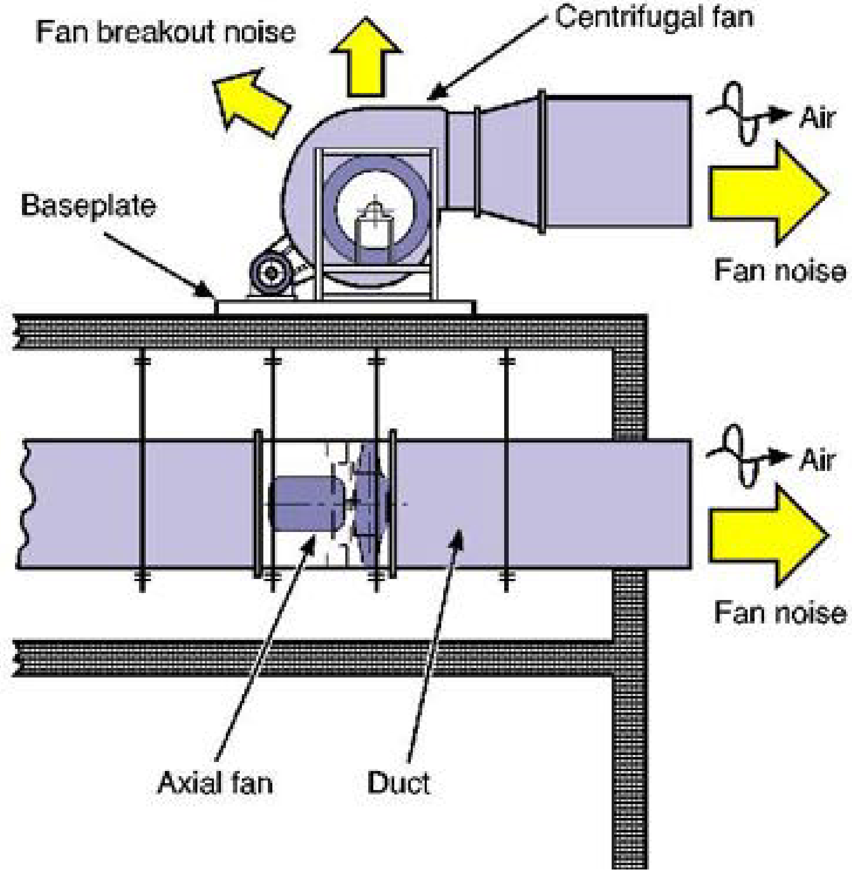
Introduction to Fan Systems

Background

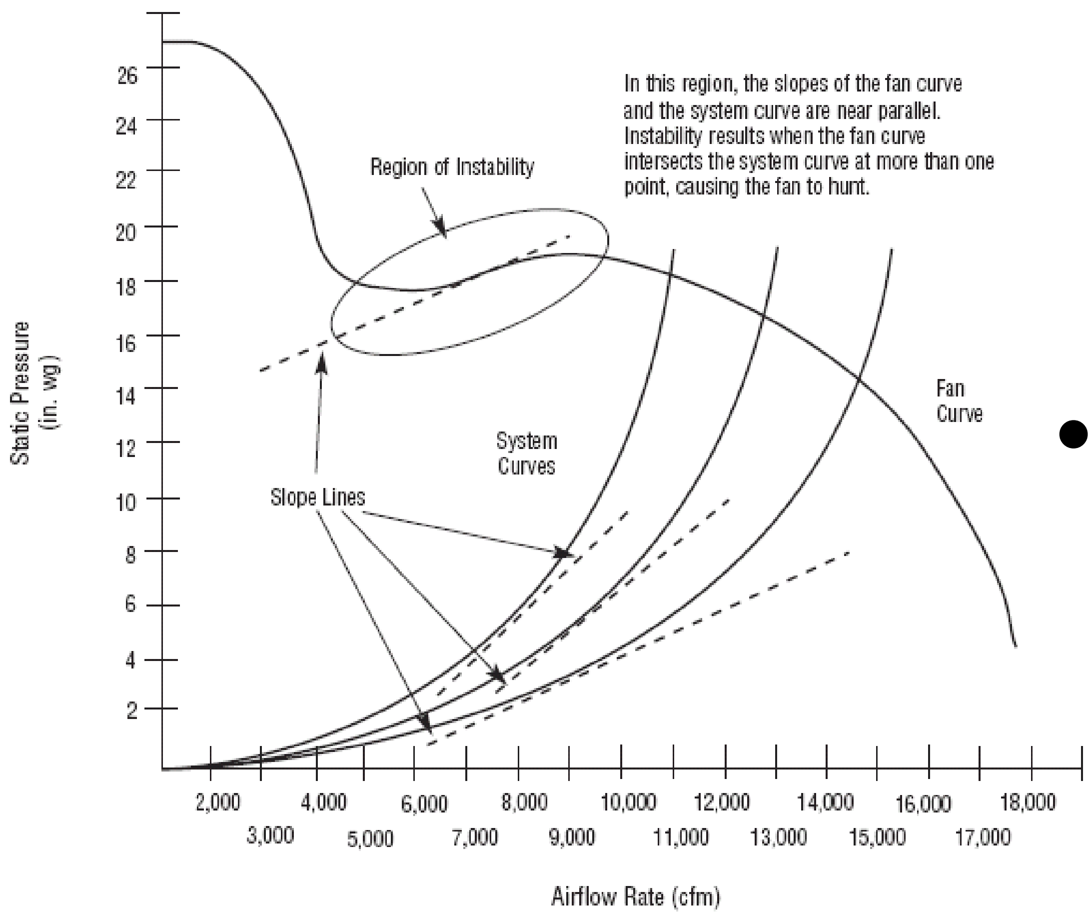
- Critical for process support & human health.
  - shop ventilation
  - material handling
  - boiler applications
- In the manufacturing sector, fans use about 78.7 billion kWh of energy per year.
  - represents 15% of electricity used by motors
- In the commercial sector, electricity needed to operate fan motors composes a large portion of the energy costs for space conditioning.

Fan Types

- **<u>Centrifugal fans</u>** use a rotating impeller to increase velocity of an airstream. Air moves from the impeller hub to blade tips, gaining kinetic energy.
  - Generate high pressures.
  - Frequently used in
    - "dirty" airstreams (high moisture & particulates),
    - material handling applications,
    - higher temperatures.
