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Aeration Blower Turndown Strategies

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Keynote Speaker

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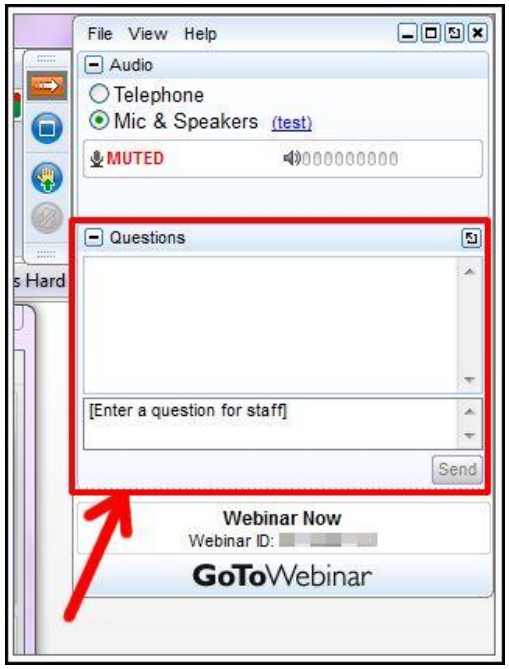
Q&A Format



- Panelists will answer your questions during the Q&A session at the end of the Webinar.
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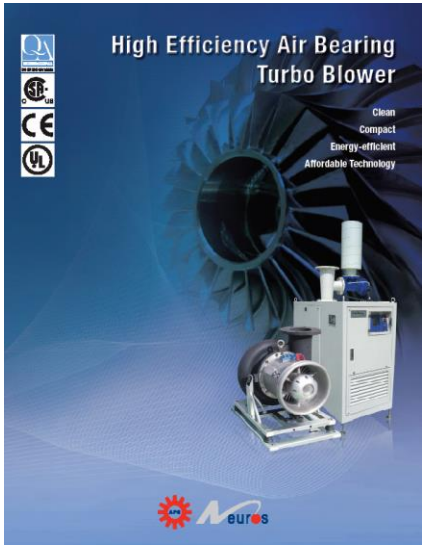
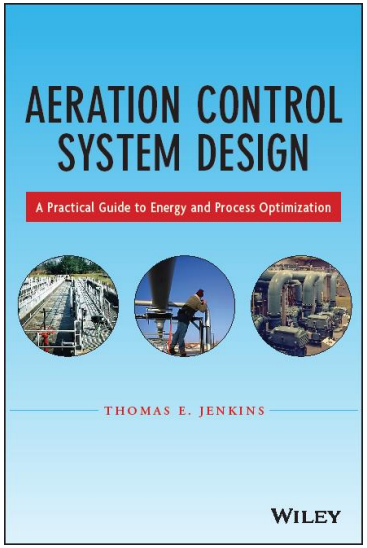
Handouts





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All materials presented are educational. Each system is unique and must be evaluated on its own merits.

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Aeration Blower Turndown Strategies

Introduction by *Rod Smith*, Publisher

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About the Speaker

Tom Jenkins, P.E.
JenTech Inc.

- President of JenTech Inc.

- Over 30 years of experience with aeration blowers and blower controls

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Aeration Blower Turndown Strategies

Thursday, August 2nd, 2018
1:00 PM CDT

BLOWER & VACUUM BEST PRACTICES

Thomas E. Jenkins
President, JenTech Inc.
414-352-573
tom.jenkins.pe@gmail.com

Topics

- Importance of Turndown
- System Turndown Recommendations
- PD Blowers
  - Basis of Limits
  - Strategies for Optimizing
- Centrifugal Blowers
  - Basis of Limits
  - Strategies for Optimizing

Importance of Turndown

- Turndown defines the operating range of a blower or a blower system
- It is usually expressed as a percent
- The higher the turndown, the more flexibility the operators have

$$\text{Turndown}\% = \frac{Q_{max} - Q_{min}}{Q_{max}} \cdot 100$$

Where:

$Q_{max,\ min}$ = maximum and minimum safe air flow rates

Importance of Turndown

- Designers must provide capacity for twenty year life at worst case demand
- Turndown is often more important than efficiency in reducing power costs
- Too much air at high efficiency is still a waste of power

Importance of Turndown

- Operators need turndown to maintain process performance
- Denitrification and phosphorus removal require anoxic and/or anaerobic zones
- Excess dissolved oxygen in recycle flow will inhibit denitrification
- Excess aeration can break up floc and inhibit settling

Turndown Recommendations

- The design should include a minimum of 5:1 (80%) system turndown
- A system turndown of 8:1 (88%) is preferred
- Most individual blowers provide a 2:1 (50%) turndown – but each case is different
- Multiple small blowers provide better turndown than one or two large blowers
- 4@33% or 2@25%+2@50% meet the recommended turndown requirement

PD Blower Turndown

- PD (Positive Displacement) blowers are generally limited in turndown by heating
- May be motor heating that limits turndown
- May be blower heating that limits turndown

PD Blower Turndown

- PD Blowers are constant torque
- Constant torque means constant current
- I^2R heating can cause damage to insulation
- At reduced speed cooling air flow from motor fans is reduced
- Motor temperature limits can be exceeded
- Typical lower limit is approximately 50% speed for ODP or TEFC

PD Blower Turndown

- NEMA insulation class refers to the temperature rise above rated ambient allowable to avoid insulation breakdown.
- Most motors are rated for service at ambient temperatures of 40 °C (104 °F) at 3,300 ft.
- Class B: 80 °C rise (max = 120 °C/248 °F)
- Class F: 105 °C rise (max = 145 °C/293 °F)
- Class H: 125 °C rise (max = 165 °C/329 °F)

PD Blower Turndown

- For any type of blower discharge temperature is a function of inlet temperature, blower efficiency, and pressure ratio

$$T_d = T_i + \frac{T_i \cdot \left[\left(\frac{p_d}{p_i} \right)^{\frac{k-1}{k}} - 1 \right]}{\eta}$$

Where:

$T_{i,d}$	=	inlet and discharge temperature, °R
η	=	efficiency, decimal
$p_{i,d}$	=	inlet and discharge pressure, psia
k	=	ratio of specific heats, dimensionless ≈ 1.395

