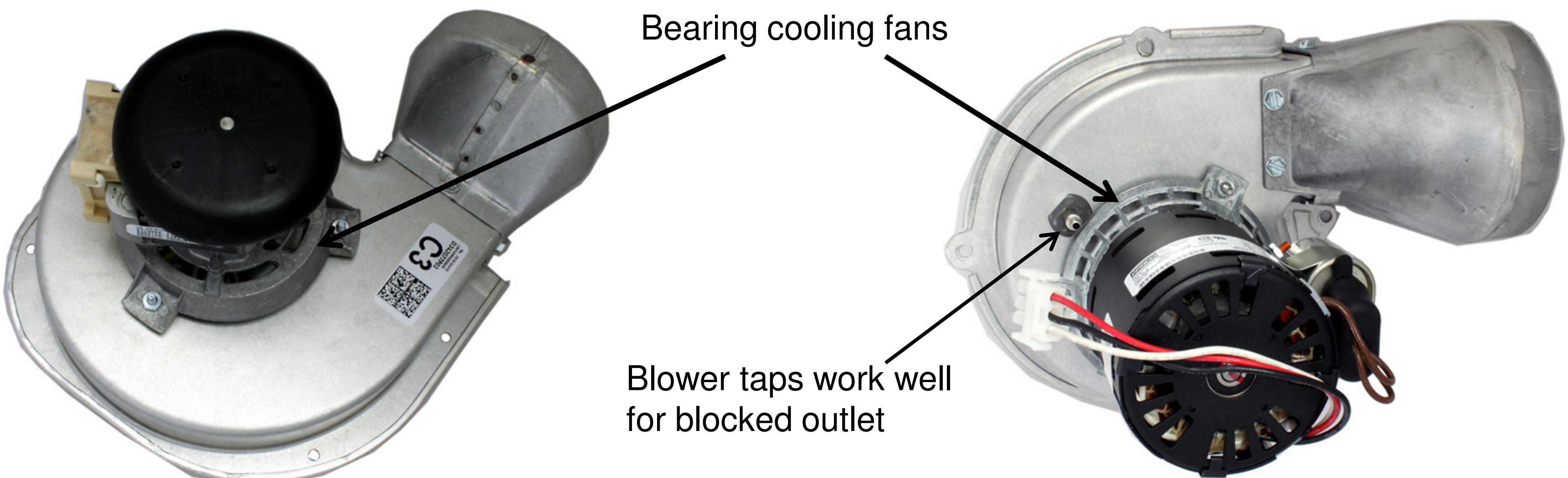
Application of Combustion Blowers
ASGE Technical Conference

June 7, 2011

Types of Combustion Blowers

- Induced metal
- Induced plastic
- Pressure metal
- Dilution air – water heater
- Non-Dilution air – water heater
- Premix

Induced Draft Metal

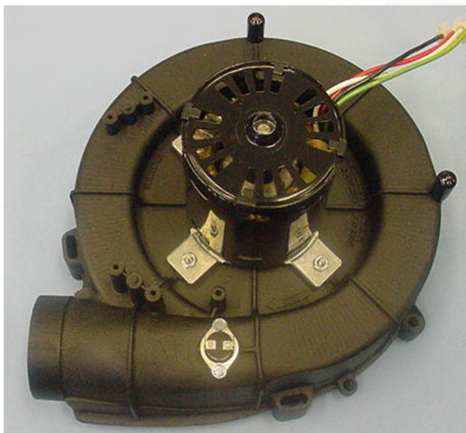


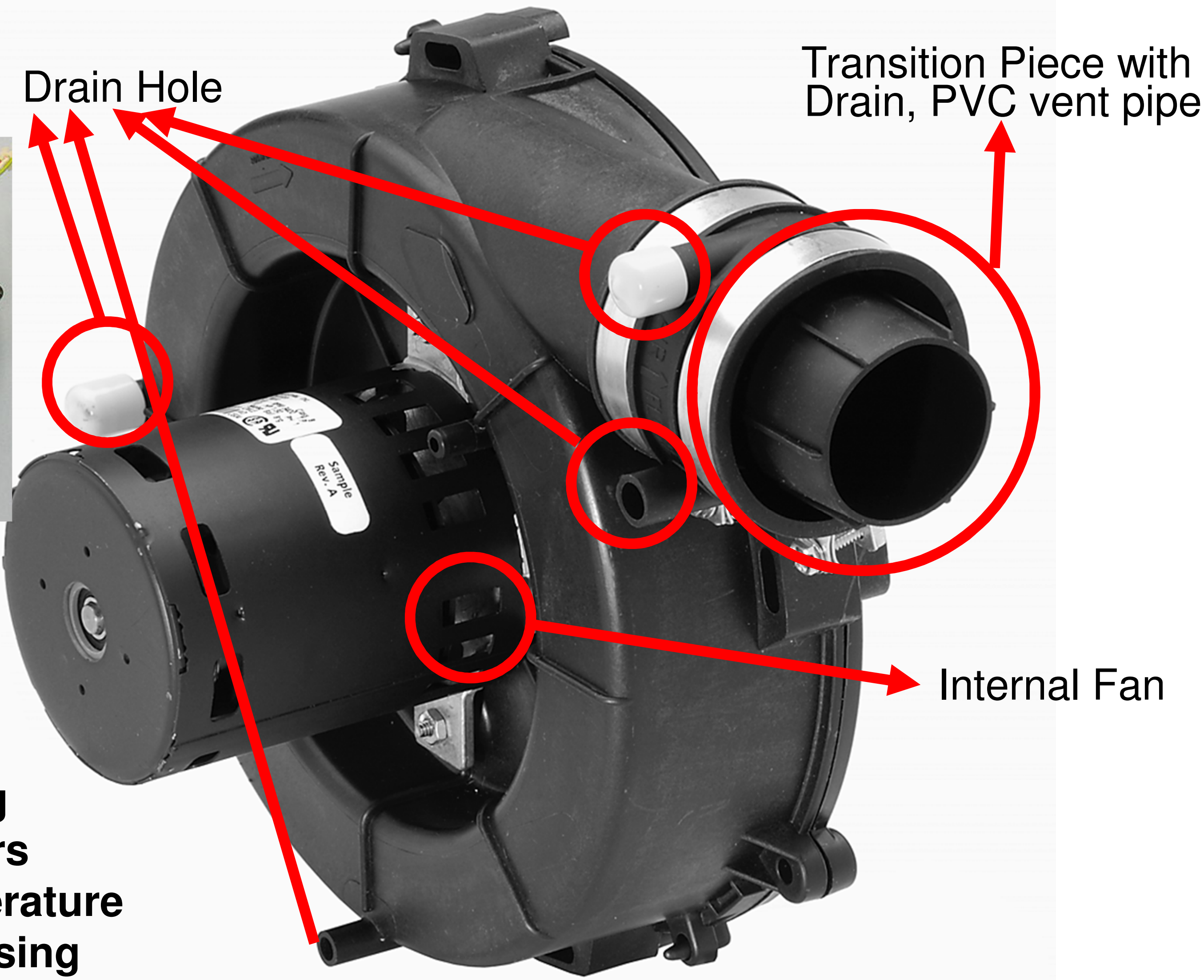
CCW rotation with 4” outlet,
C-Frame Motor
Clinch seam construction

CW rotation with 4” outlet,
PSC Motor
Clinch seam construction

- **Aluminized steel housing**
- **Aluminized or galvanized steel impellers**
- **Flue gas temperature throughout housing typically 350˚F - 450˚F**
- **No Condensate**

