This presentation will focus on a fan system that did not perform as designed due to equipment and installation deficiencies. The methods of testing and verification of measurements will be discussed as well as system effect on the fans. The equipment issues found stemmed from modifications made to the fan to use 316 Stainless Steel as the required material. The fan issues could not be resolved until an aluminum fan was installed for comparative testing.

Learning Objectives

At the end of the this course, participants will be able to:

1. How system effect can be measured in the field.

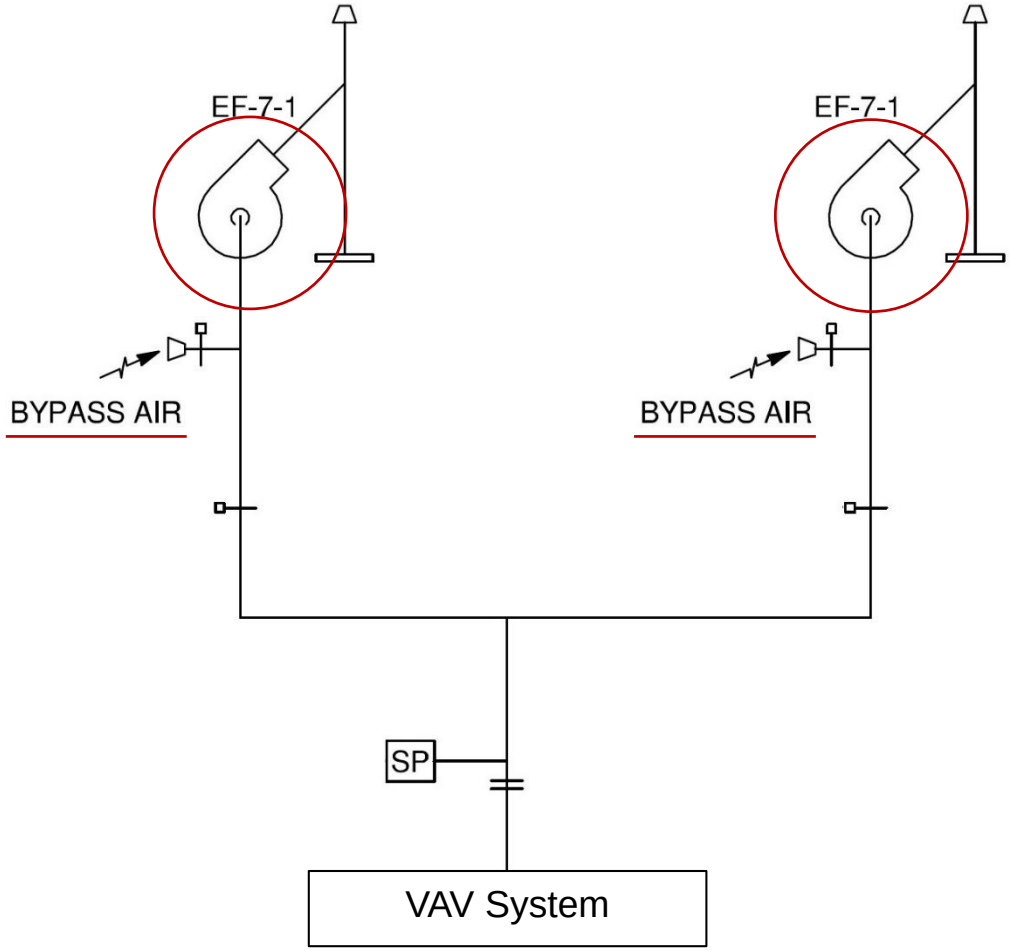
2. The importance of recognizing and reducing system effect.

3. Potential impact of fan manufacturer's assuming one wheel testing is the same for all wheels the same size.

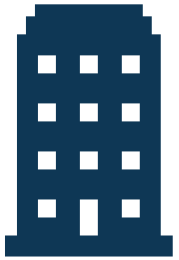
4. How a controlled testing environment must be maintained to identify different variables.

System Information

Two redundant exhaust fans serve a research facility.



System Information



System Total Airflow Design

25,000 CFM

Fan Selection Point

- 25,000 CFM
- 3.9” WC
- 1070 RPM and 55 Hz

Wind Study required
(plume height and dilution rate)

24,000 CFM

Challenges

All pressure independent control valves calibrated.

Independently, each fan was unable to satisfy the system.

The system required 3.5 IWC at fan inlet to satisfy all terminal unit setpoints.

Challenge Results

Both fans were traversed and measured:

- 23,065 CFM
- 2.10” SP
- 60 Hz or 1170 RPM

Results did not match the fan curve:

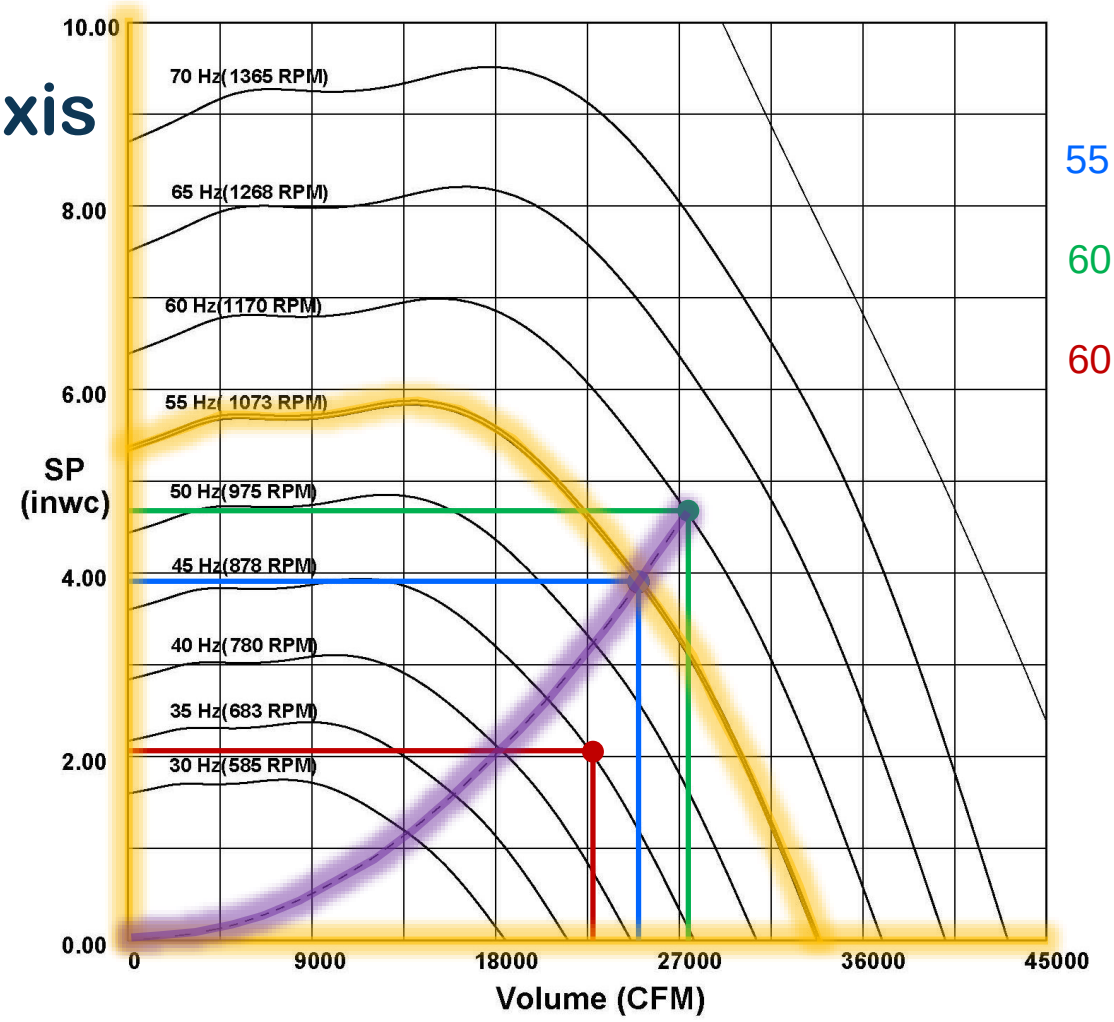
- Airflow
- Static
- RPM

Challenge Fan Curve

Fan Curve Showing 60Hz Test Results

Fan Curve
System Curve

Y - Axis



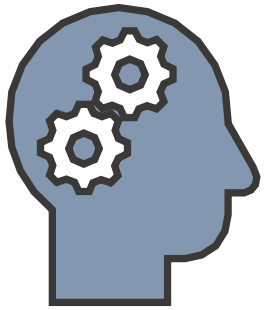
55 Hz Design Point

60 Hz Fan Curve Operating Point

60 Hz Actual Operating Point

X - Axis

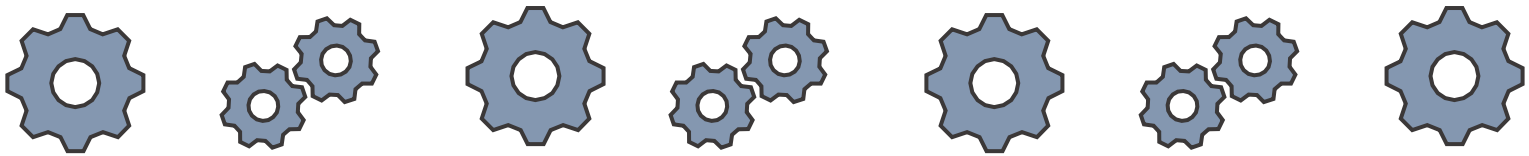
Brainstorming Solutions



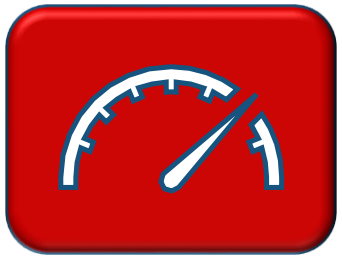
1. **Are the measurements accurate?**

2. **Would increasing the fan speed provide the needed capacity?**

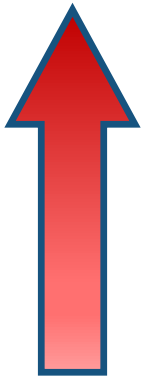
3. **What is causing the fan to not operate on the fan curve?**
   - **External System Effect**
   - **Internal System Effect**