PD Blower Turndown

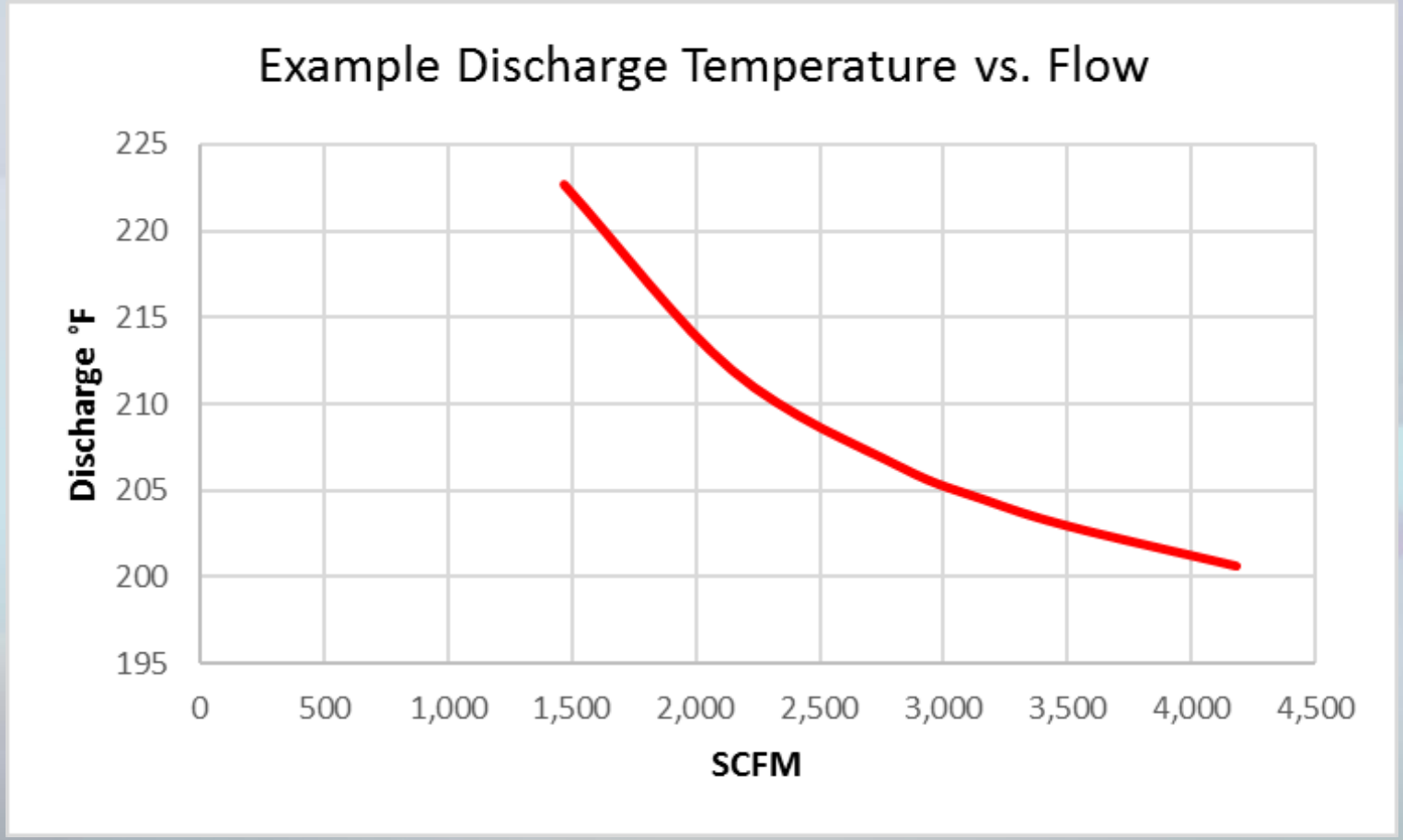
- For PD blowers temperature limits are based on two factors
- Exceeding max discharge temperature can cause deterioration of lubricants and seals
  - 250 °F is a common limit, but verify with the manufacturer
- Exceeding max ΔT across the blower can cause warping of casing and mechanical damage

PD Blower Turndown

- PD blower efficiency drops with decreasing speed
- Leakage is constant at constant pressure ratio, so at reduced speed/flow it becomes a greater percentage of total power
- Friction and mechanical losses don’t decrease as rapidly as speed
- Lower air flow means heat removal is decreased

PD Blower Turndown

- PD temperature increases at lower speed:



PD Blower Turndown

- To improve turndown:
- Follow manufacturer’s recommendations
- Monitor motor temperature directly with RTDs in windings
- Monitor inlet and discharge air temperature

- Note: Screw PDs often have more turndown than lobe type PDs

Centrifugal Blower Turndown

- Centrifugal (dynamic) blowers are generally limited in turndown by surge

- Blower heating may also limit turndown

Centrifugal Blower Turndown

- Surge is a pulsating air flow and pressure that occurs in centrifugal blowers at low air flow rate or high pressure
- The occurrence of surge greatly increases blower temperature
- Surge pulsations can also cause vibration and mechanical damage to the blower
- High impeller speed increases sensitivity to surge

Centrifugal Blower Turndown

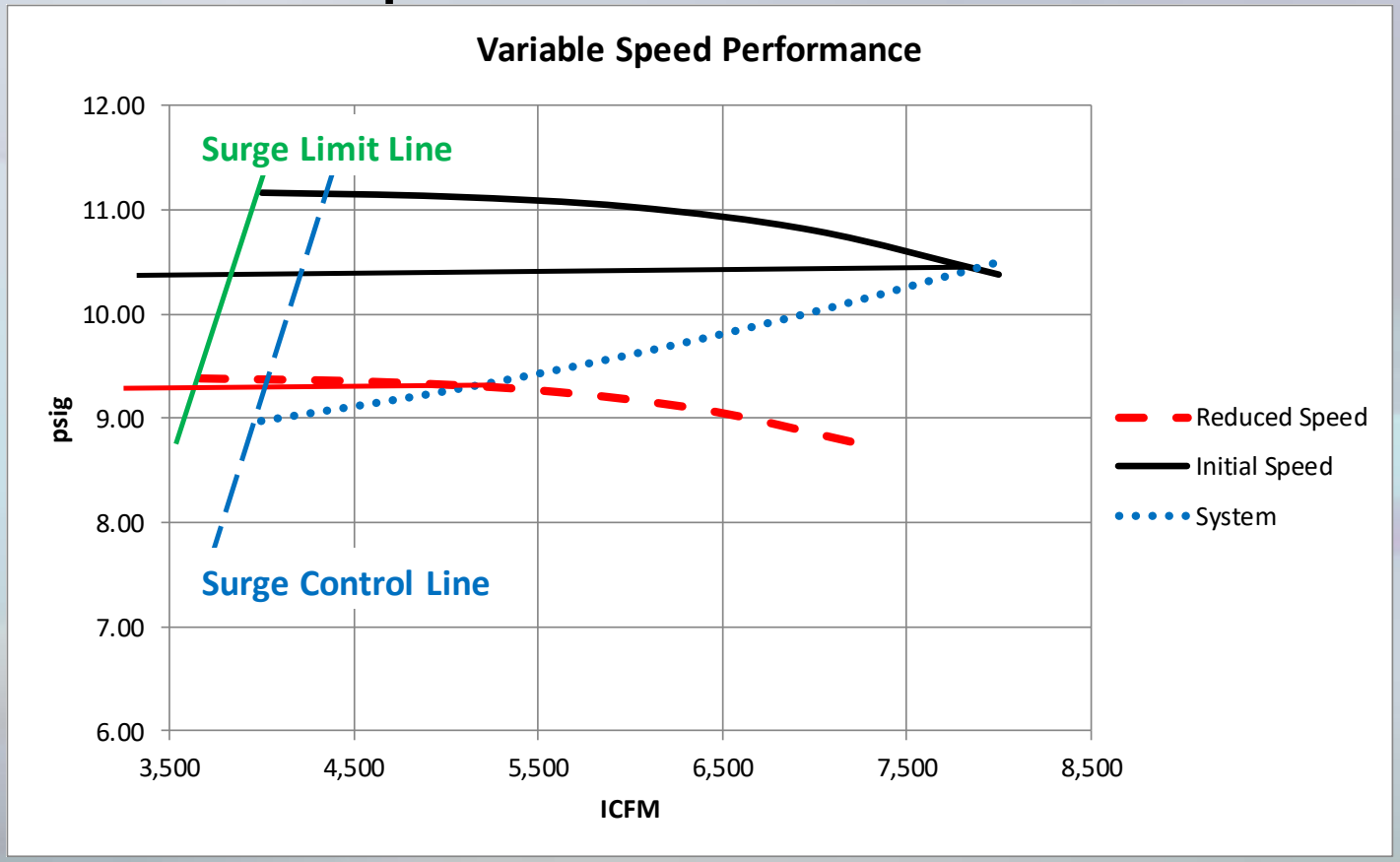
- Surge control (protection) can incorporate several features
- Shut down blower
- Open blow-off valve to reduce pressure and increase flow rate
- Modulate blower to increase flow rate or pressure capability
  - Speed, guide vanes or throttling valve may be used

Centrifugal Blower Turndown

- Sure protection should engaged with some margin of safety
- The surge “point” is dependent on multiple parameters
- Speed
- Inlet temperature
- Control method
- Piping configuration