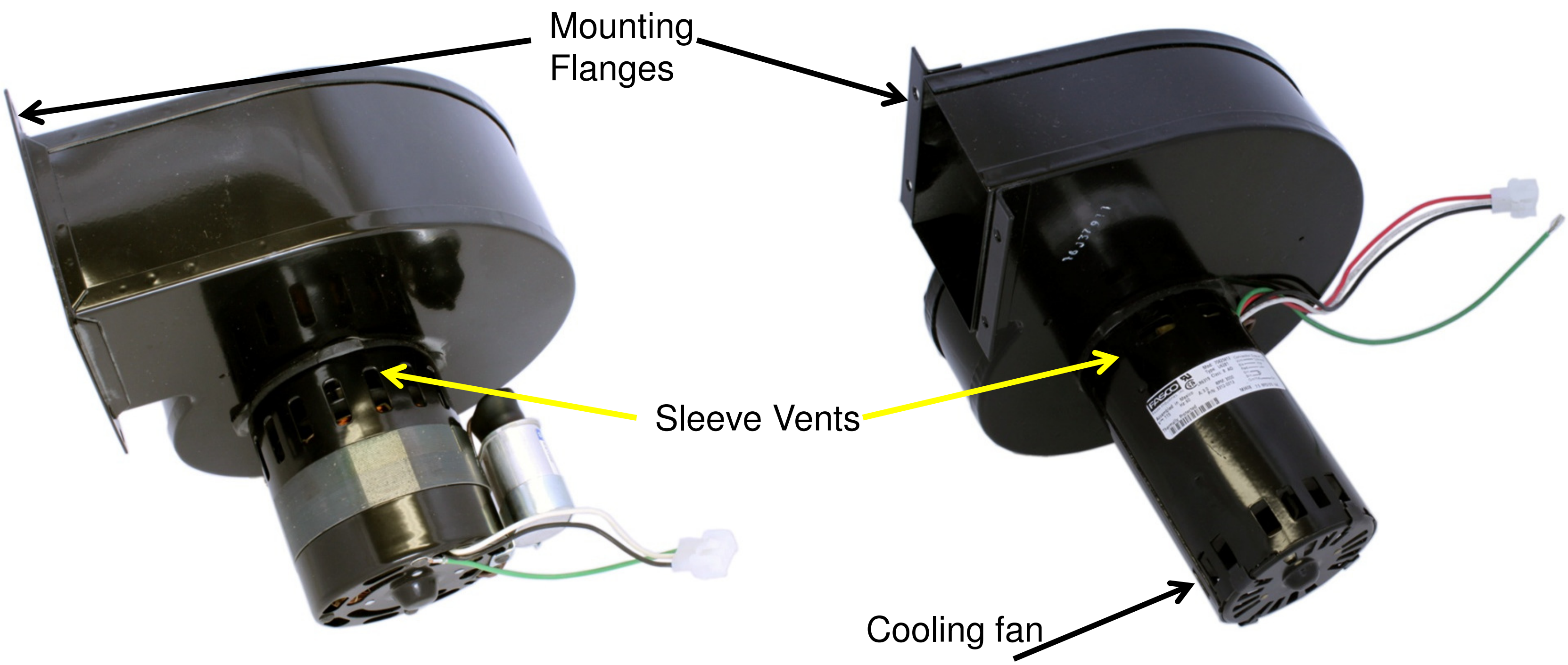
Induced draft Plastic



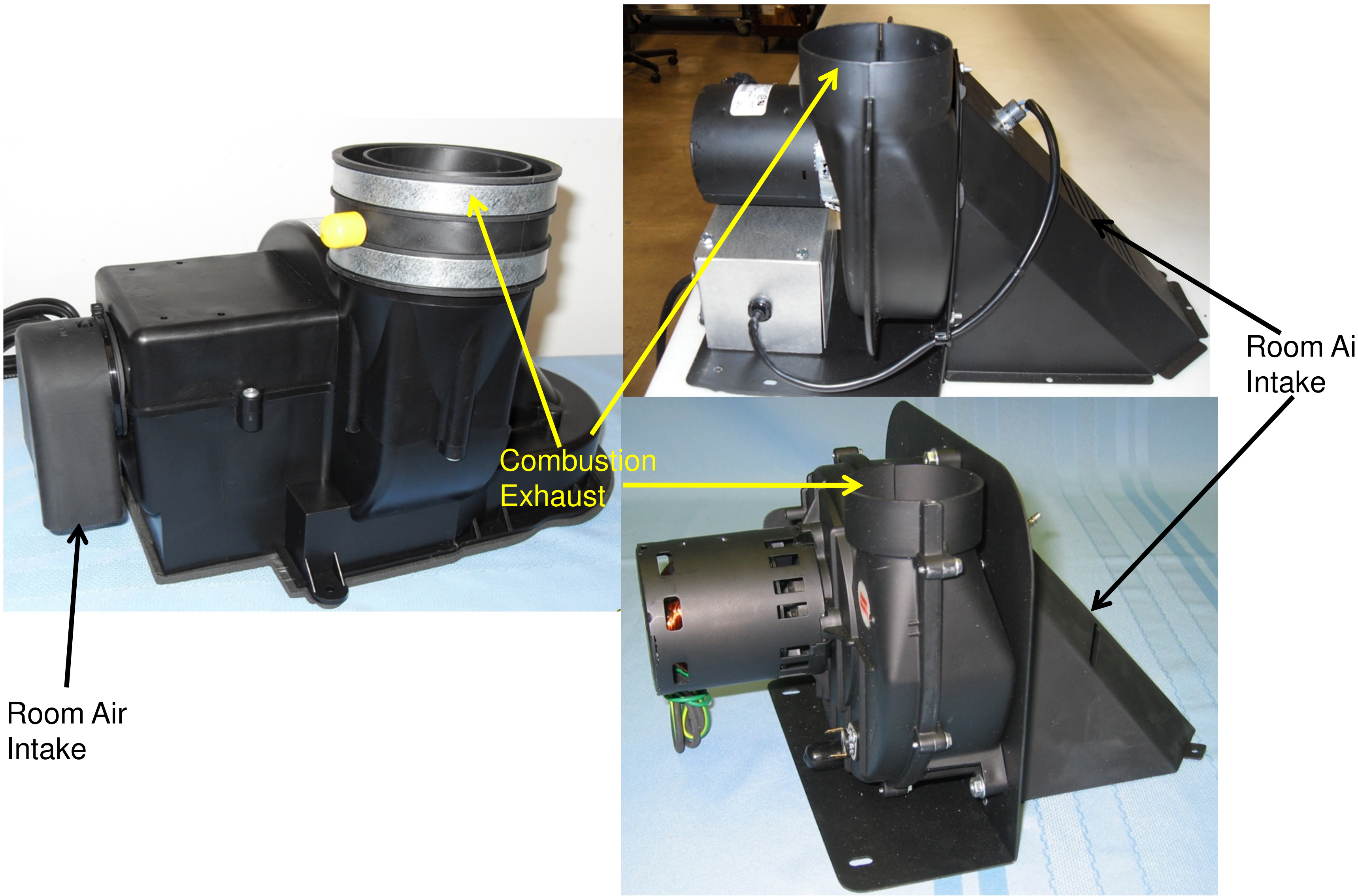


- **Plastic housing**
- **Plastic impellers**
- **Flue gas temperature throughout housing typically 120˚F +/-**

