Better Plants
U.S. DEPARTMENT OF ENERGY

In-Plant Trainings

8 – Session Virtual Platform

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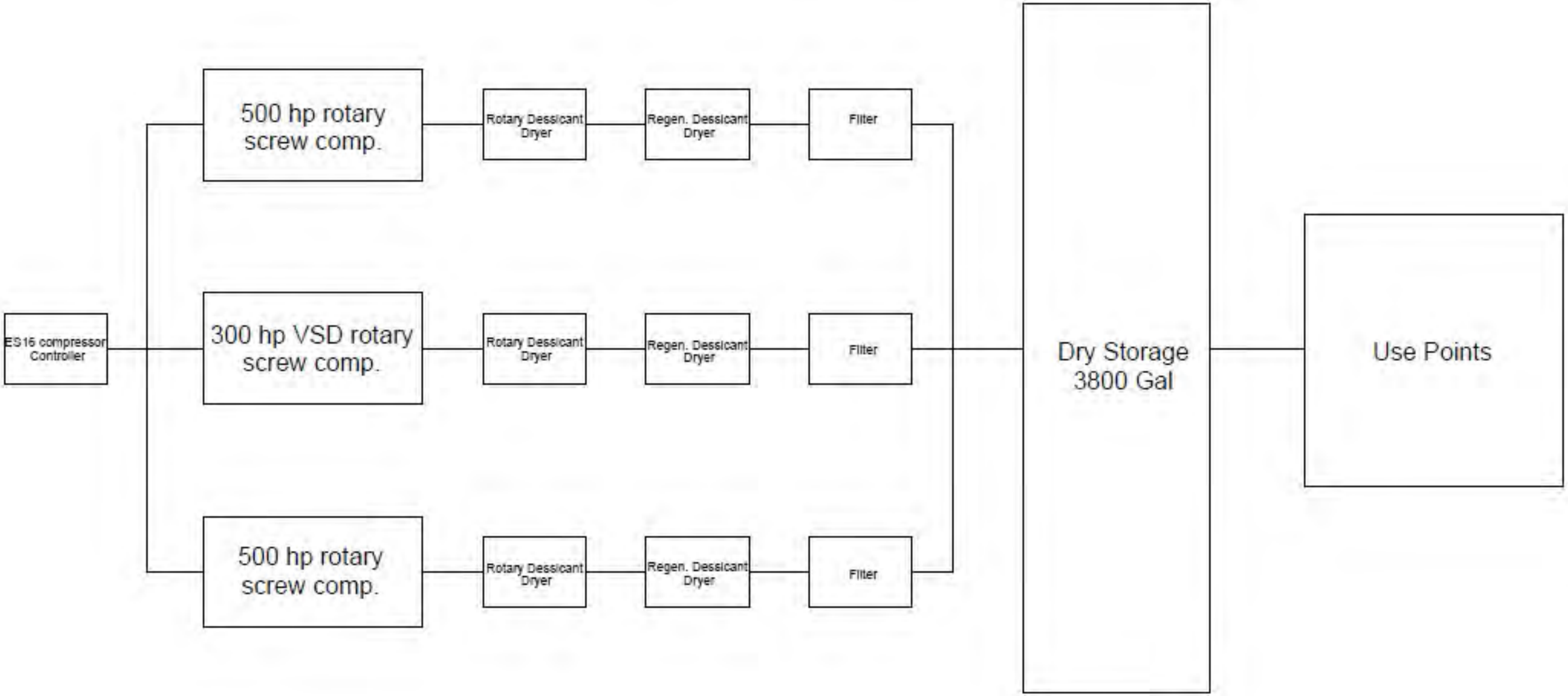
Last Session was Week 2, where we reviewed:

Compressor Types
Maintenance
Compressor Room Best Practices and Ventilation

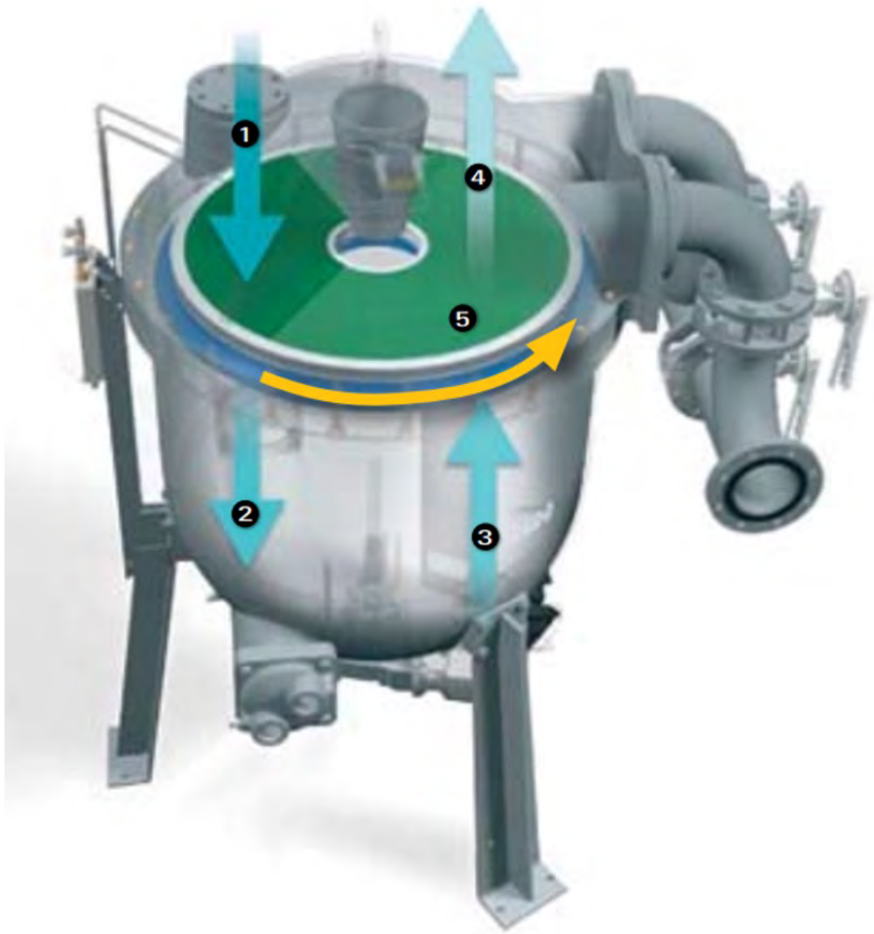
This is Session 3 – Week 3, where we will be discussing:

Compressor Controls
Intro to Airmaster+
Intro to LogTool
Intro to MEASUR

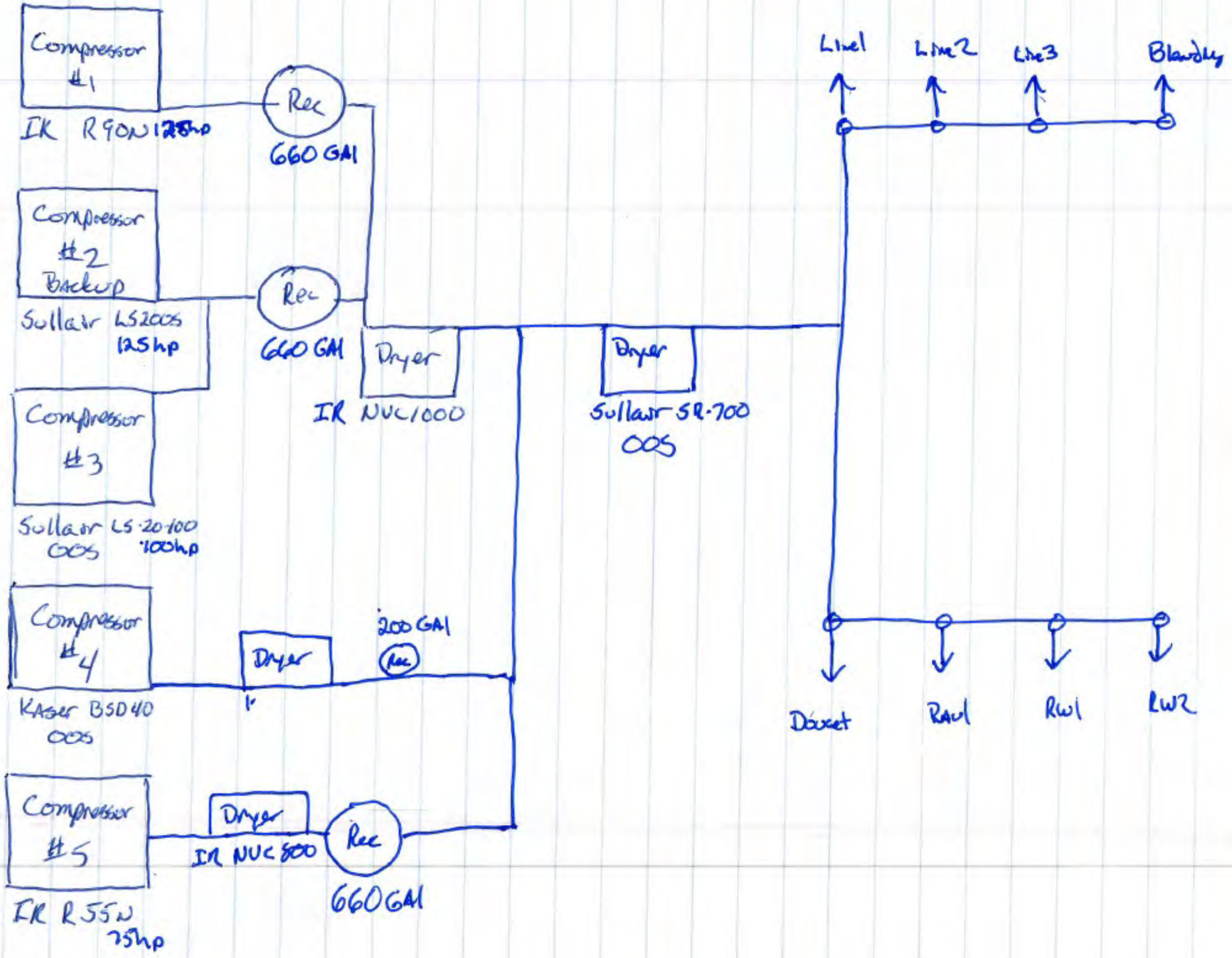
A few more Block Diagrams from Last Week



Heat of Compression Dryer

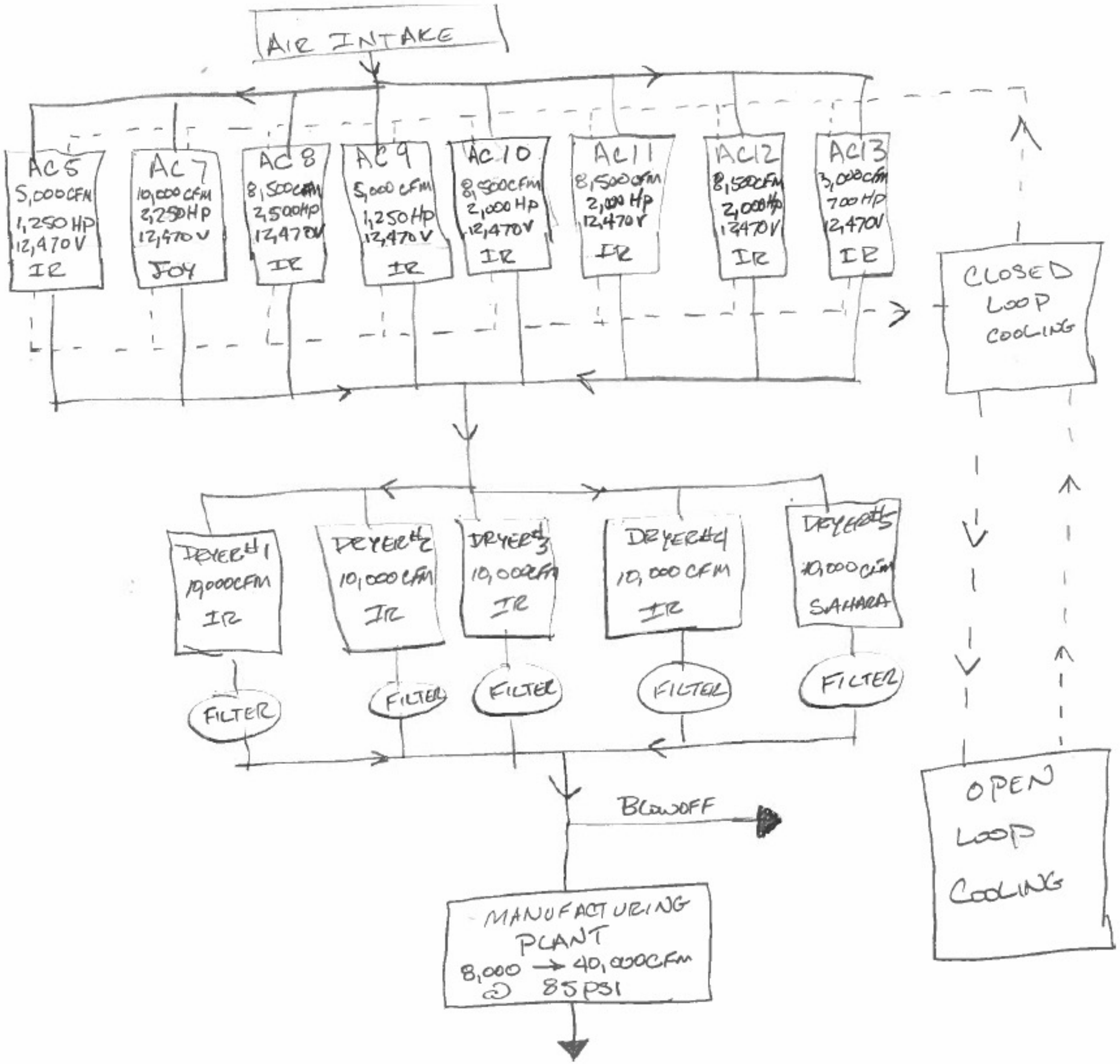


A few



Compressor #1
IR R90N 125hp
Rec
660 Gal
Compressor #2 Backup
Sullair LS200S 125hp
Rec
660 Gal
Dryer
IR NVC1000
Dryer
Sullair SR-700 OOS
Compressor #3
Sullair LS-20-100 OOS 100hp
Compressor #4
Kaeser BSD40 OOS
Dryer
200 Gal
Rec
Compressor #5
Dryer
IR NVC800
Rec
660 Gal
IR R55N 75hp
Line1
Line2
Line3
Blowdry
RW1
RW2

A few mor



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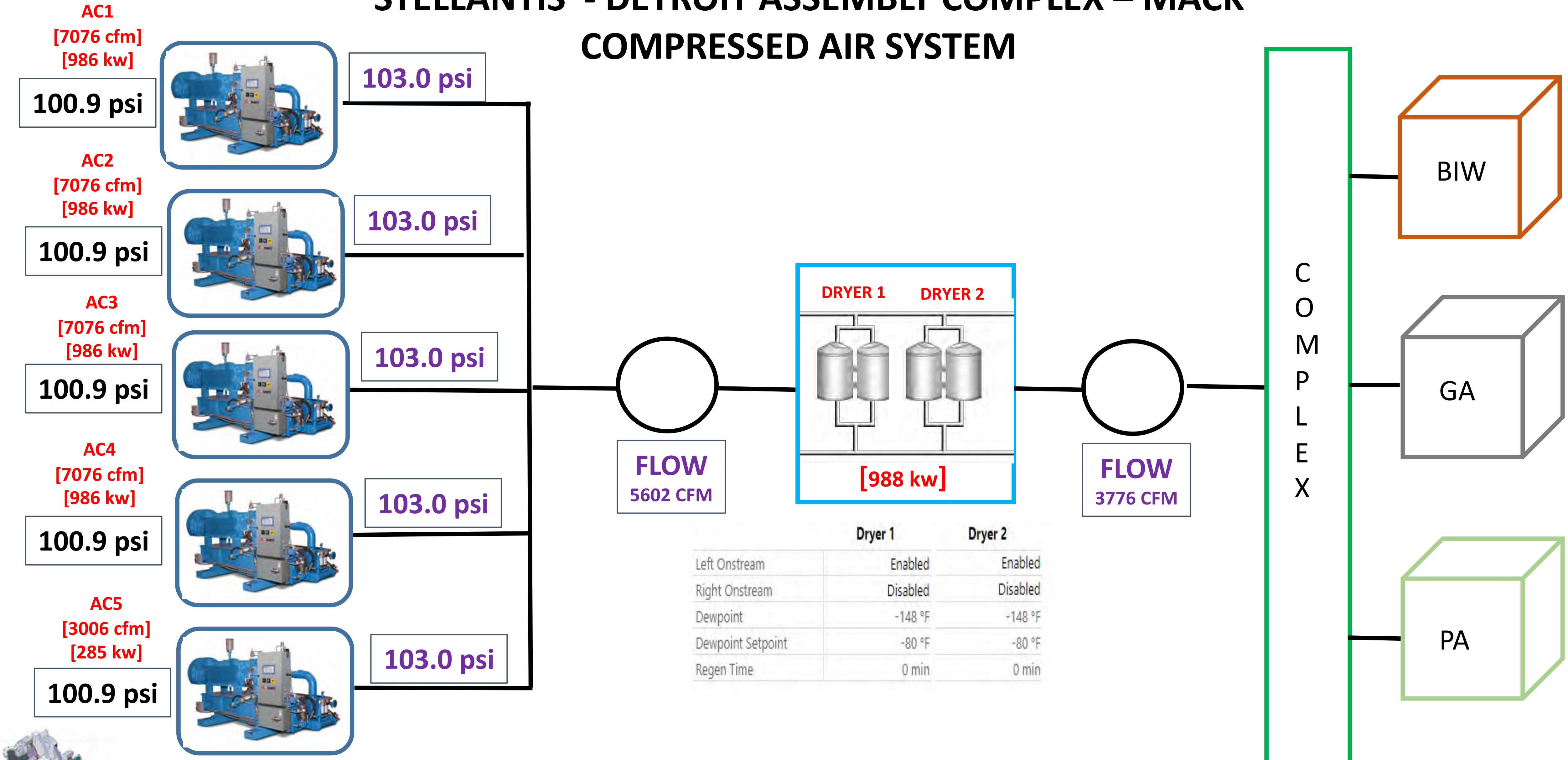
STELLANTIS - DETROIT ASSEMBLY COMPLEX – MACK COMPRESSED AIR SYSTEM



	Dryer 1	Dryer 2
Left Onstream	Enabled	Enabled
Right Onstream	Disabled	Disabled
Dewpoint	-148 °F	-148 °F
Dewpoint Setpoint	-80 °F	-80 °F
Regen Time	0 min	0 min

P400 + FRAME [Bay Controls]
[Polaris Model DA3 – three stage centrifugal compressors]
Motor Running amps 151.6 Amps
Motor Power 1017 kw

STELLANTIS - DETROIT ASSEMBLY COMPLEX – MACK COMPRESSED AIR SYSTEM

DACM | General Assembly | Body Shop | Energy Center | Power M… | 7 Alarm(s)

Air Compressor Overview

Network Pressure: 100.90psi | Network Setpoint: 98.00psi | Total Flow: 3,763.00cfm | Total Power: 945.00kW | Network Efficiency: 0.00cfm/kW

	AC 1	AC 2	AC 3	AC 4	AC 5
					
Design Flow	7076 cfm	7076 cfm	7076 cfm	7076 cfm	3006 cfm
Flow	5306 cfm	0 cfm	0 cfm	0 cfm	0 cfm
System Pressure	100.9 psi	101 psi	100.8 psi	100.8 psi	100.8 psi
Discharge Pressure	103.6 psi	0 psi	0.1 psi	0.1 psi	0 psi
Power	943 kW	2 kW	0 kW	0 kW	0 kW
Efficiency	0 cfm/kW	### cfm/kW	### cfm/kW	0 cfm/kW	### cfm/kW
Blowoff Position	0 %	100 %	100 %	100 %	100 %
Inlet Position	21.2 %	0 %	0 %	0 %	0 %
System Priority	9	6	8	5	7
Compressor State	Running Auto-Min Flow	Stopped-Local or Auto Rdy	Stopped-Local or Auto Rdy	Stopped-Local or Auto Rdy	Stopped-Local or Auto Rdy
Alarm State	No	No	No	No	No
	STARTED	STOPPED	STOPPED	STOPPED	STOPPED

	Dryer 1	Dryer 2
Left Onstream	Enabled	Enabled
Right Onstream	Disabled	Disabled
Dewpoint	-147 °F	-147 °F
Dewpoint Setpoint	-80 °F	-80 °F
Regen Time	0 min	0 min

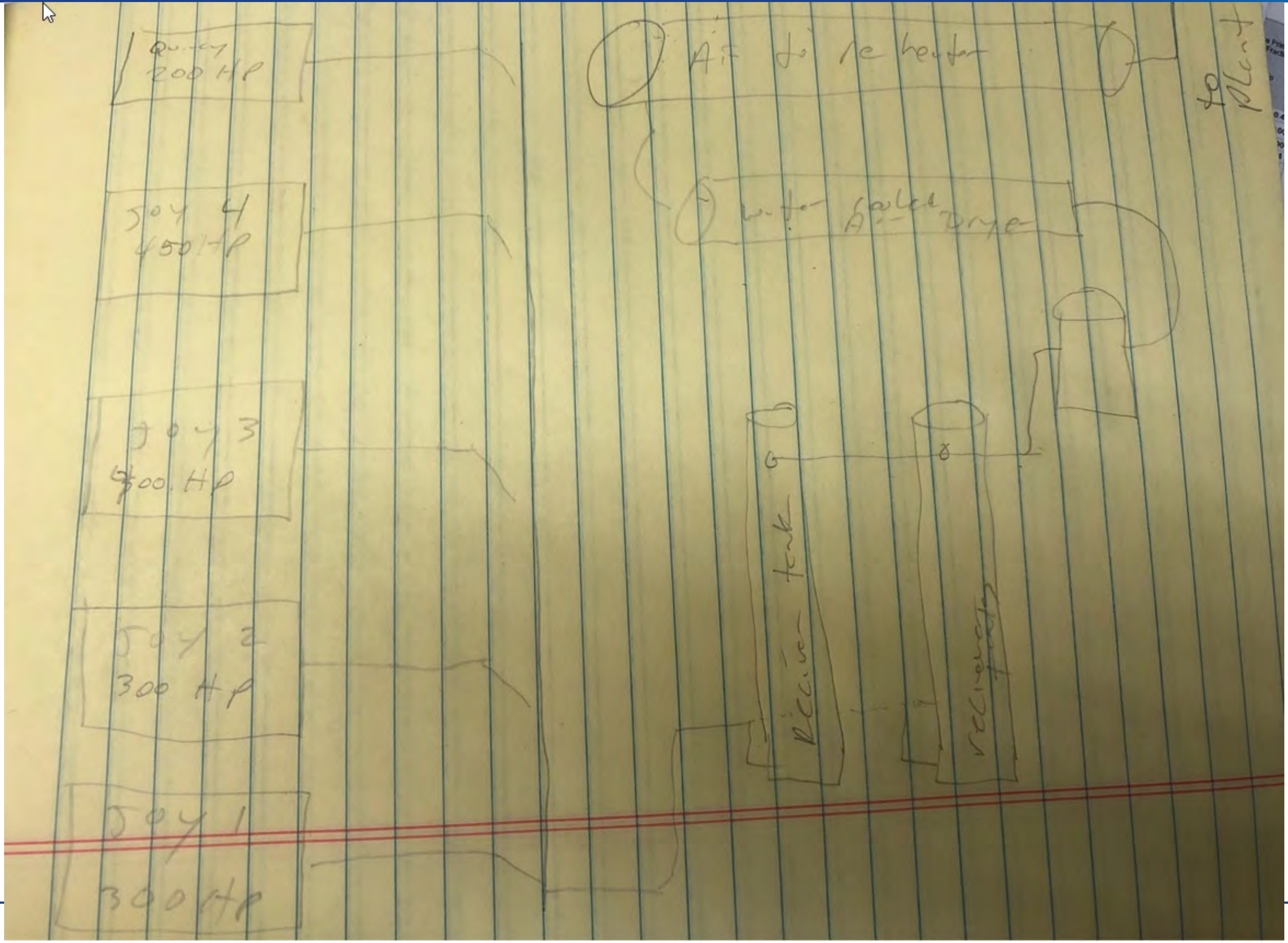
Network Pressure
100.90psi
Network Setpoint
98.00psi

Legend: Active (On) | Fault | Inactive (Off) | No Comm | Warning

Communication Status
Status: 0 Updates Received
Current Time: 08/23/2021 10:22 AM
User: t8903el

leidos

A few more Block Diagrams from Last Week



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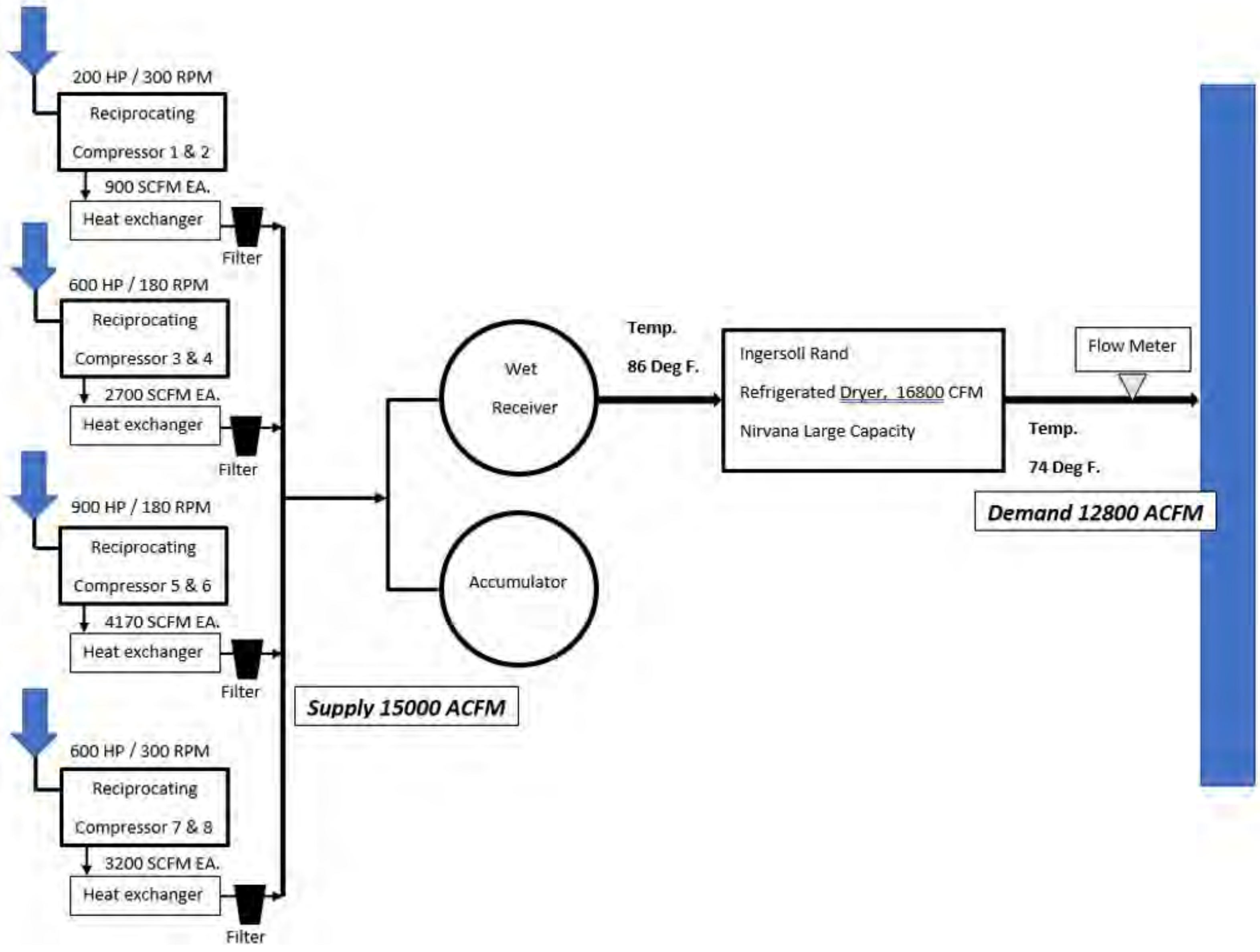
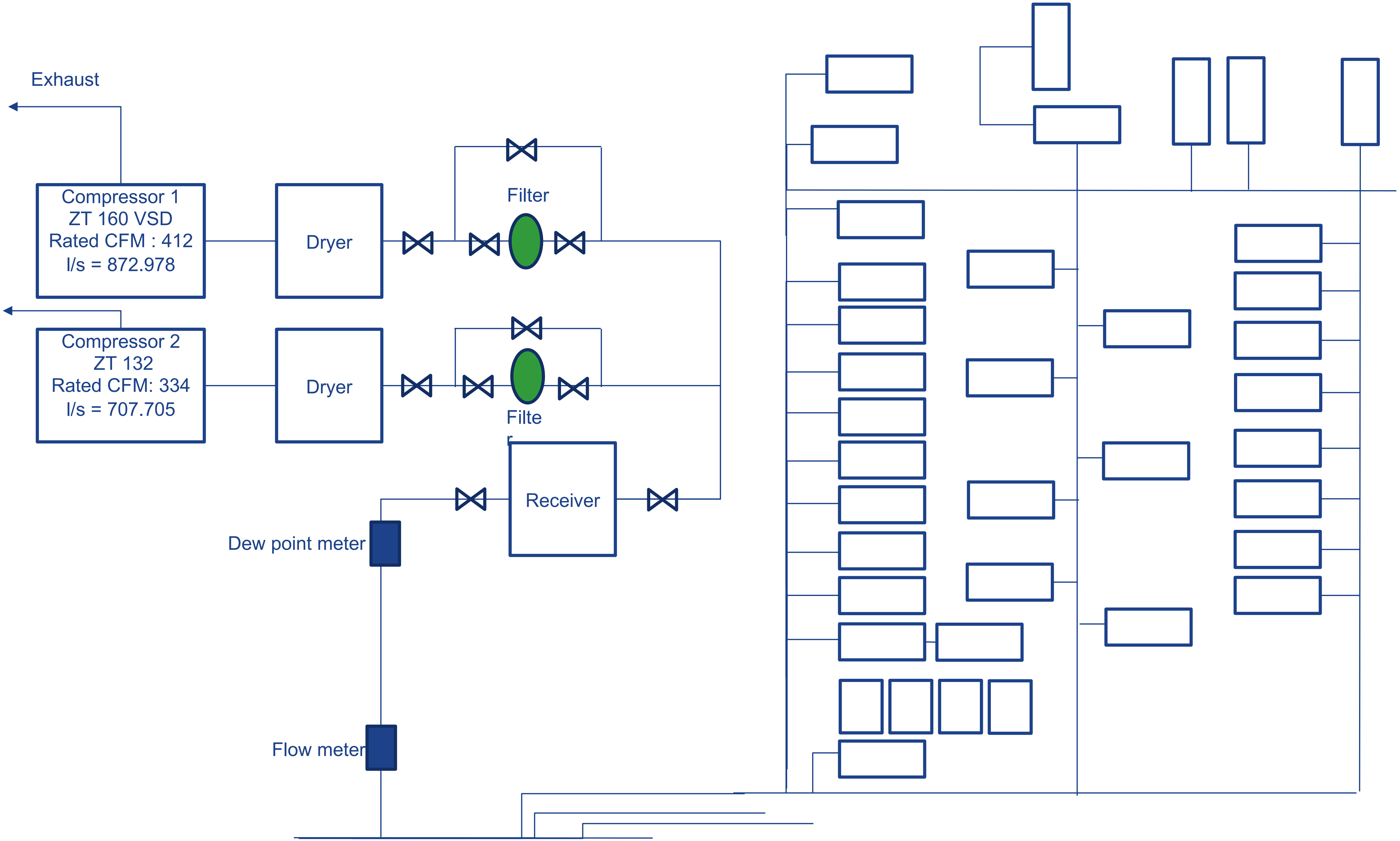
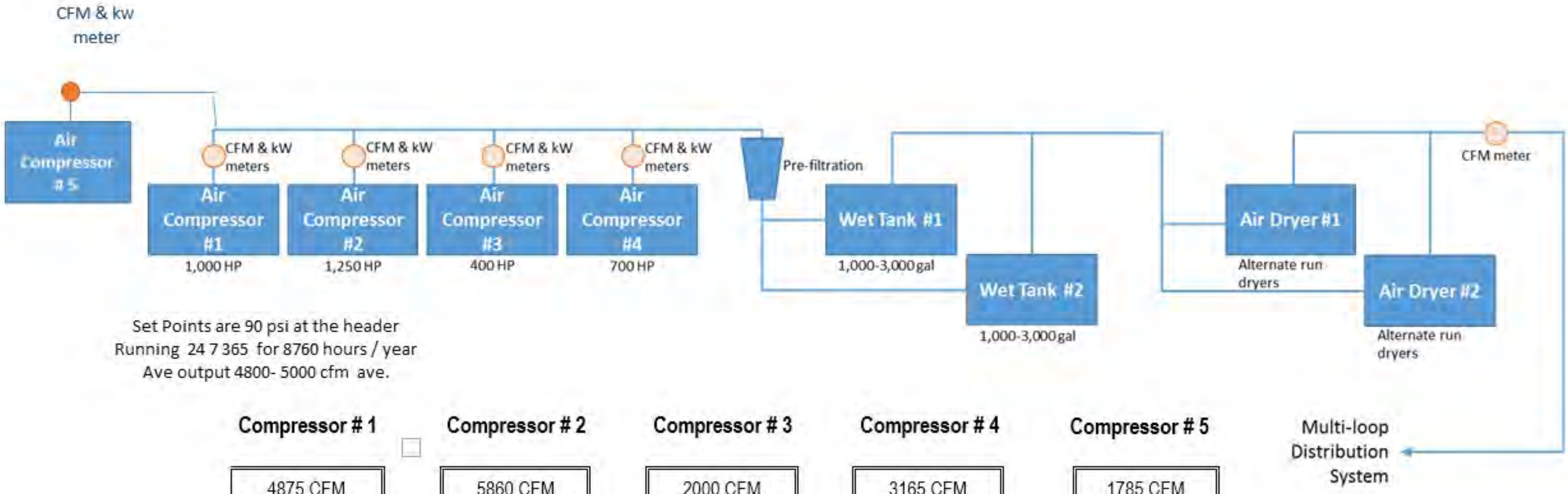