Centrifugal Blower Turndown

- Typical surge line and surge control line for variable speed blower



Centrifugal Blower Turndown

- At reduced air flow heating from compression isn’t removed as rapidly
- Efficiency is lower at reduced flow
- Heat can degrade lubricants and seals
- Heat can eliminate clearances between impellers and case
- Throttled centrifugal blowers have more issues with temperature than variable speed applications

Centrifugal Blower Turndown

- To improve turndown:
- Follow manufacturer’s recommendations
- Use a modulating blow-off valve to direct some air flow to process
- Correct surge control line and detection for operating conditions
- May use some throttling to increase control range
- Use advanced algorithms to detect surge

Blower Turndown Strategies

Thank You

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About the Speaker

Omar Hammoud
APG-Neuros

- CEO and President of APG-Neuros
- Over 30 years of experience with leaders in the aerospace and defense industry

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Blower Turndown

Air Best Practices Webinar

August 2, 2018

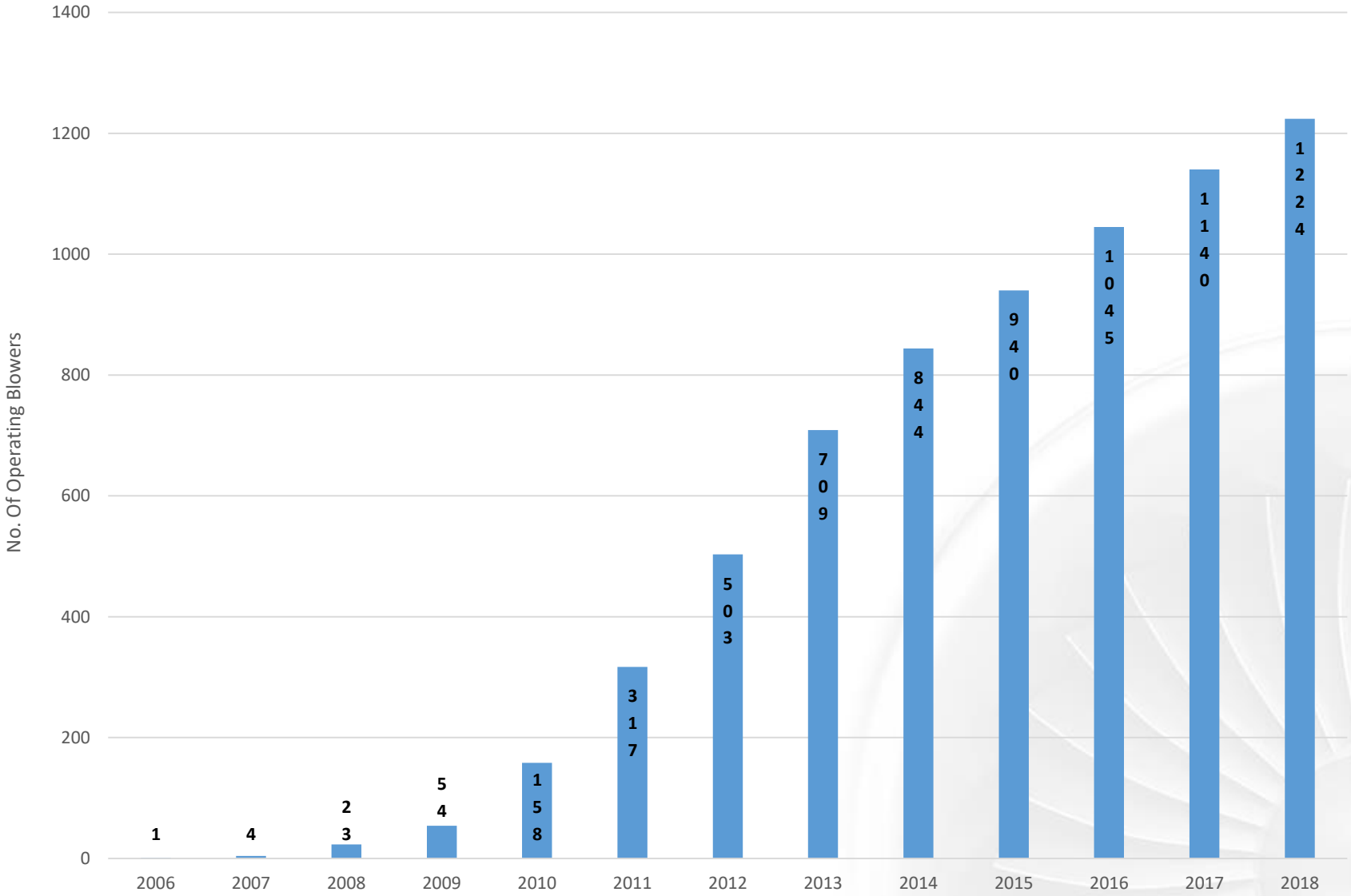
APG-Neuros

Customer Benefits - Overview

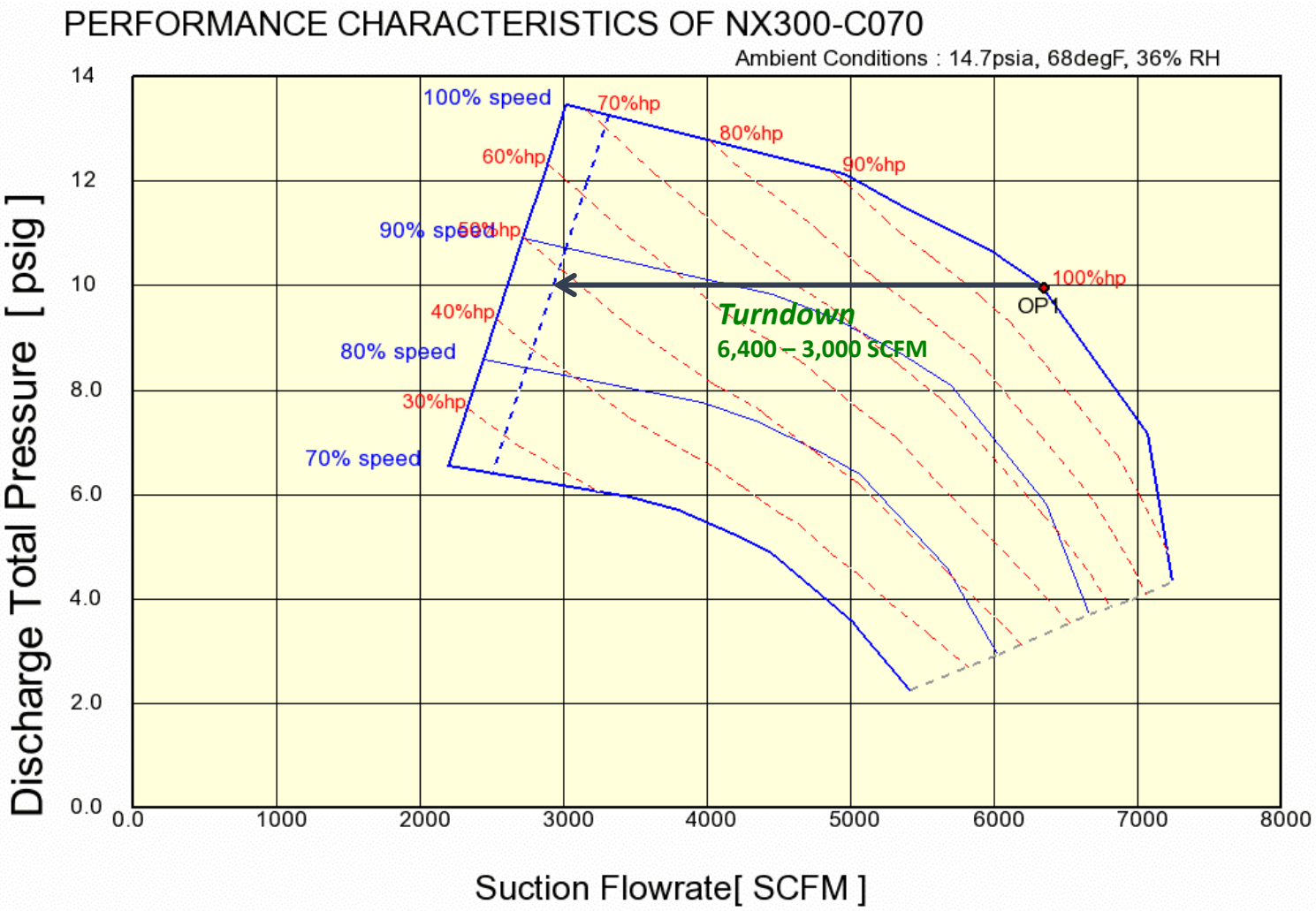
- **We offer the widest range of products**
  - 30 HP to 1600 HP Single and Multiple Core models
  - Air Bearing all models 30 to 1600 HP models
  - Magnetic Bearings 150 to 1450 HP models
- **Higher efficiency over other technologies**
  - Up to 35% over traditional blowers
  - Up to 11% over other turbo blowers
- **Low maintenance**
  - Condition based maintenance – no scheduled periods
  - Filter Changes is only routine maintenance action
- **Environmentally friendly**
  - No Oils to change or dispose
  - Quiet Operation below 80 dBa
  - No Heat Rejection into Blower Room
- **Easy installation**
  - Plug and Play, small footprint
  - Indoor and outdoor installation
- **Smart connect for remote monitoring**