Pressure Blowers

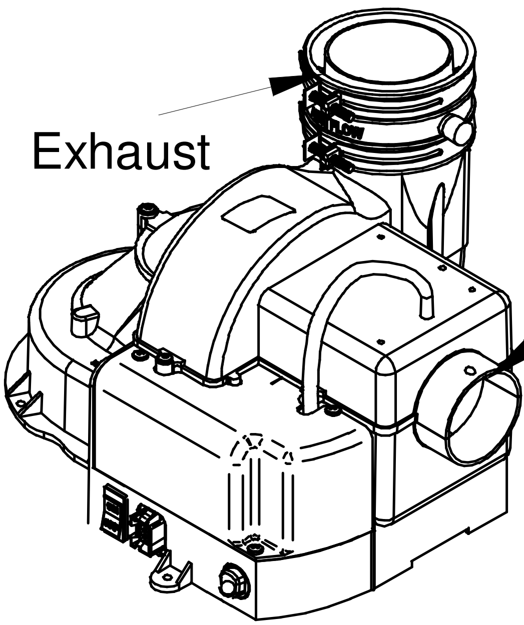


Dilution Air Blowers

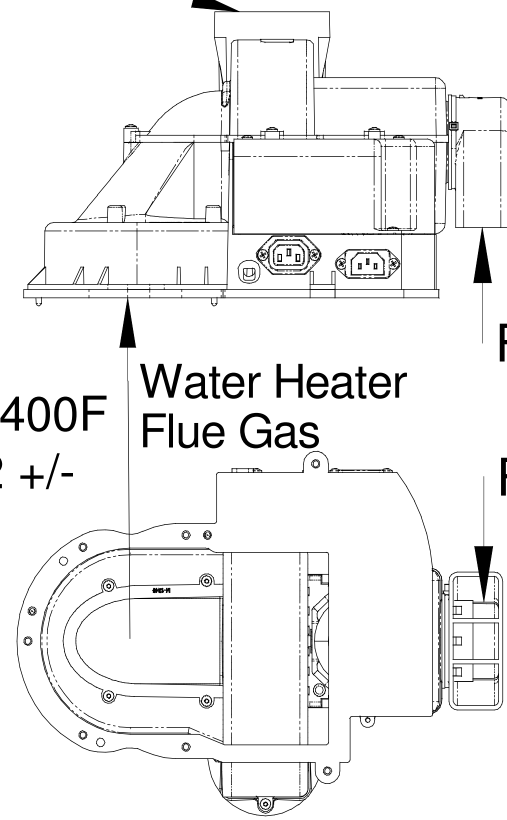


Dilution Air Blowers

Direct Vent



Power Vent



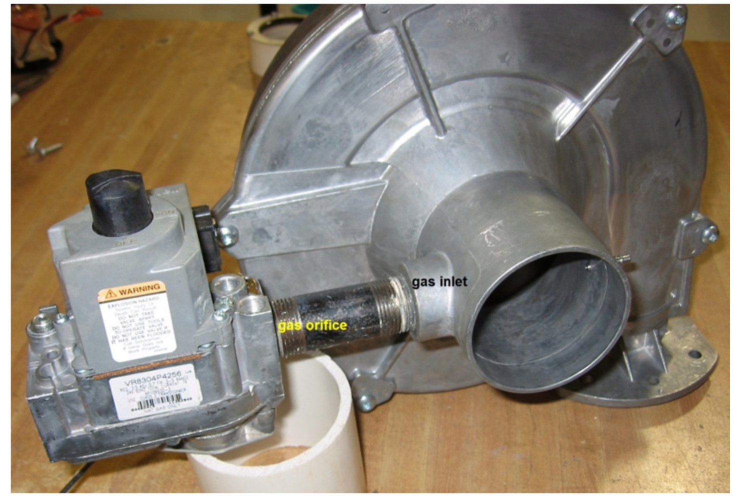
Non-Dilution Air Blowers

- **Aluminum or Aluminized steel housing**
- **Aluminized or galvanized steel impellers**
- **Flue gas temperature throughout housing typically 350˚F - 450˚F**