- **<u>Axial fans</u>** move an airstream along the axis of the fan. Air is pressurized by the aerodynamic lift generated by the fan blades, like a propeller & an airplane wing.
  - Used in "clean air," low-pressure, high-volume applications.
  - Less rotating mass, more compact than centrifugal fans of comparable capacity.
  - Higher rotational speeds, noisier than in-line centrifugal fans of the same capacity.



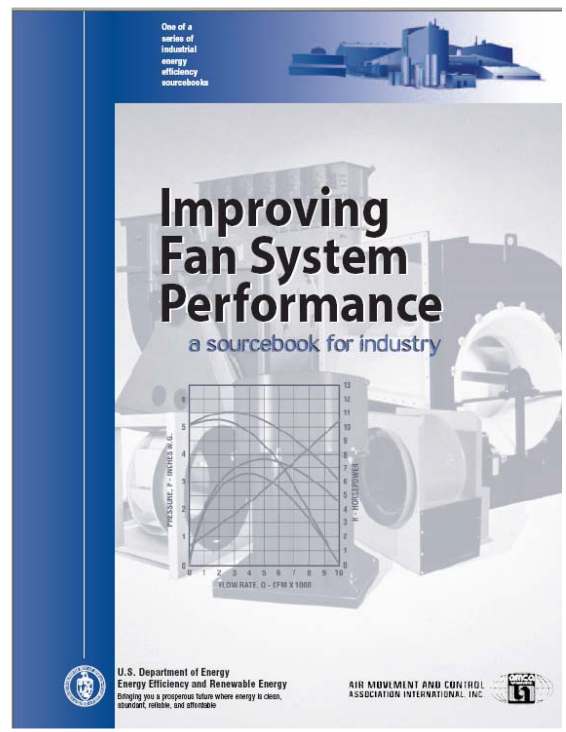
Fan Selection



- Starts with a basic knowledge of system operating requirements and conditions such as
  - Airflow rates
  - Temperatures
  - Pressures
  - Airstream properties
  - System layout
- Other considerations, such as
  - Cost
  - Efficiency
  - Operating life
  - Maintenance
  - Speed
  - Material type
  - Space constraints
  - Drive arrangements
  - Range of operating conditions