Woodland, California
2 x NX300-C070, 2 x NX200-C070

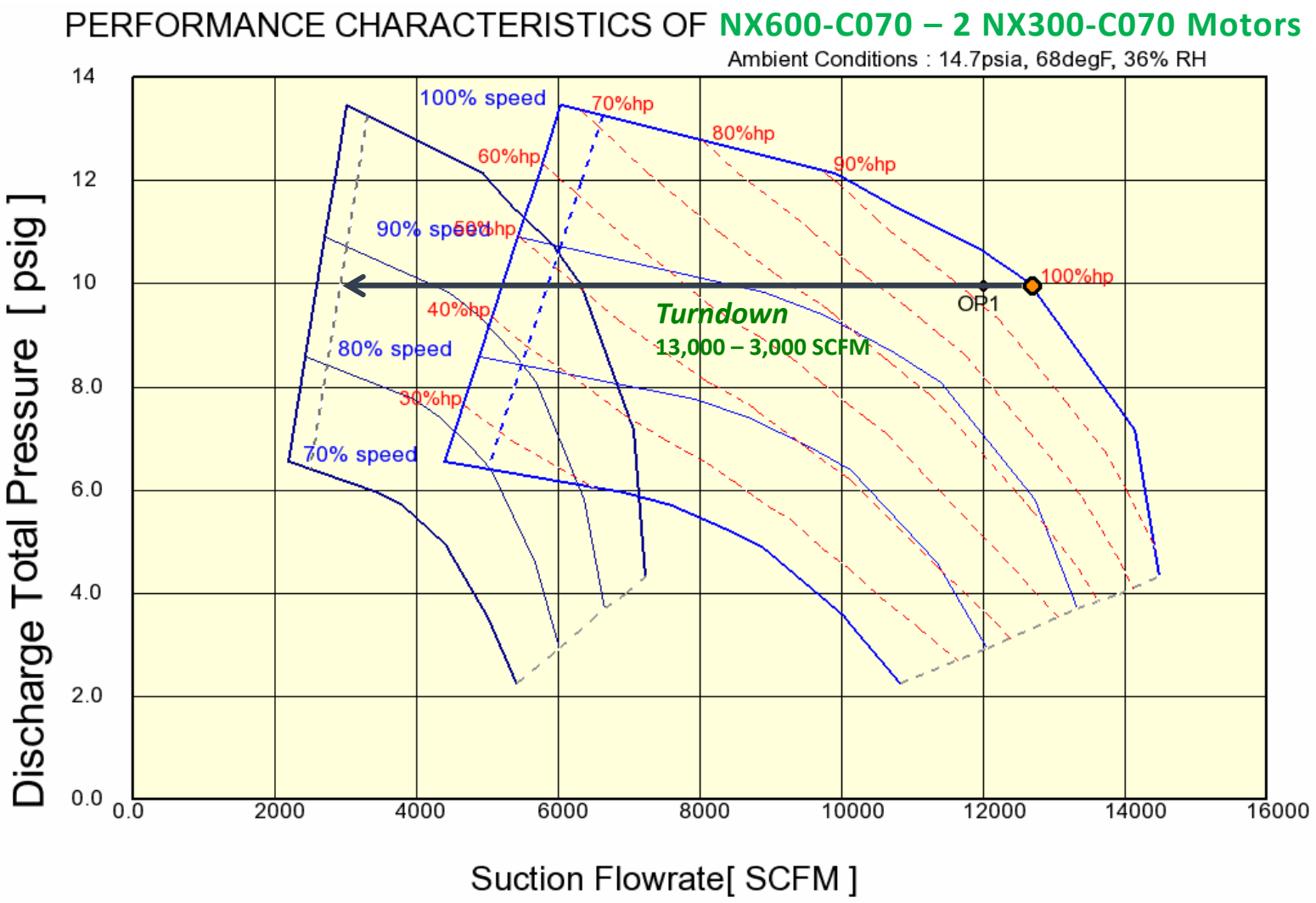
APG-Neuros Blower Installation Growth – 10+ YRS