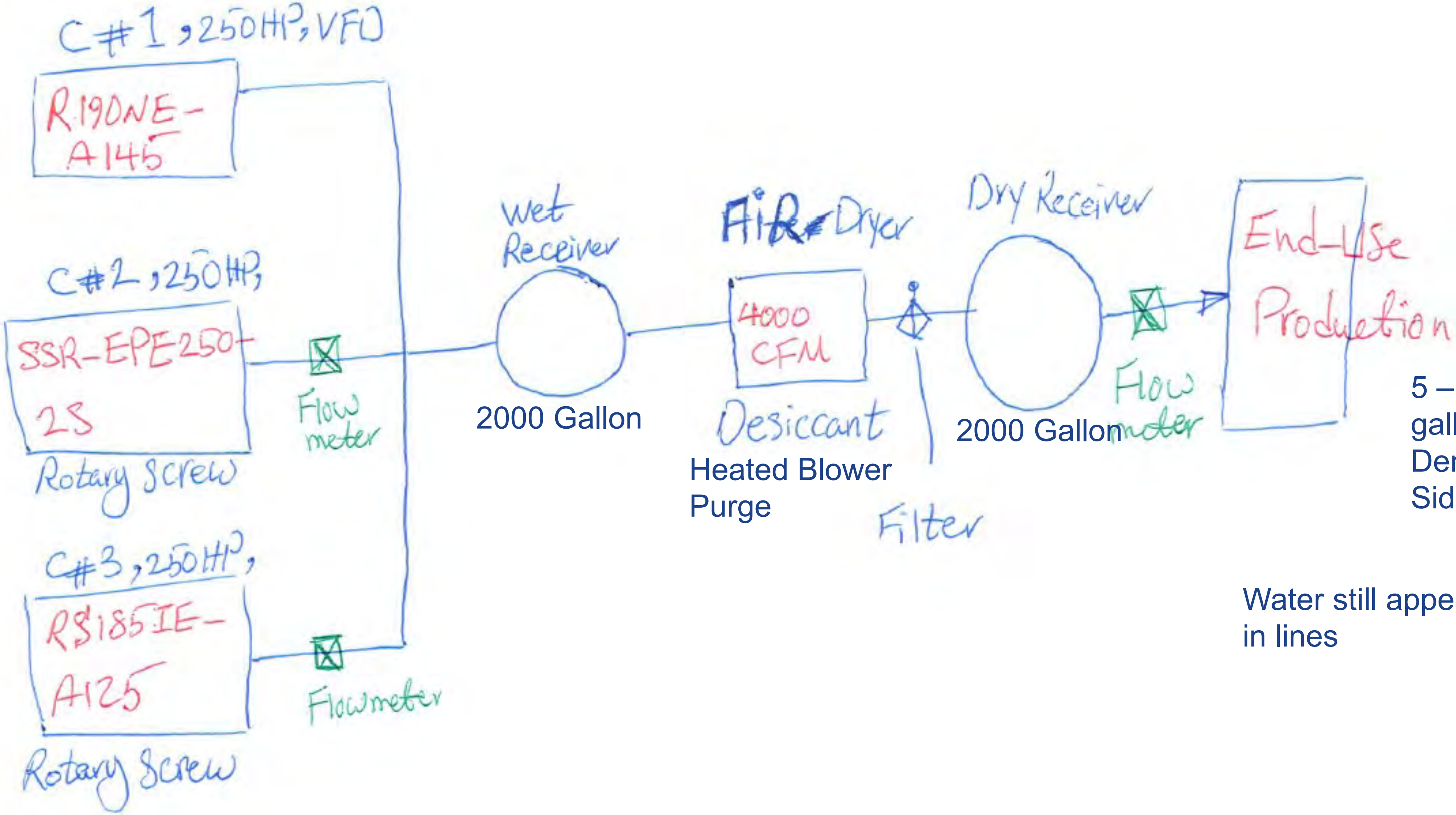

Exhaust
Compressor 1
ZT 160 VSD
Rated CFM : 412
l/s = 872.978
Compressor 2
ZT 132
Rated CFM: 334
l/s = 707.705
Dryer
Dryer
Filter
Filte
r
Receiver
Dew point meter
Flow meter



Set Points are 90 psi at the header
Running 24 7 365 for 8760 hours / year
Ave output 4800- 5000 cfm ave.

Compressor # 1	Compressor # 2	Compressor # 3	Compressor # 4	Compressor # 5
4875 CFM 1100 H.P. DE-56336	5860 CFM 1250 H.P. DE-36959	2000 CFM 400 H.P. DE-28336	3165 CFM 700 H.P. DE-56335	1785 CFM 400 H.P. DE-56818
Manufacturer: Ingersoll Rand	**Manufacturer:** Ingersoll Rand	**Manufacturer:** Ingersoll Rand	**Manufacturer:** Ingersoll Rand	**Manufacturer:** Ingersoll Rand
Type: Centrifugal	**Type:** Centrifugal	**Type:** Reciprocating	**Type:** Centrifugal	**Type:** Screw

A few more Block Diagrams from Last Week



2000 Gallon

Heated Blower Purge

2000 Gallon

5 – 500 gallons in Demand Side

Water still appearing in lines

So How Do I Measure My Dewpoint? (Covered Next Session)

- Maintaining the dew point of your air or gas system will prolong the lifetime of your equipment and reduce maintenance costs.
- For dew points related to production processes, guarding the dew point is critical for the end-product and key in preventing costly production losses.
- Permanent monitoring enables you to detect and prevent problems quickly and may provide visibility that a change in dew point is capacity or maintenance related.

Homework for Week 2 – Compression Ratio

- What's the compression ratio of the single stage compressor below:
  - 13.5 psia inlet pressure
  - 113.5 psia discharge pressure

$$\frac{113.5\,psia}{13.5\,psia} = 8.4$$

Homework for Week 2 – Compressor Info

Nameplate Information

Compressor # ______ (from block diagram)
Manufacturer ____________________________________
Model ____________________________________
Compressor Type ____________________________________
Motor Nameplate Horsepower ______ hp ____________ voltage
Rated CFM ______ cfm
Maximum Design Full Load Pressure ______ psig
Age/Comments: ____________________________________

____

How are the pressure setpoints on the compressors' controls configured?

	Load	Unload/Modulate
Pressure setting:	_______ psig	_______ psig
Pressure setting:	_______ psig	_______ psig
Pressure setting:	_______ psig	_______ psig

Operating Schedule Information

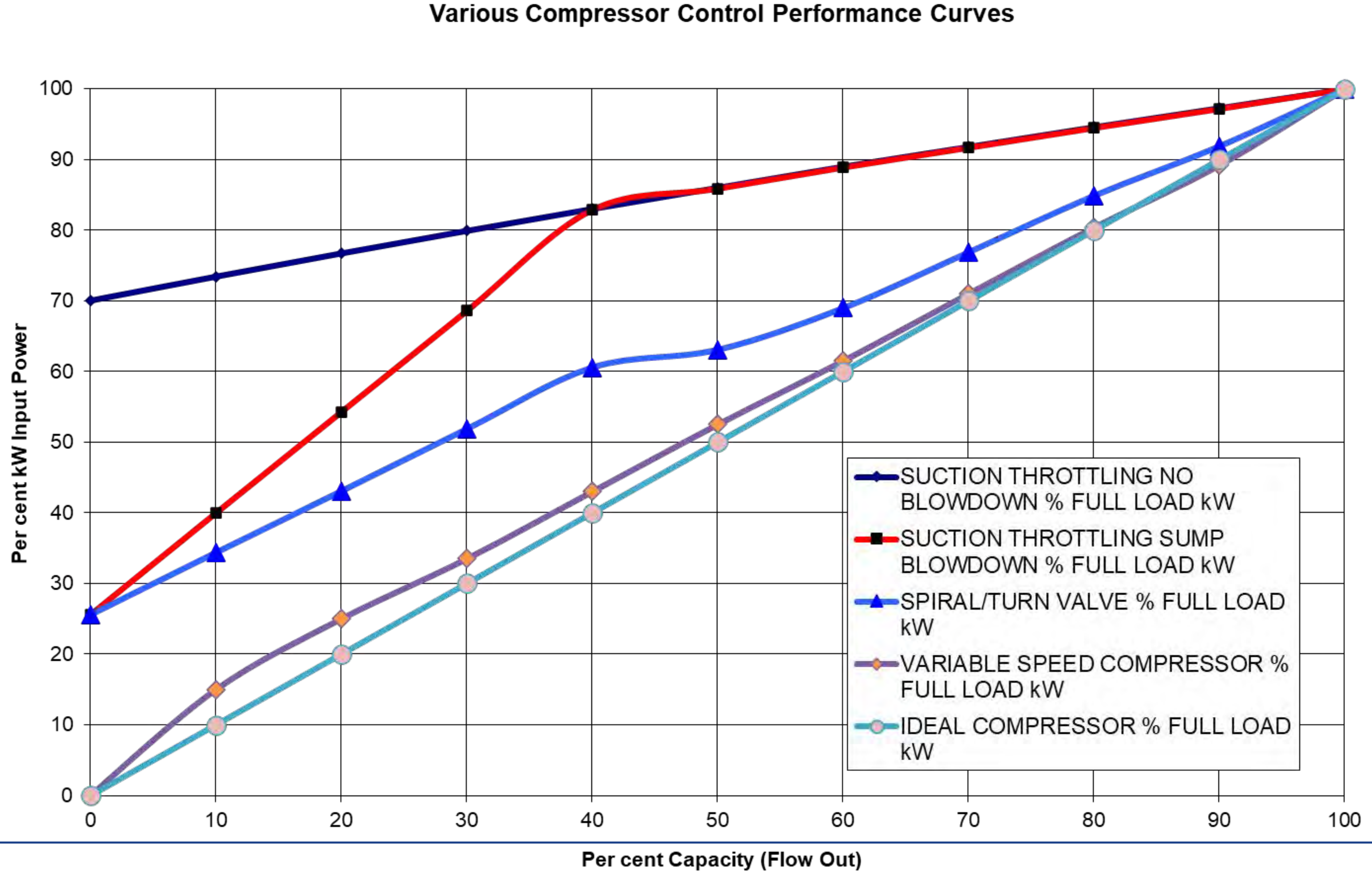
Number of Days of Operation Annually ______________________________
Number of Hours per Day ______________________________
Compressor Discharge Pressure ______ psig

Compressor Controls

System capacity control is based on:

- Number of compressors in a system
- Type and size of the compressors
- Application requirements

Performance Curves



Compressor Control Pros and Cons

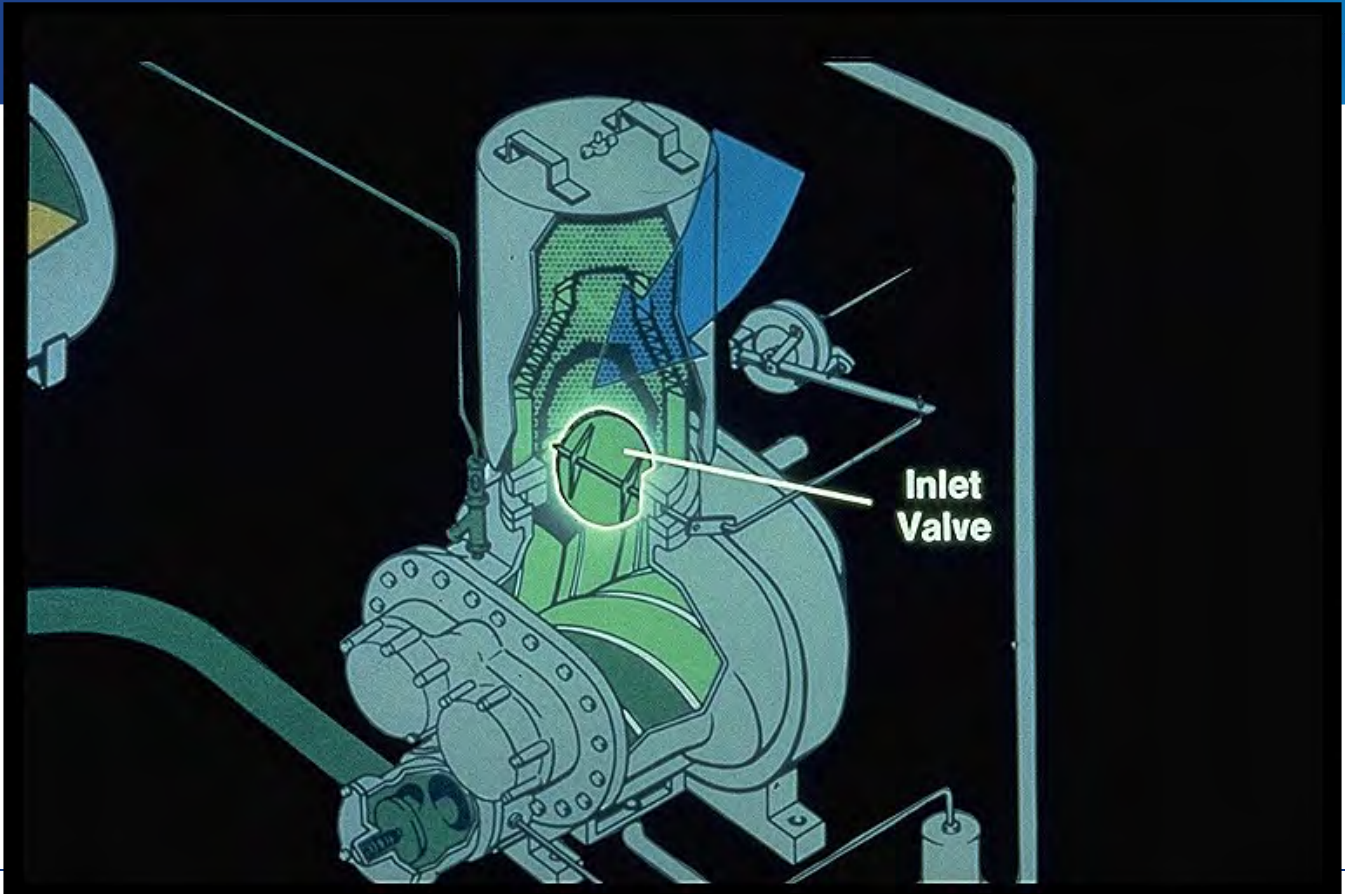
- Start/Stop
  - Pros:
    - Simple control using only a pressure switch
    - Motor and compressor operate only when needed
    - Good for small compressors
  - Cons:
    - Frequent full load starting wears down motor and compressor
    - Loose pressure control as high as 35 psi
    - Limited to small units

Compressor Control Pros and Cons

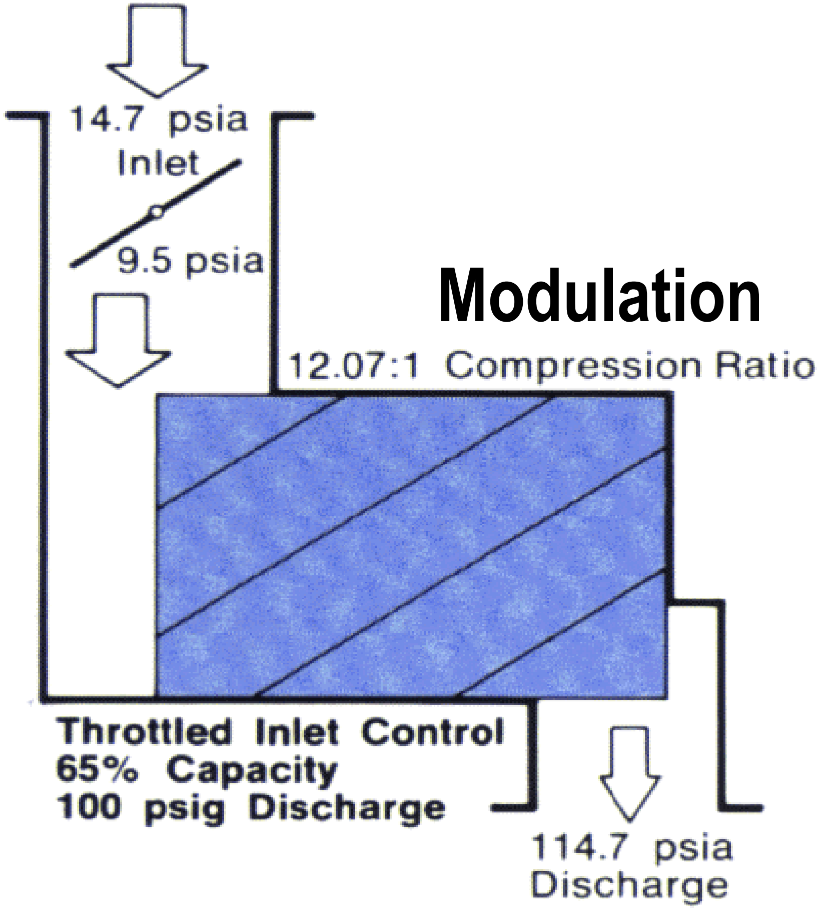
- Load/Unload
  - Pros:
    - Motor and compressor run continuously reducing wear
    - Tighter range of pressure control
  - Cons:
    - Improperly applied can cause short cycling which causes premature wear and failure

Compressor Control Pros and Cons

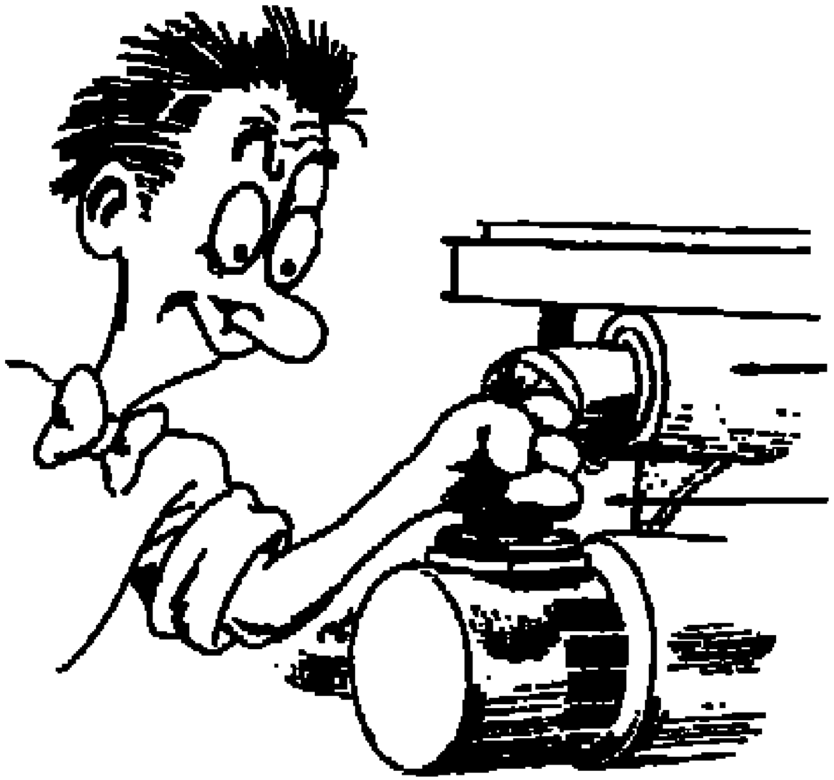
- Modulating
  - Pros:
    - Motor and compressor run continuously reducing wear
    - Tighter range of pressure control
    - Steadily progressive capacity control to match demand
  - Cons:
    - Inefficient at lower loads, centrifugal units limited by potential surge and can require discharge blowoff
    - Pressure ratios increase as inlet is throttled


Inlet
Valve

Inlet Throttling

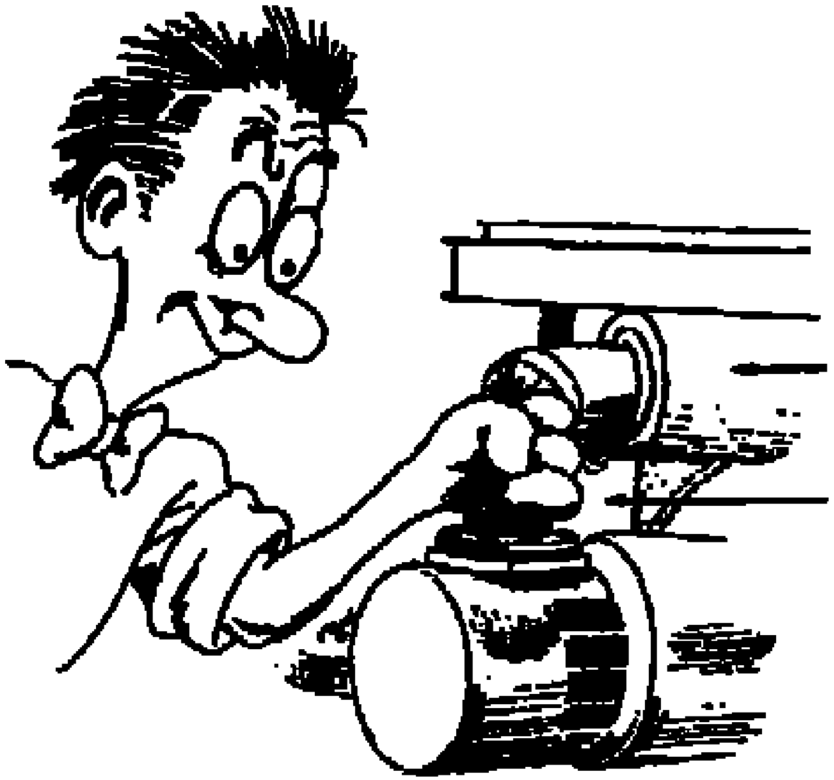


Capacity Control by Inlet Throttling



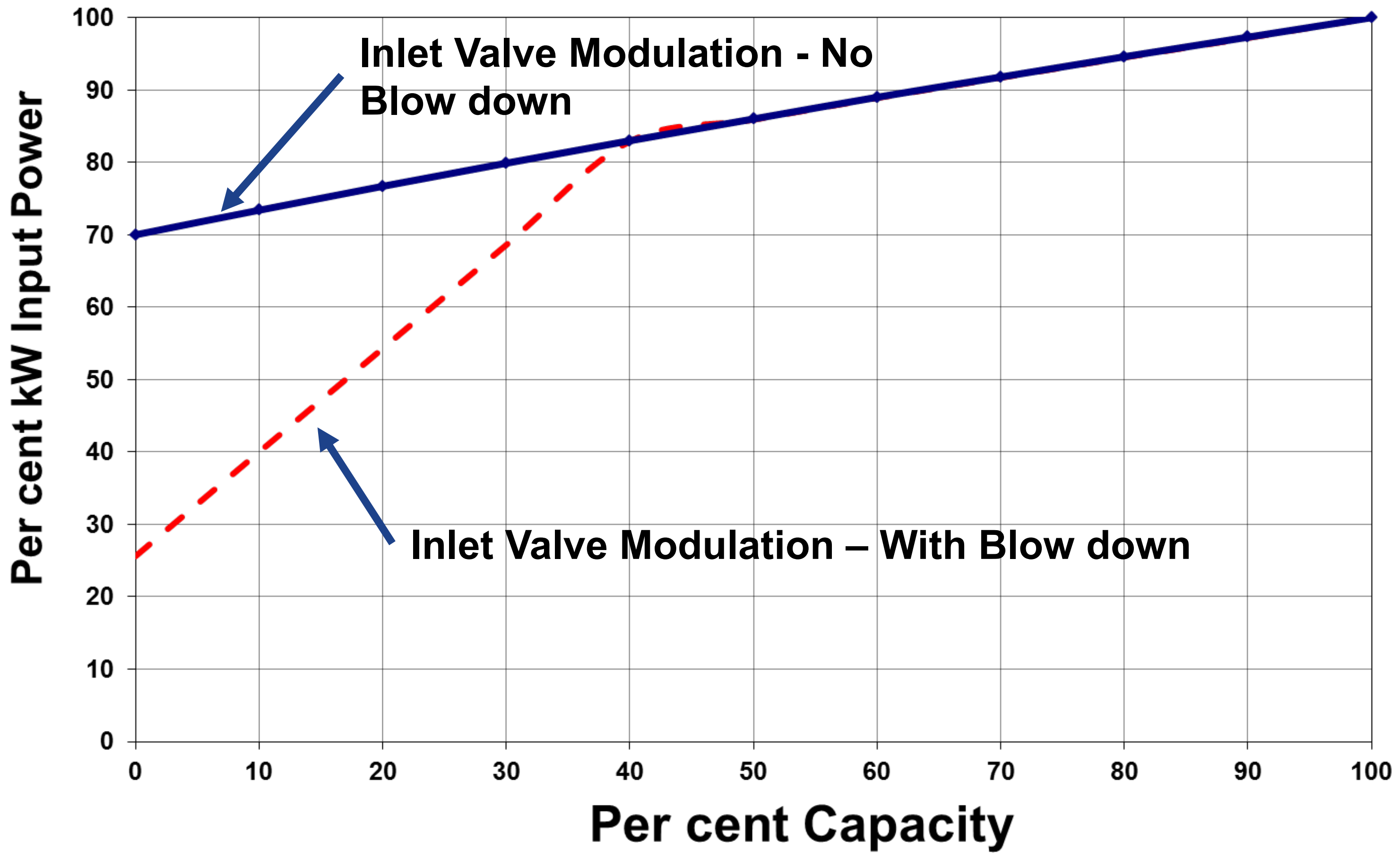
- Atmospheric pressure 14.7 psia
- Intake pressure 9.0 psia from inlet throttling
- Discharge pressure 100 psig or 114.7 psia
- Compression ratio: 114.7/9.0 = 12.7 to 1
- End Result?? Increased internal leakage due to a higher compression ratio