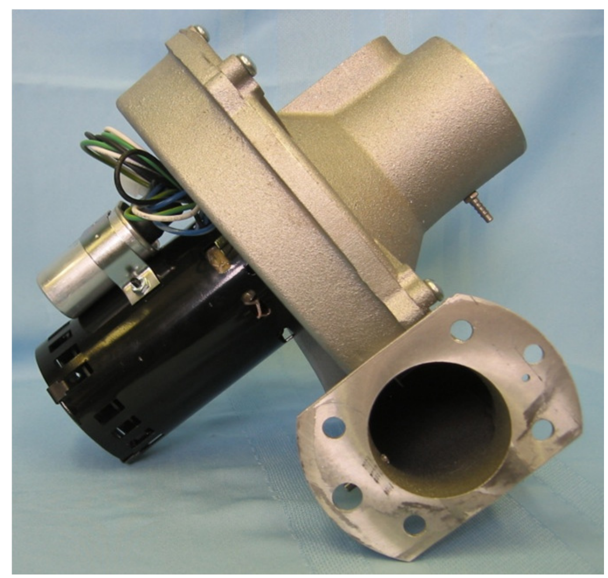
CAT 1

Premix Blowers

Negative pressure gas valve



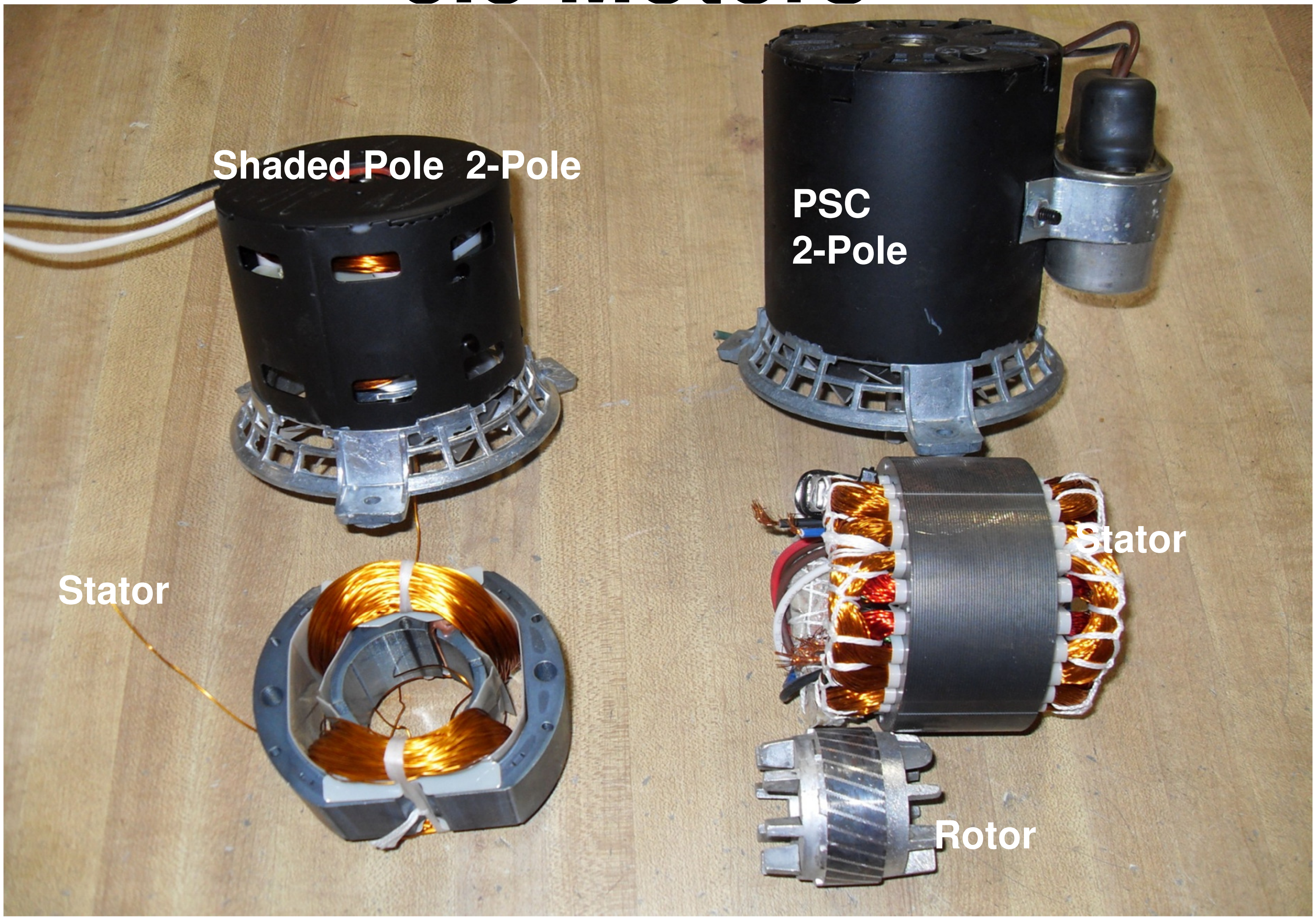
Positive pressure gas valve



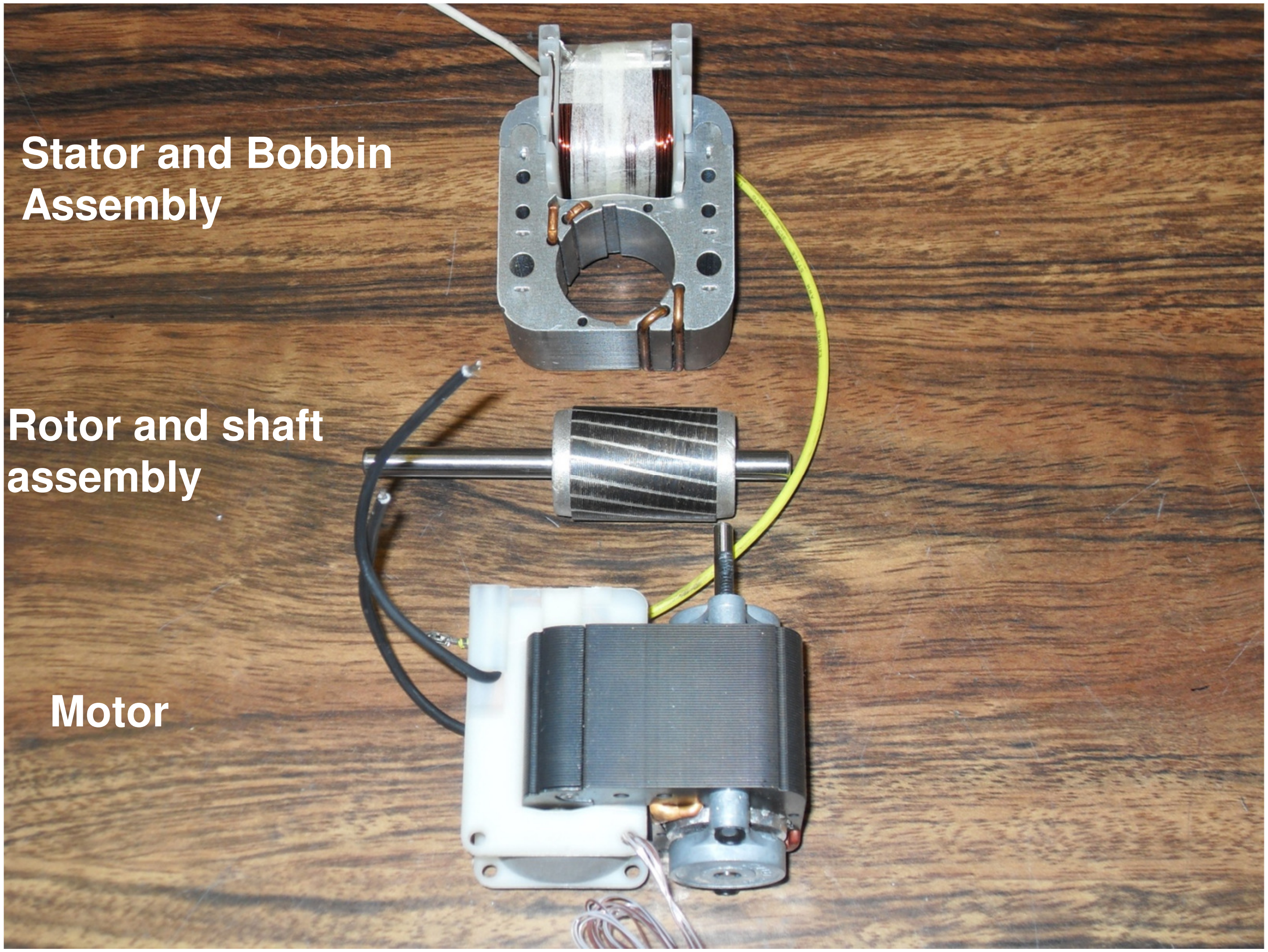
Typical Combustion Blower Motors

- C-Frame – lowest cost and efficiency, up to 2 speeds. Dual and single voltage to 480 VAC.
- Shaded Pole – up to 2 speeds. dual and single voltage to 480 VAC.
- PSC – (Permanent Split Capacitor Motor) 3 speeds available. Dual & single voltage to 480 VAC.
- 3-Phase - No additional starting devices, capacitors or switches are required for operation. Can be controlled with electronics (VFD)
- BLDC/BLAC - Permanent Magnet

3.3 Motors



C-Frame Motor



Thermal Protection

Common Protector types include:

- *Auto reset* overloads automatically reconnect power to the motor after the coils have cooled to a safe level.

- *Manual reset* protectors include a reset button to close the protector contacts when the motor can be safely re-started.
- *One shot* protectors will not be reset. The motor winding is permanently opened if the protector operates.

- *Impedance* protection means the motor is simply to weak to develop dangerously high temperatures. These motors do not include an additional protective device.