Turndown > 50%

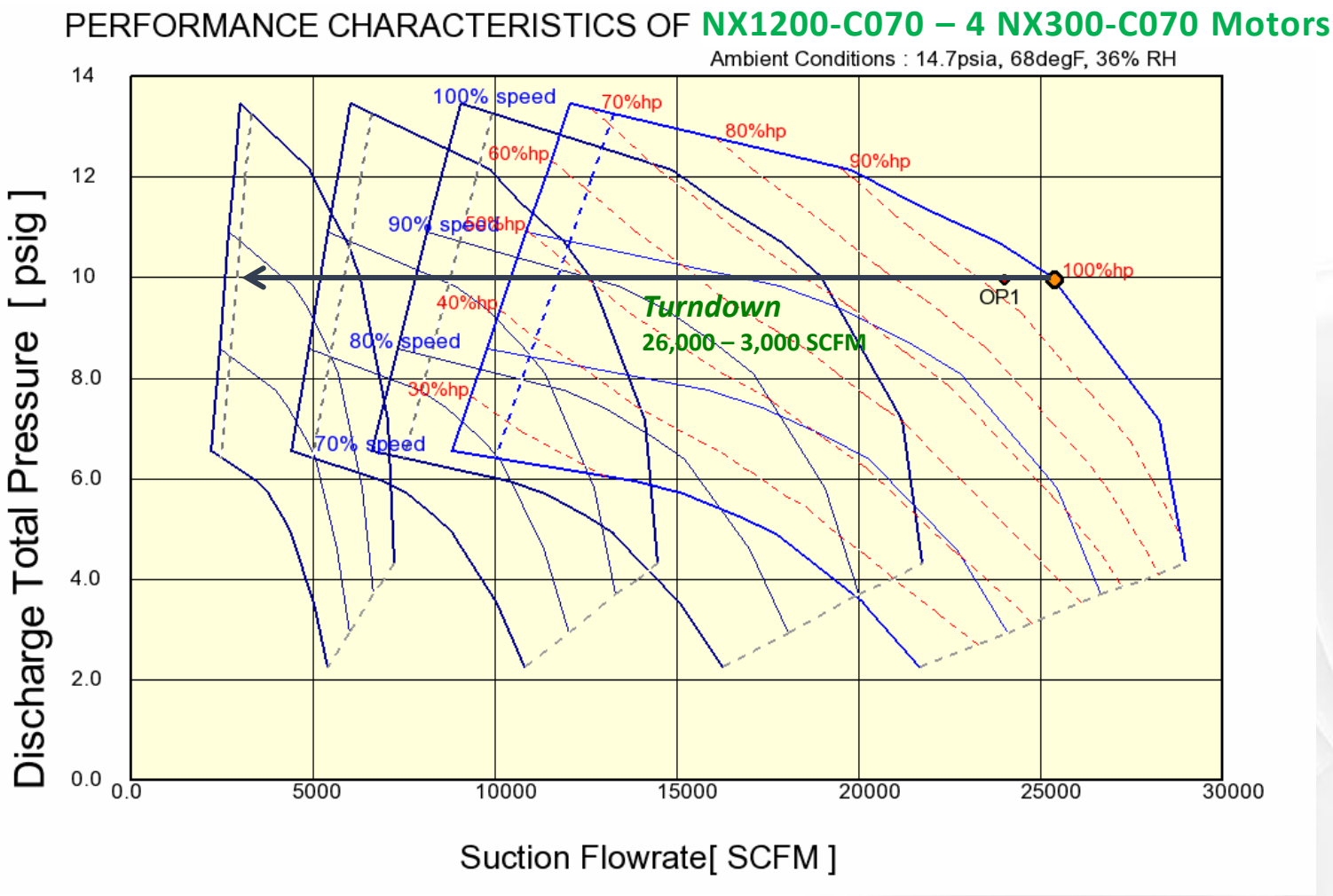

PERFORMANCE CHARACTERISTICS OF NX300-C070
Ambient Conditions : 14.7psia, 68degF, 36% RH
Discharge Total Pressure [psig]
Suction Flowrate[SCFM]
14
12
10
8.0
6.0
4.0
2.0
0.0
0.0
1000
2000
3000
4000
5000
6000
7000
8000
100% speed
90% speed
80% speed
70% speed
70%hp
80%hp
60%hp
90%hp
50%hp
40%hp
30%hp
100%hp
OP1
Turndown
6,400 – 3,000 SCFM