Capacity Control by Inlet Throttling

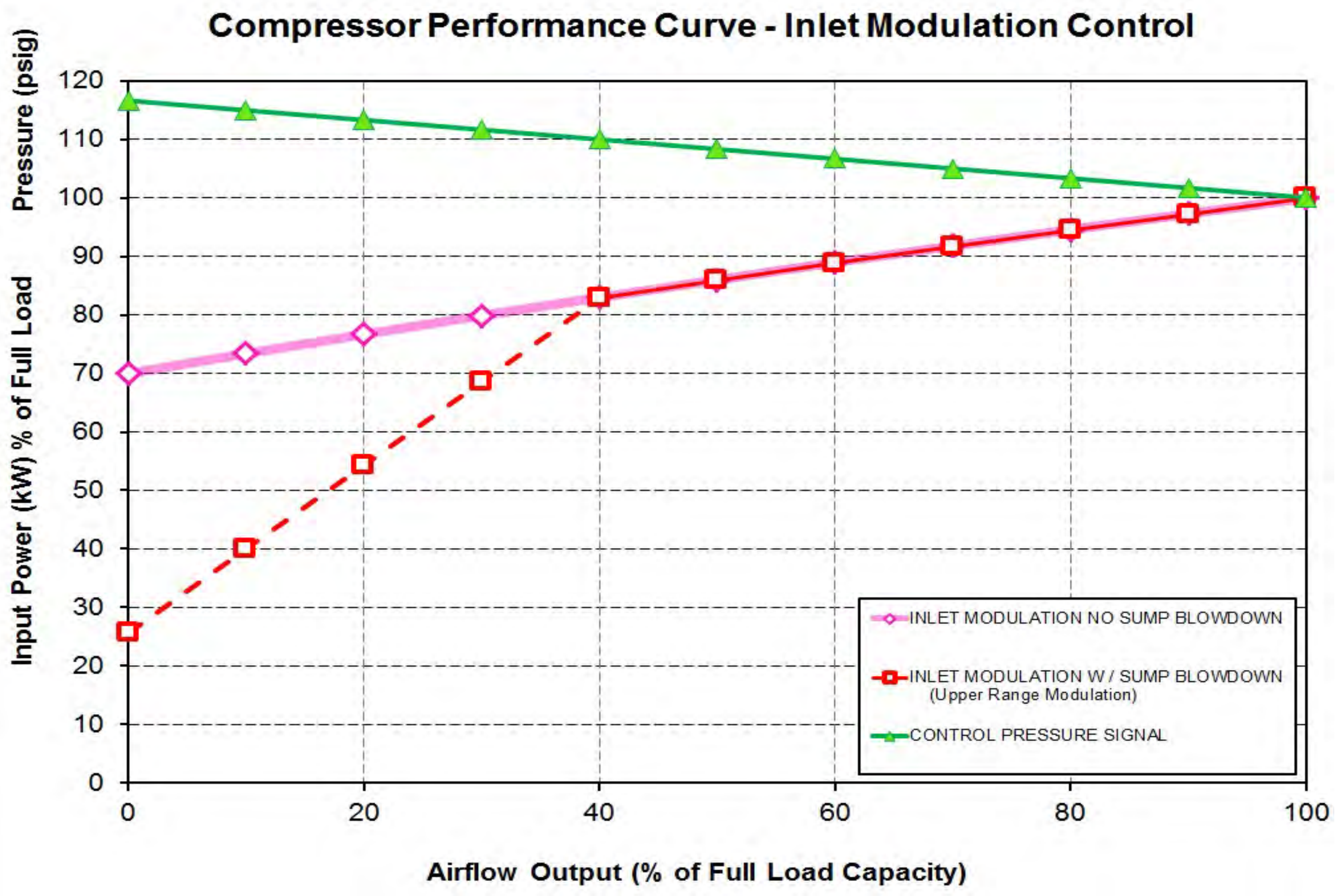


- Varies capacity by throttling (restricting) the inlet flow
- Provides a relatively stable output pressure.
- Energy hog… least efficient.
- Every 10% reduction in capacity yields only a 3% reduction in power(BHP)
- At zero capacity, power remains at 70% of full load power.

Inlet Valve Modulation

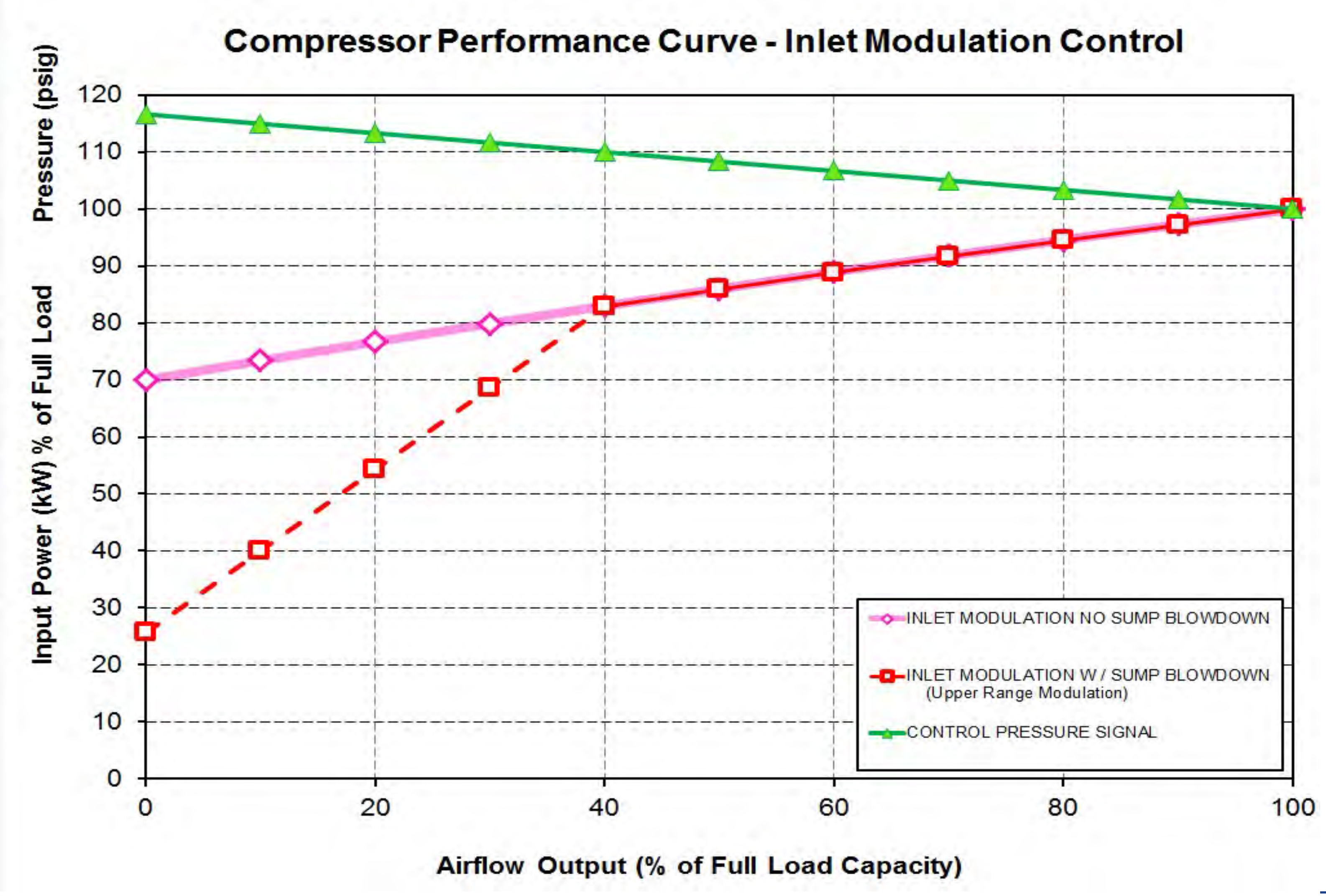


Inlet Valve Modulation

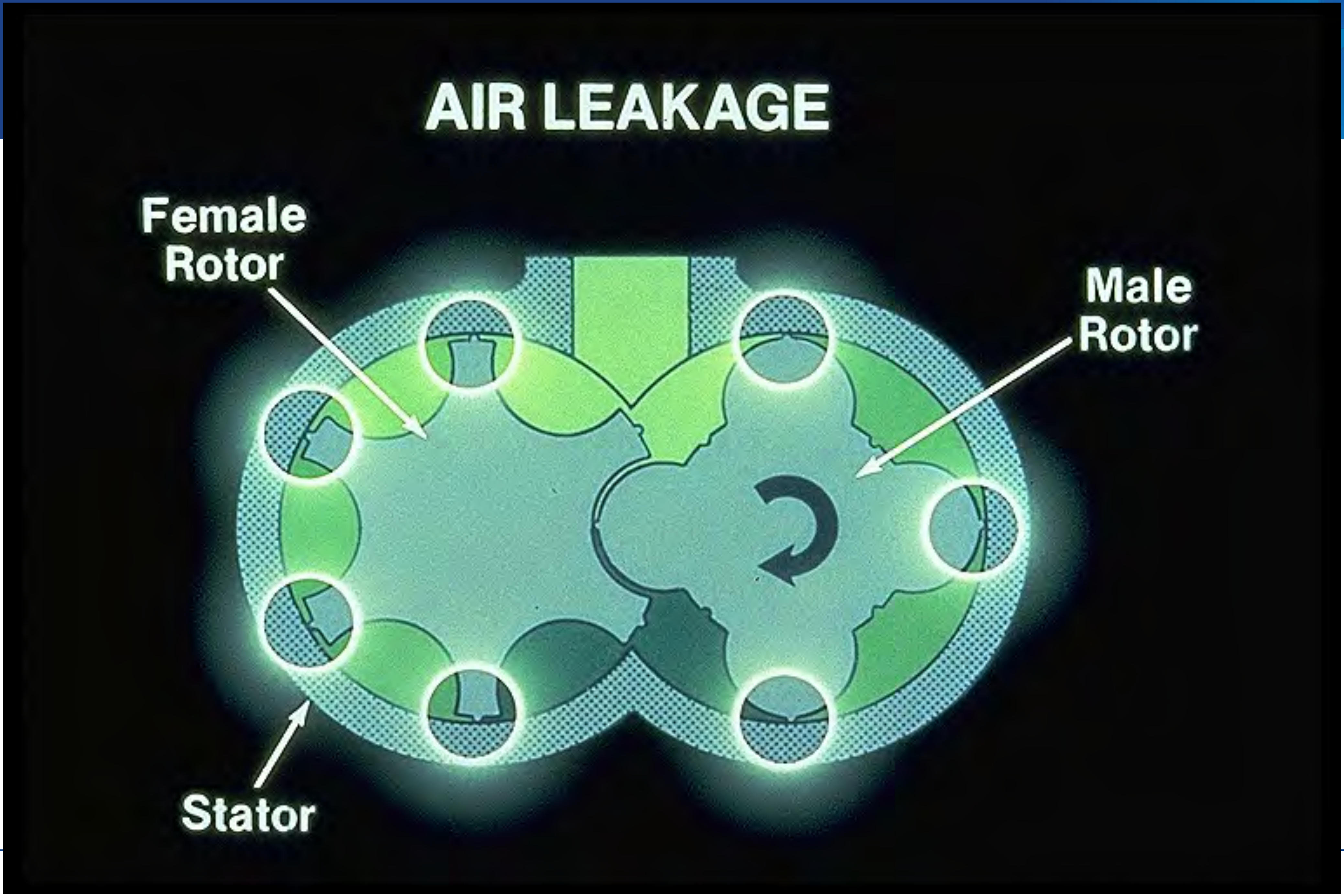


- The example shows a discharge pressure range of 100 - 110 psig.
- As discharge pressure rises from 100 to 110 psig, a proportional pressure regulator provides a control pressure typically from 0 - 30 psig, to progressively close the inlet valve.

Inlet Valve Modulation



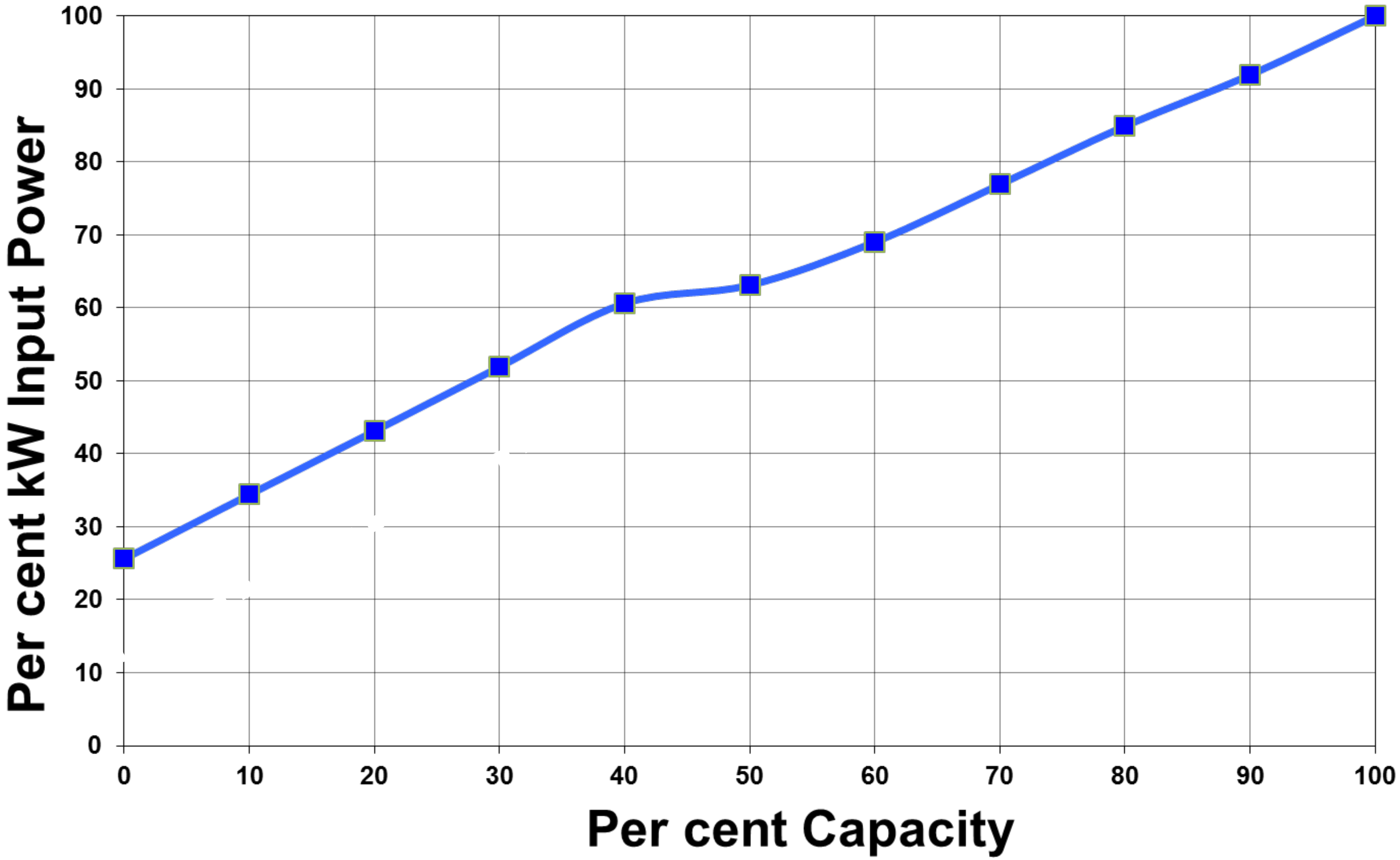
- As the inlet valve closes, the absolute pressure at the inlet of the air end is reduced.
- This reduces the mass flow of air entering the air end in direct proportion to the absolute pressure.
- However, the reduced inlet pressure, with increasing discharge pressure, results in increasing pressure ratio.
- At 40% capacity the pressure ratio will be 124.7/5.88 = 21.2:1
- This is why there is not much reduction in the power requirement.


AIR LEAKAGE
Female Rotor
Male Rotor
Stator

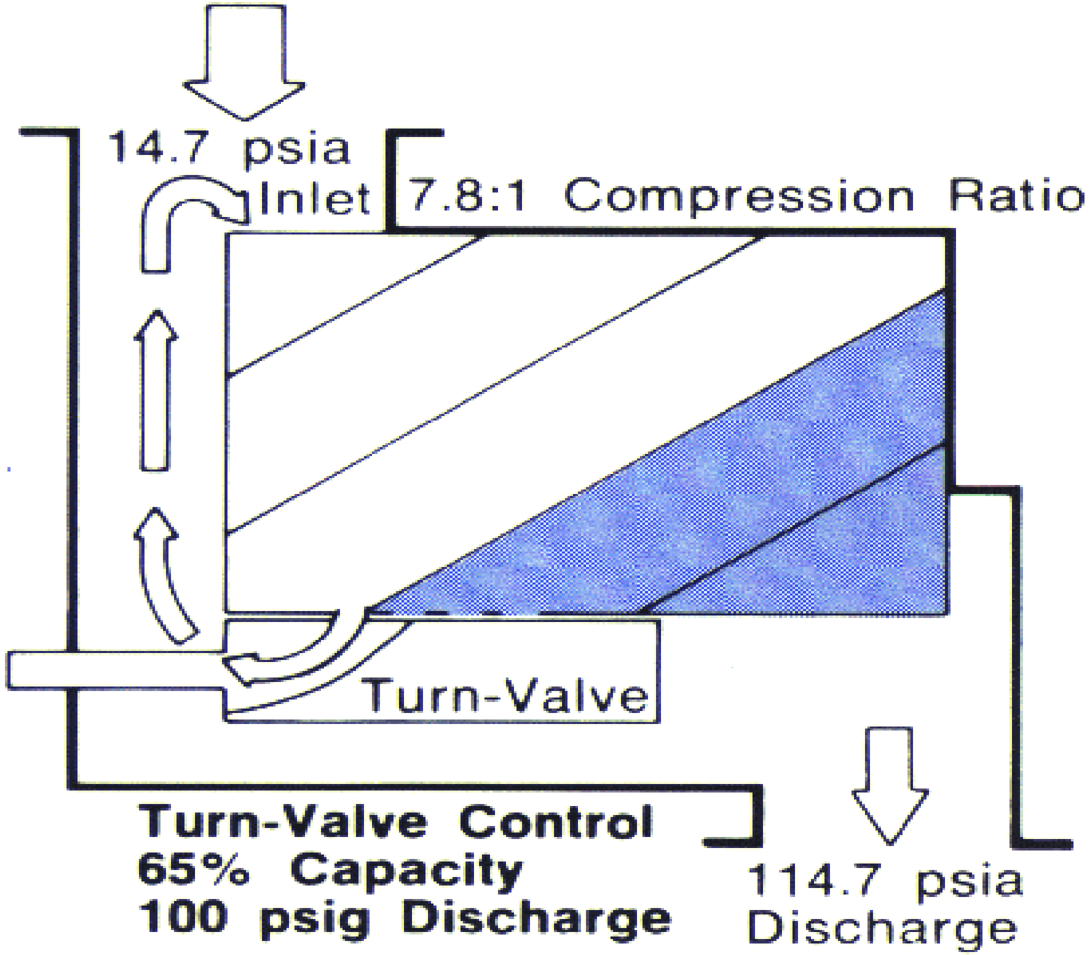
Variable Displacement

- Valves progressively opens ports connecting the compression chamber back to the compressor intake in response to rising discharge pressure.
- This allows some of the intake air to be returned to the compressor inlet before it gets compressed and uses power.
- This progressive opening of by-pass ports has the effect of shortening the length of the rotors after the lobes seal without choking the intake and increasing the compression ratio.