Increasing Fan Speed



Maximum Fan Speed
1334 RPM ≈ 67 Hz

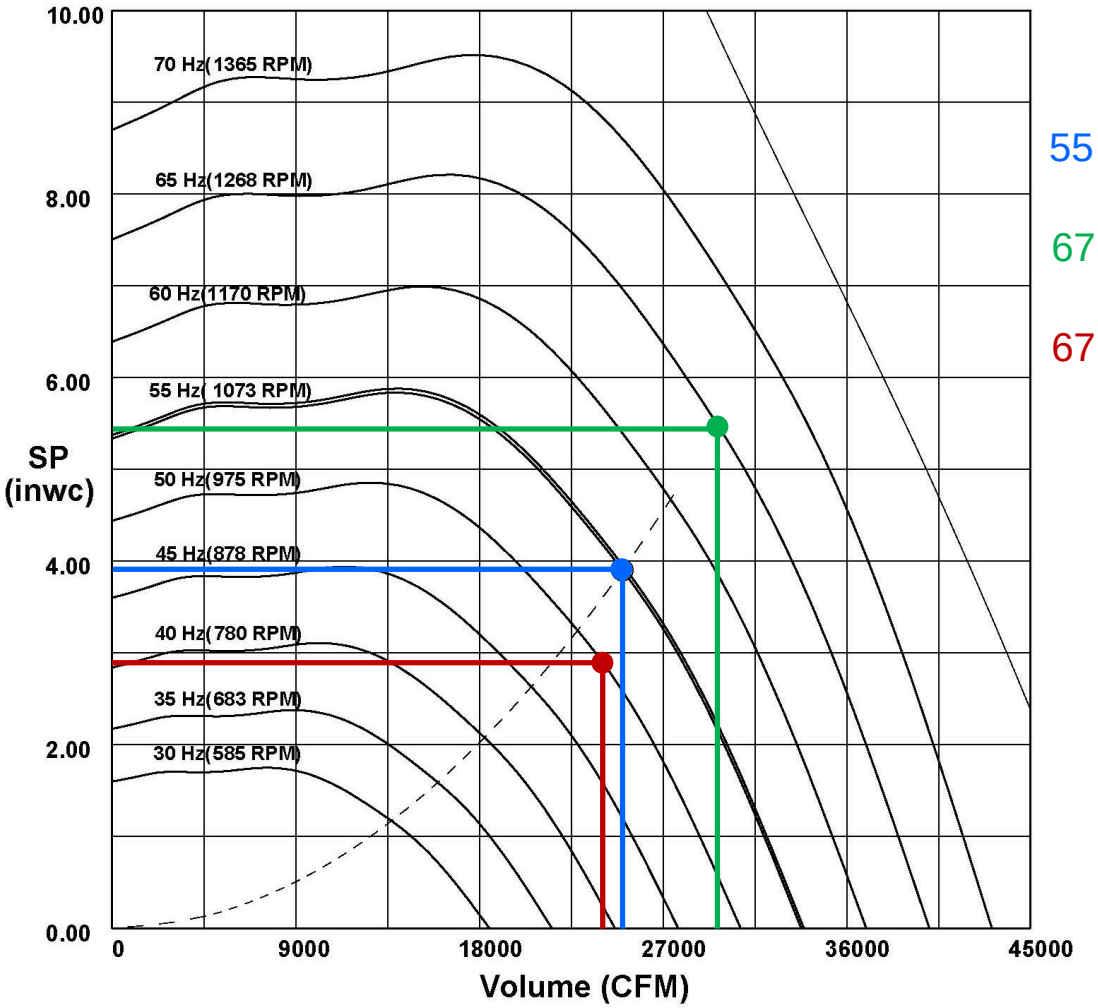


The increased fan speed produced
24,145 CFM at 2.9” SP

Increasing fan speed did not address System Effect.

Increasing Fan Speed

Fan Curve Showing 67Hz Test Results

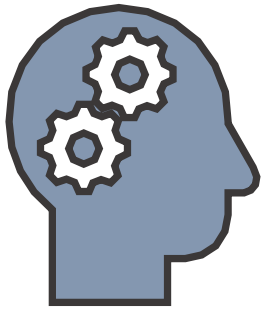


55 Hz Design Point

67 Hz Fan Curve Operating Point

67 Hz Actual Operating Point

Brainstorming Solutions

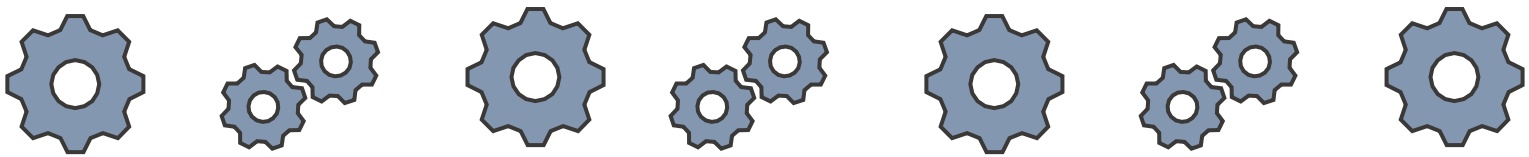


~~1. Are the measurements accurate?~~

~~2. Would increasing the fan speed provided the needed capacity?~~

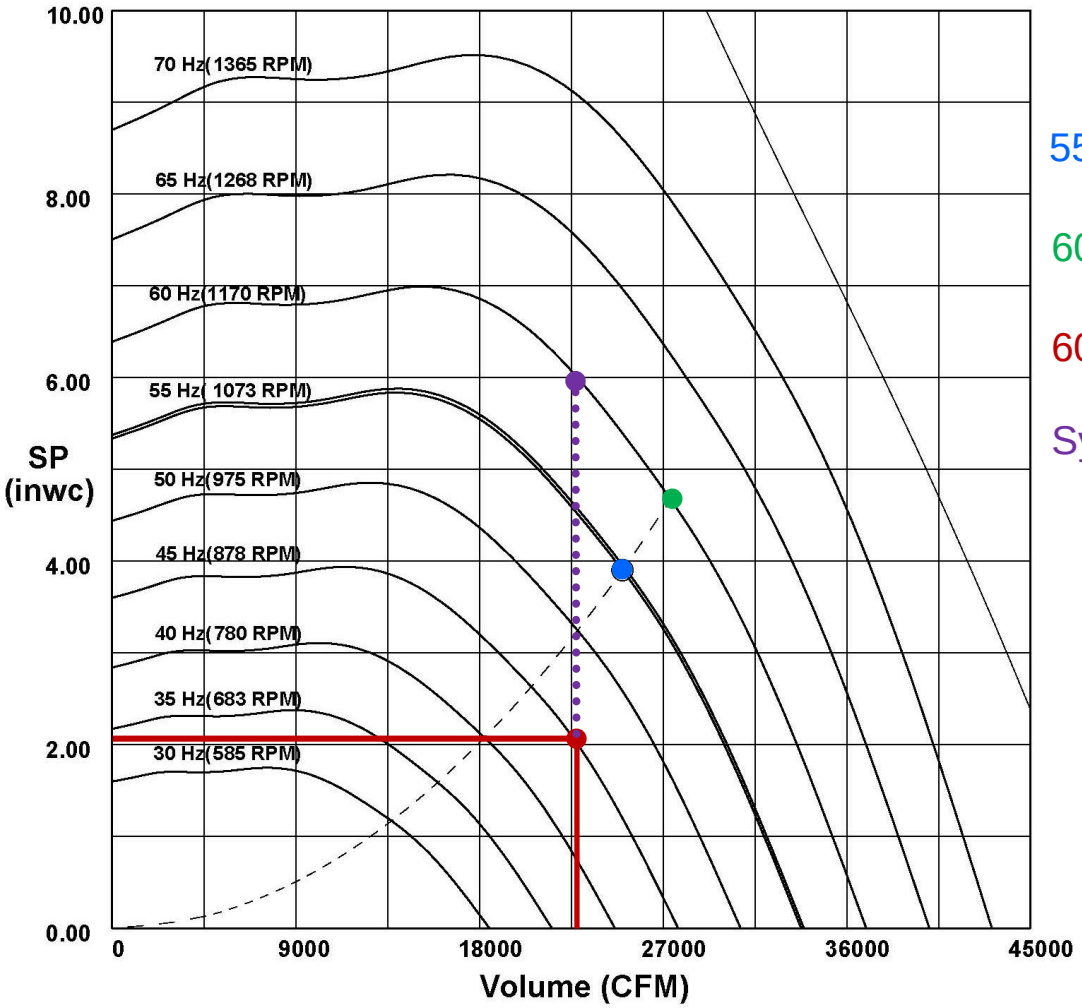
3. What is causing the fan to not operate on the fan curve?