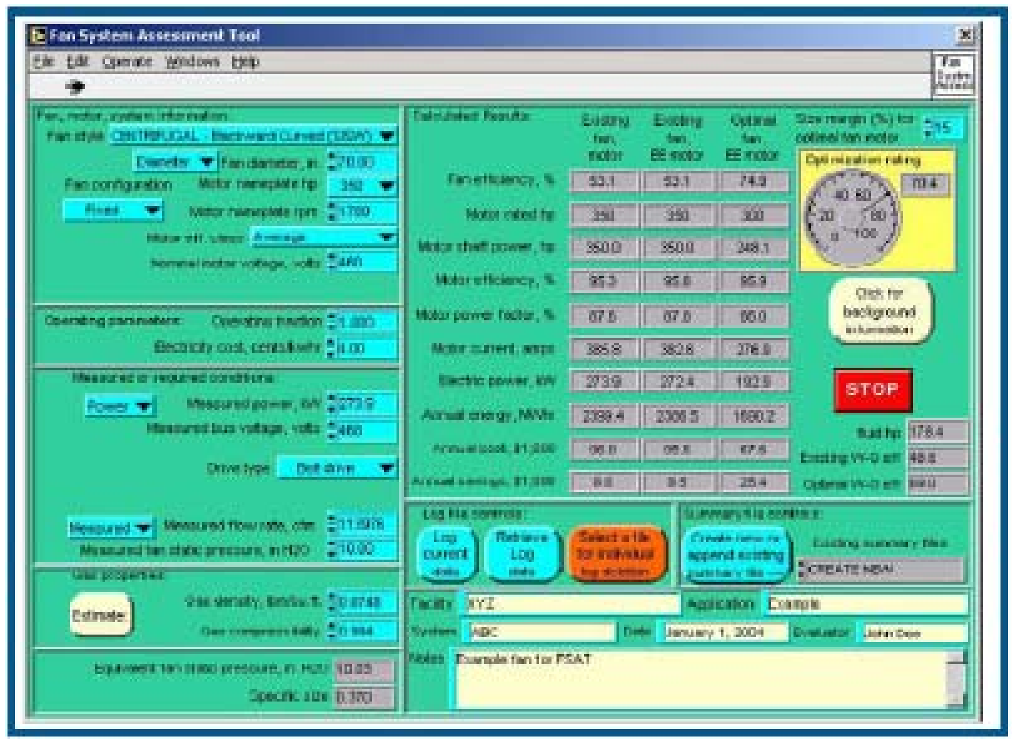
Fan Design & Performance

- High level of uncertainty associated with predicting system airflow and pressure requirements.
  - Tendency to *increase* the specified size of a fan/motor assembly, protection against being responsible for inadequate system performance.
- Oversized fan/motor assembly creates a different set of operating problems, including
  - Inefficient, more costly fan operation
  - Excess airflow noise, pipe/duct vibrations
  - Poor reliability
- 'Systems Approach' in fan selection process will yield a quieter, more efficient & more reliable system.
- Sourcebook available to help designers and operators improve fan system performance through better fan selection and improved operating and maintenance practices.



Fan System Assessment Tool

- Use the Fan System Assessment Tool (FSAT) to help quantify the potential benefits of optimizing fan system configurations that serve industrial processes.
  - Requires only basic (?) information about your fans and the motors that drive them.



- Calculate the amount of energy used by your fan system
- Determine system efficiency
- Quantify the savings potential of an upgraded system
- This tool DOES NOT tell the user how to improve the system. But it does provide a means of prioritizing energy improvement opportunities.