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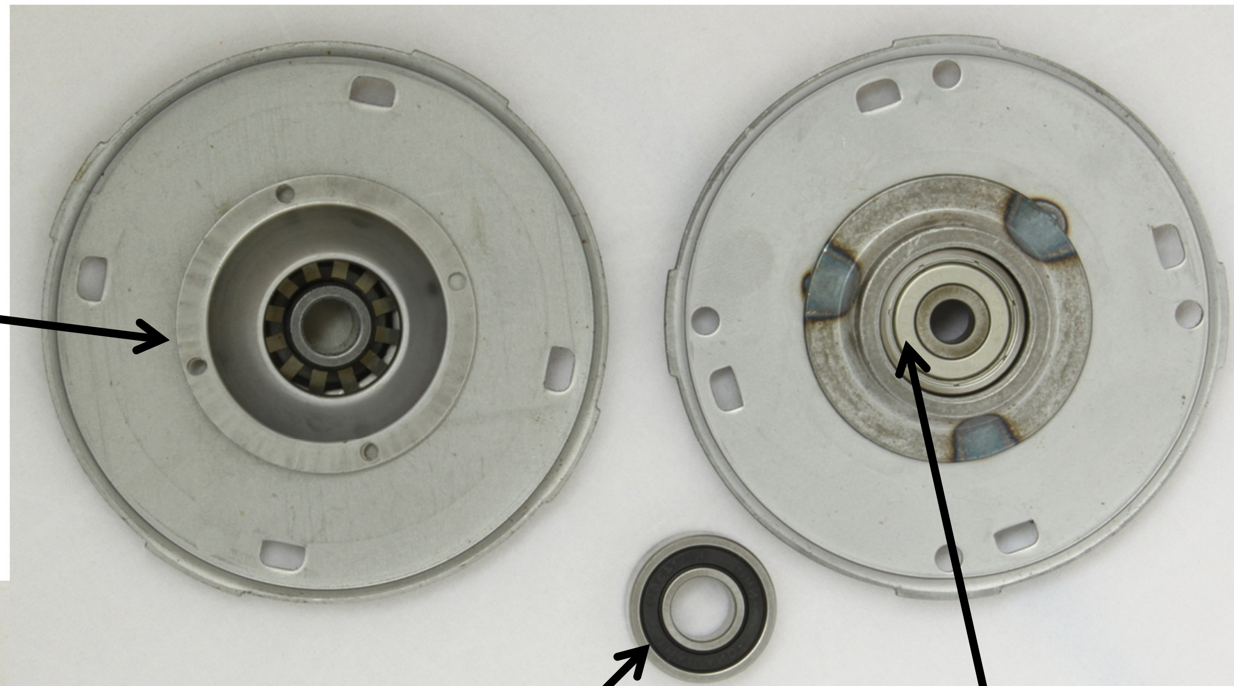
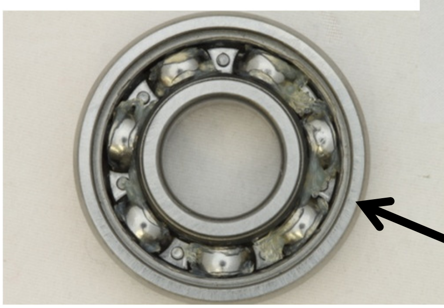
Types of Bearings





Sleeve Bearing in a motor end plate

Ball Bearing

Ball Bearing in a motor end plate

Appliance Blower Sizing

- Type of appliance determines the type of combustion blower needed.
- Negative pressure heat exchanger – induced draft blower, Condensing? Flue Temperature?
- Single burner with modulation option – Pre-Mix

Appliance Blower Sizing

- Heat exchanger pressure drop and vent length determine blower pressure requirements
- Voltage, number of speeds and speed split.

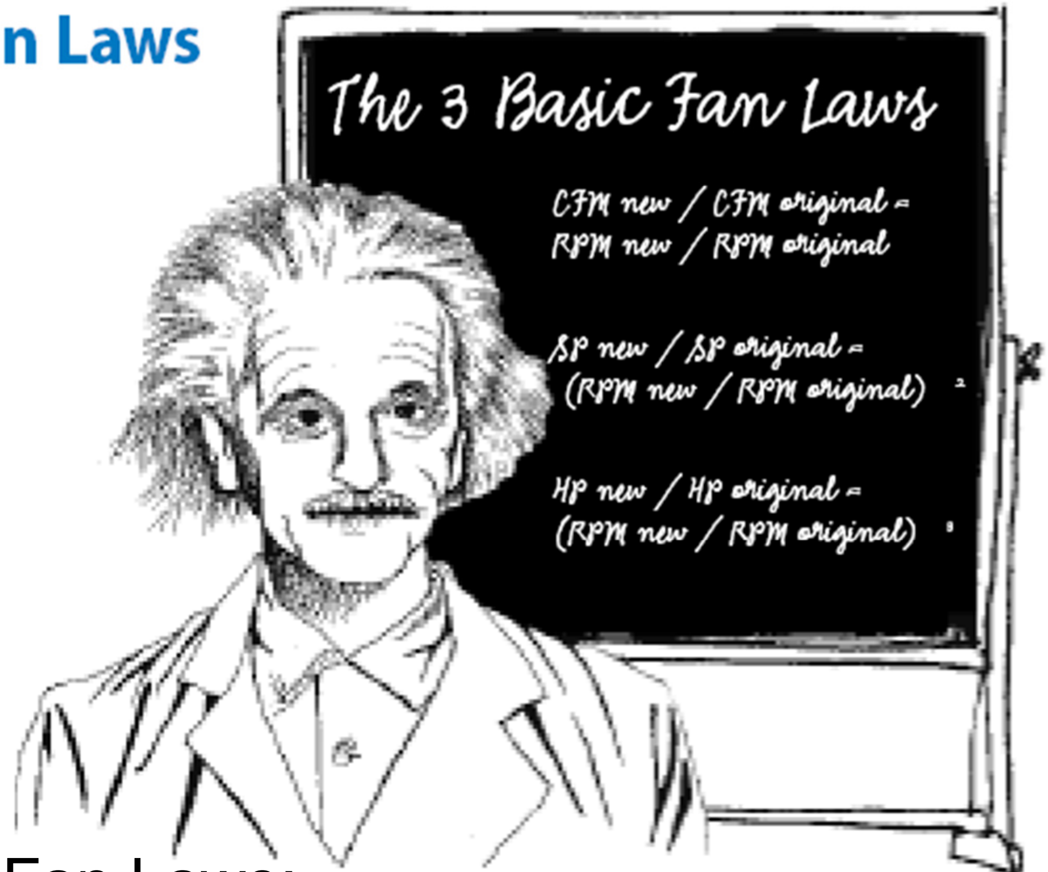
Note: speed tolerance 10% of slip.

Slip = Sync speed – operating speed

Synchronous Speed =(120 X Line Freq.)/(#of Poles) or 120 x 60/2 = 3600

- CFM required – Approximately 25 CFM per 100kBtu/hr, if no dilution in the exhaust.

Basic Fan Laws



The 3 Basic Fan Laws:

CFM new / CFM original = RPM new / RPM original

SP new / SP original = (RPM new / RPM original)^2

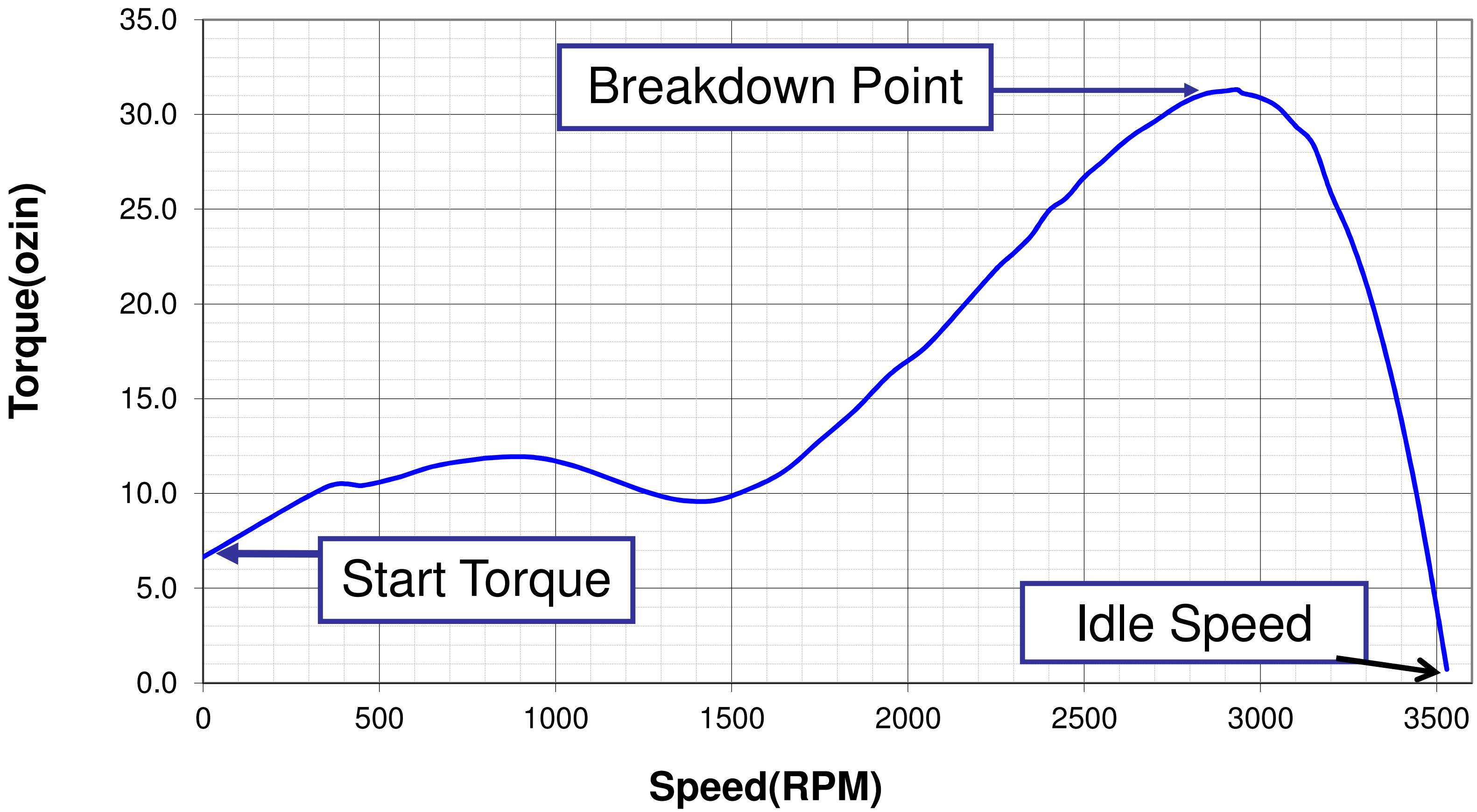
HP new / HP original = (RPM new / RPM original)^3