- **External System Effect**
- **Internal System Effect**



System Effect

60Hz Fan Curve



55 Hz Design Point

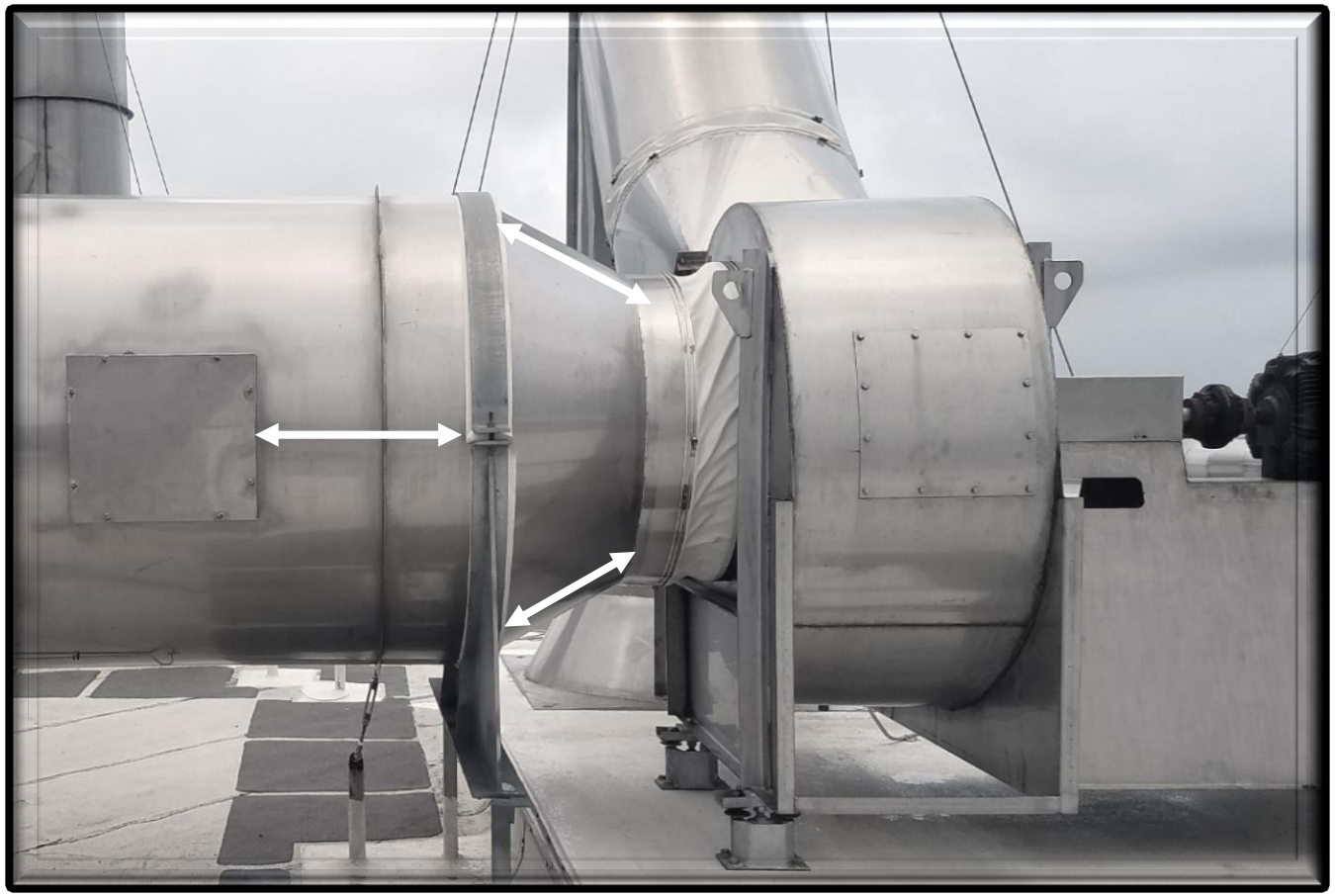
60 Hz Fan Curve Operating Point

60 Hz Actual Operating Point

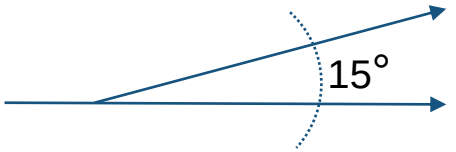
System Effect

System Effect

Duct Connections



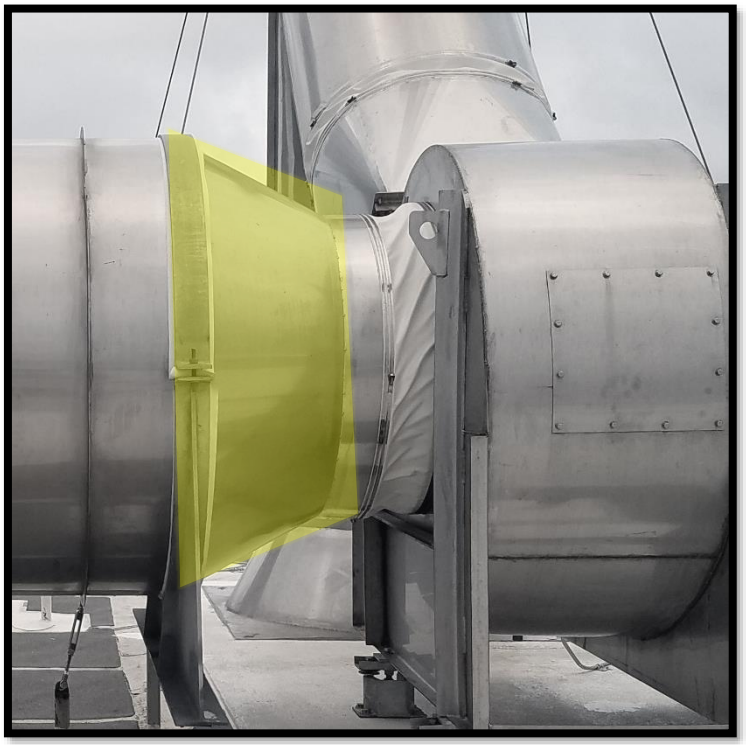
System Effect
External