CSU IAC Case Study Example Plant 582: A Beverage Container Manufacturer

- Manufacturer of beverage containers
- Plant area: 336,000 ft^2
- 100,000,000 kW annual energy consumption
  - about 11 MW peak demand
- Annual electricity costs: $4.6 million/yr
- Estimated 10,000 hp of motors
- Two 30 hp combustion air fans on each of three units – one backup per unit

CSU IAC Case Study Example Plant 582: Combustion Fan Nameplate Information

- Twin City Fan (Type BCS-SWSI, Model 270BCS) backward curved single-width/single inlet (SWSI) high volume/pressure fan

- 30 hp Siemens premium efficiency motor rated at 93.0%, rated speed of 1,794 rpm, and a measured current of 35 A at 460 V

- At full load, the motor power is 30 hp × 0.746 kW/hp ÷ 93.0% = 24.1 kW.

CSU IAC Case Study Example Plant 582: Combustion Fan Operating Conditions

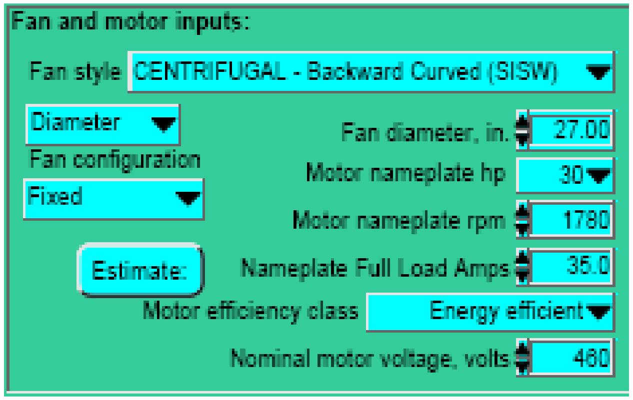
- Static pressure at fan outlet: 3.4 in. H_2O
- Dry bulb temperature: 79.7°F at inlet & 82.5°F at outlet
- Wet bulb temperature: 66°F at inlet & 67°F at outlet
- A venturi-type flowmeter was installed downstream of (just above) the combustion air fan.
- Flow typically varies from about 6,000 cfm to 6,667 cfm.
- Flow (from flowmeter): about 6,333 cfm.
- Motor amp load: about 19 amps.

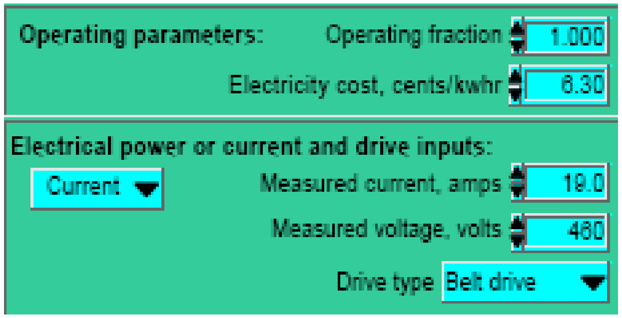
So What's The Big Deal?

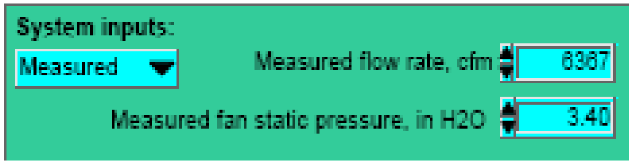
- One 30 hp fan out of 10,000 hp!!!
- Fan runs 100% of time (8,760 h/yr)
- Plant personnel suggested that despite their protestations, the fan was oversized when designed