Variable Displacement

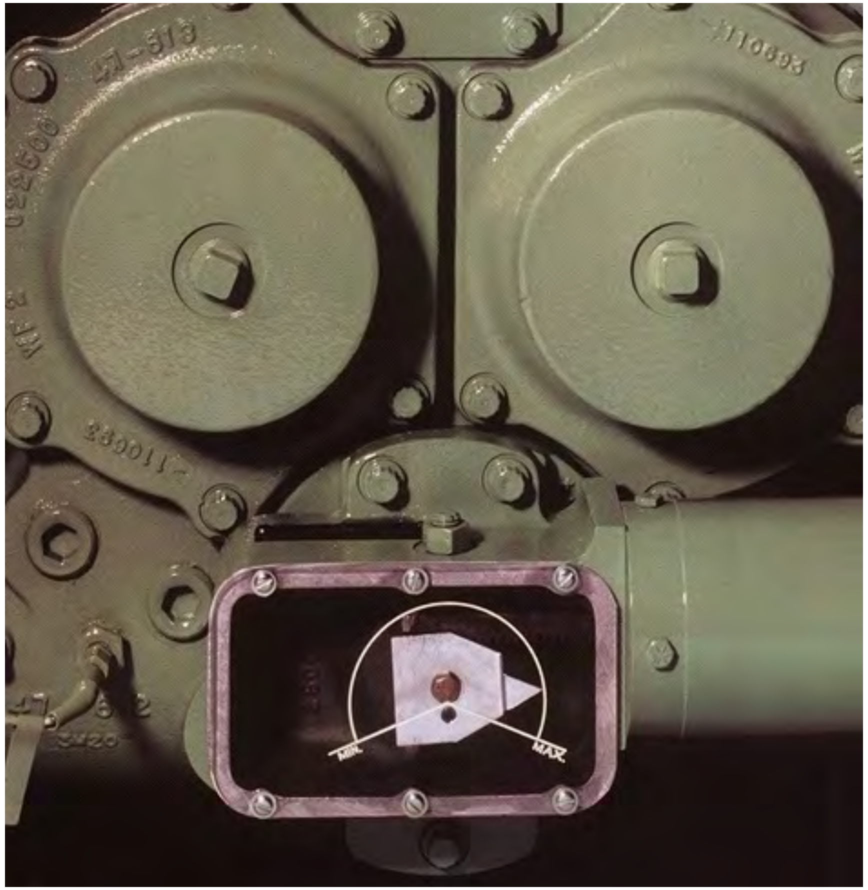


Variable Displacement



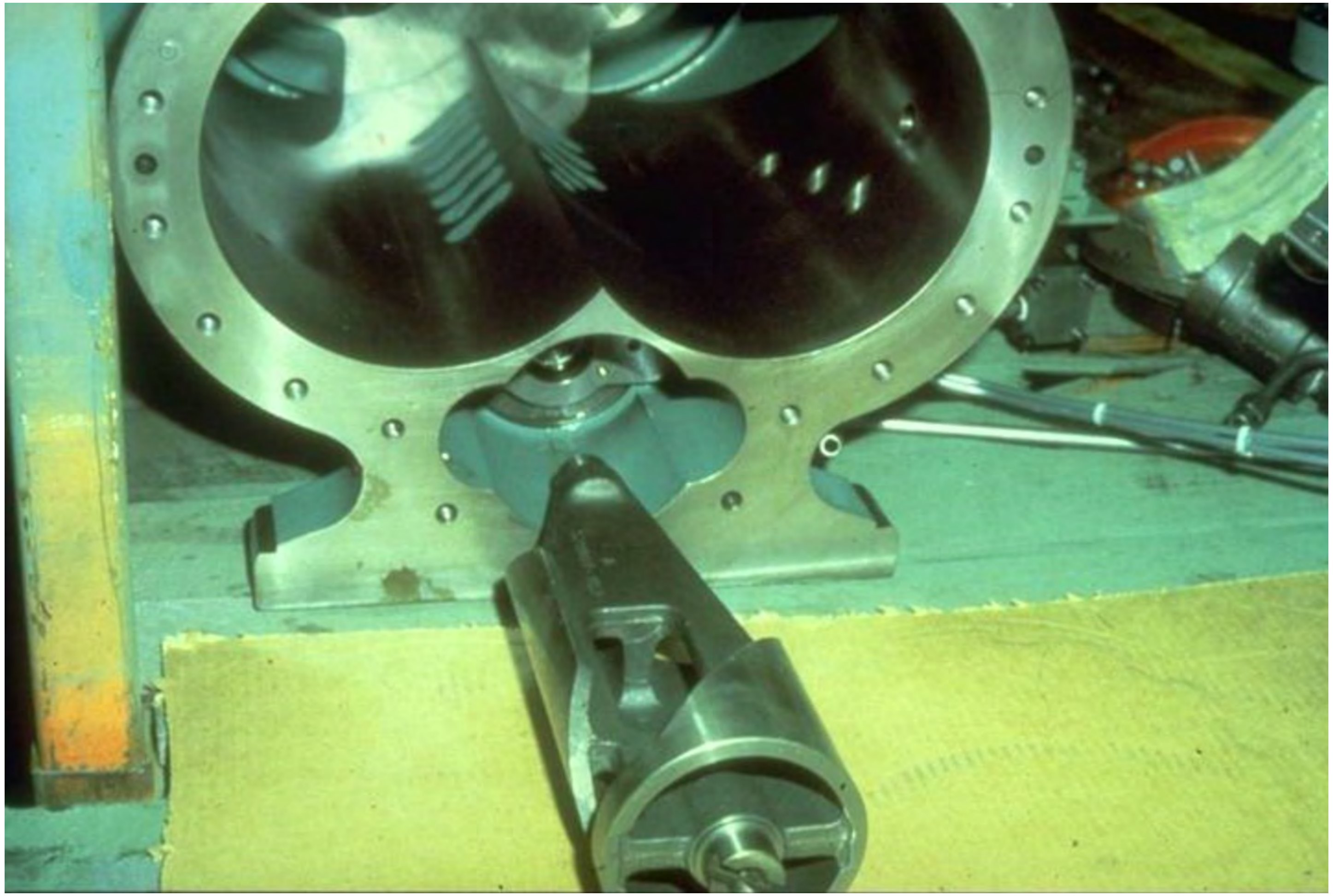
Variable Displacement

Original Version

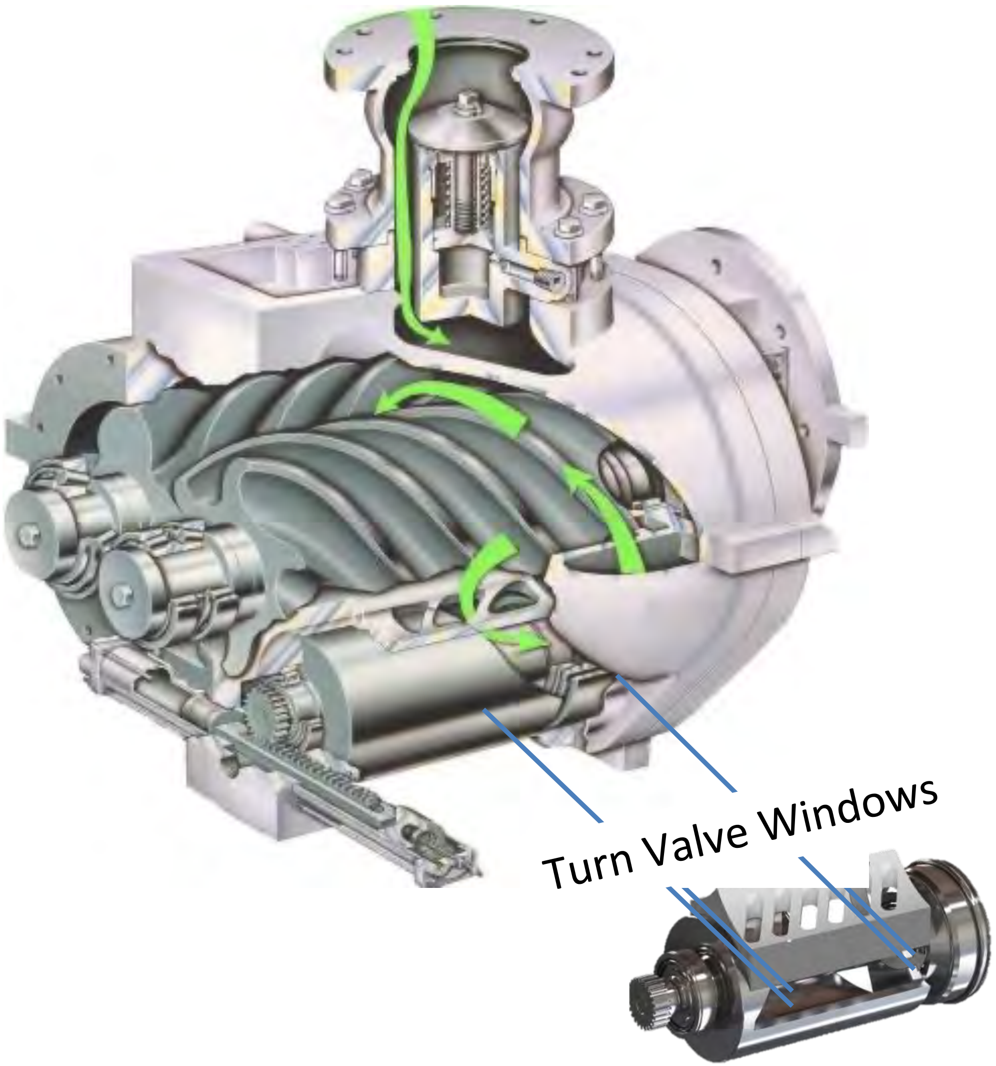


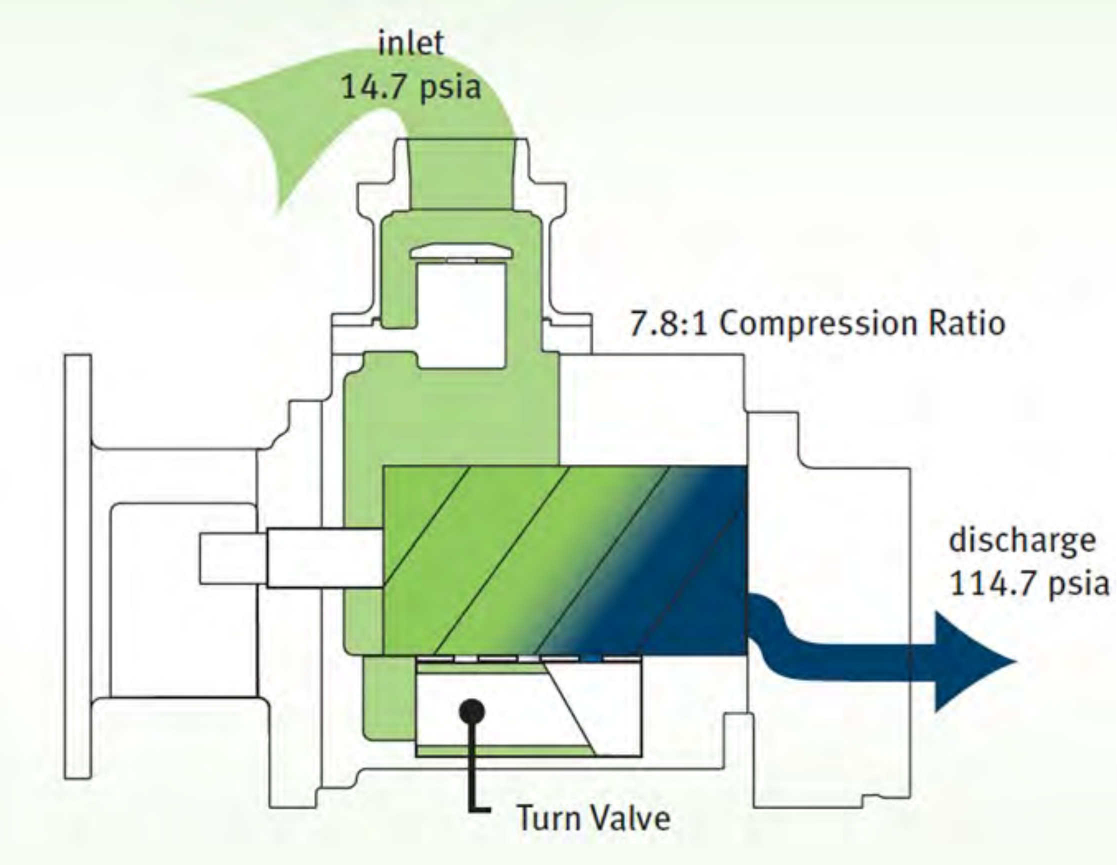
— UP TO 55% TURN DOWN

Variable Displacement

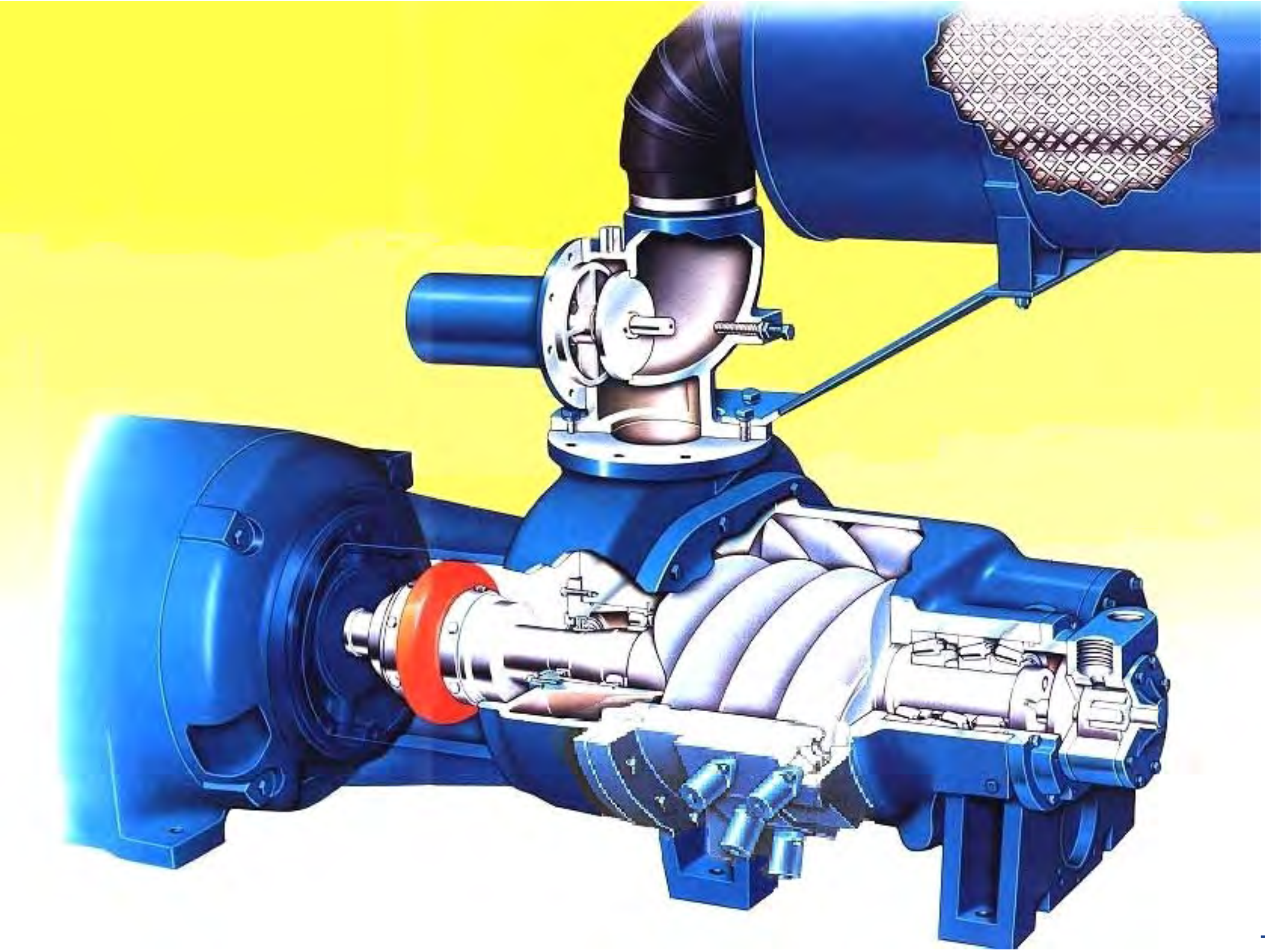


Variable Displacement

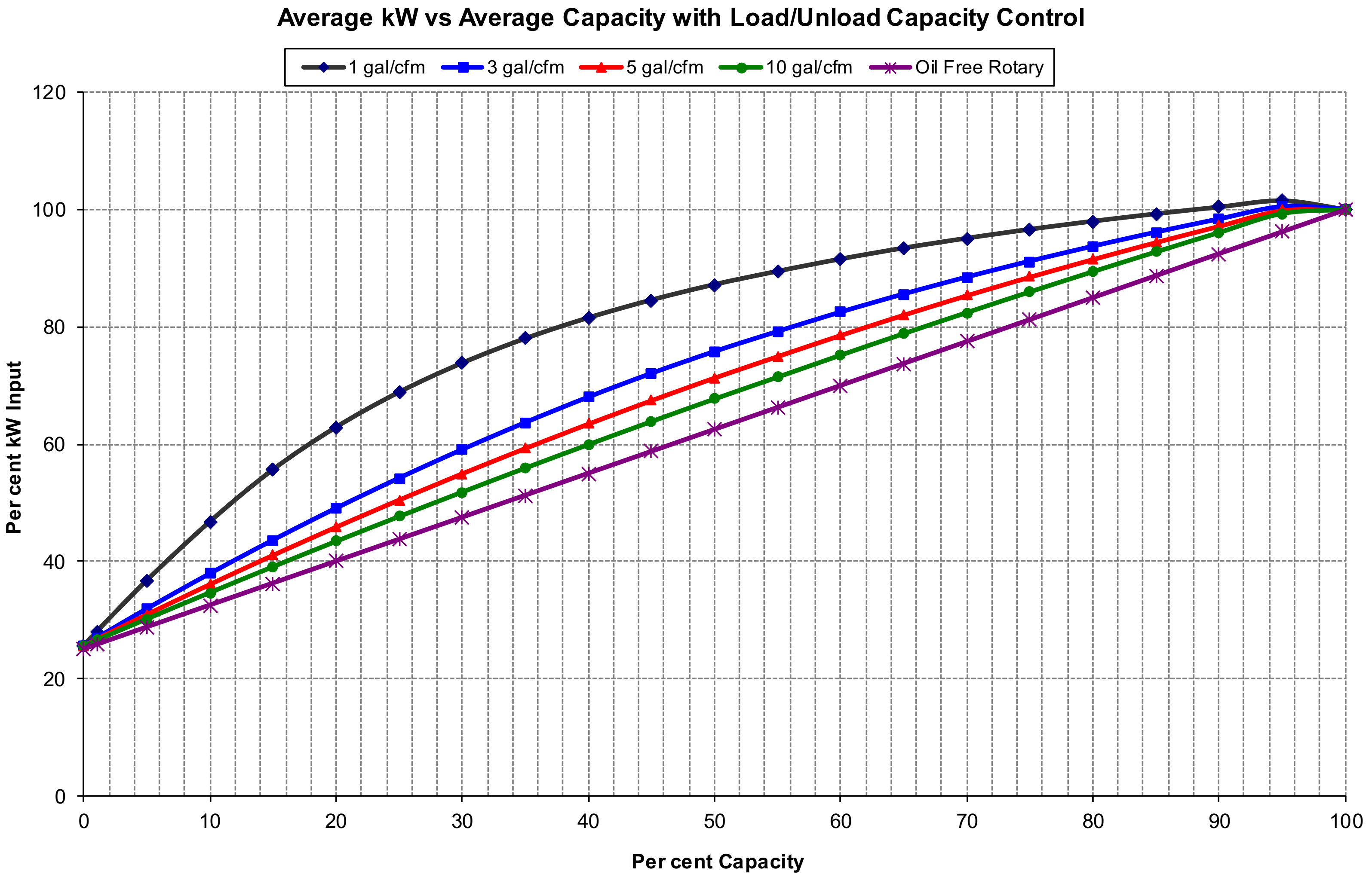




Variable Displacement



Load/No-load Control Curve



- This graph shows the effect of receiver size on the part load power of a lubricant injected rotary screw compressor with load/noload controls

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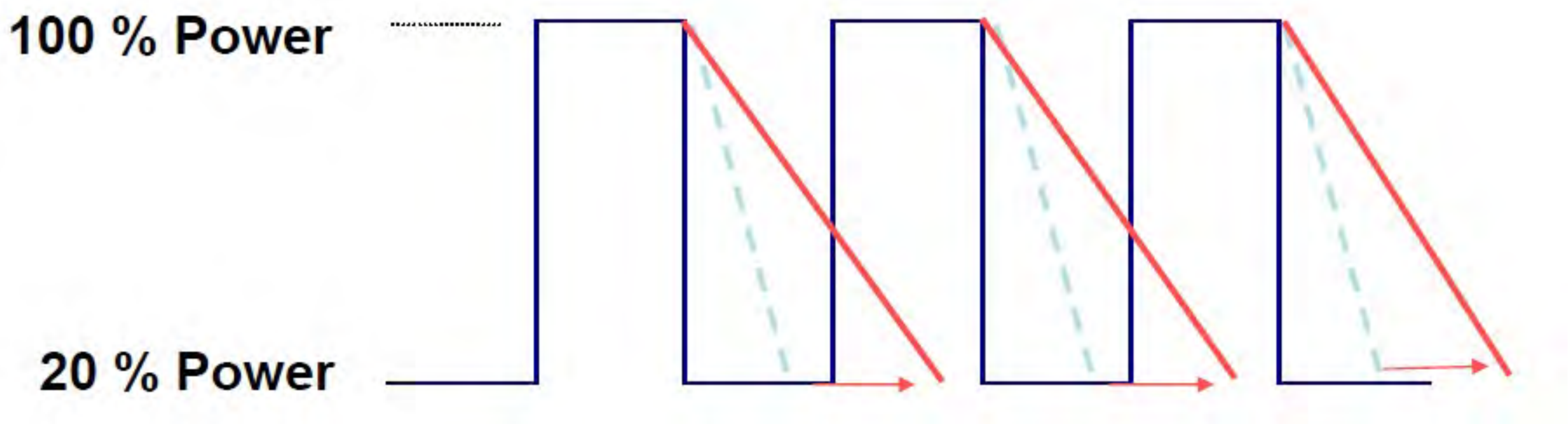
Load/Unload and Storage Size

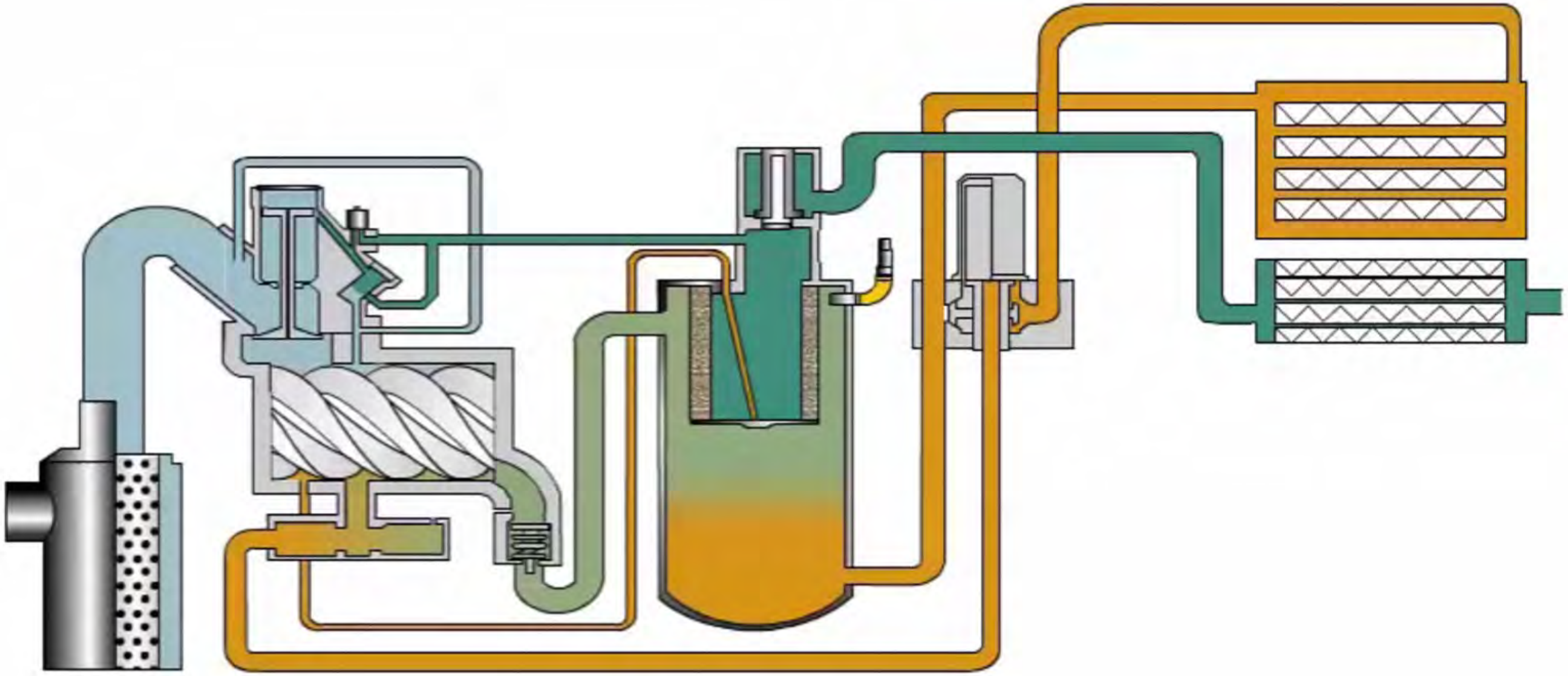
- It is falsely assumed that a straight line, from full load bhp to unloaded bhp, represents the actual power requirement in this mode of operation.
- Sump blow down times will vary by machine size, but typically this takes in the range of 20 to 60 seconds to prevent foaming of the lubricant with the potential of excessive lubricant carry-over.
- In many cases, the system pressure will fall and the compressor will re-load before the fully unloaded power is realized.

Capacity Control by Load/No-Load

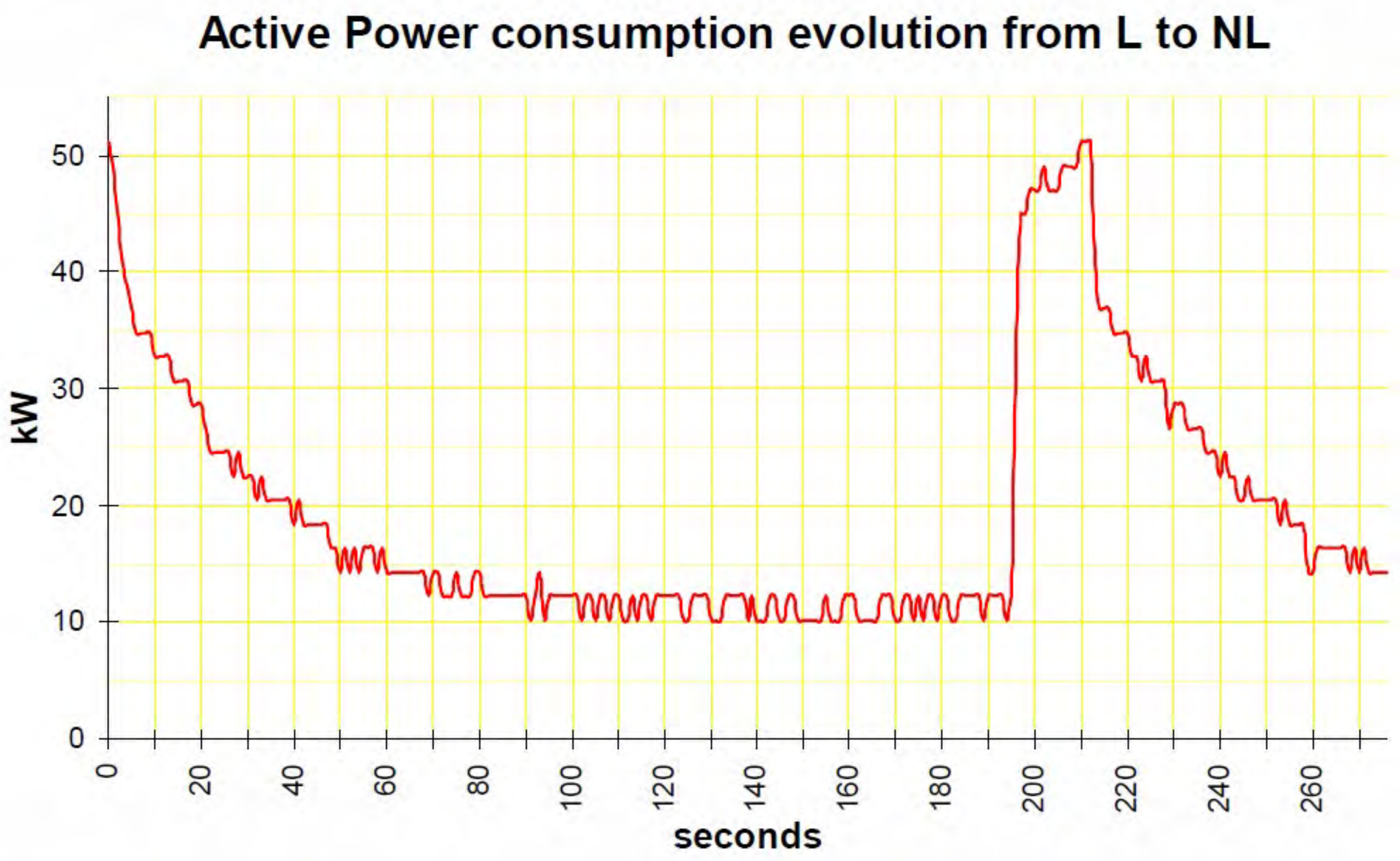


- During blow-off, the compressor is still running against significant back pressure and consuming a lot of power
- Bigger sump vessels lead to longer blow-off times and more energy consumption

Rotary Screw



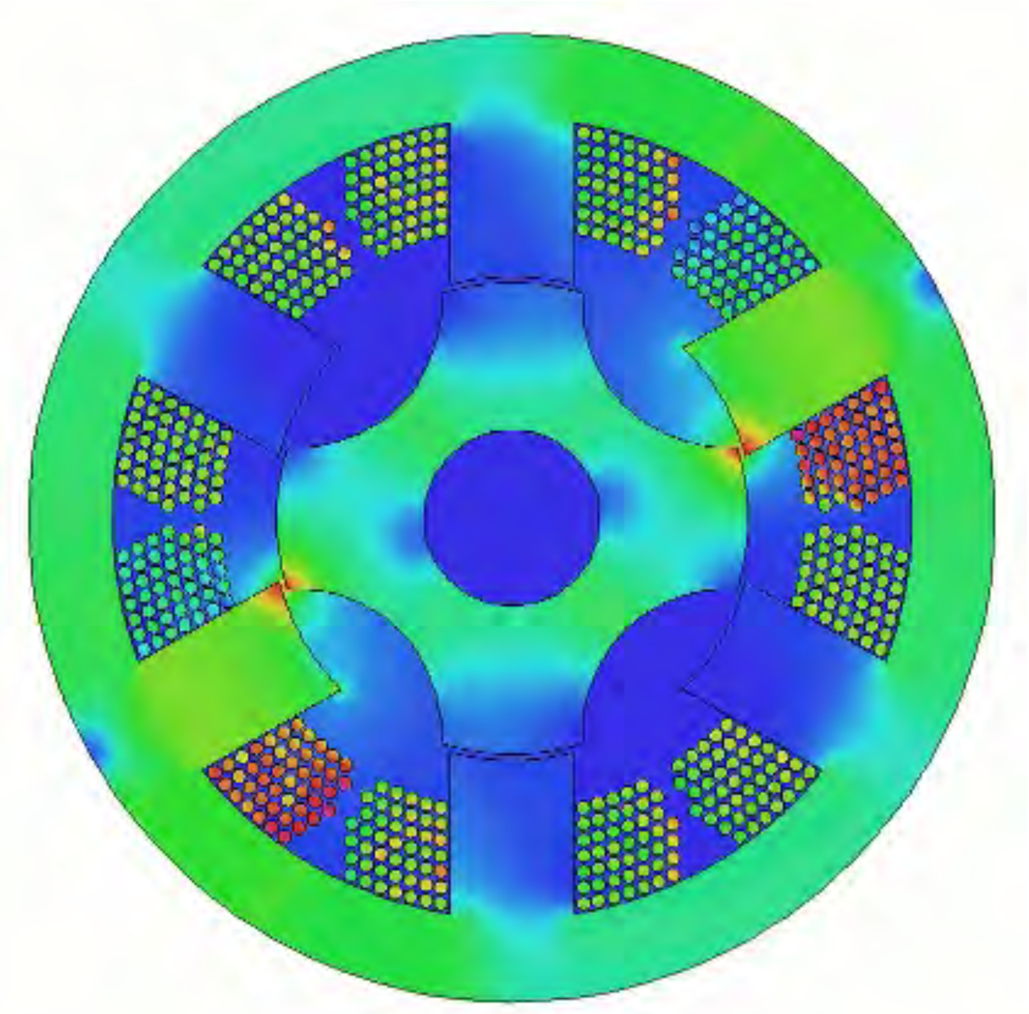
Capacity Control by Load/No-Load



Variable Speed Compressors

- Efficient means of rotary compressor capacity control,
- Integrated variable frequency AC or Switched reluctance DC drives.
- Compressor discharge pressure can be held to within +/- 1 psi
- In order to provide efficient VSD regulation over the complete range of the customer's air profile, the VSD needs to be sized so it will always be in its turndown range.
- VSD (variable speed drive) and VFD (variable frequency drive) are used interchangeably
- VFD is only one of the VSD technologies available.

Switched Reluctance DC Drive

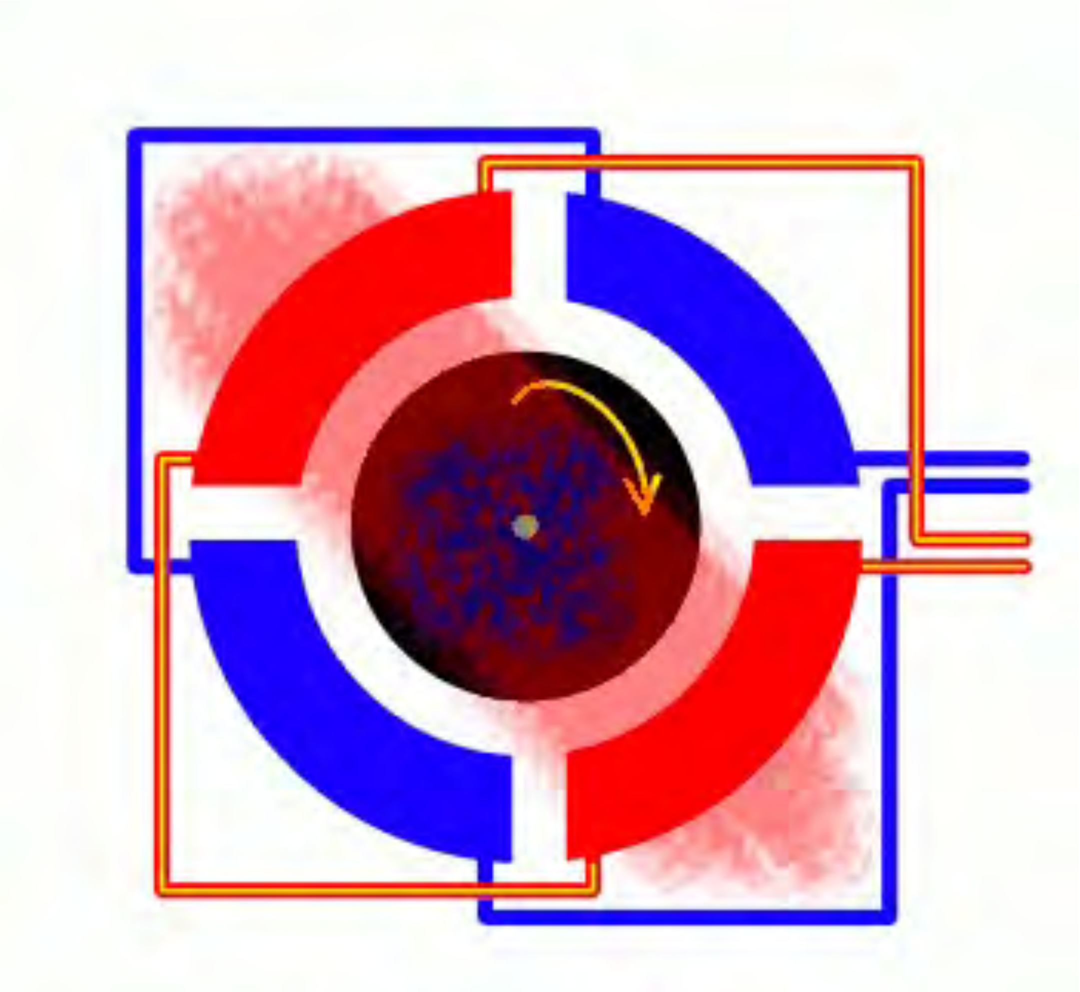


- Unlike common brushed DC motor types, power is delivered to windings in the stator (case) rather than the rotor.
- SR motors are designed for continuous operation.
- Switched Reluctance motors are capable of high torques with low weight.
- The motors are structurally simple but need relatively advanced control for optimum performance.

Variable Speed Compressors

- The most common VSD is the variable frequency drive, which converts 60 Hz alternating current to direct current and then reconverts it to the proper frequency required to turn the drive motor at the desired speed.
- The variable frequency drive is less efficient at full load compared to modulation controls because the electrical conversions usually consume an additional two to four percent more energy.