Manufacturer Product Data

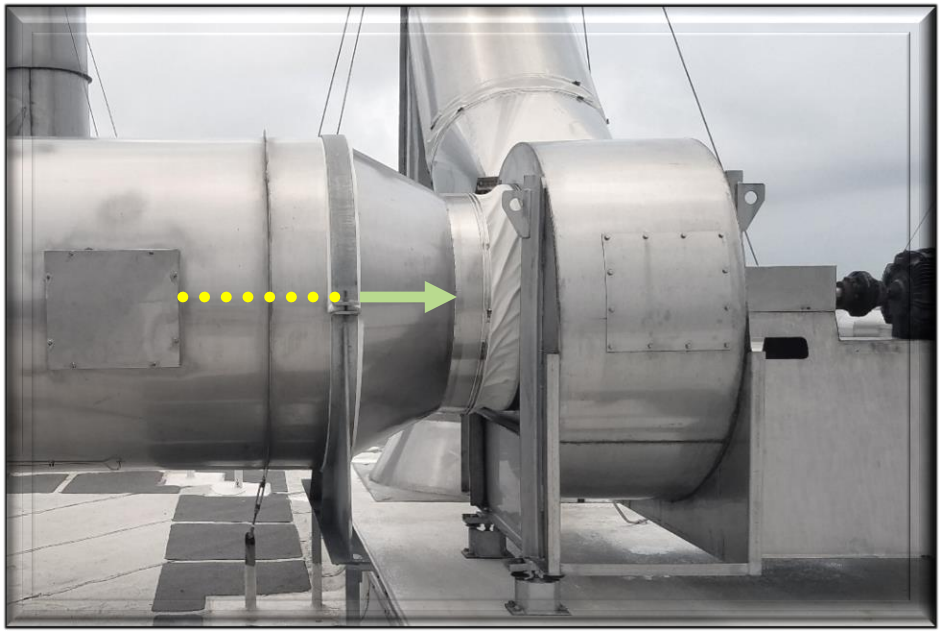
- Maximum allowable contracting duct angle = 15 degrees

1st modification to eliminate system effect = Adjust Inlet Cone

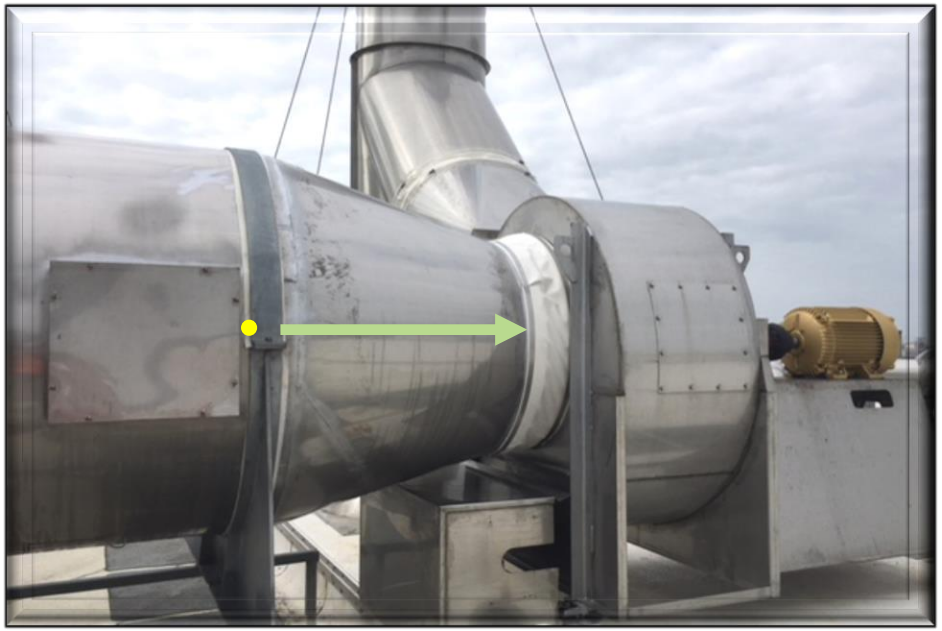


System Effect
External

Old Inlet



New Inlet

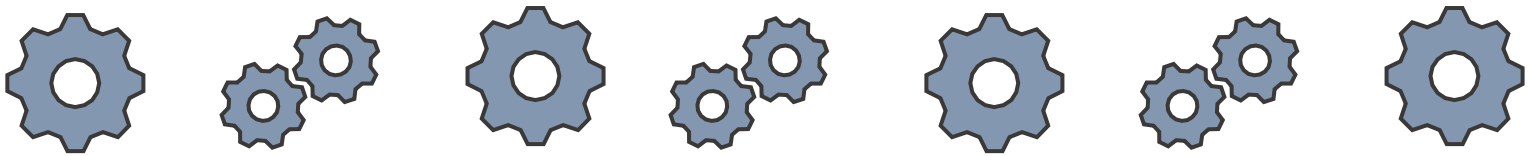


Step in the right direction but not a complete solution.