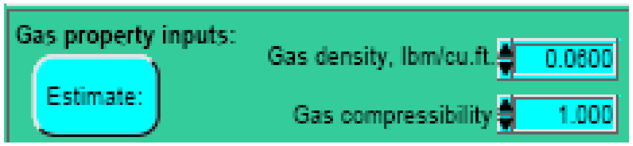
Let's see if this is a big deal

FSAT Inputs

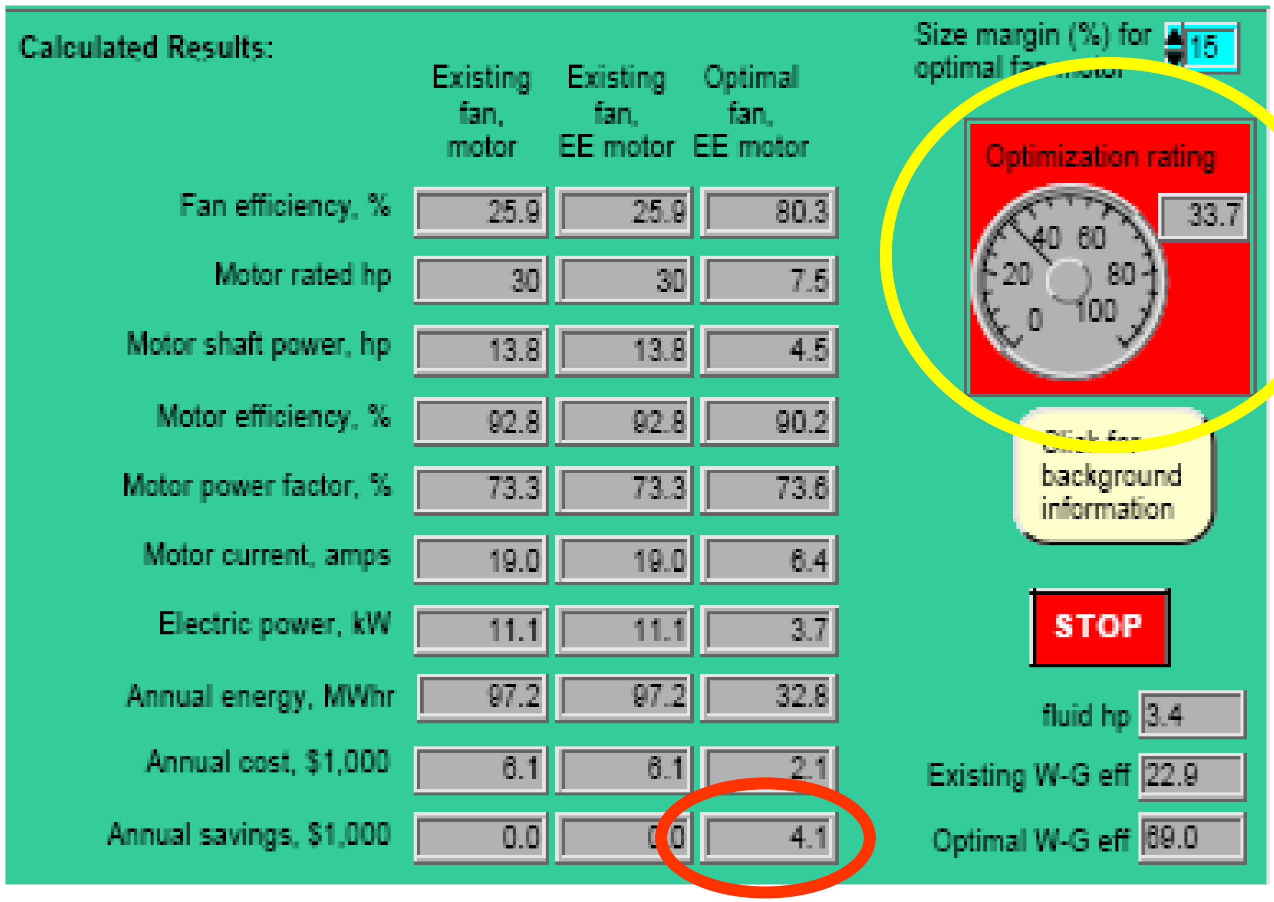

Fan and motor inputs:
Fan style
CENTRIFUGAL - Backward Curved (SISW)
Diameter
Fan configuration
Fixed
Estimate:
Fan diameter, in.
27.00
Motor nameplate hp
30
Motor nameplate rpm
1780
Nameplate Full Load Amps
35.0
Motor efficiency class
Energy efficient
Nominal motor voltage, volts
460


Operating parameters:
Operating fraction
1.000
Electricity cost, cents/kwhr
6.30
Electrical power or current and drive inputs:
Current
Measured current, amps
19.0
Measured voltage, volts
460
Drive type
Belt drive