Variable Frequency Induction AC Motor



- An ac motor's speed is determined by the number of poles and the frequency.
- So as frequency is adjusted the motor's speed can be controlled as well.
- One of the most common types of drives is a variable frequency drive (VFD),

To calculate RPM for an AC induction motor, you multiply the frequency in Hertz (Hz) by 60 — for the number of seconds in a minute — by two for the negative and positive pulses in a cycle. You then divide by the number of poles th

Variable Frequency Induction AC Motor

- To calculate RPM for an AC induction motor, you multiply the frequency in Hertz (Hz) by 60 — for the number of seconds in a minute — by two for the negative and positive pulses in a cycle. You then divide by the number of poles the motor has:

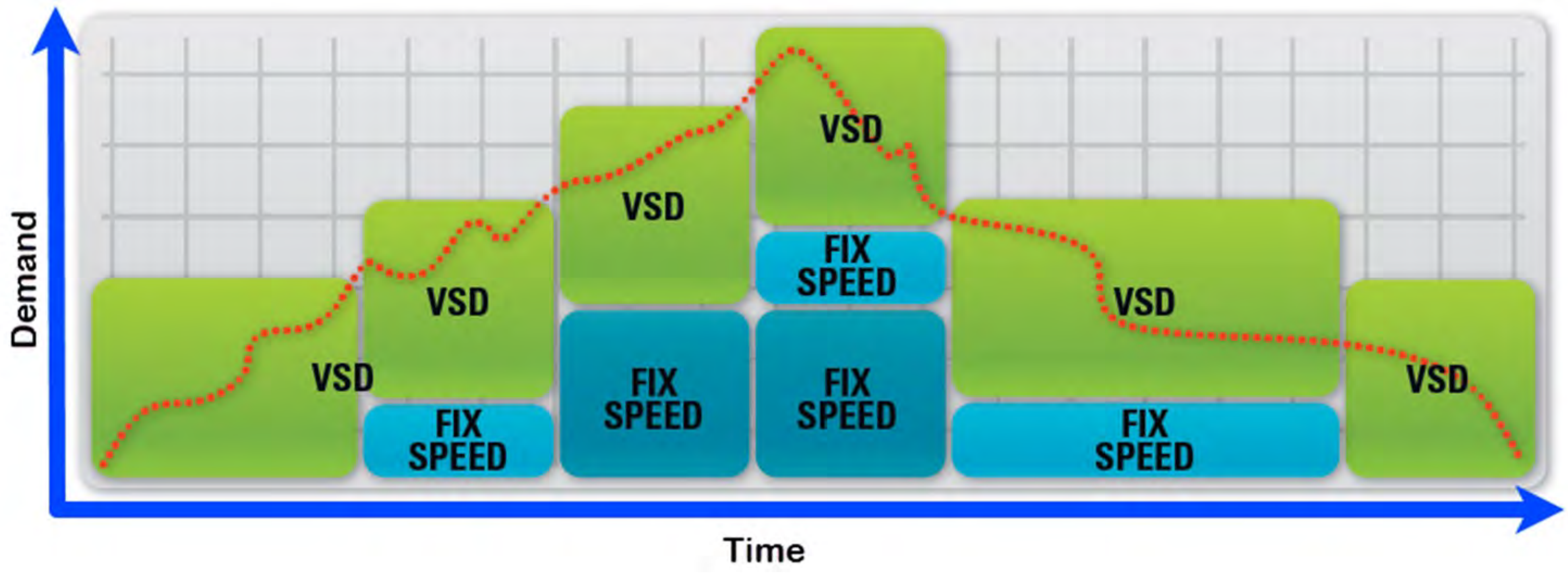
$$n = \frac{2 \times f \times 60}{p}$$

- *n* = no load rpm
- *f* = frequency
- *p* = Number of poles
- Example: 4-pole motor running at 50Hz

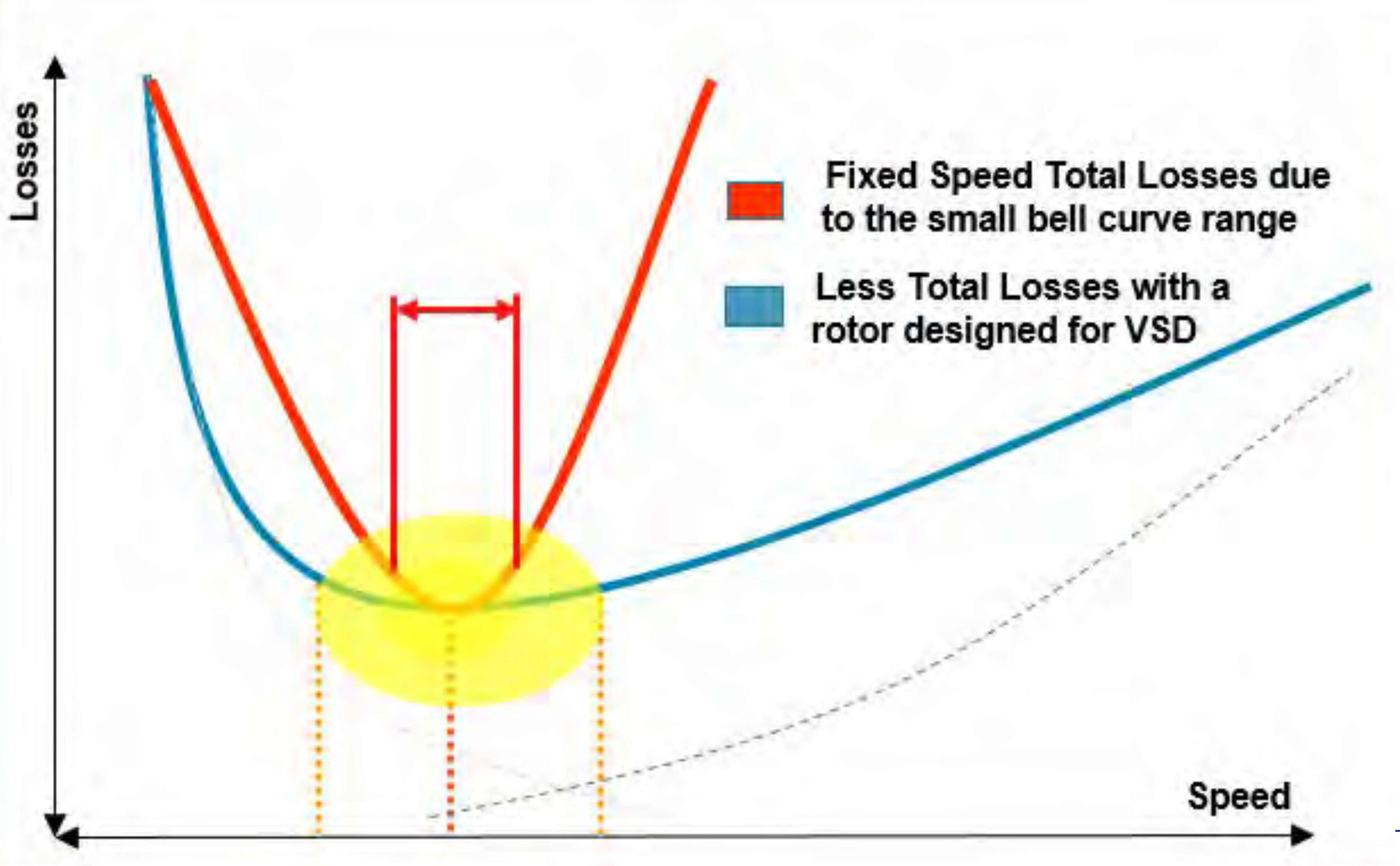
$$n = \frac{2 \times 50 \times 60}{4} = 1500 rpm$$

Variable Speed Compressors

- In order to provide efficient VSD regulation over the complete range of the customer's air profile, the range of the VSD from min to max needs to be sized greater than the load/no load machine

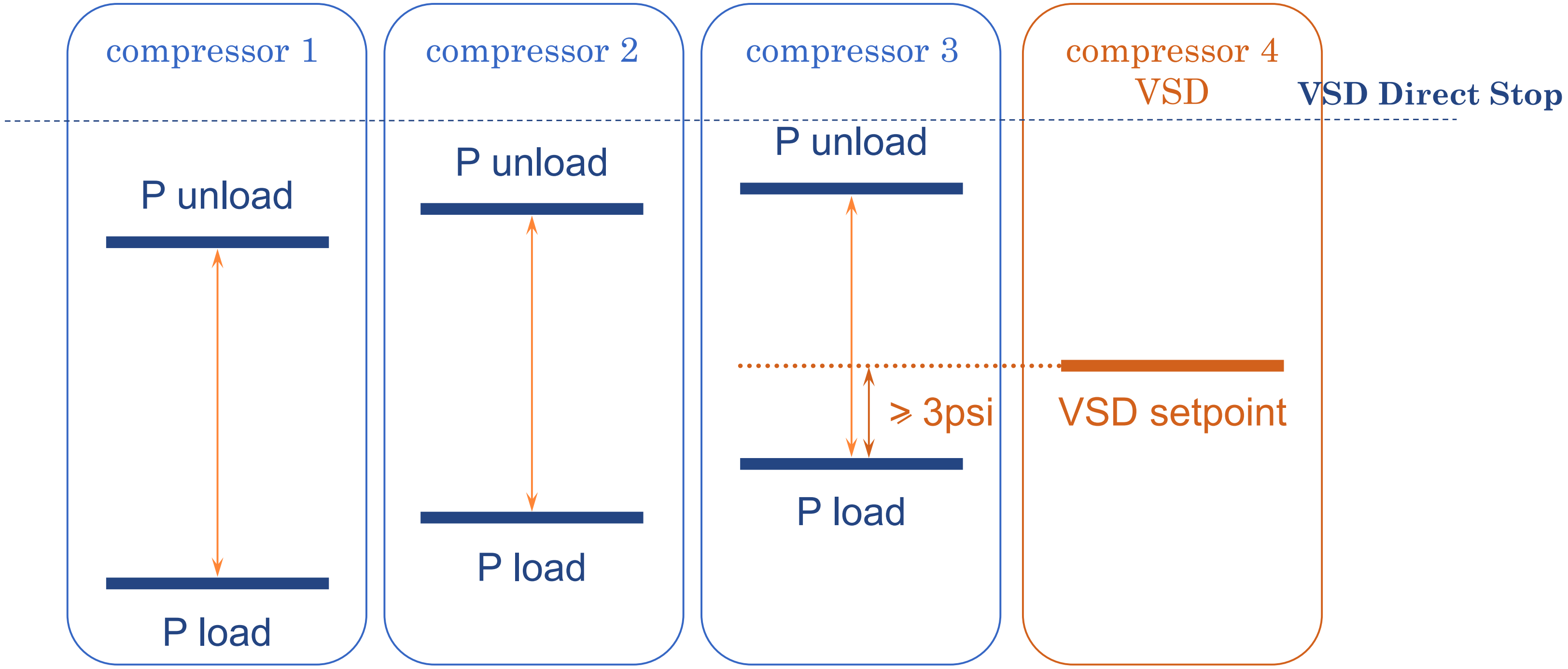


Variable Speed



Control Gap and Position

- In order to provide efficient VSD regulation over the complete range of the customer's air profile, the cfm of the VSD needs to be greater than the load/no load machine

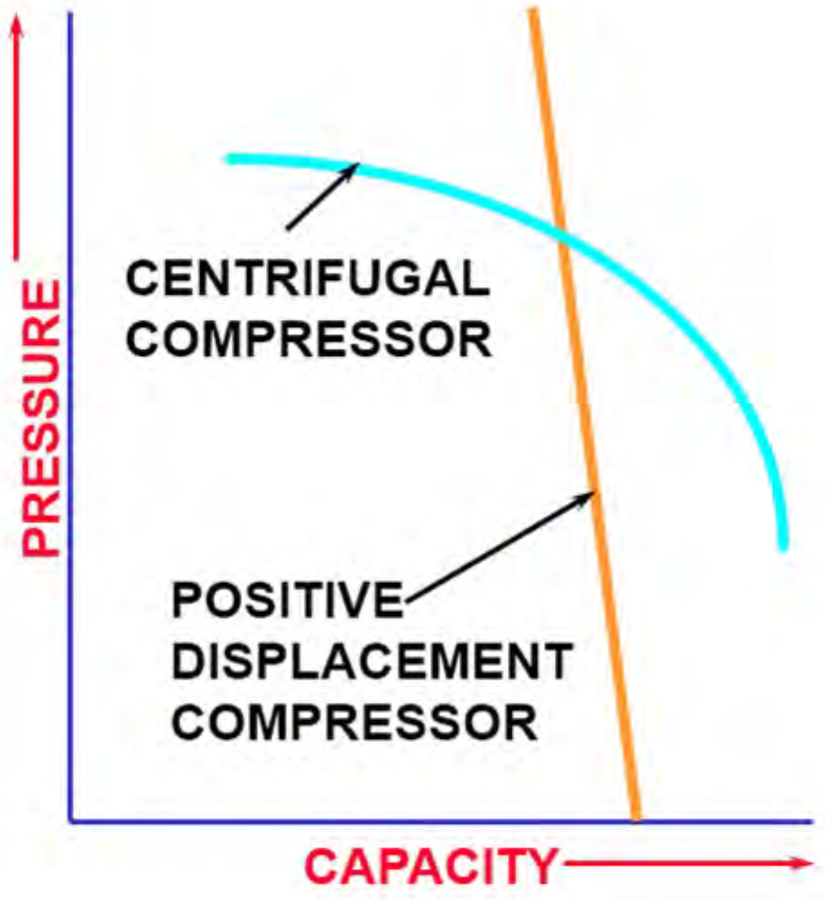


Centrifugal Compressor Control

- Performance is affected by inlet conditions and cooling water temperature
- Characteristic curve is determined by impeller design
- Two conditions should be avoided:
  - Surge (flow reversal)
  - Choke (excessive flow vs. frame design)
- Inlet throttle valves modulate the compressor to reduced flow and power but are limited by surge condition
- Blow-off valves control capacity below throttling limit

Centrifugal Compressor Control

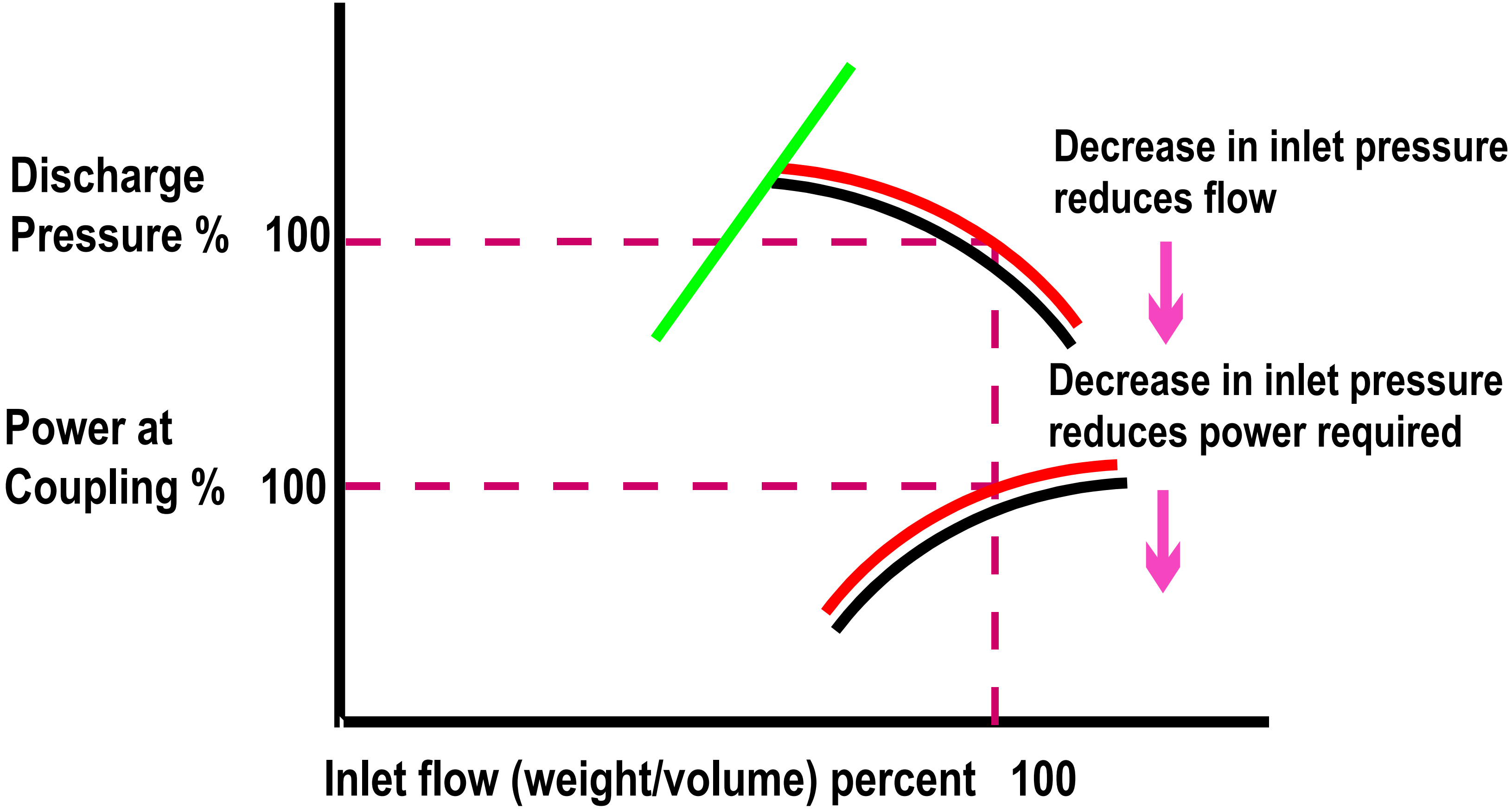
The relationship of flow and pressure for dynamic compressors is different from that of positive displacement machines.



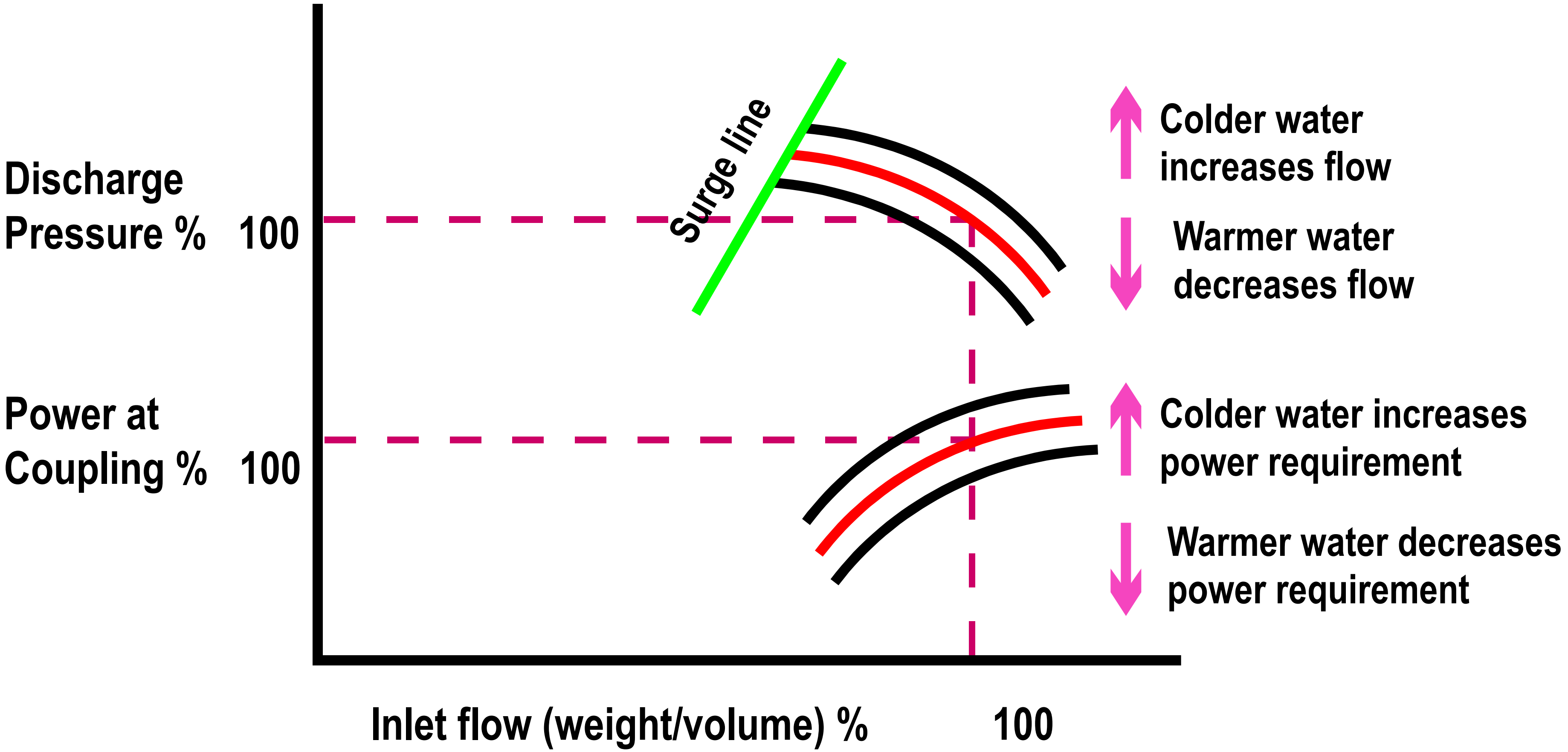
Effects on dynamic compressor performance

- Inlet pressure
- Inlet air temperature
- Cooling water temperature

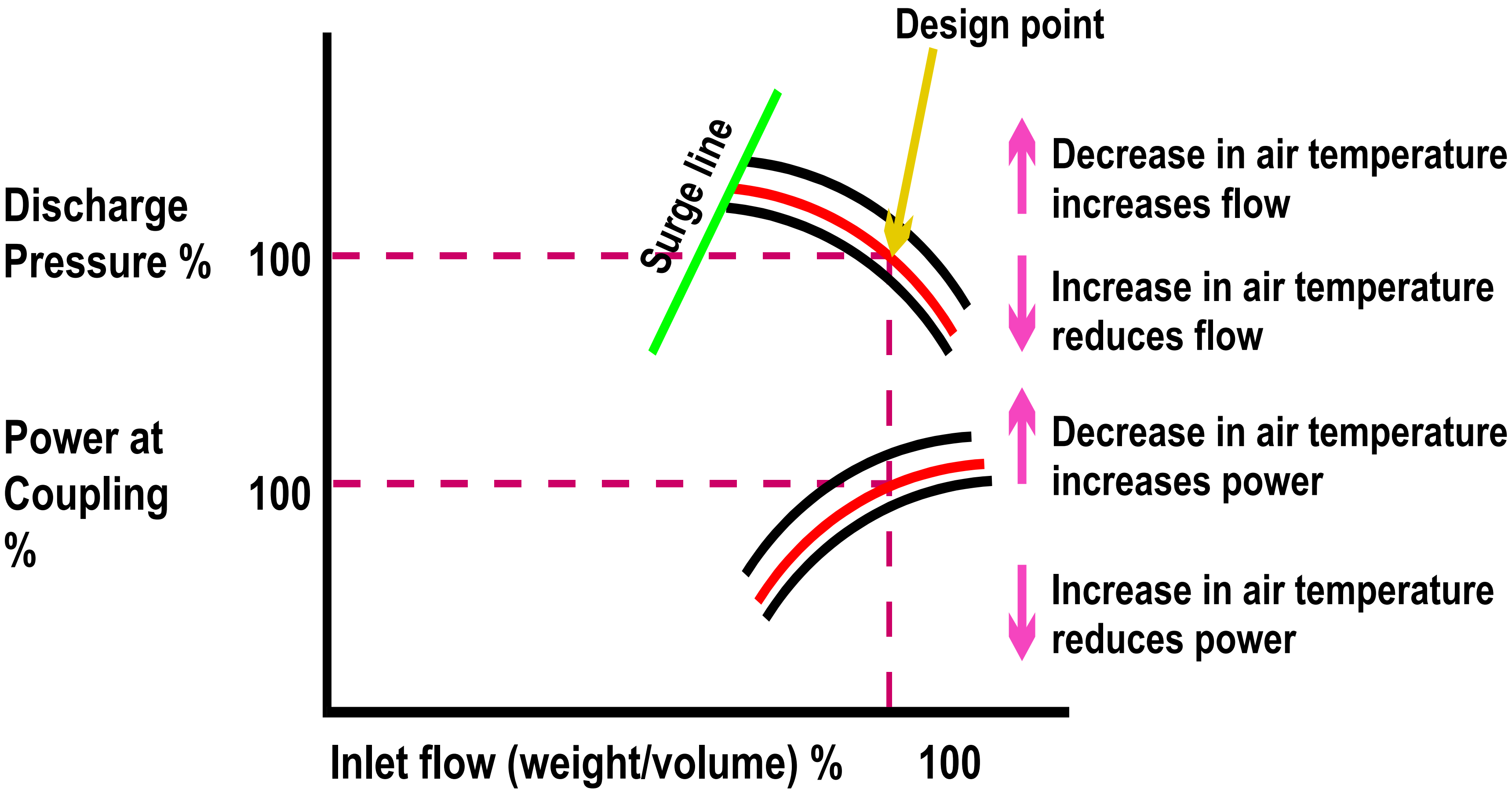
Inlet Pressure



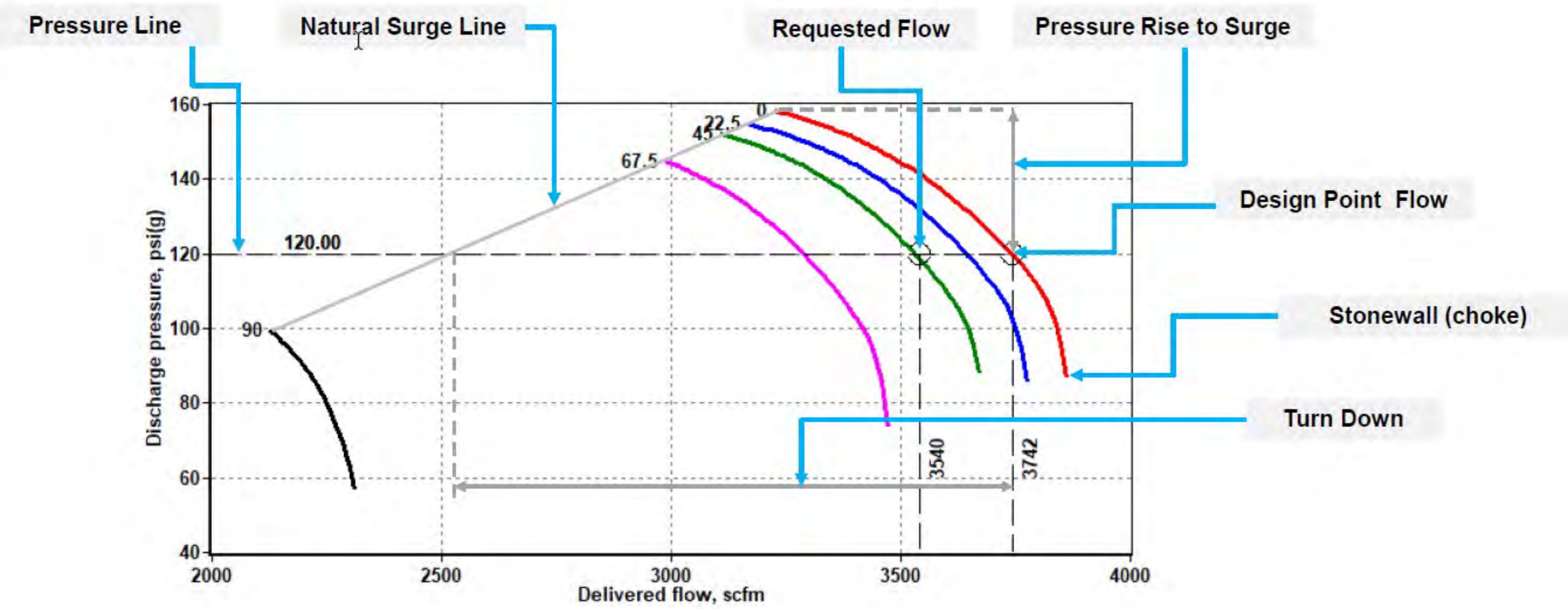
Cooling Water Temperature



Inlet air temperature influence

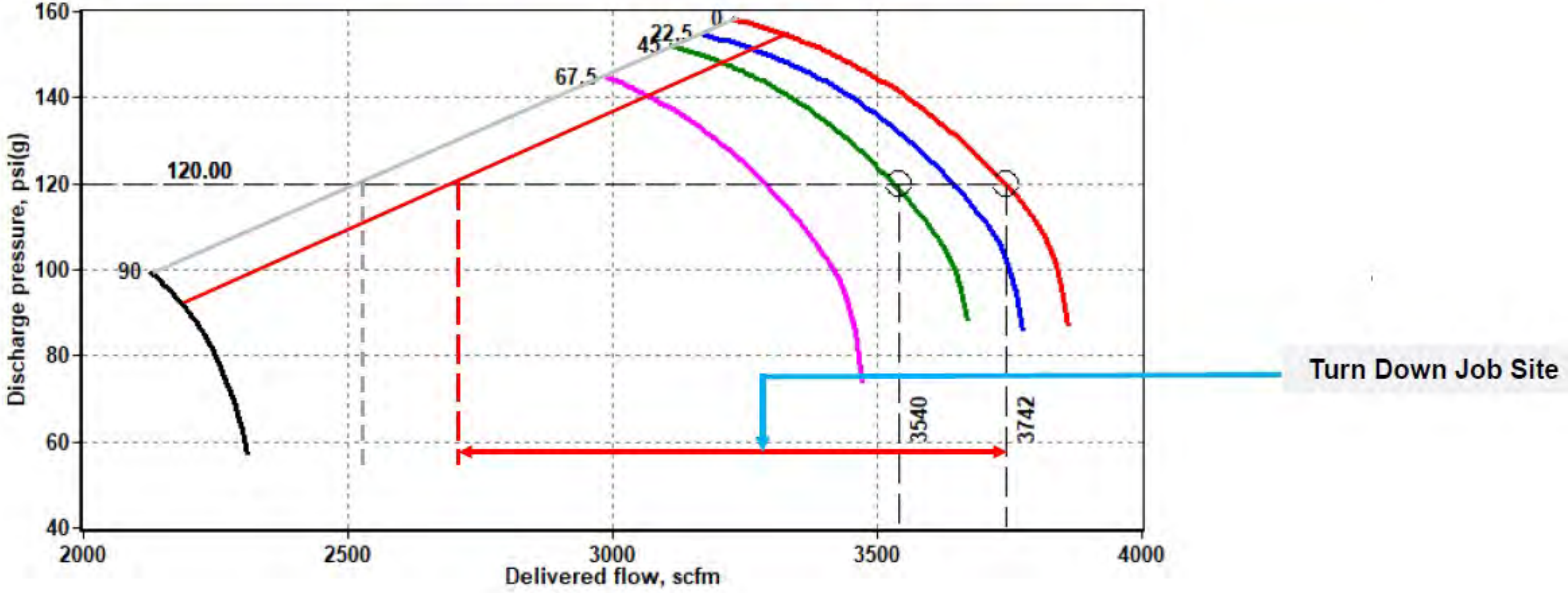


Centrifugal Performance



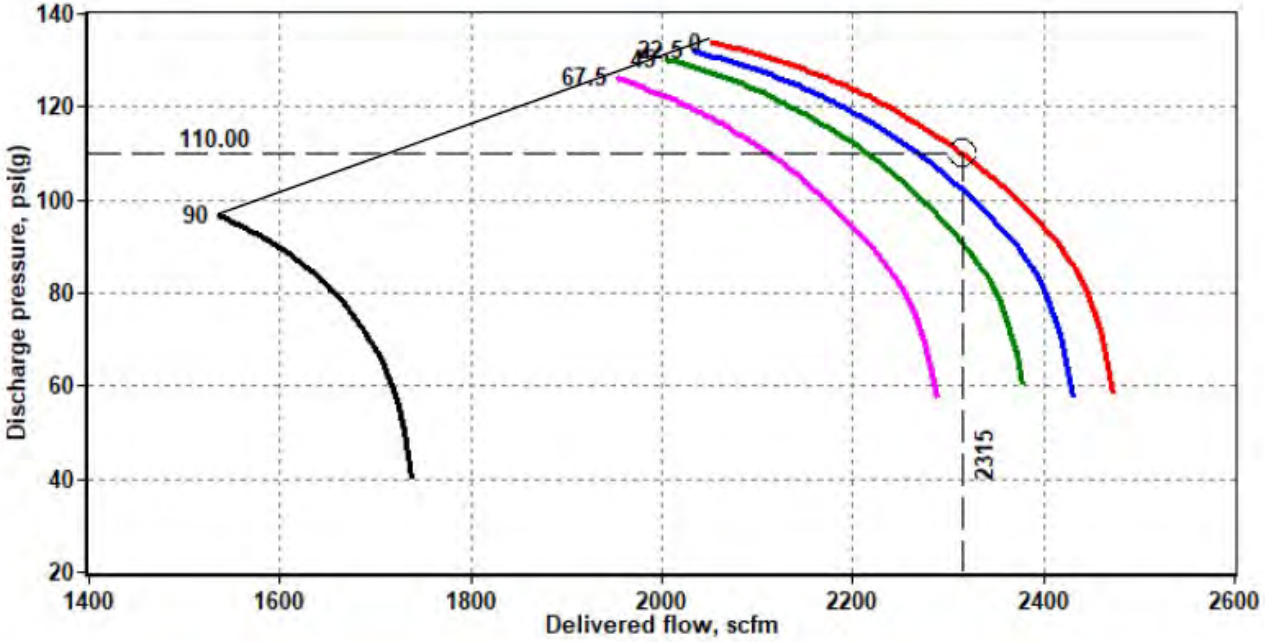
Centrifugal Performance

Installation site control line turn down – protecting natural surge. Blow-off point