Up to 75% Turndown

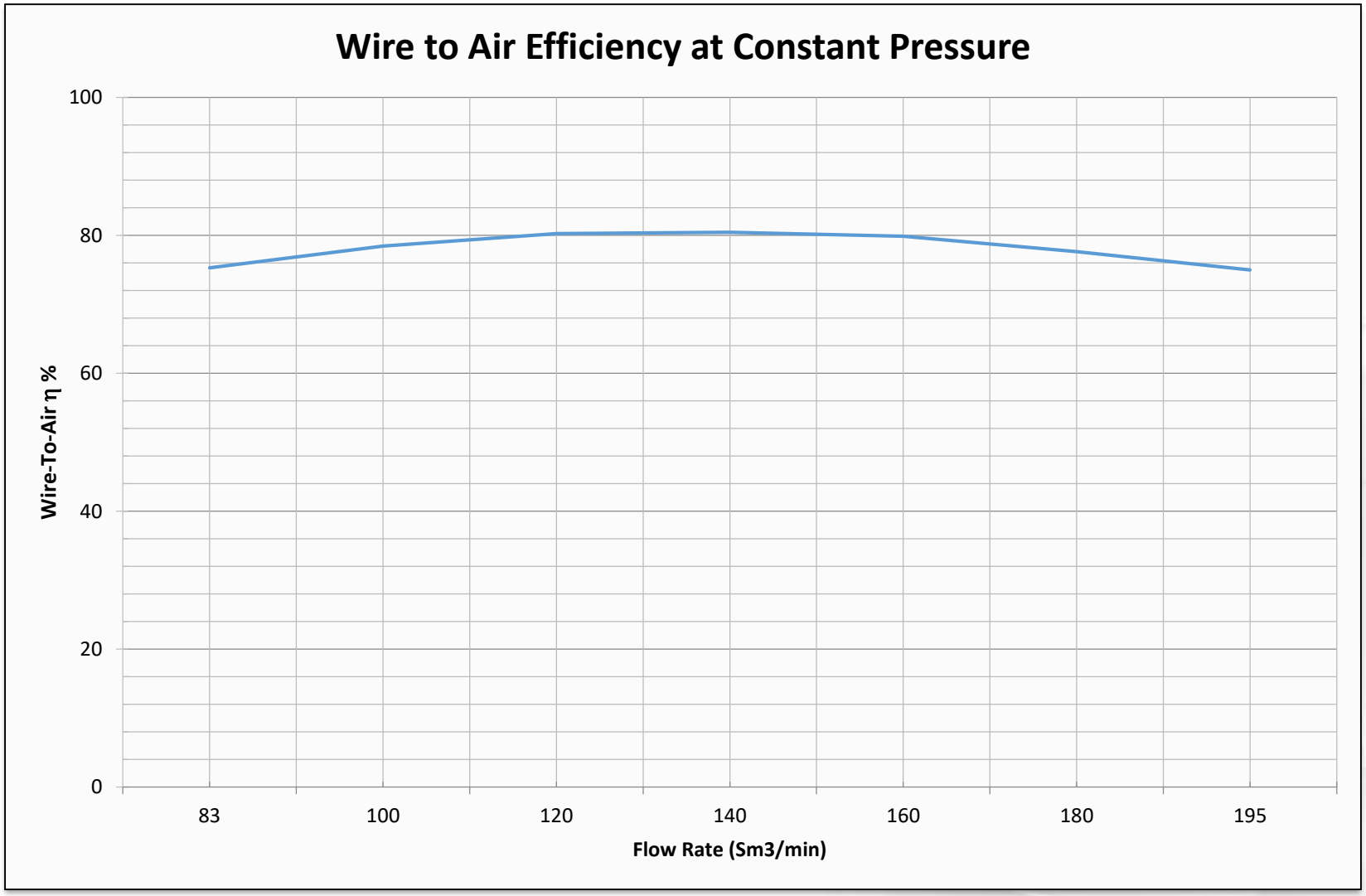


Quad Core Blower Turndown Range

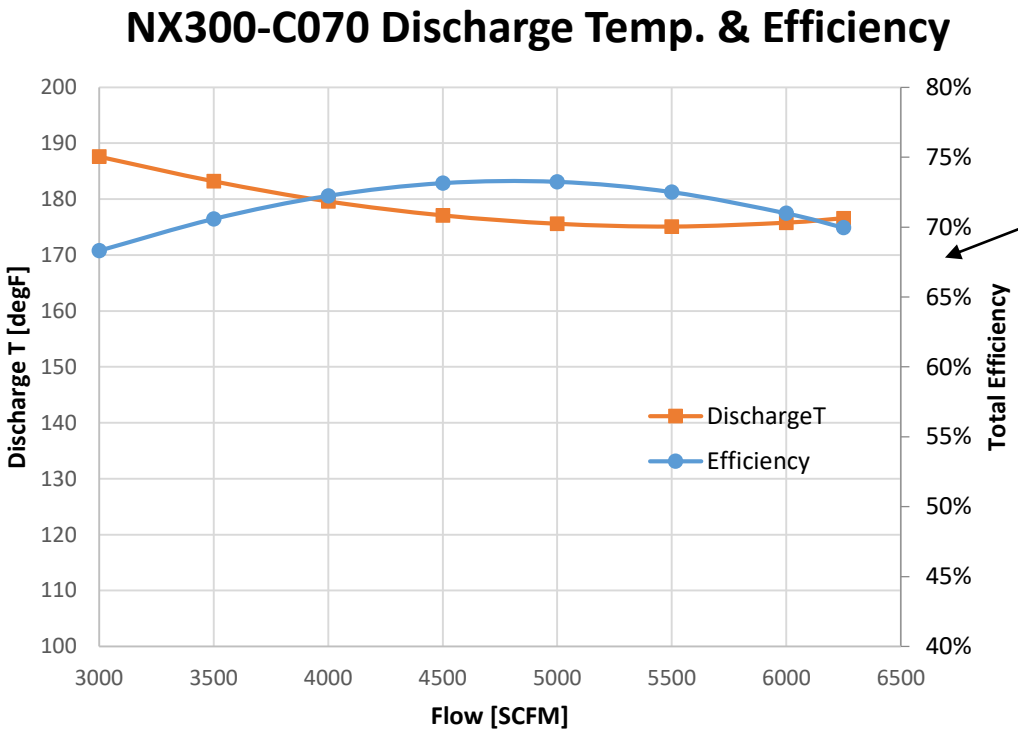
Up to 88% Turndown

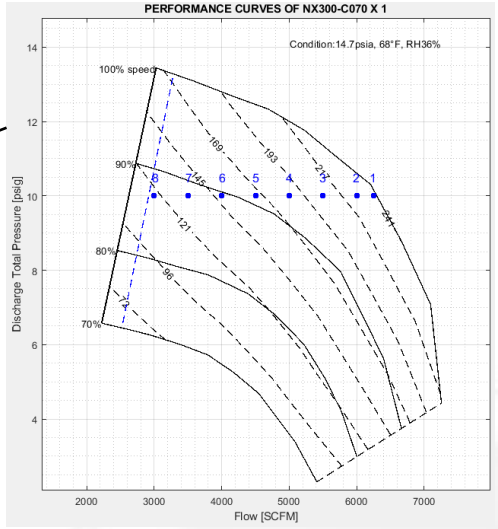


High Efficiency Over the Flow Range

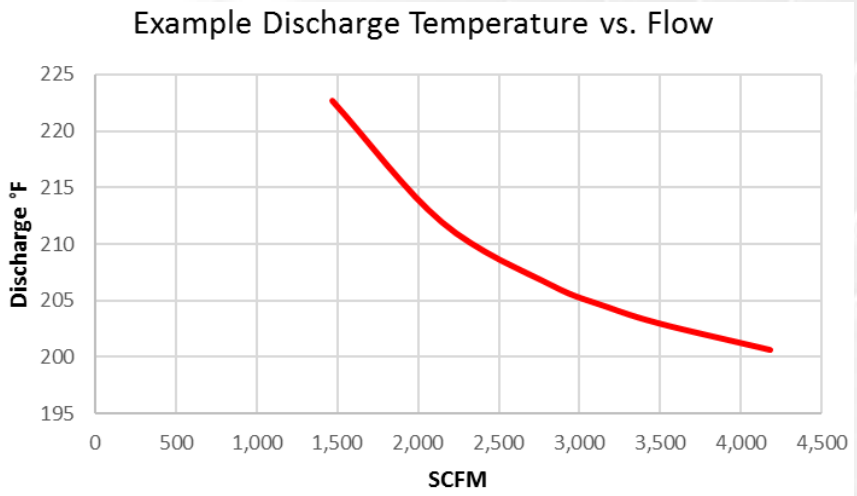


High Efficiency Over the Flow Range vs. PD



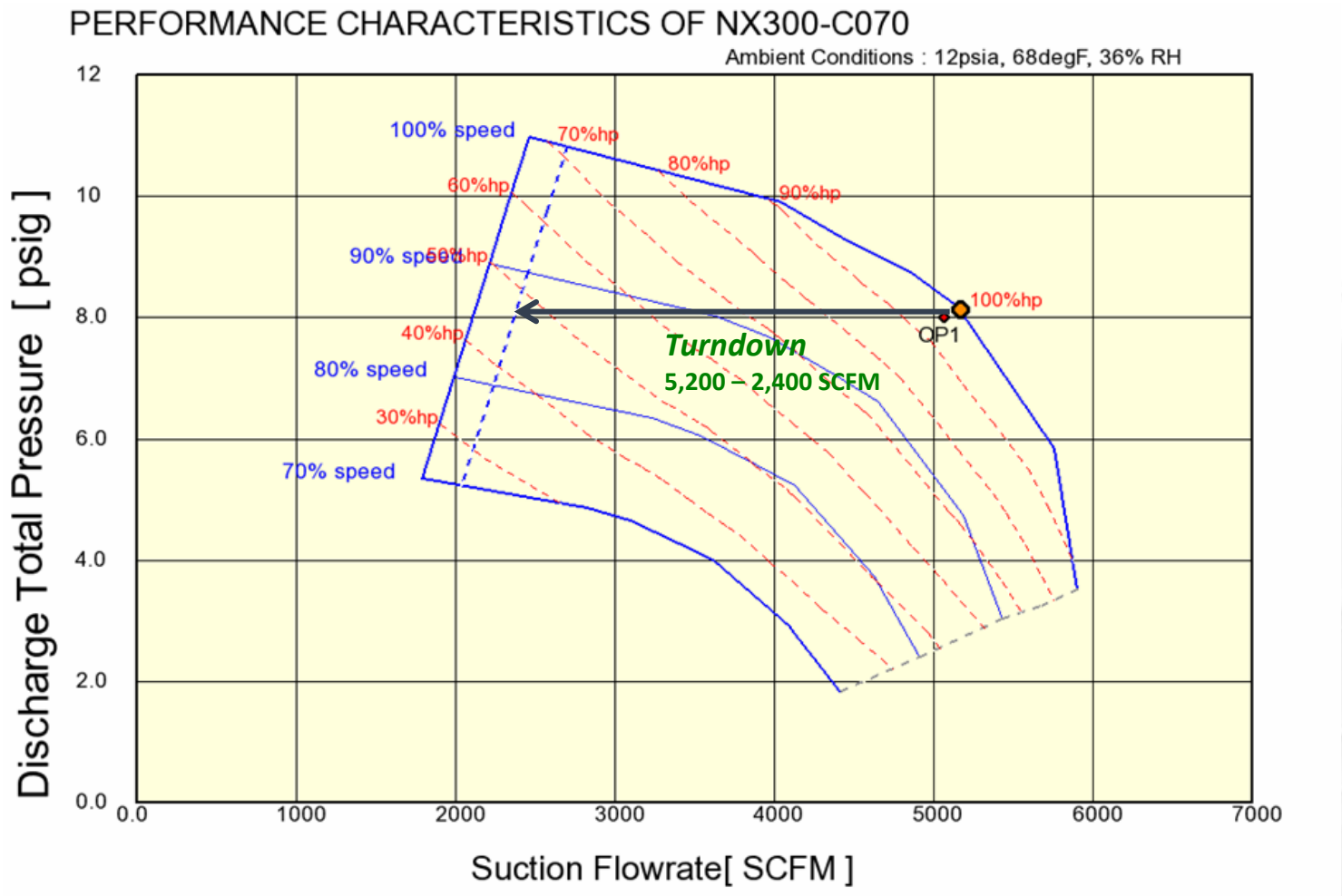


PD temperature increases at lower speed



Courtesy of Thomas E. Jenkins