System Effect
Internal

1. **Could the construction of the fan be causing system effect?**

2. **What difference does 316 Stainless Steel make when building the fan?**

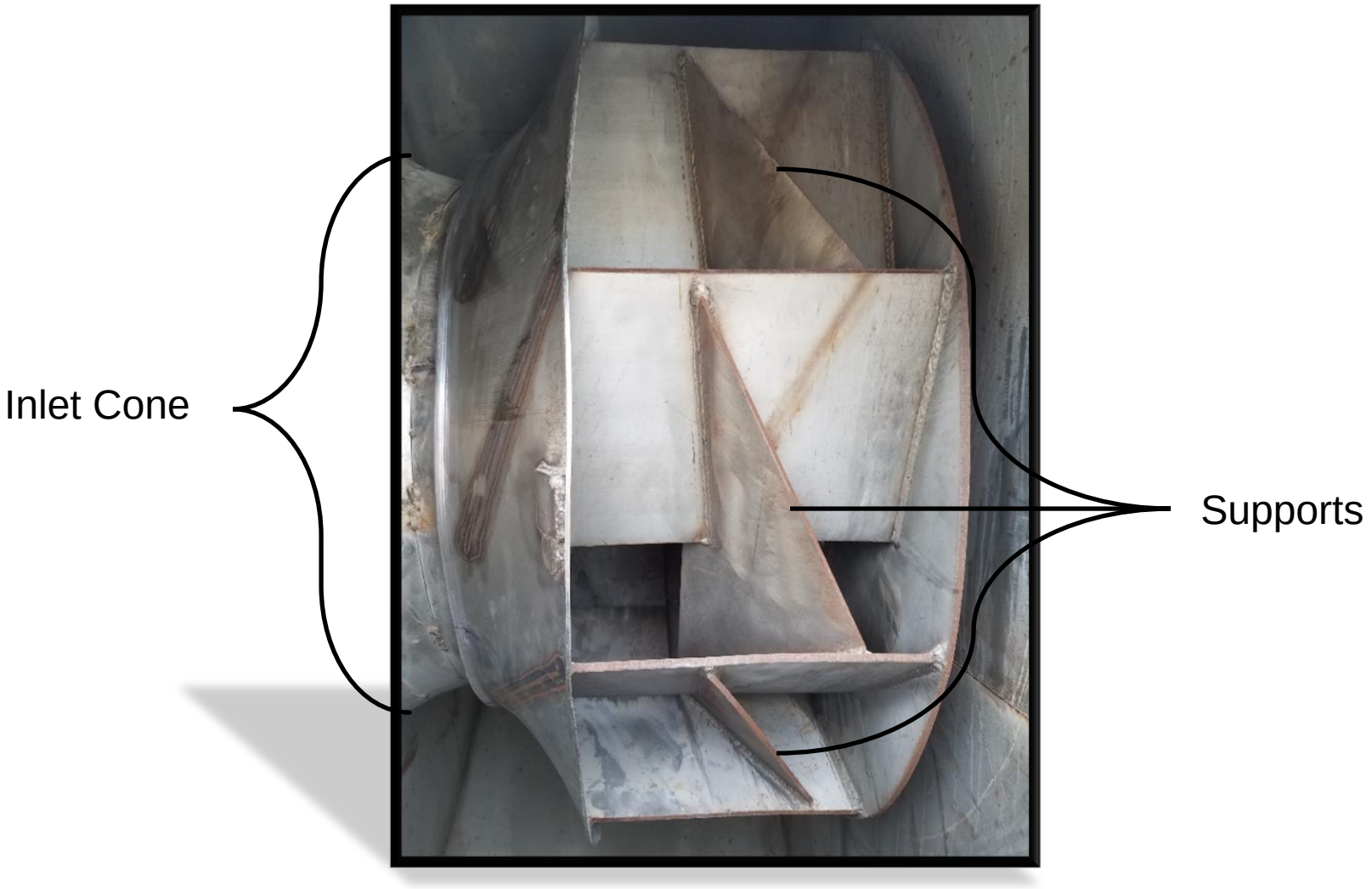


System Effect
Internal

Fan Wheel Supports

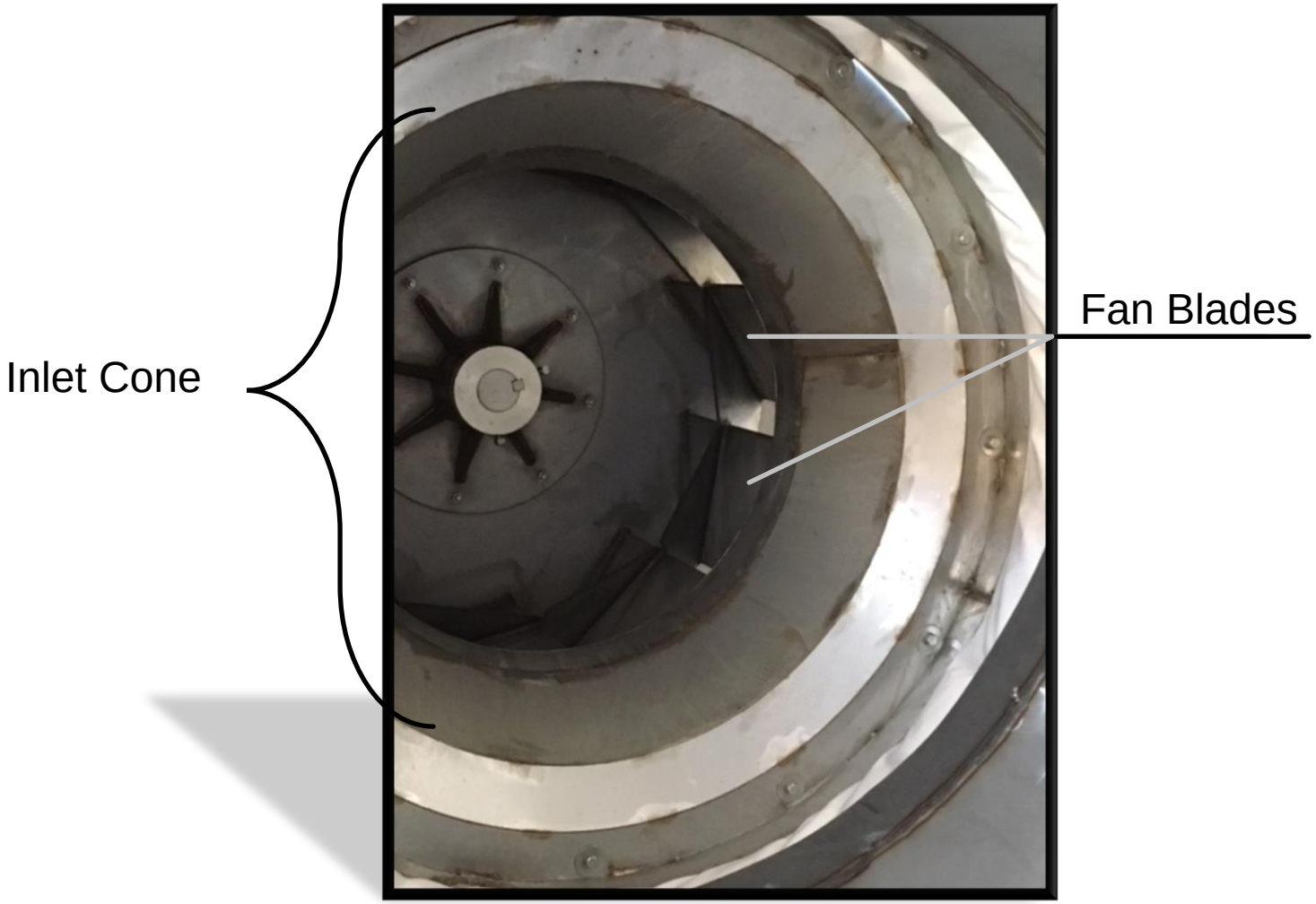
Inlet Cone Construction

System Effect
Fan Wheel



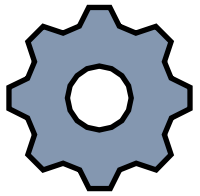
System Effect - Fan Wheel Supports

Inlet Cone



Inlet Cone

Construction Materials

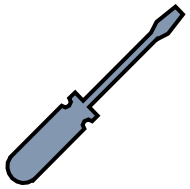
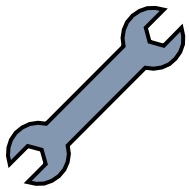
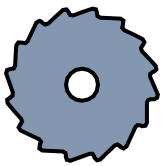
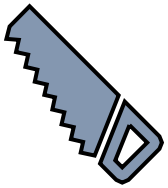