Fan Laws

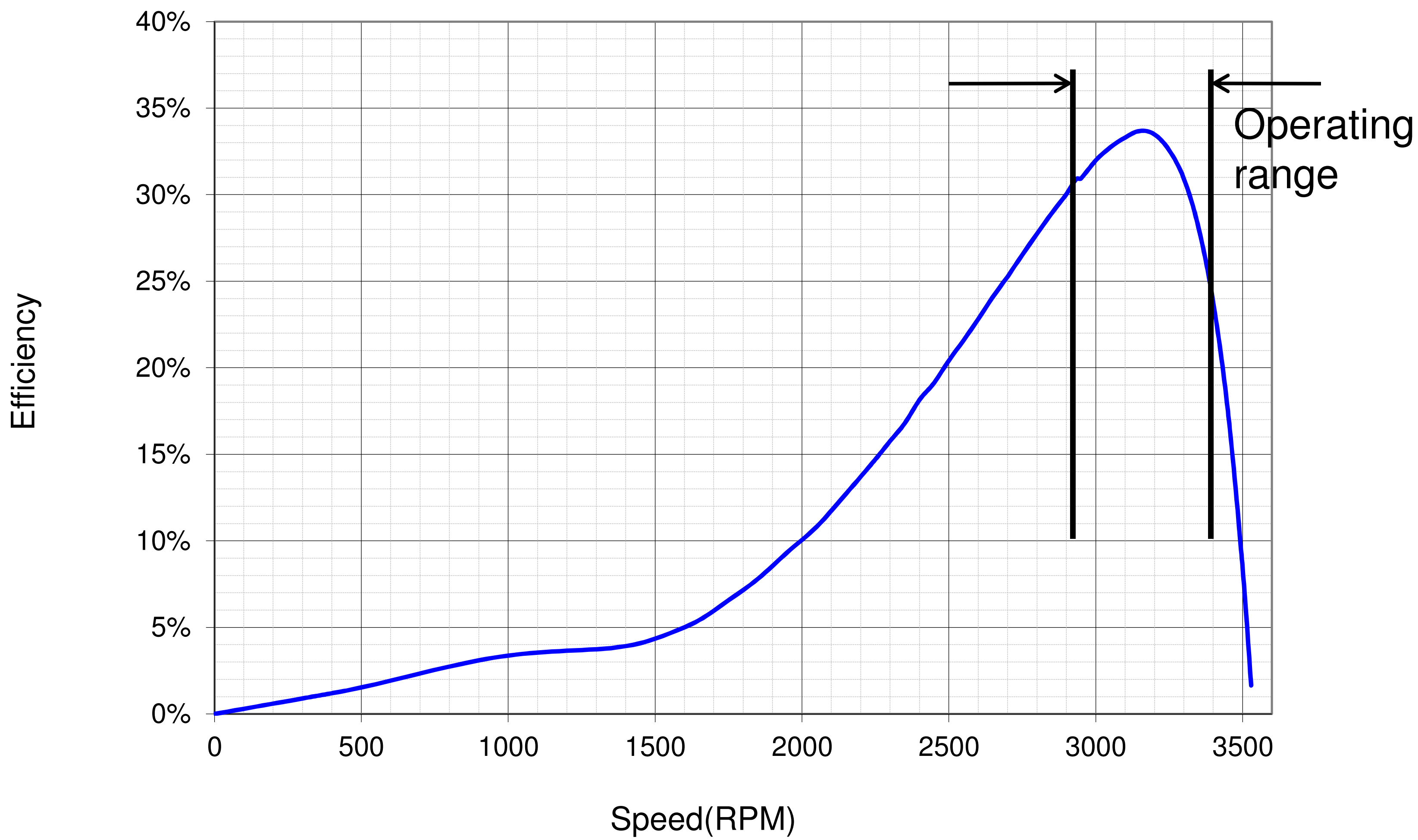
- ***Flow rate varies directly as the speed ratio***
- ***Flow rate varies directly as the width ratio***
- ***Pressure varies as the square of the speed ratio***
- ***Flow rate varies as the cube of the fan diameter ratio***
- ***Horse Power varies as the cube of the speed ratio.***
- ***Horsepower varies inversely as the square of the density ratio***

Pressure varies as the square power of the fan diameter
Horsepower varies as the 5th power of the fan diameter
Horsepower and pressure vary directly as the air density ratio
Horsepower varies directly as the width ratio
Air flow varies inversely as the density ratio
Pressure varies inversely as the density ratio
Speed varies inversely as the density ratio