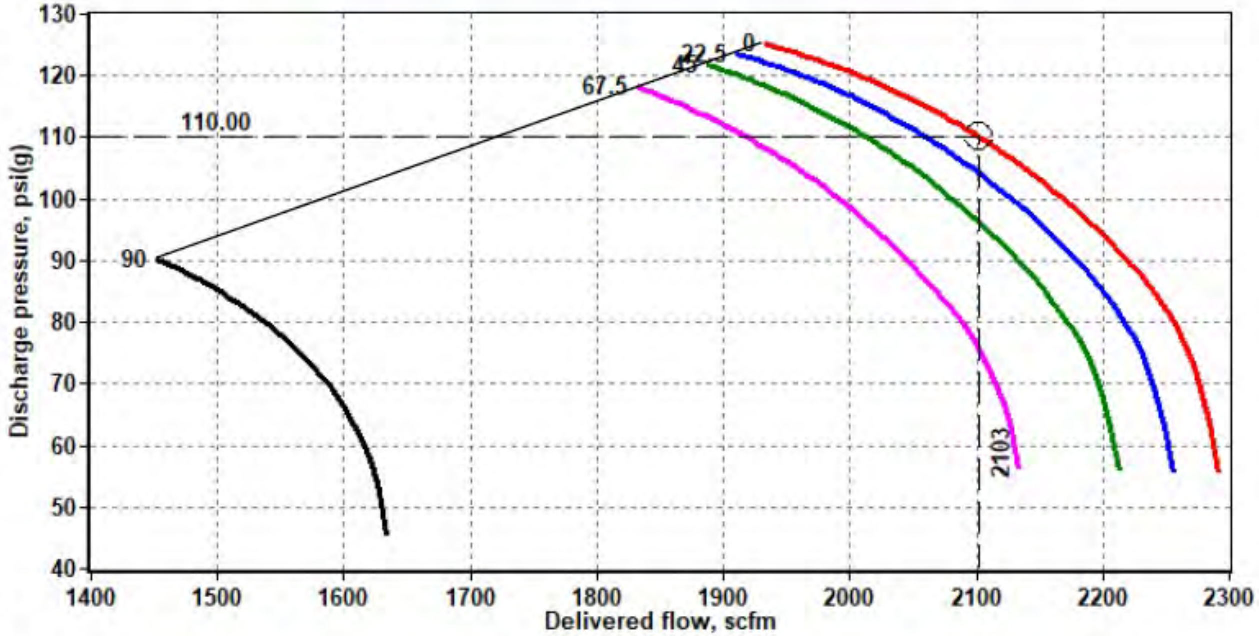
INLET TEMPERATURE CHANGE – EFFECT ON AIR OUTPUT

Capacity at 95⁰F inlet Temp



2,315 scfm, 497.75 HP, 24 psi rise to surge

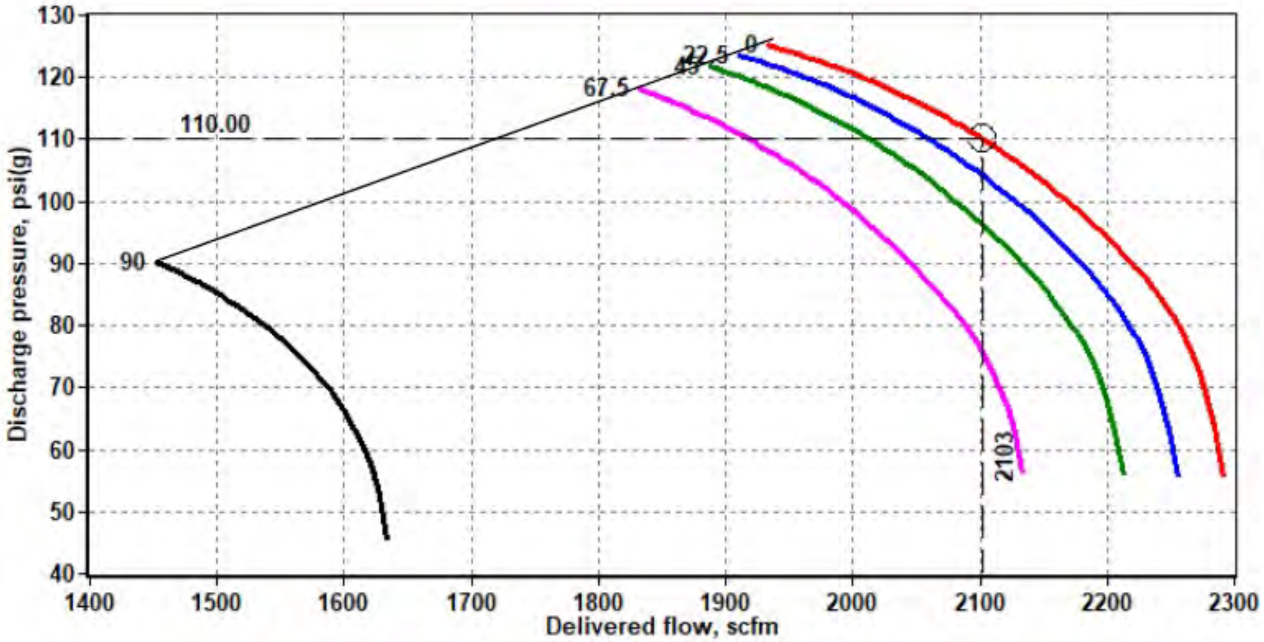
Capacity at 119⁰F inlet Temp



2,103 scfm, 467.74 HP, 15 psi rise to surge

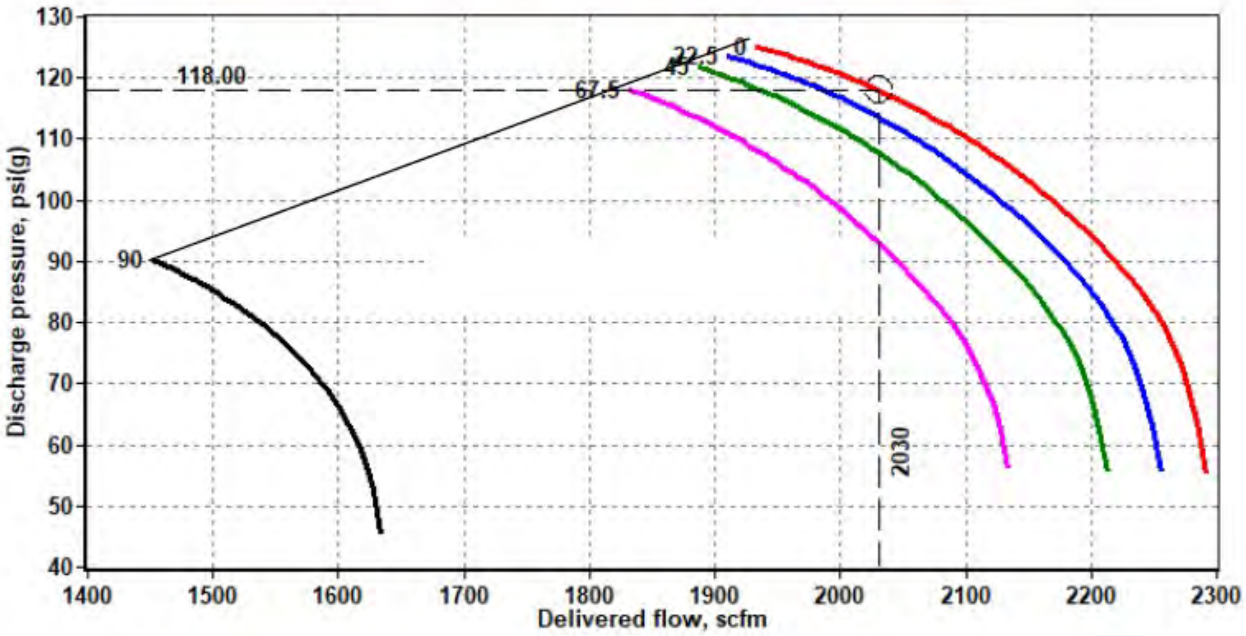
DISCHARGE PRESSURE CHANGE – EFFECT ON AIR OUTPUT

Capacity at 110 psig discharge pressure

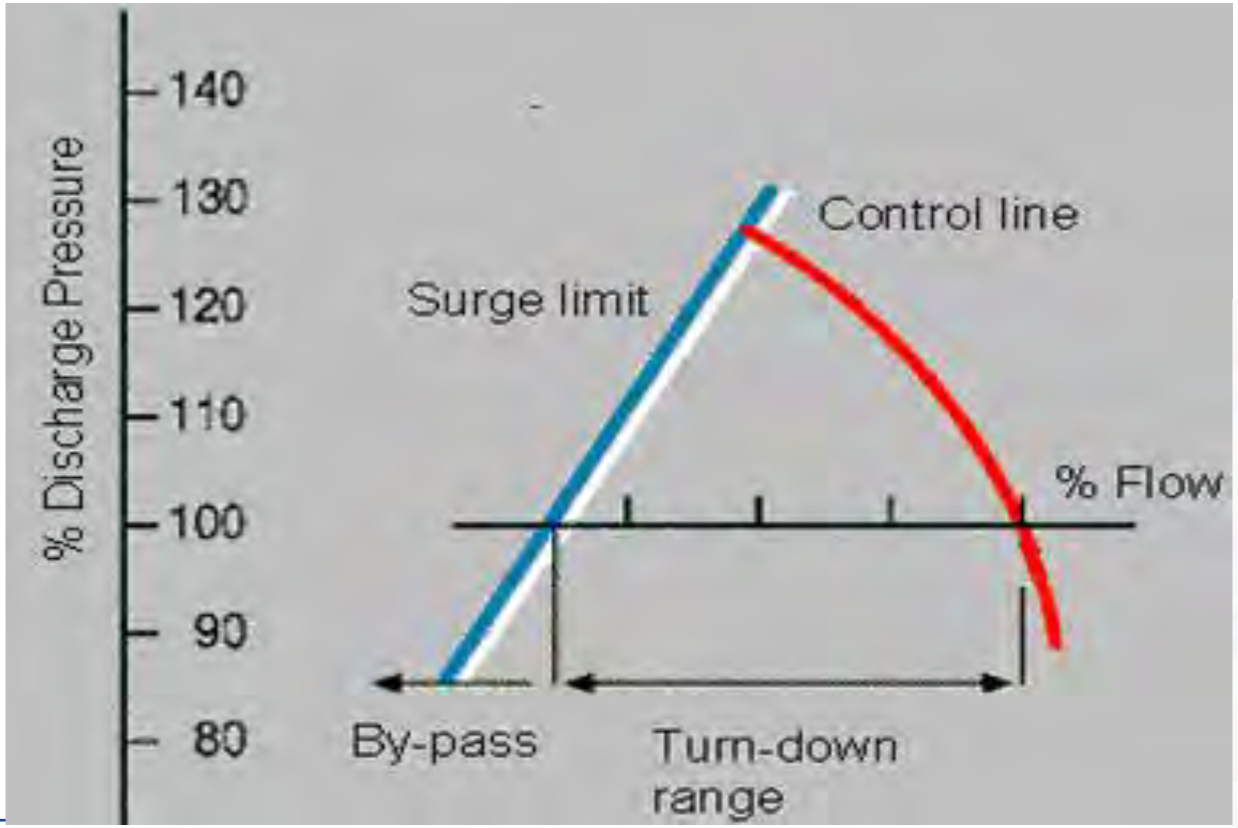


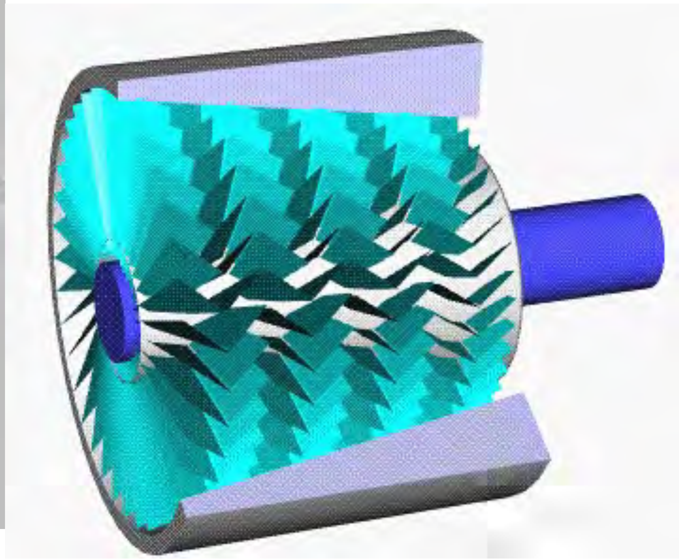
2,103 scfm, 467.74 HP, 15 psi rise to surge

Capacity at 118 psig discharge pressure

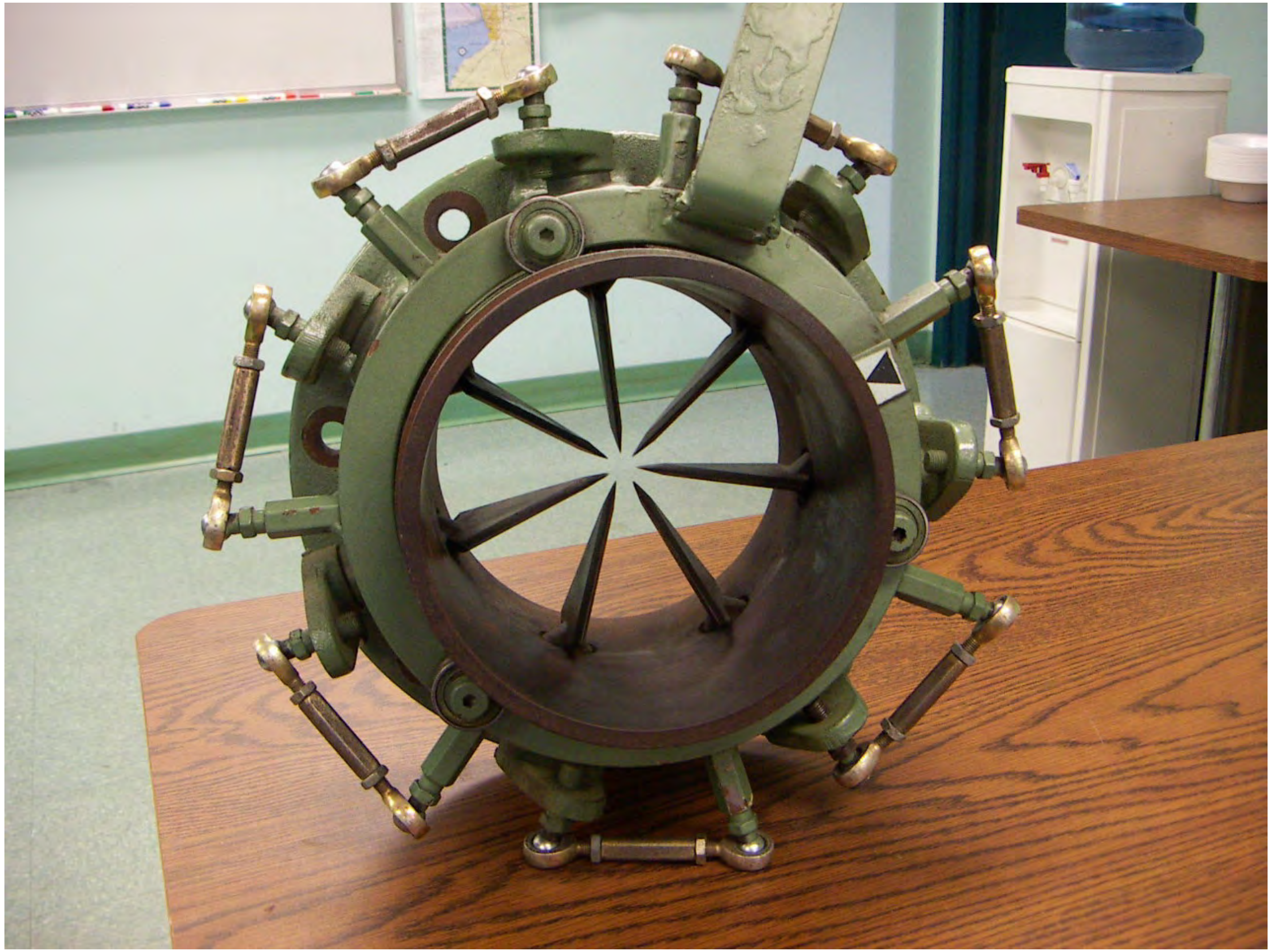


2,030 scfm, 464.94 HP, 7 psi rise to surge

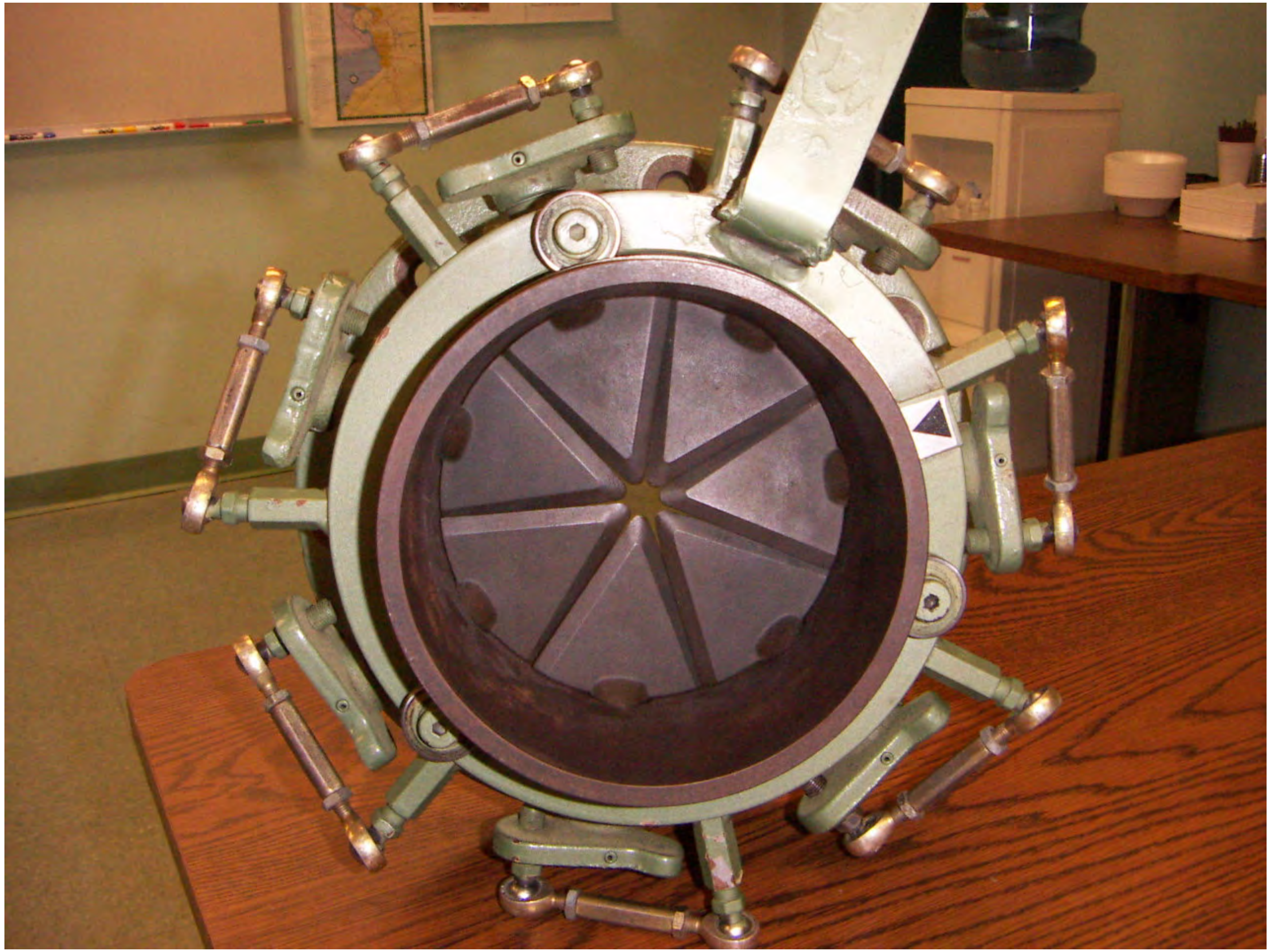

% Discharge Pressure
140
130
120
110
100
90
80
Control line
Surge limit
% Flow
By-pass
Turn-down range



Inlet Guide Vanes - Open



Inlet Guide Vanes - Closed



Multiple Compressor Control

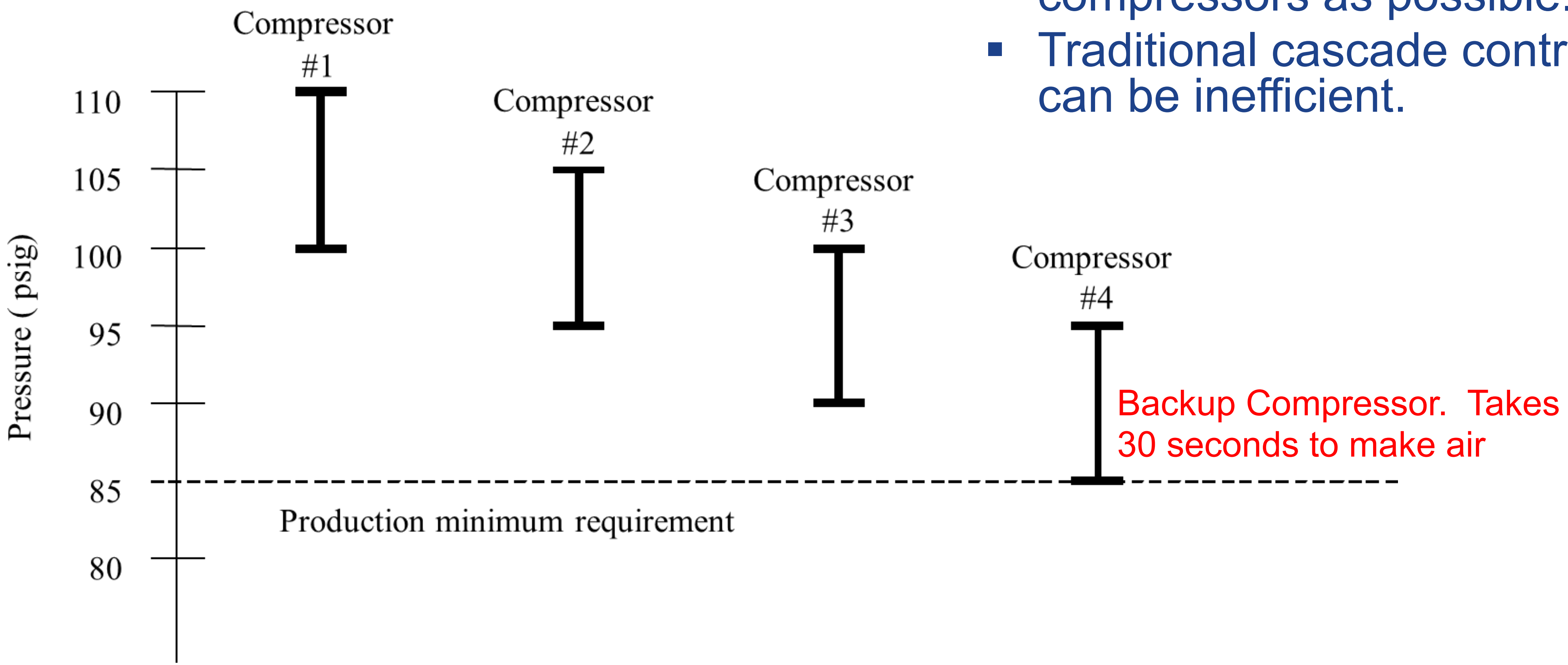
- Holds constant air pressure in the distribution piping within narrow limits.
- Connectable to all kinds of compressors.
- Priority selection : old versus new machines.
- Delayed start : NEVER start two machines or more at the same time => high current peaks are avoided.
- Base load compressors can fill distribution piping in advance, to avoid load peaks.

Multiple Compressor Control

- Very simple user interface = minimum user training.
- Machines are used more efficiently.
- Energy reduction = immediately saves money.
- Full compressor & network status feed- back.
- Programmable pressure schedule.
- PC monitoring & analysing possibilities.

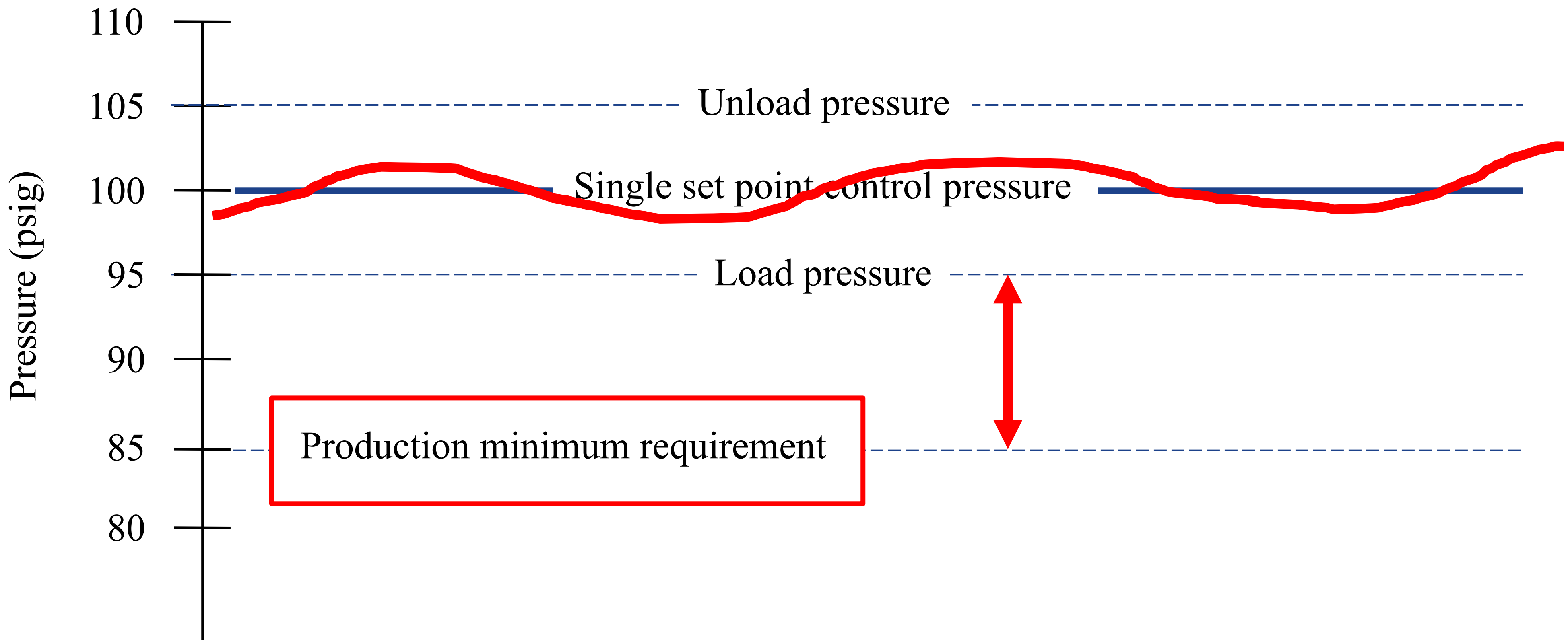
Multiple Compressor Control with Manual Cascade

- Base load as many compressors as possible.
- Traditional cascade control can be inefficient.