1. **External sources** of system effect have been **minimized.**

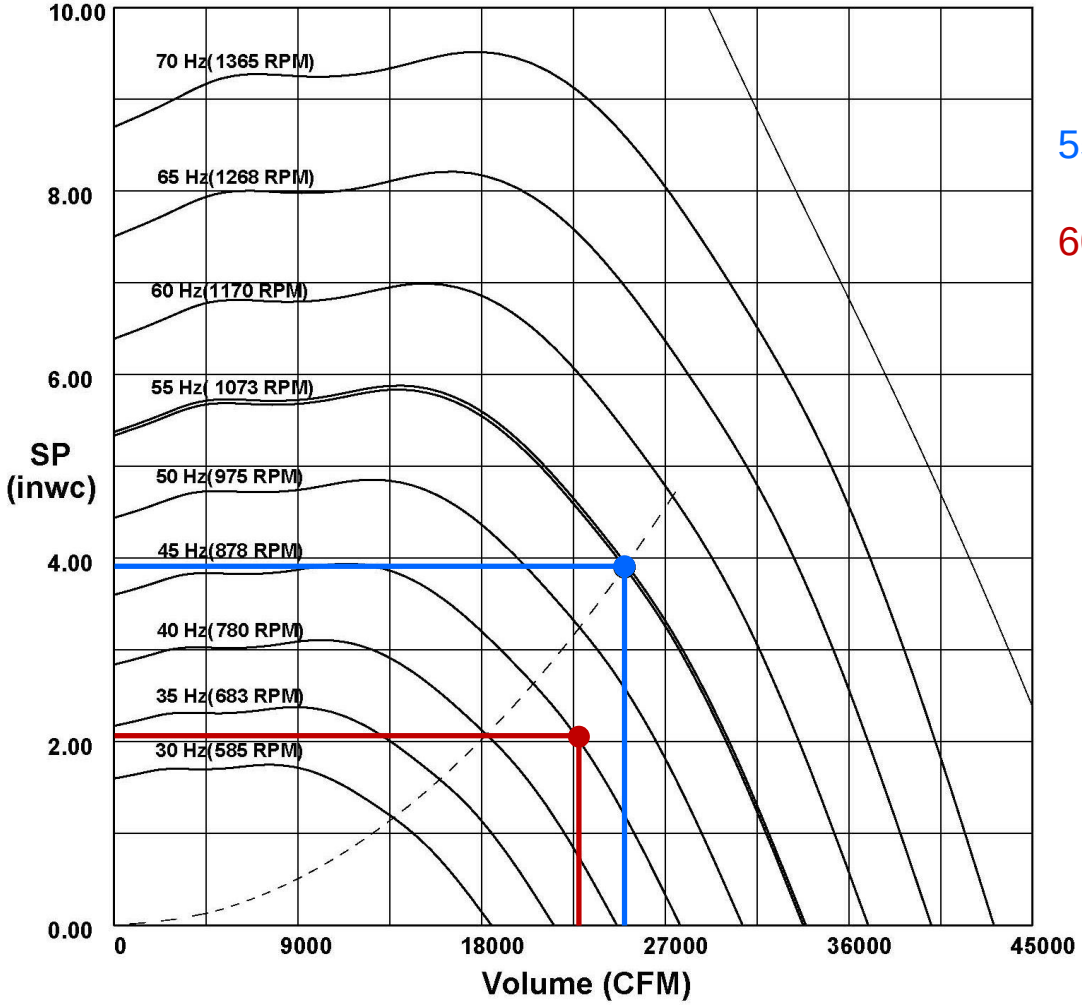
2. **System effect must** be caused by something **internal to the 316SS fan.**

3. **Temporary** factory tested **aluminum** fan was provided to replace the 316SS fan.

4. **Aluminum** fan **successfully** achieved the design capacity for both:
   - Airflow
   - Static Pressure

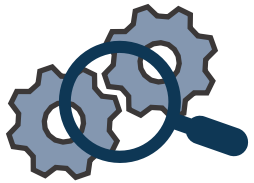

Construction Materials



55 Hz Aluminum Fan Operating Point

60 Hz 316 SS Operating Point

Controlled Environment Testing



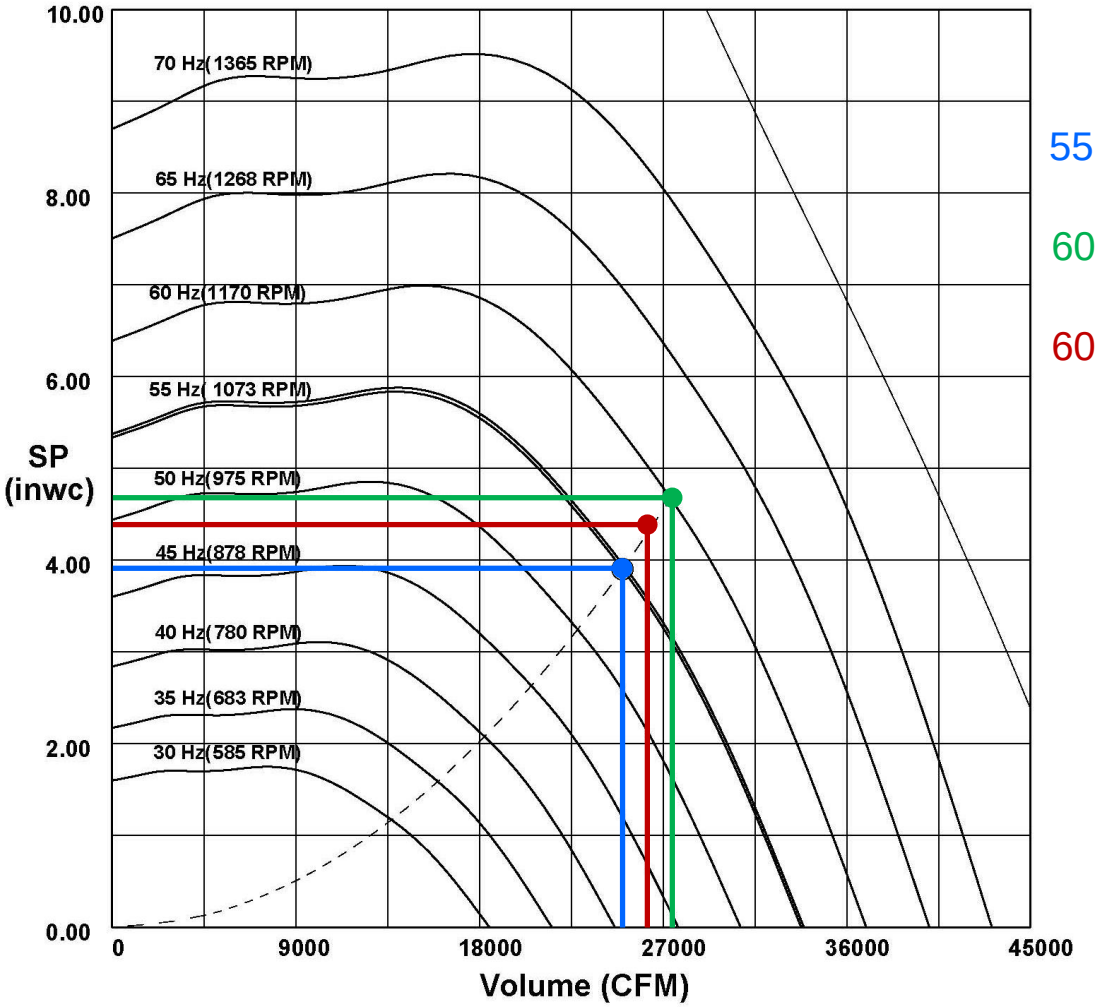
- **Stainless Steel fan** tested on the **test stand**:
  Made it possible to measure capacity with various static restrictions.