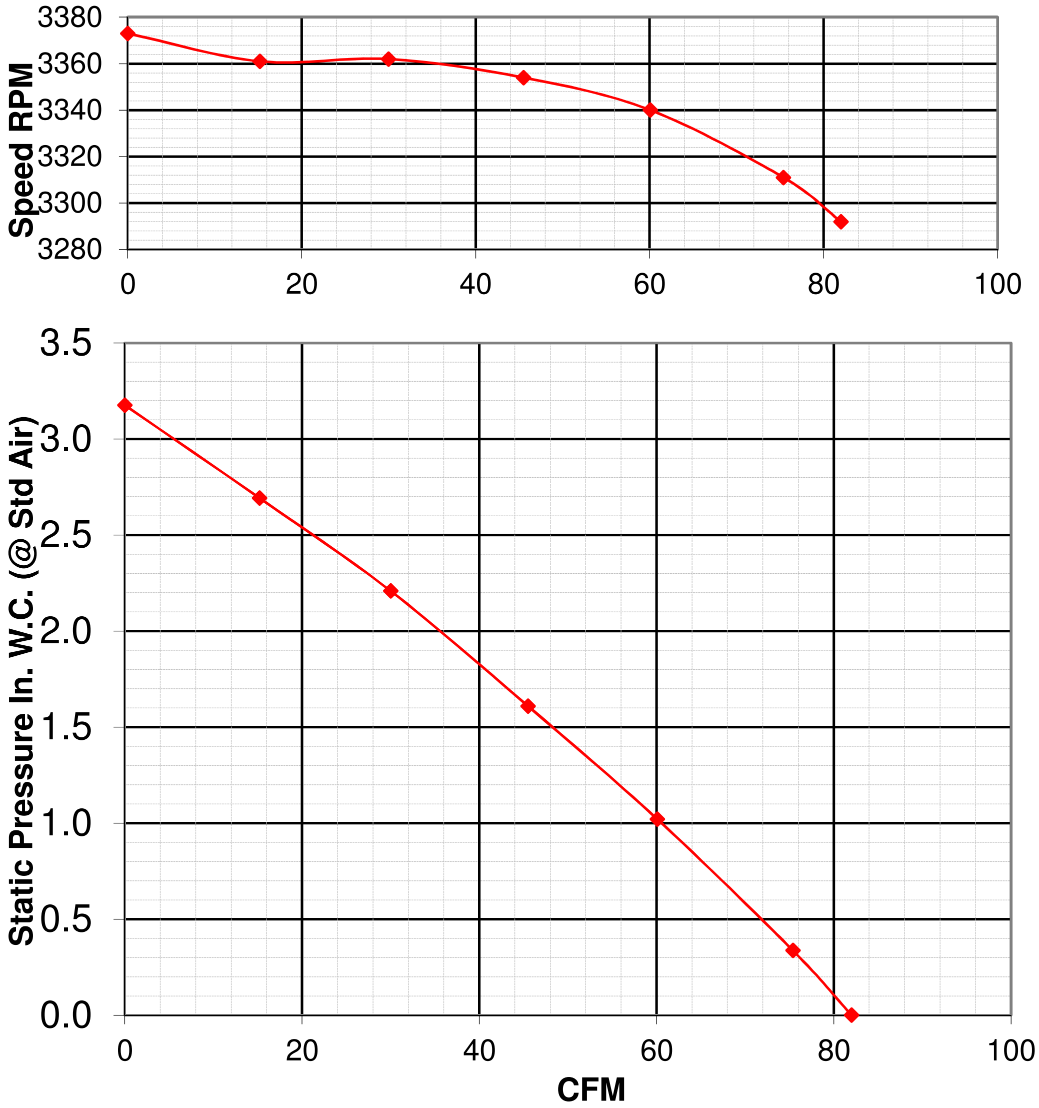
Motor Testing Torque Curves



Motor Efficiency Curve



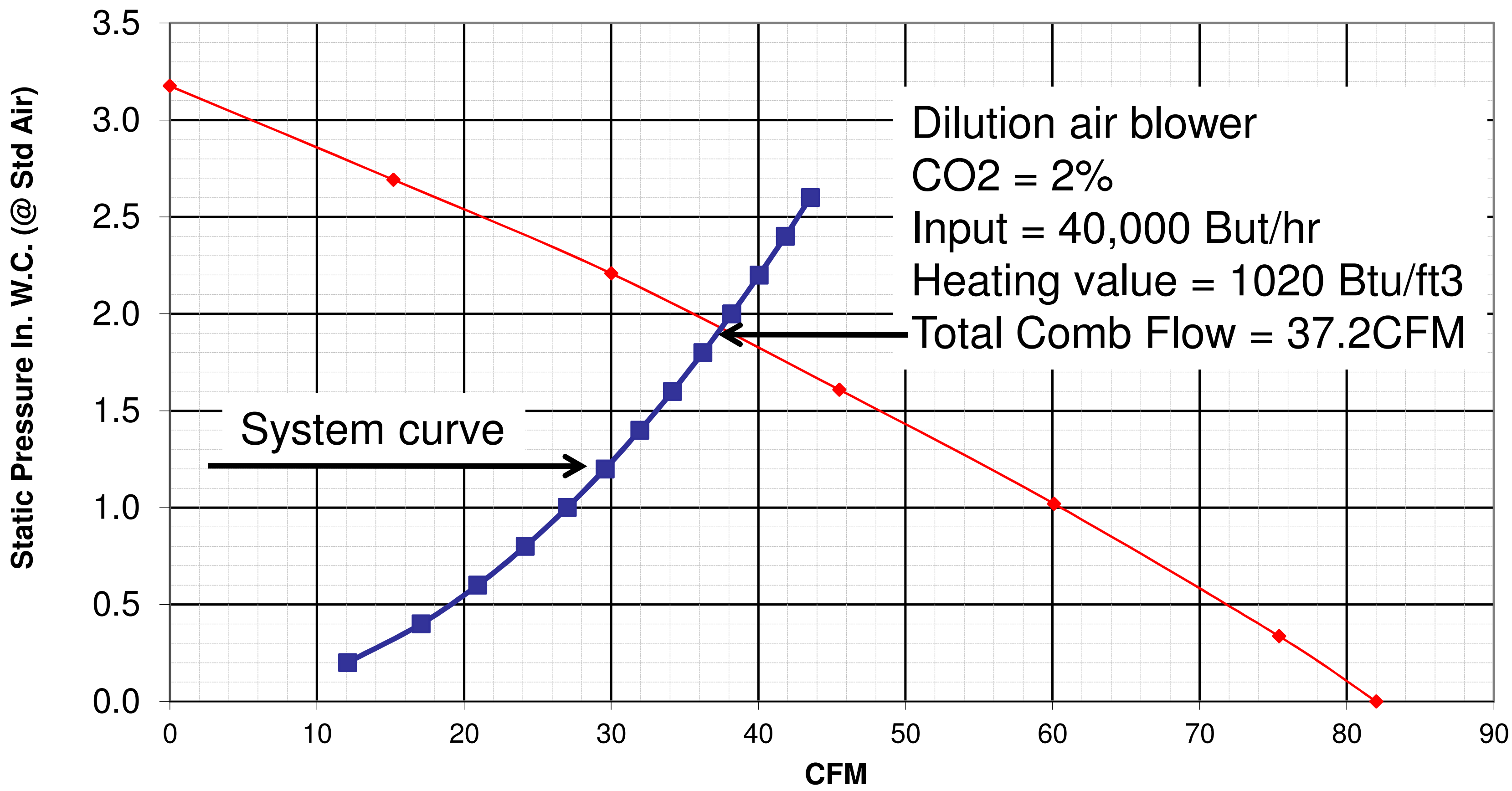
Blower Wind Tunnel Curve



Calculate System Curve

- Calculate required combustion air flow required
- Pick that air flow point to get static pressure
- Calculate System Constant (K) = Static Pressure/(air density x CFM^2)
- Generate system curve at various pressure points