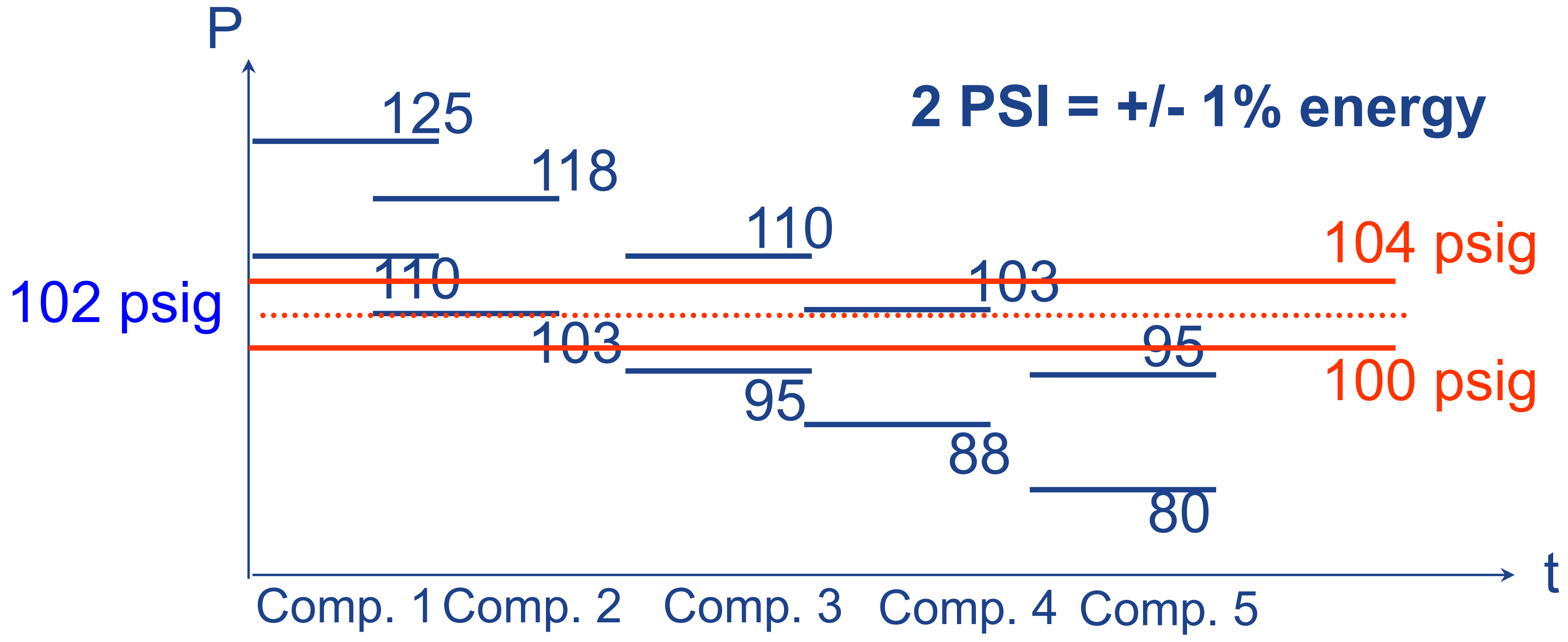


Master Controls

- Basic single set point control scheme



Master Control Basics

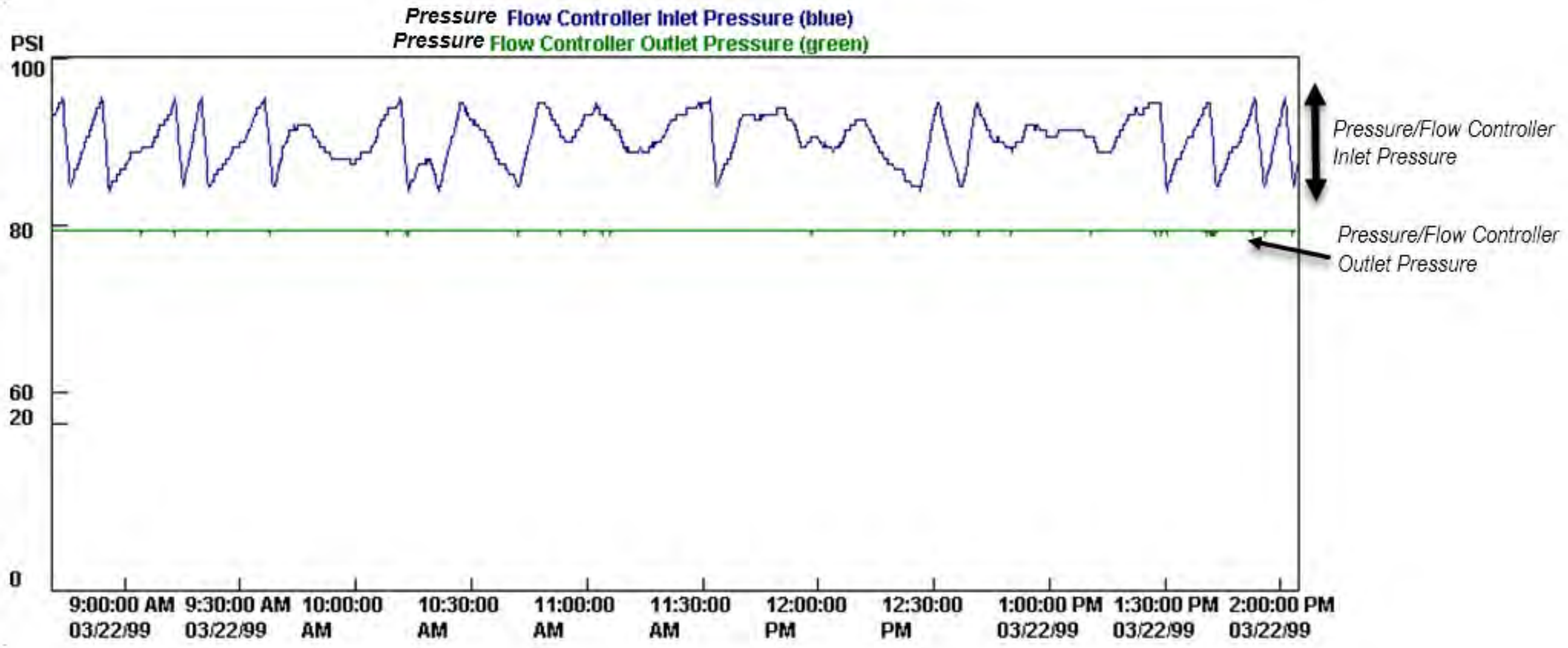


Cascaded Pressure Switches Vs Master

Pressure/Flow Controllers

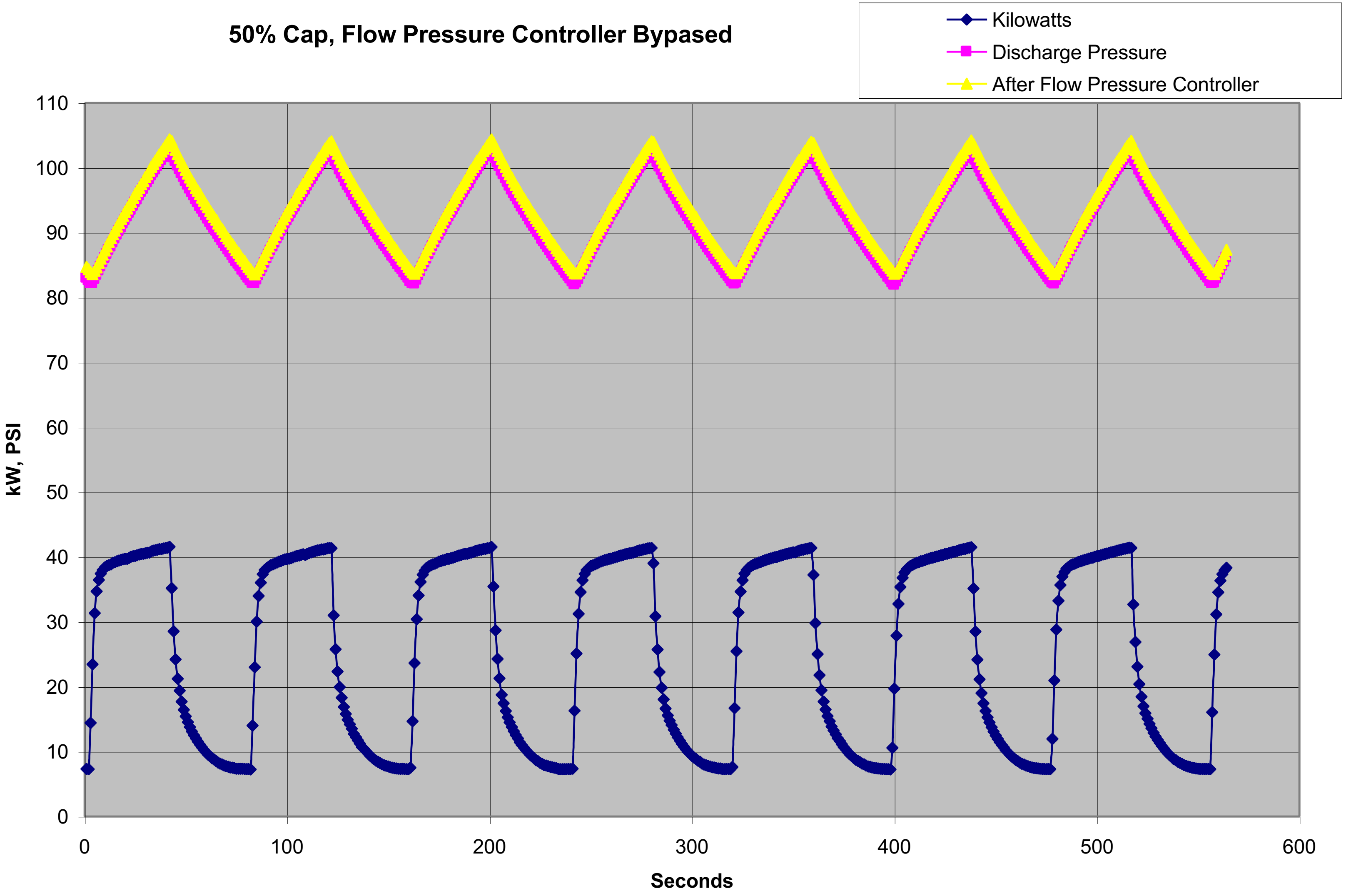
- Primary function: Stabilize pressure regardless of demand
- Most compressor controls cause 3-10 psi swings
- Multiple compressors can compound the system pressure swings
- Pressure/flow controllers typically hold pressure to production within ± 1% of set point
- The following graph is from a system with 9 compressors totaling over 6,000 hp – pressure is set at 79 psig

Pressure/Flow Controllers

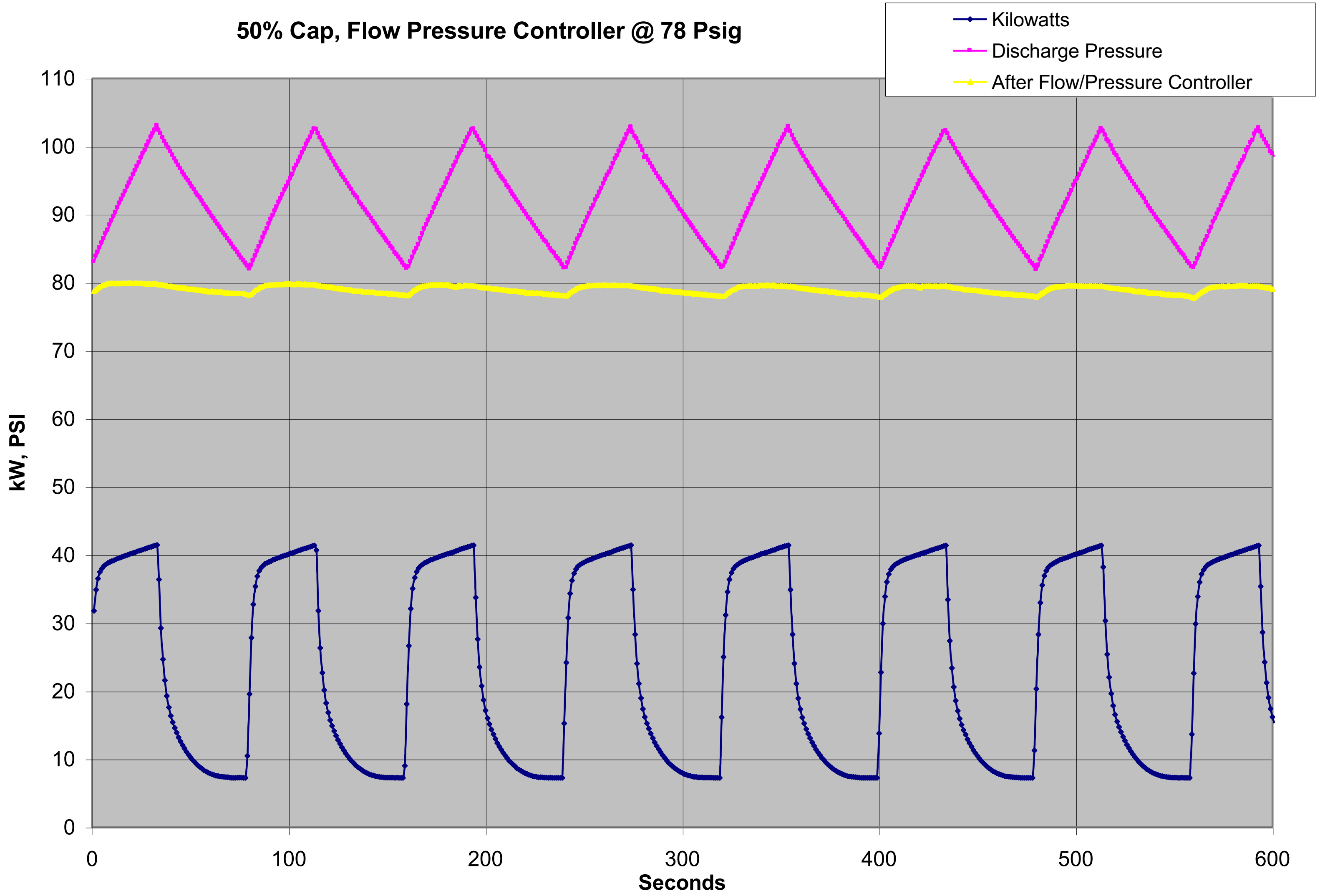


- The compressor discharge pressure varies about 10 psi as the trim compressor loads and unloads to meet plant demand.
- The pressure to the plant is kept at a constant 79 psig.