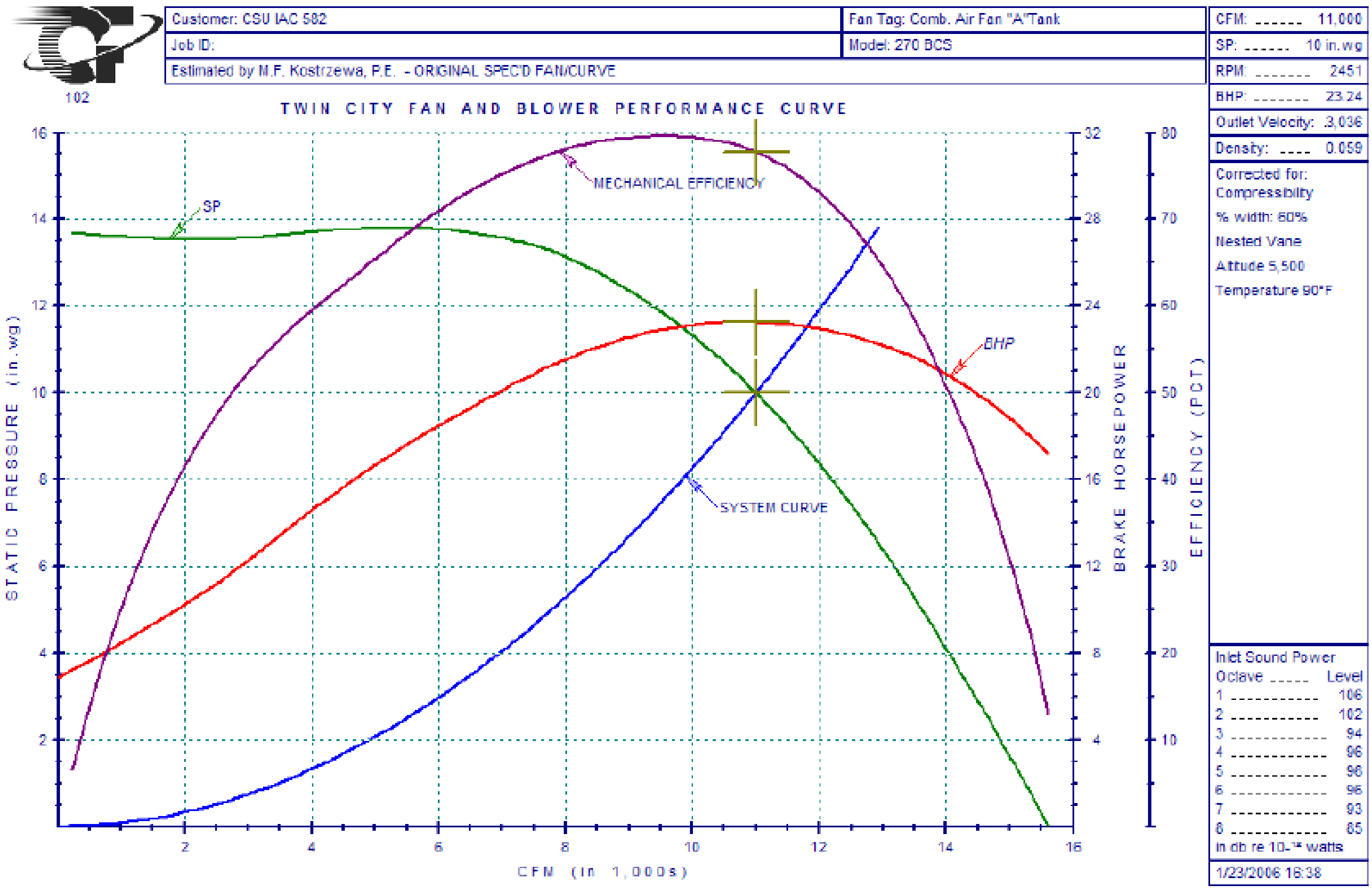

System inputs:
Measured
Measured flow rate, cfm
6367
Measured fan static pressure, in H2O
3.40


Gas property inputs:
Estimate:
Gas density, lbm/cu.ft.
0.0600
Gas compressibility
1.000