- **Ability** to determine the **cause**:
  System effect was caused by the fan.

- **Manufacturer identified** the inlet cone was **not built per design**:
  Different Material and Construction methods caused the system effect.

- **New Fan** was **re-tested** on the bench:
  Success; it performed as desired.

Repaired Fan Performance



55 Hz Design Point

60 Hz Fan Curve Operating Point

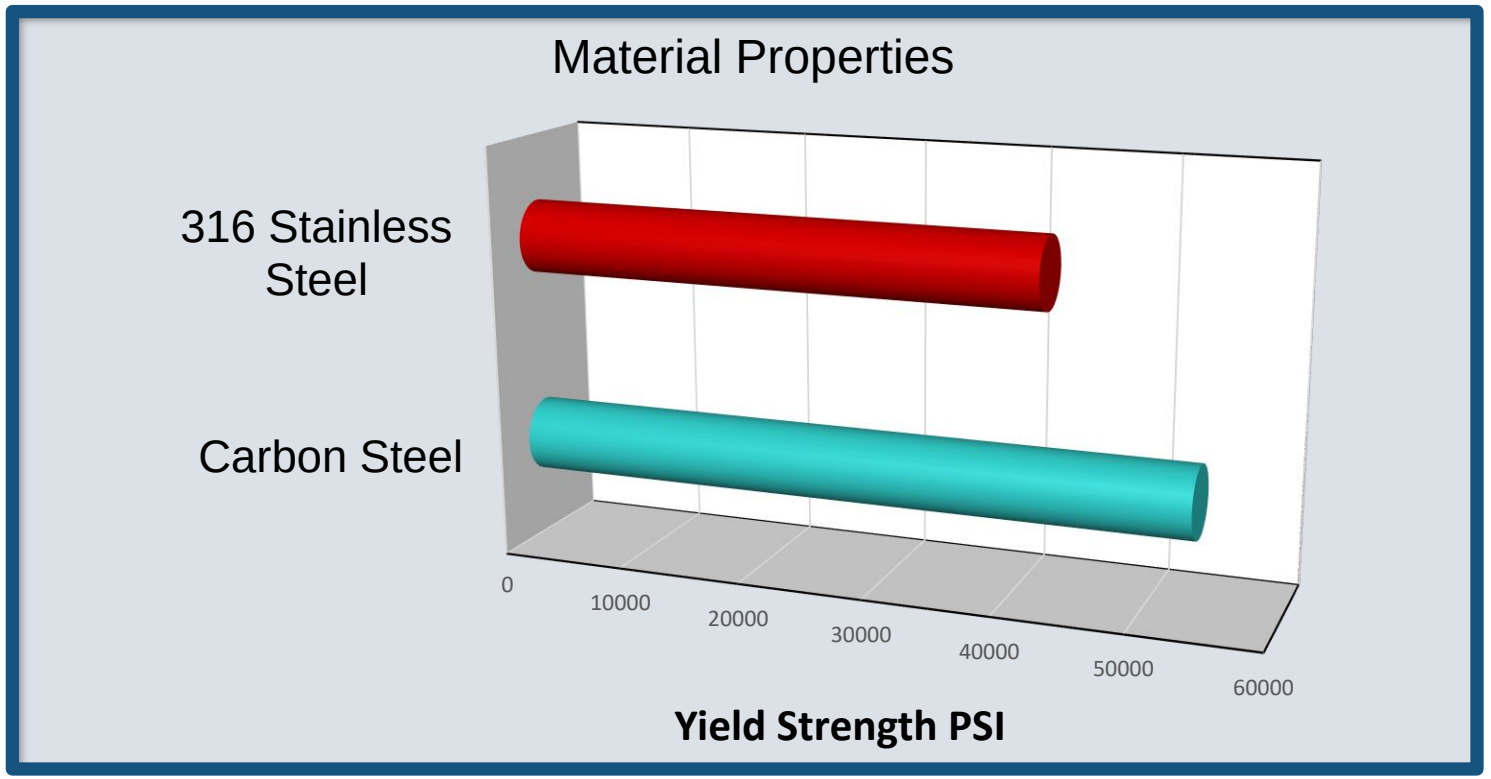
60 Hz Actual Operating Point

Fan Curve Cause and Effect

Not every manufactured fan is tested in the factory

Construction Materials

Assuming different materials will work interchangeably Causes Significant Problems

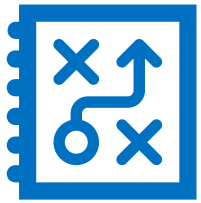


Product Verification

Verify Product Delivery

Dramatization - Not an actual fan

Controlled Testing



Controlled Environment testing made it possible to determine the cause of system effect.

Learning Objectives Overview

1. How system effect can be measured in the field.
    - Using the Fan Curve

2. The importance of recognizing and reducing system effect.
    - External and Internal components

3. Potential impact of fan manufacturer's assuming one wheel testing is the same for all wheels the same size.
    - 316 SS vs. Carbon Steel

4. How a controlled testing environment must be maintained to identify different variables.
    - Identify the deficient component

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