Turndown > 50%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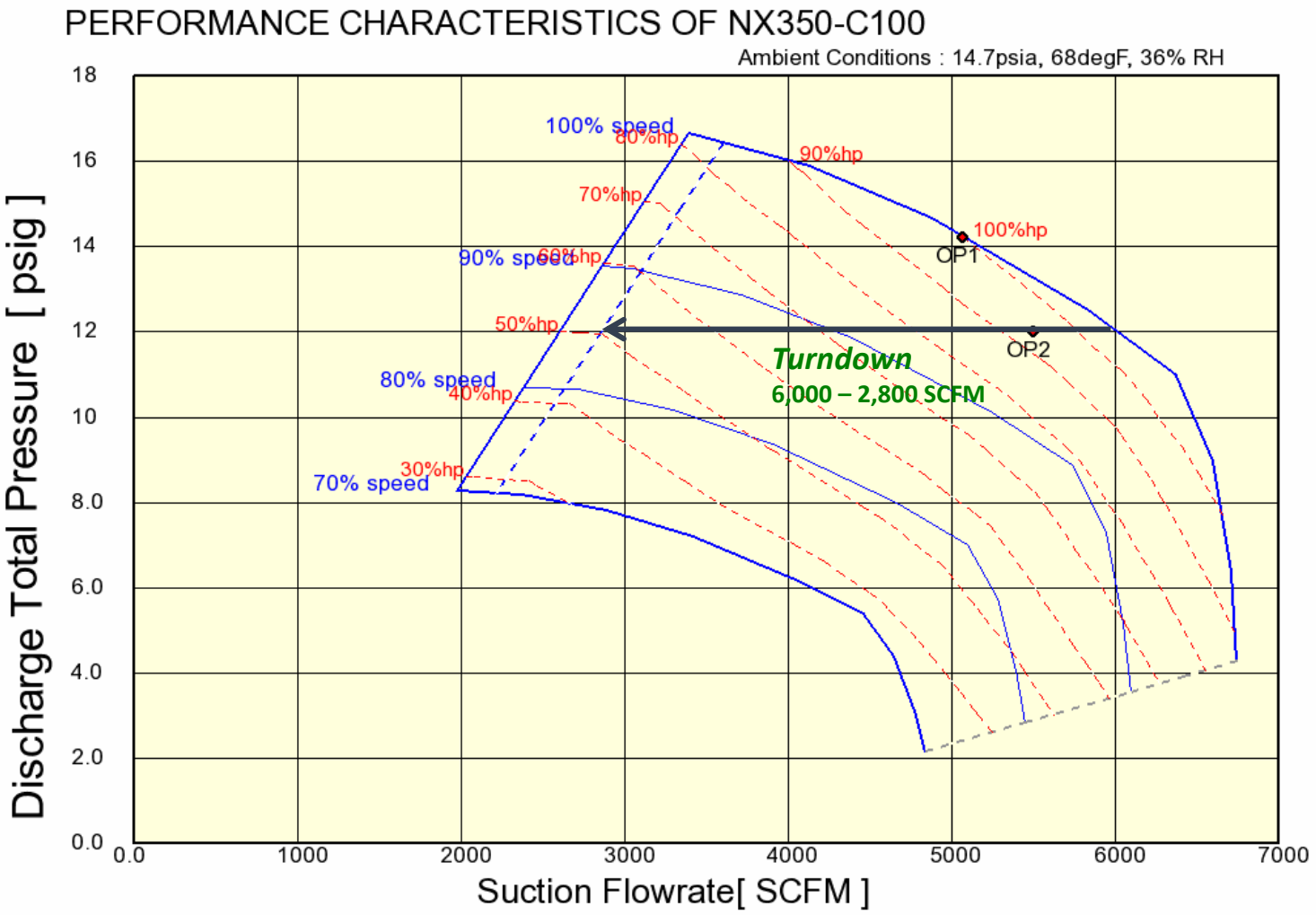
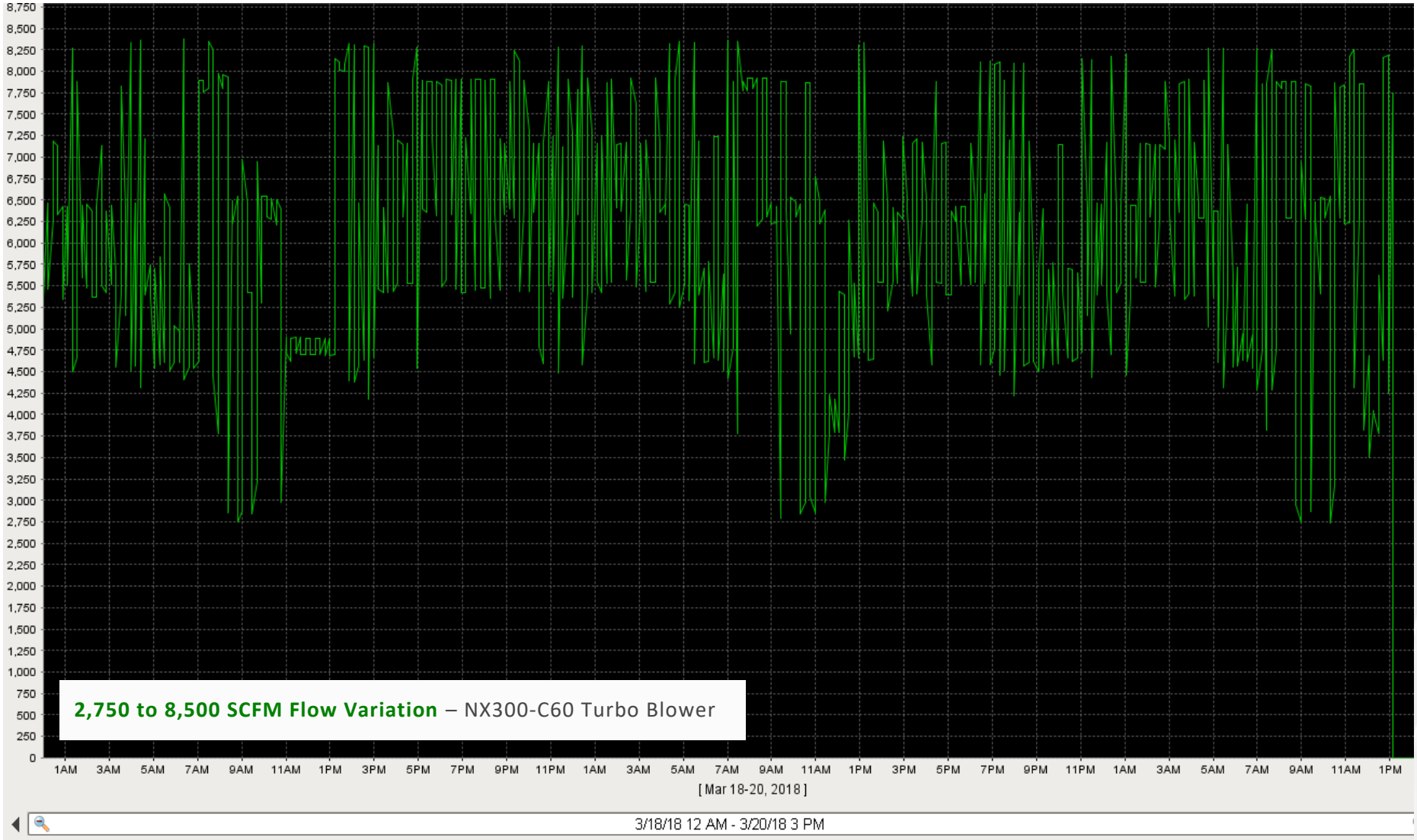
Ambient Conditions : 12psia, 68degF, 36% RH
Discharge Total Pressure [psig]
Suction Flowrate[SCFM]
0.0
2.0
4.0
6.0
8.0
10
12
0.0
1000
2000
3000
4000
5000
6000
7000
100% speed
90% speed
80% speed
70% speed
70%hp
80%hp
90%hp
100%hp
60%hp
50%hp
40%hp
30%hp
QP1
Turndown
5,200 – 2,400 SCFM