FSAT Results



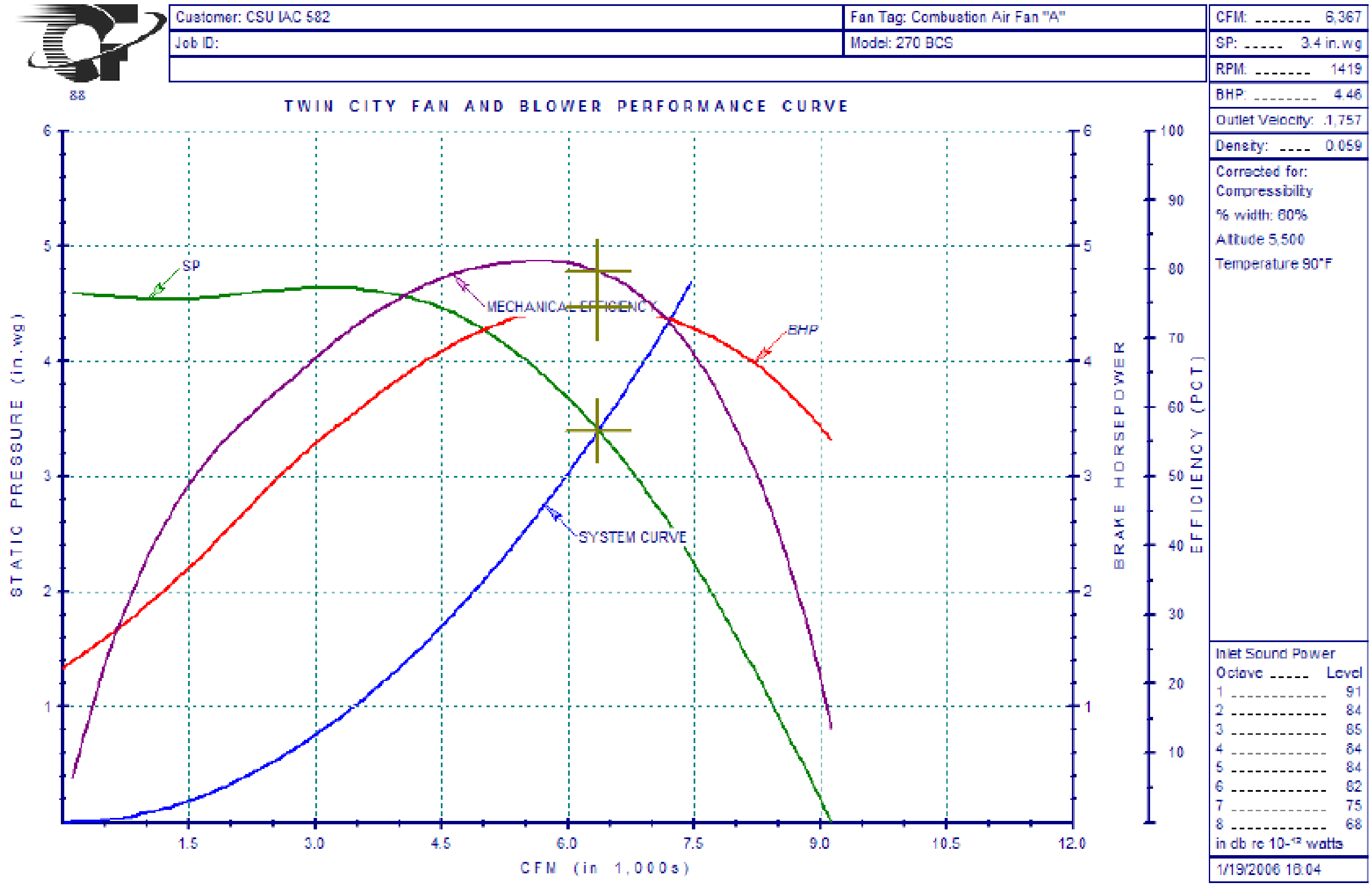
Original Fan Curve



Several Options Considered

- Resheave the fan to reduce flow
- Get a new, smaller fan
- Add a variable speed drive

Resheaved Fan Curve



Recommendation

Resheave the fan – cheapest option
(plus, this was suggested by fan mfg)

Savings: 64,700 kWh/yr and 7.5 kW-mo.

Total energy and demand savings: $4,080/yr

Estimated installed cost: $500

Simple payback: 1.5 <u>months</u>