Estimate Pressure Drop



Example - Speed Tolerance Effects

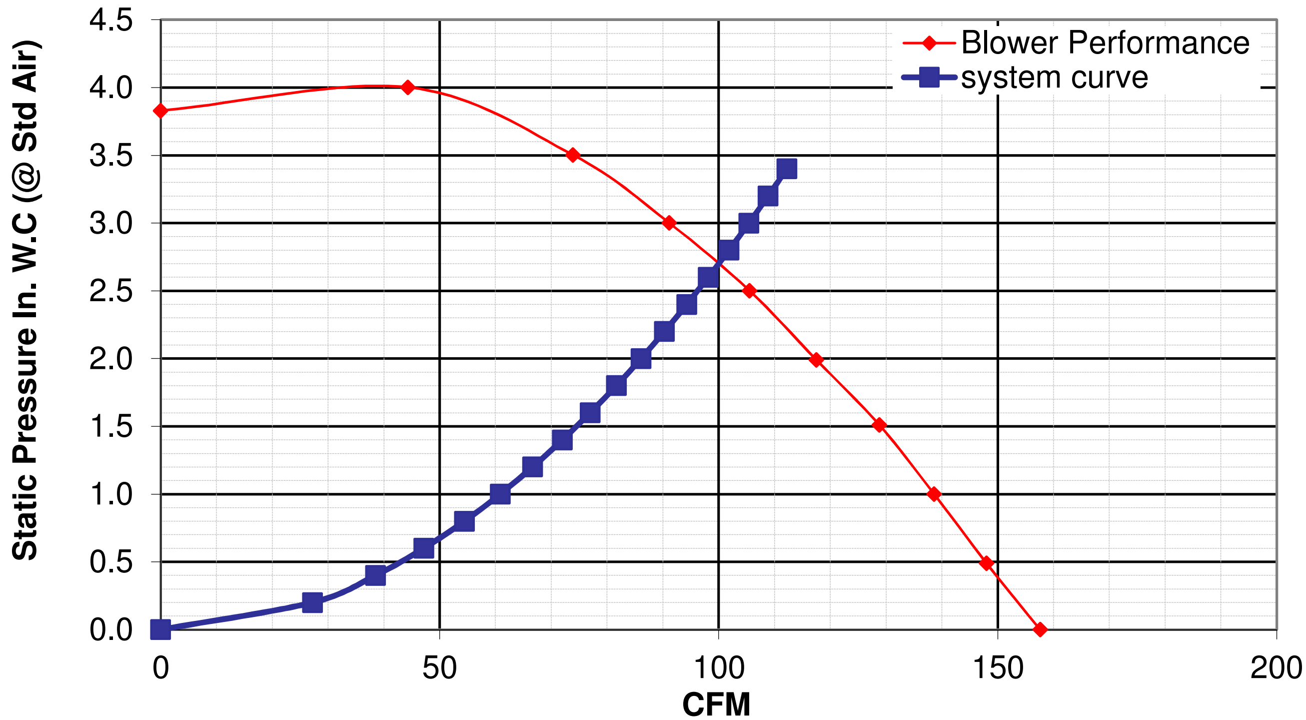
- Appliance 100kBtu/hr, 8.26%CO2, 1.20” static pressure, 3200RPM, 25CFM.
- Speed tolerance = (3600-3200) x 10% = 40RPM
- At plus tolerance – 3240RPM, 25.3CFM, 8.15% CO2, 1.23” SP.
- At minus tolerance - 3160RPM, 24.7CFM, 8.37% CO2, 1.17” SP.

Example - 60 to 50hz

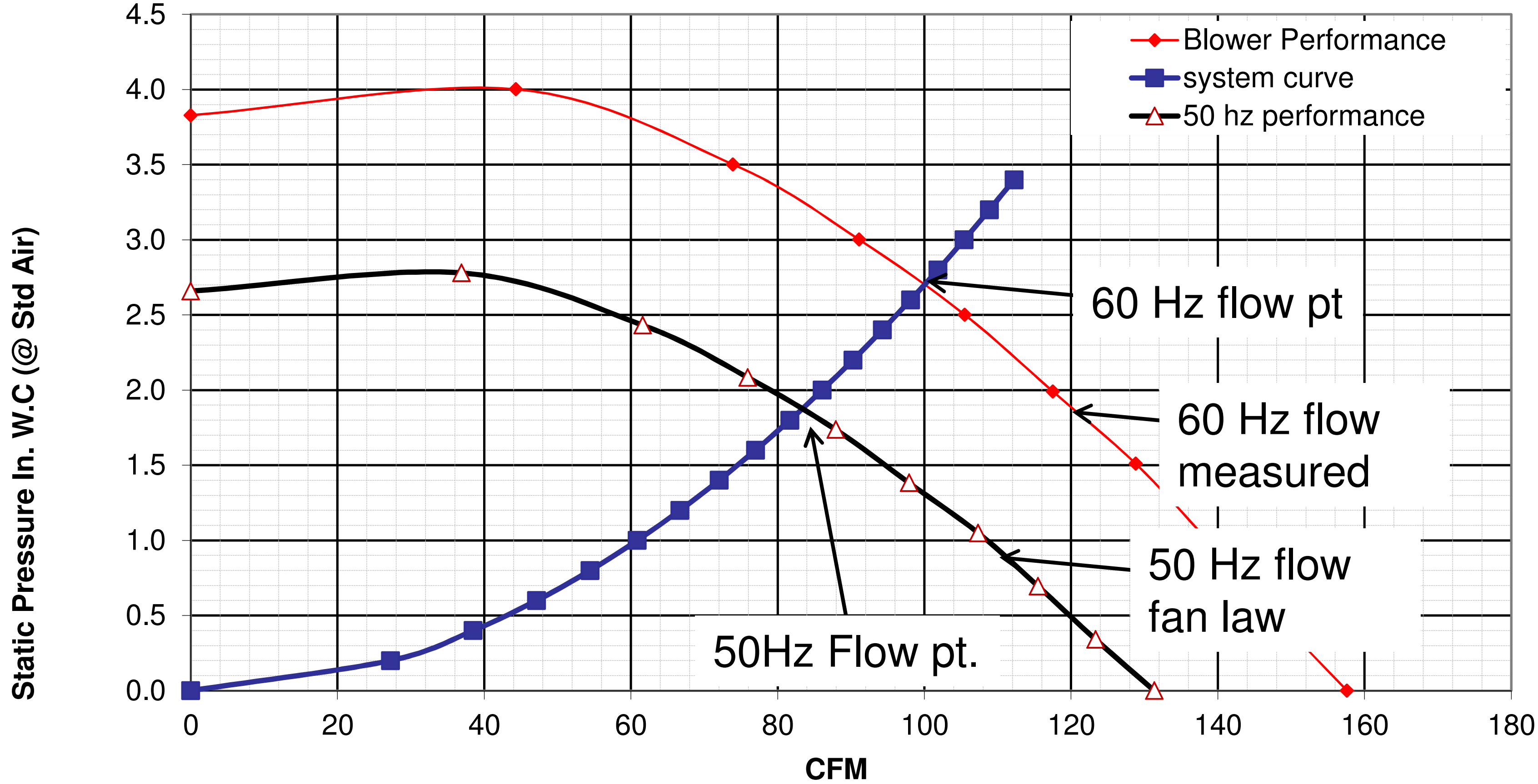
- Appliance input rate = 400,000Btu/Hr
- Blower – 100CFM 2.7 Static press 3530RPM 60Hz 2.2% slip
- At 50 Hz speed=(120X50/2) X .978 = 2934RPM
- New Flow = 100 X 2940/3530 = 83.3 CFM
- New SP = 2.7 X(2940/3530)^2 = 1.87In.W.C.

60 to 50hz Effect

- 60hz blower – Gas Input 400,000; 8.3% CO_2; 1020HV



60 to 50hz Effect



60 to 50hz Result

- 50hz blower – 83.3CFM
- Gas Input 333,000 with original CO_2 = 8.3% & 1020HV

Design to return to 60hz performance at 50hz

- 83.3 to 100 cfm
- 1.87 to 2.7 In. W.C. Static pressure
- Flow rate varies as the cube of the fan diameter ratio
- Pressure varies as the square power of the fan diameter (this example target press)
- Horsepower varies as the 5th power of the fan diameter

Design to return to 60hz performance at 50hz

- Current Impeller diameter = 7.0 In.
- Impeller Required = 8.4 in
- New SP = 1.87 X (8.4/7.0)^2 = 2.70
- New Flow = 83.3 X (8.4/7.0)^3 = 144
- HP = .08 X (8.4/7.0)^5 = 0.20