Single Core Turndown at High Pressure

Turndown > 50%



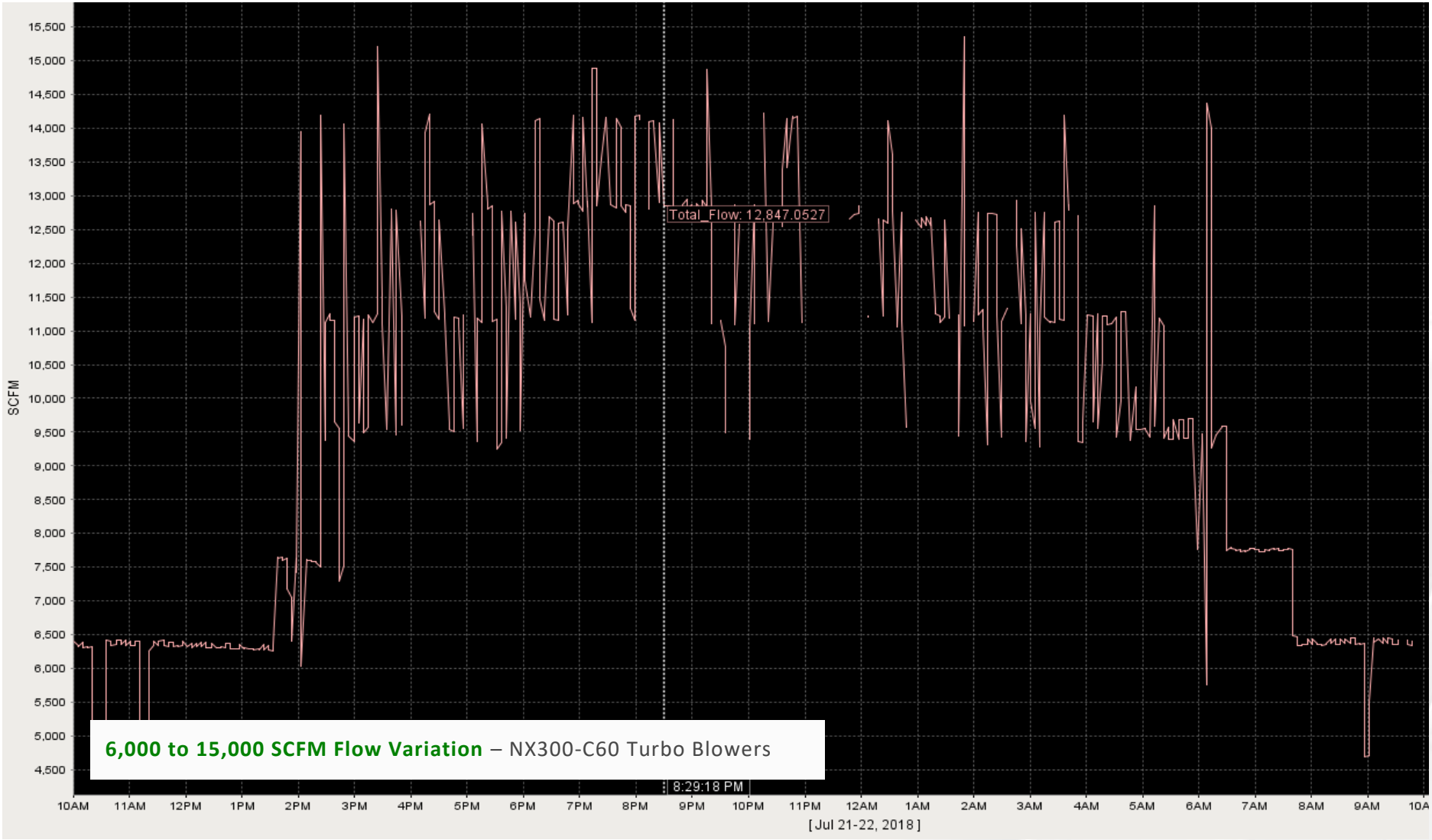
Visalia, CA – MBR Application – Turndown Range



2,750 to 8,500 SCFM Flow Variation – NX300-C60 Turbo Blower

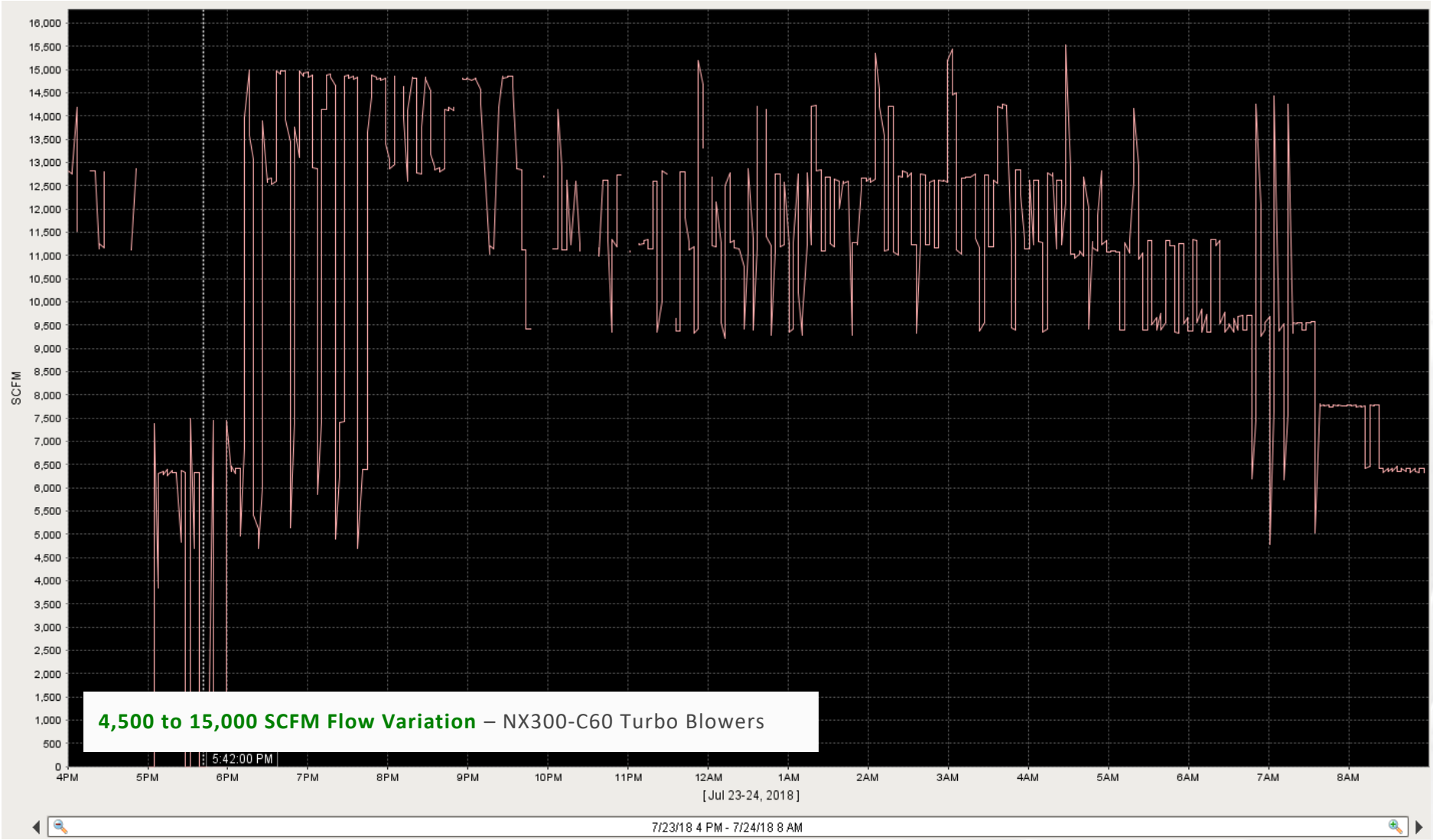
SCFM for NX300-C060 (1 blower).

Visalia, CA – MBR Application – Turndown Range



Total flow from all the operating blowers – Master Control Panel. 10 am to 6 am – July 21-22

Visalia, CA – MBR Application – Turndown Range



4,500 to 15,000 SCFM Flow Variation – NX300-C60 Turbo Blowers

Total flow from all the operating blowers – Master Control Panel. 4 pm to 8 am – July 23-24

Concluding Remarks

- Proper system design can help achieve the necessary turndown.
- Establish the required turndown and the most efficient blower operating point by defining:
  - Dissolved Oxygen
  - Influent
  - Ambient conditions
  - Actual pressure veruses specification/design pressure
  - Discharge temperature
  - Power consumption

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Q&A

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