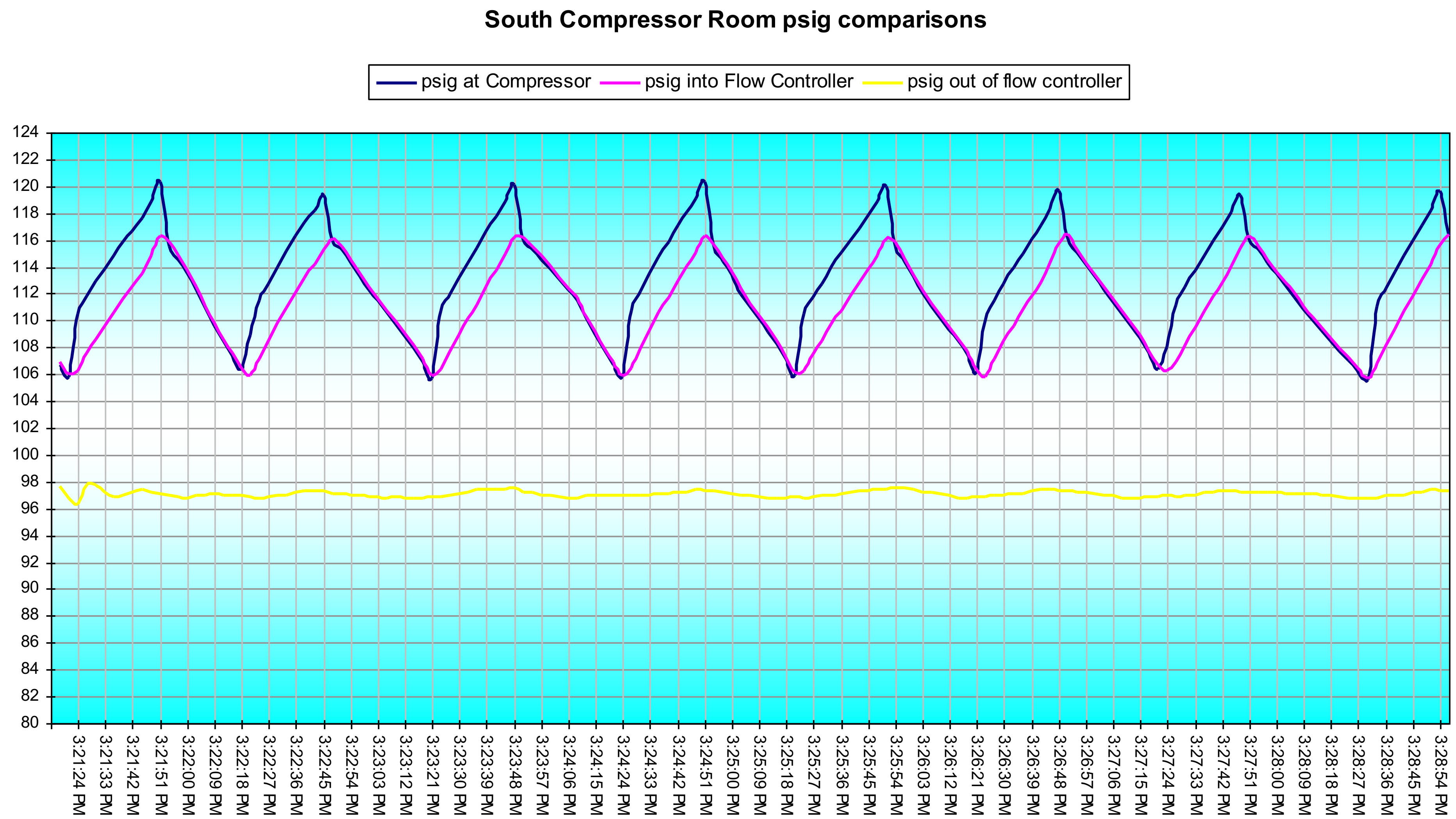
Pressure/Flow Controllers



Pressure/Flow Controllers



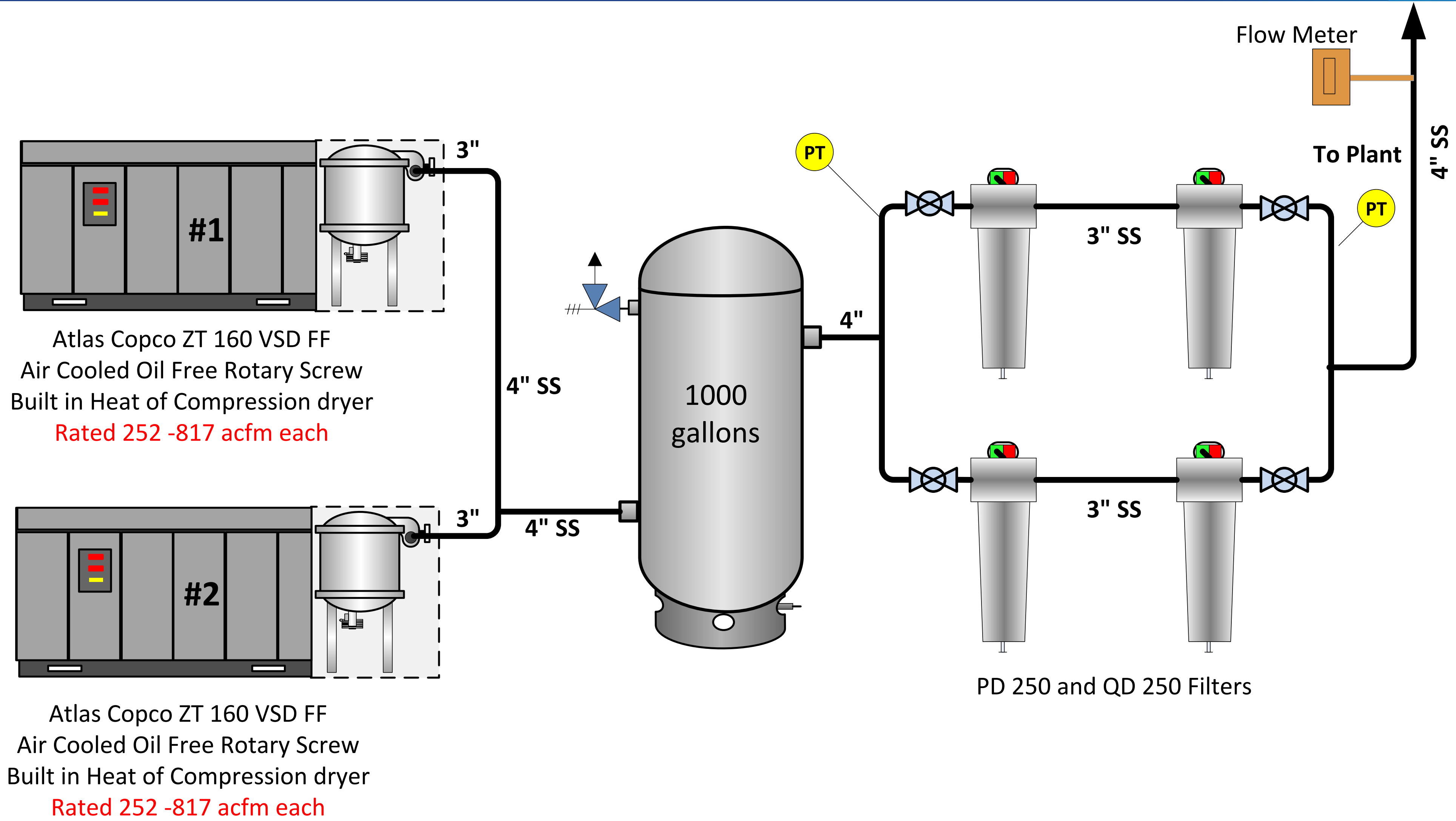
Pressure/Flow Controllers



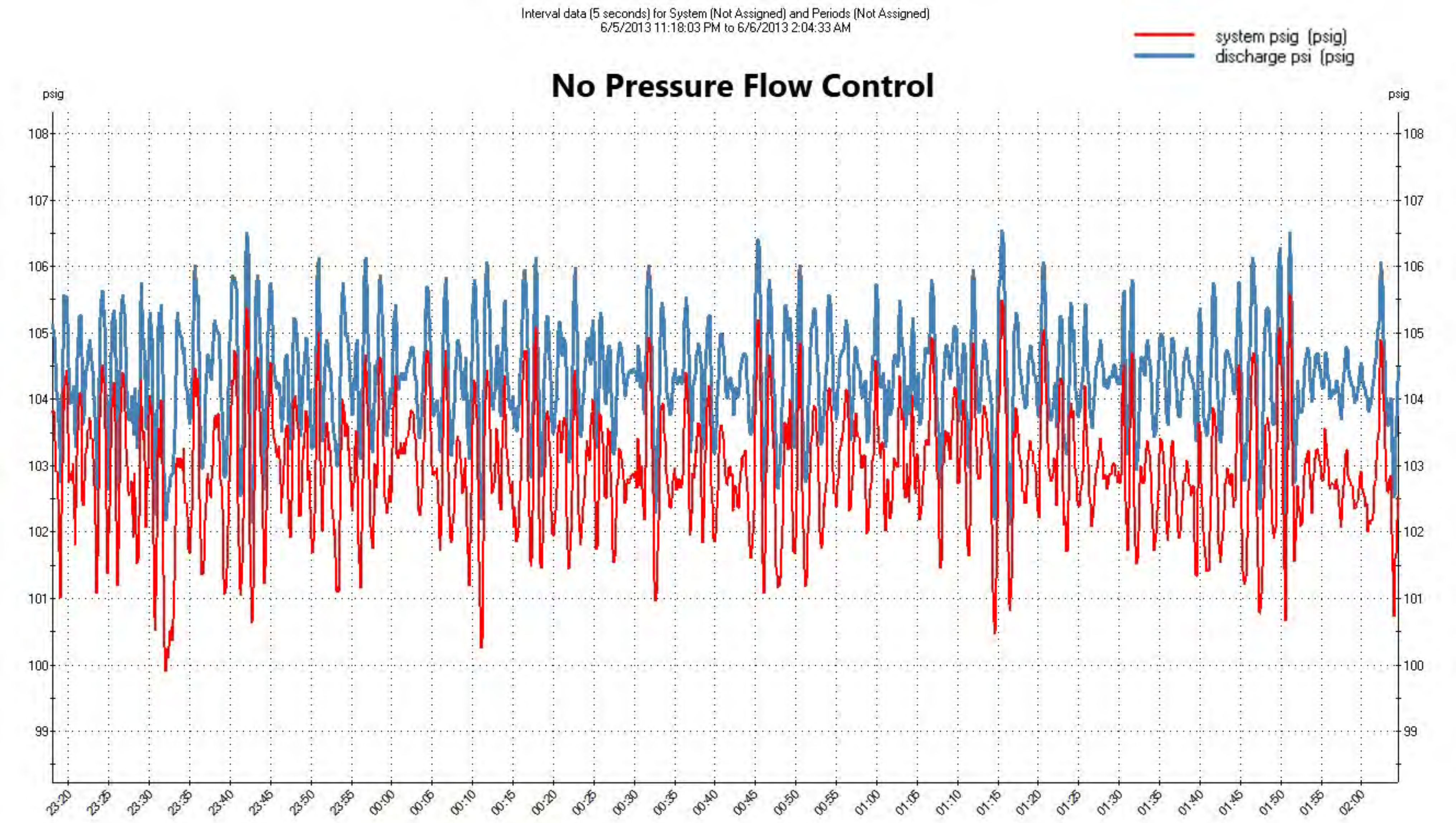
Pressure/Flow Controllers

Pressure/Flow Controllers

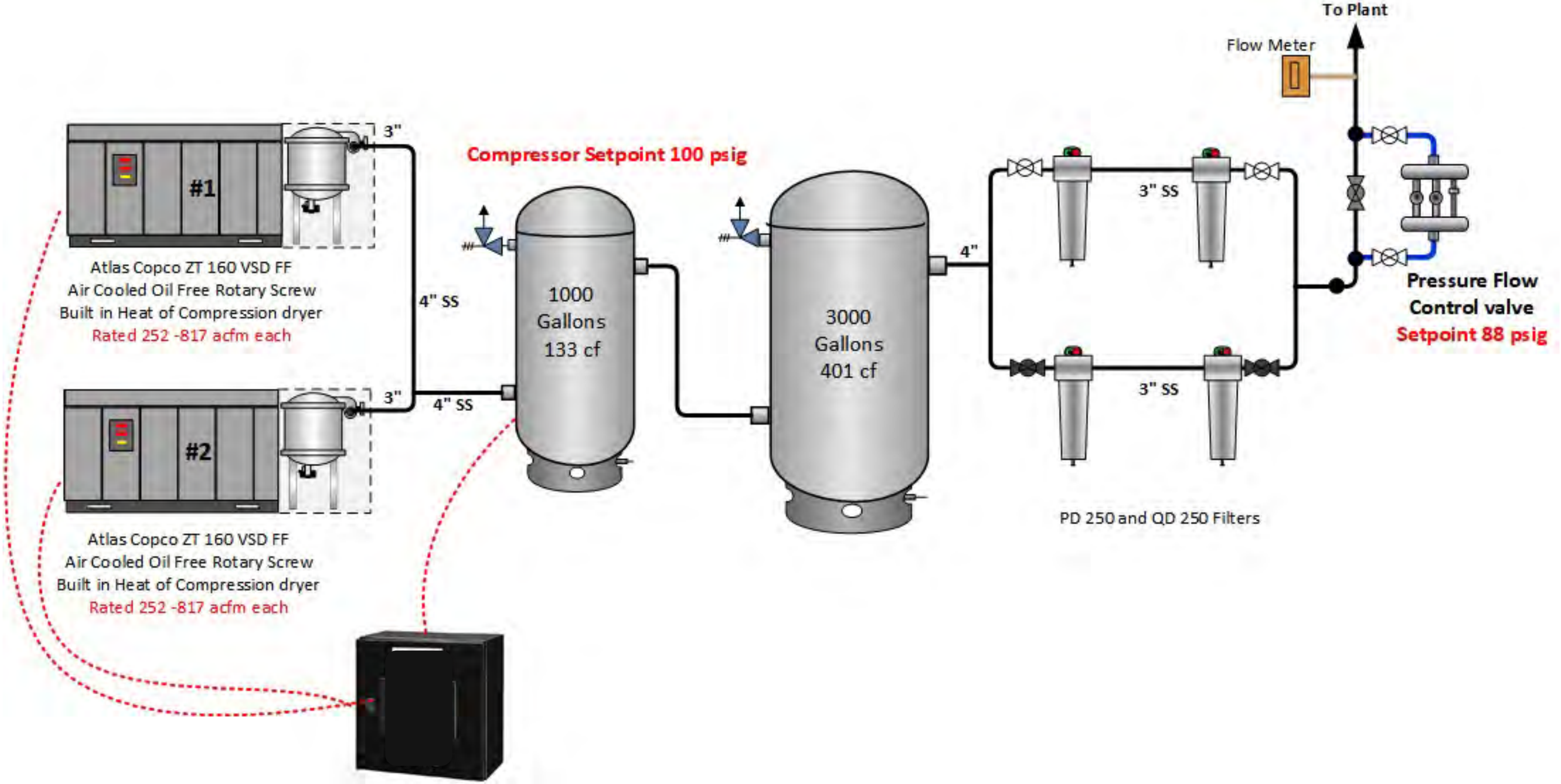
Example Pre PFC



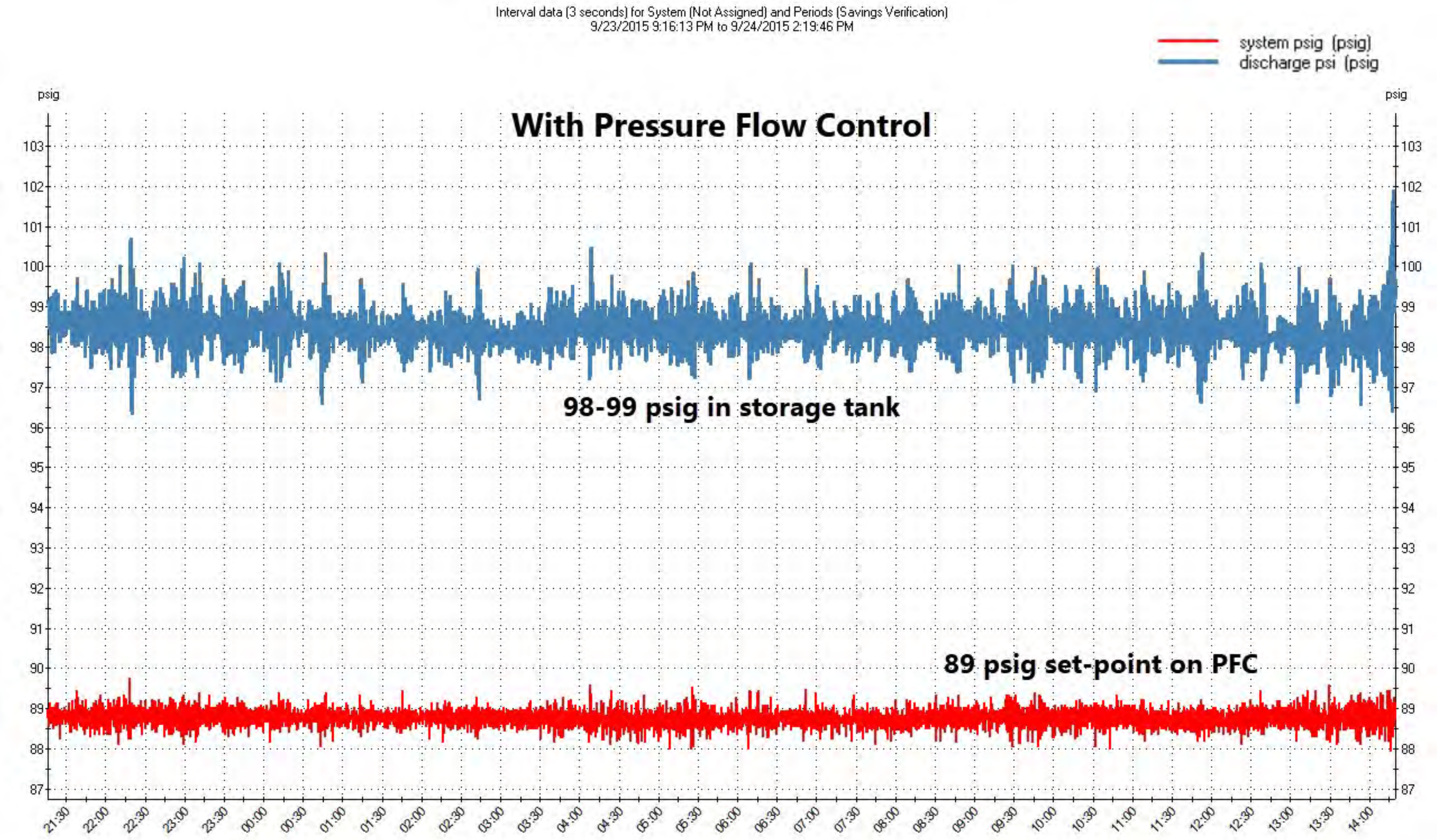
Pressure Fluctuates



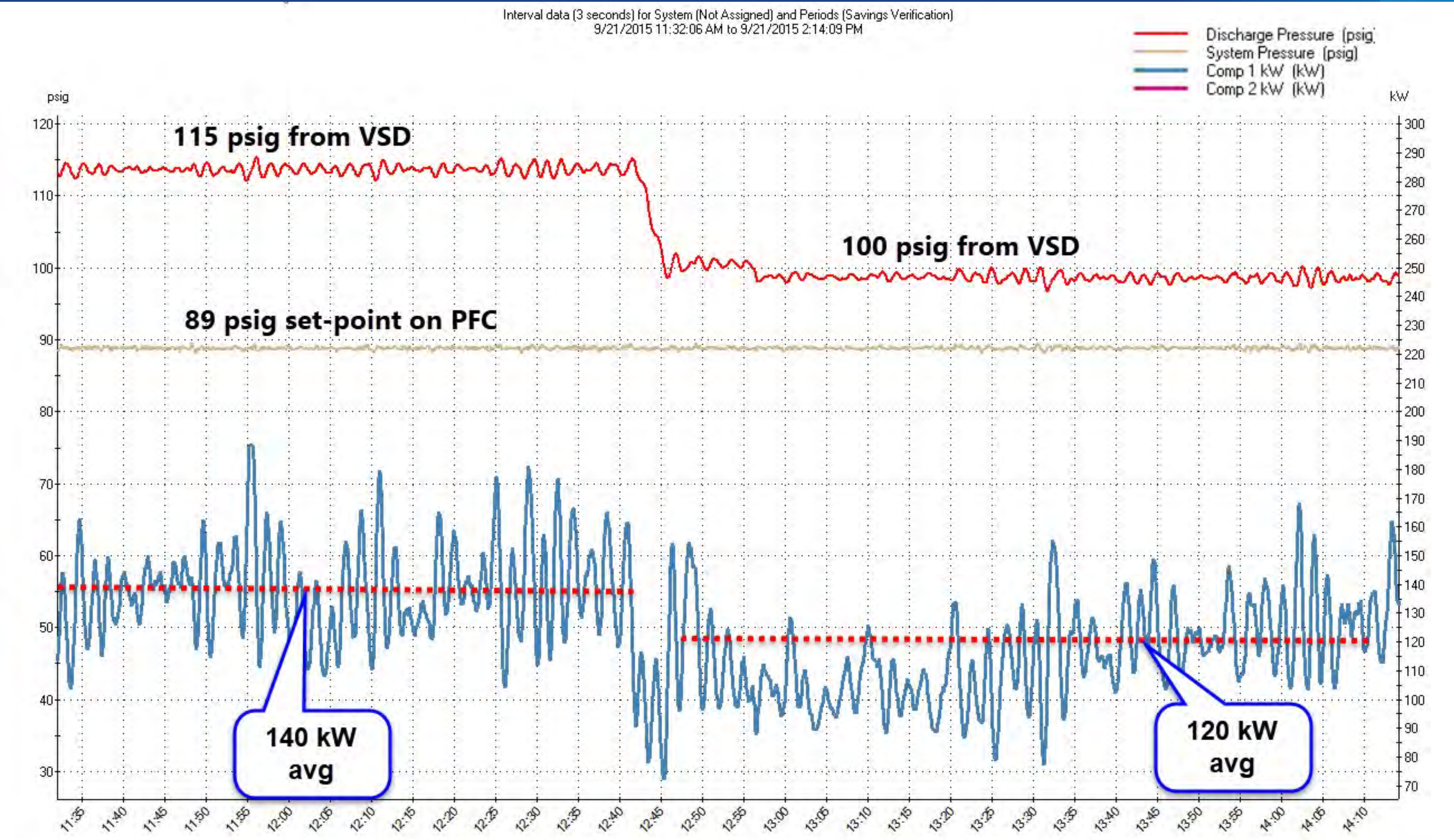
Example Post PFC



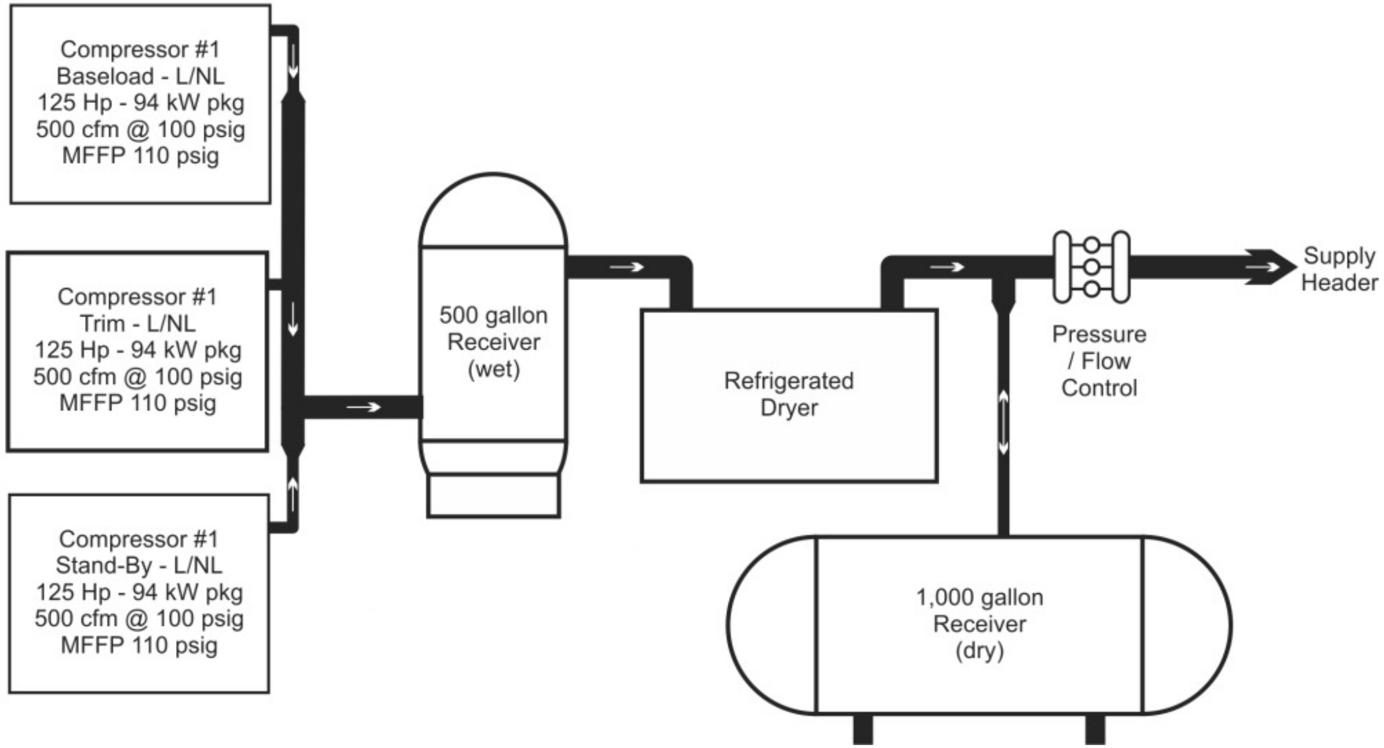
Stable Pressure



Pressure Stable

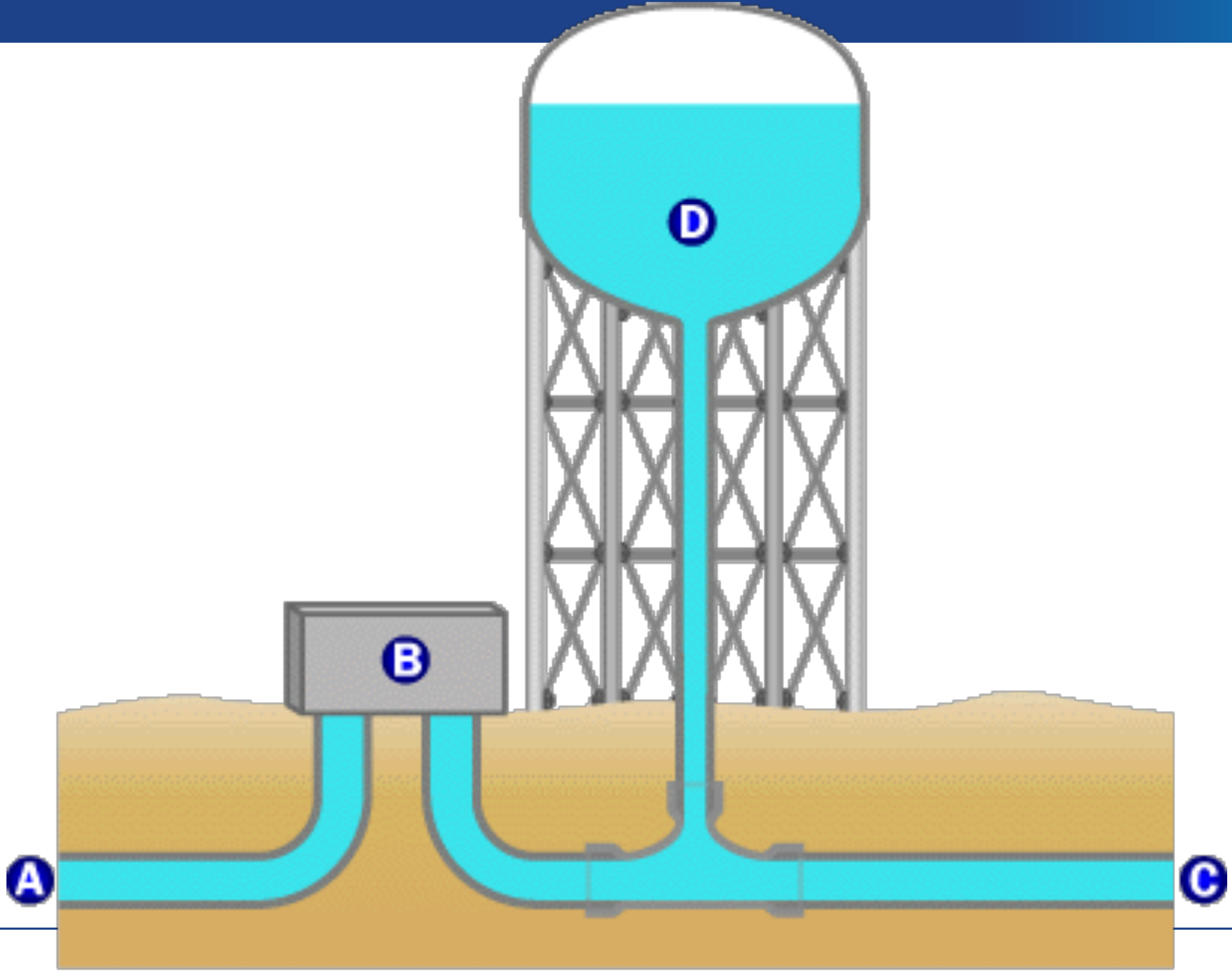


Pressure/Flow Controllers



- A typical block diagram of a pressure/flow controller in a compressed air system with one point of entry (single compressor room)

Pressure/Flow Controllers



Primary Storage

How does Volume Help

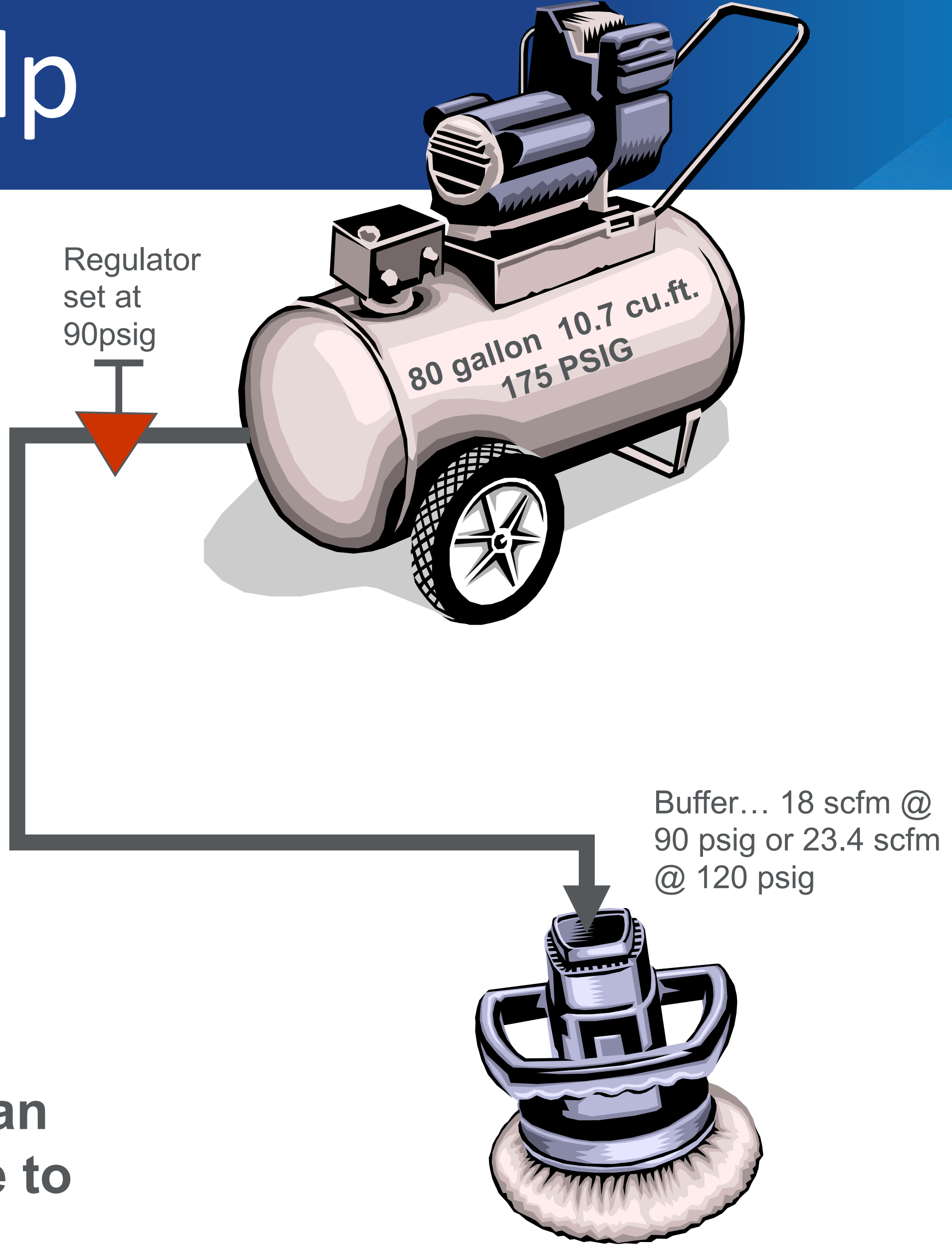
A paint area in a body shop has a 5 HP compressor mounted on an 80-gallon air receiver. This receiver is pumped up to 175 psig. The air flow to the buffer which uses 18 SCFM at 90 PSIG, is regulated to 90 PSIG outflow from the regulator.

The compressor delivers 12-13 SCFM at 90 psig but yet it runs the 18 SCFM sander OK.

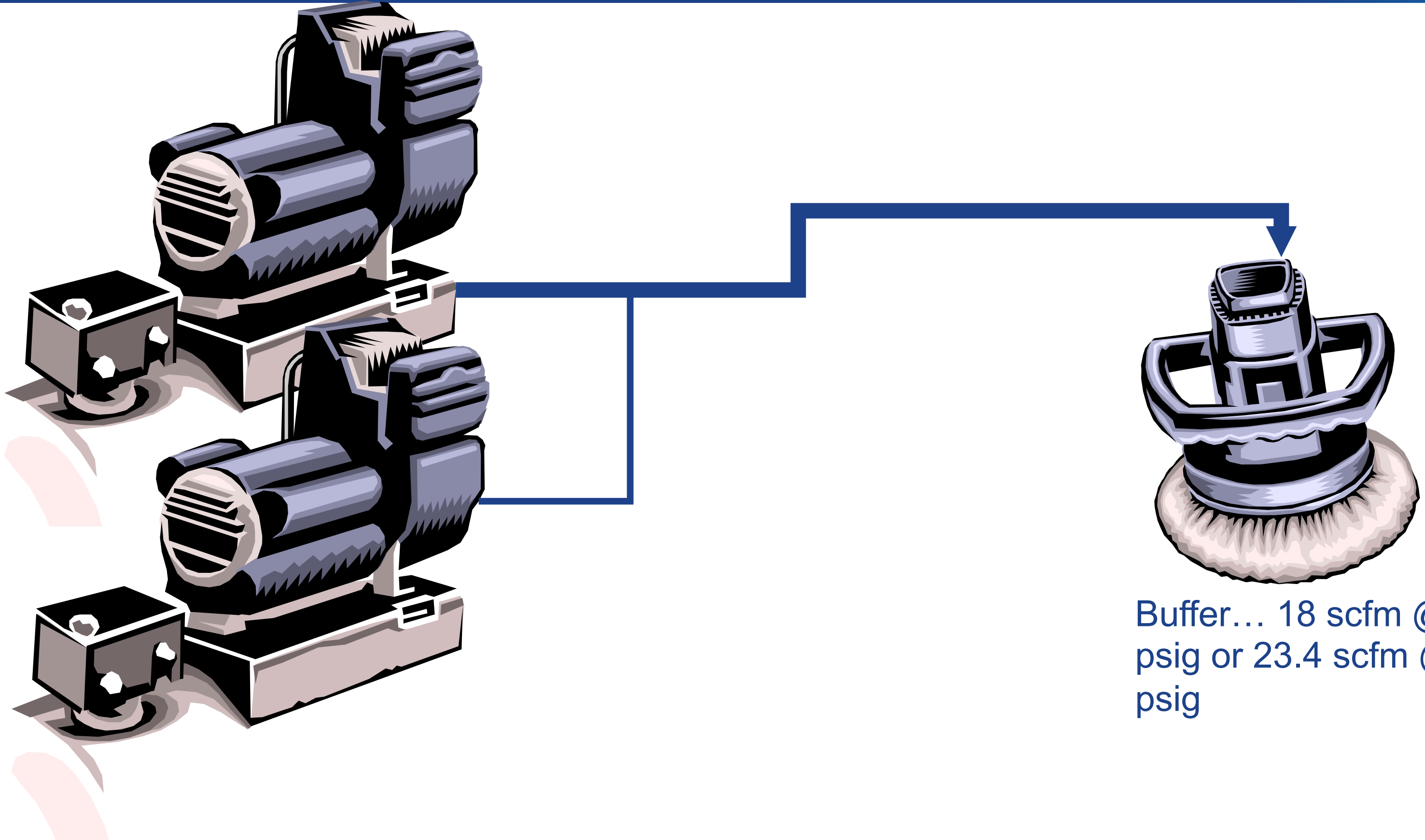
How can this work???

The buffer uses more volume(scfm) than the compressor can deliver !!

If there were no regulation and receiver, you can be sure that the compressor would not be able to run the tool



How does Volume Help



Buffer… 18 scfm @ 90 psig or 23.4 scfm @ 120 psig

With no receiver, the painter must install a second 5 hp compressor and therefore use twice the energy as before

Controls Summary

- Create a control strategy:
  - Know how your controls work
  - Realize the pros and cons of different controls
  - Recognize how controls affect part load efficiency
  - Understand how storage affects the effectiveness of control strategies

Session 3

CAS Assessment Module and the MEASUR Tool

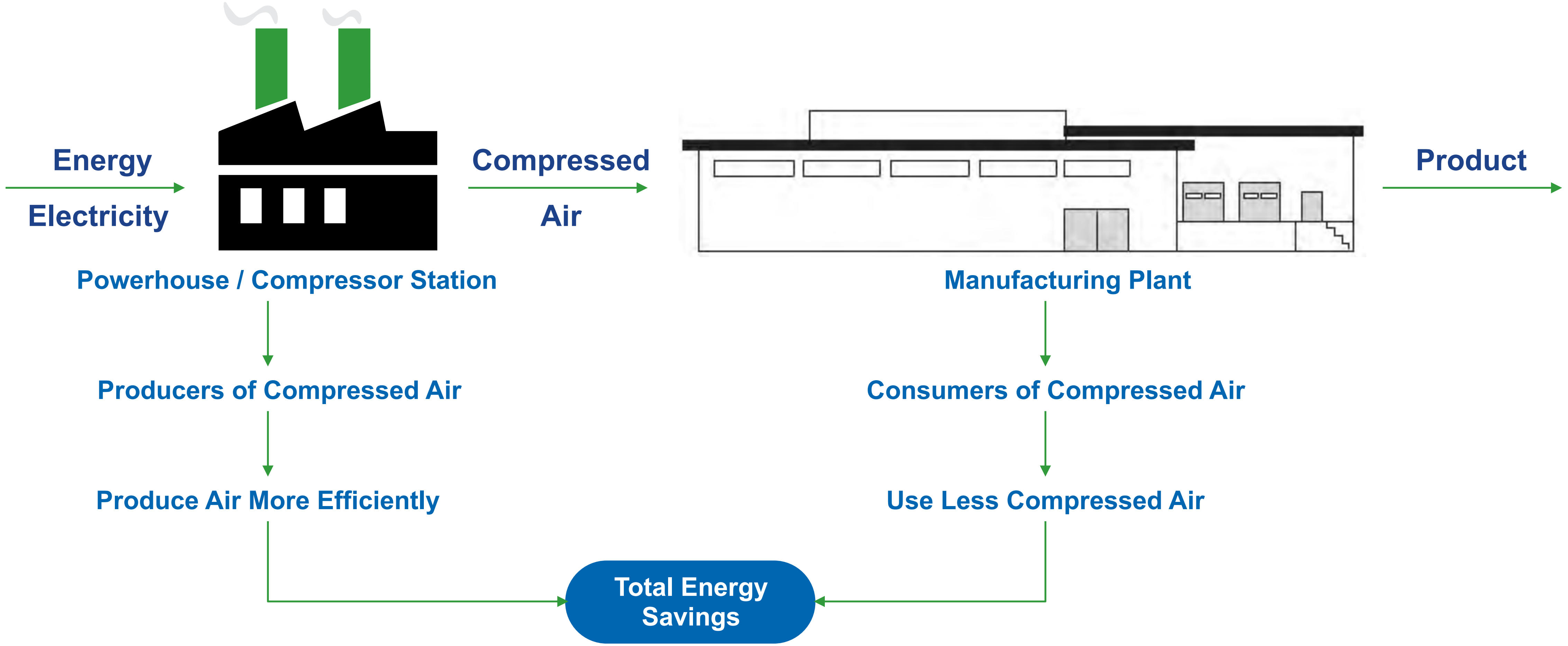
Airmaster+ and LogTool

Why AIRMaster+?

- ~90% of energy input to compressor never reaches tools (waste heat, drying, etc.)
- Leaks +pressure drops remove air energy before reaching tools--sometimes >50%
- Poor or improperly adjusted controls leave several compressors operating a part load.
- System assessments can be an arduous task using spreadsheets that must be modified for each job.
- AIRMaster+ provides a systematic approach to assessing compressed air systems, analyzing collected data, and reporting results.

Compressed Air Systems Approach
plant efficiency: energy >> product

There are two basic ways to reduce the energy consumption of a compressed air system: produce compressed air more efficiently; and consume less compressed air.

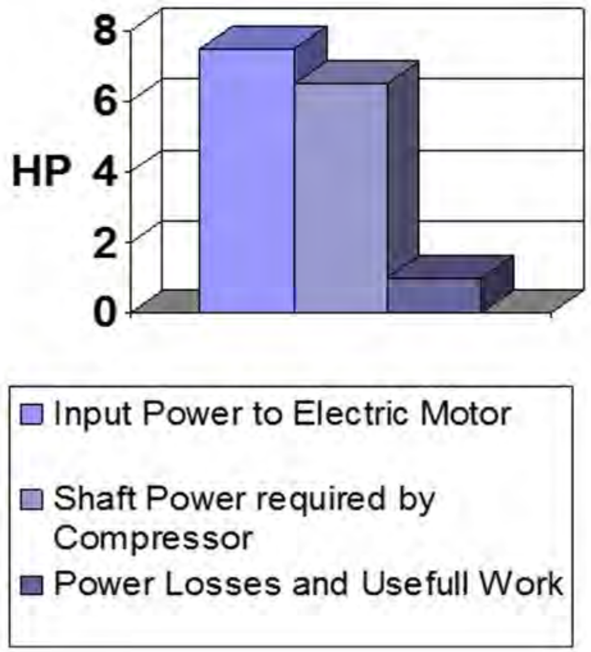


What Can This Tool Help Me With?

- Produce more efficiently
  - Improve Compressor Control
  - Type of Compressor Control
- Use less compressed air
  - Reduce System Pressure
  - Reduce Air Demand
  - How does compressed air support production?

Compressed Air Versus Other Energy Sources

- 1 hp air motor = 7-8 hp of electrical power
  - 30 scfm @ 90 psig is required by the air motor
  - 6 - 7 bhp at compressor shaft required for 30 scfm
  - 7 - 8 hp electrical power required for this
- Annual energy cost for a 1 hp air motor versus a 1 hp electric motor, 5-day per week, 2 shift operation, $0.05/kWh
- $ 1,164 vs. $ 194



AIRMaster+ Features

- AIRMaster+ is a Windows-based software tool used to analyze industrial compressed air systems.
- Simulates existing and modified compressed air system operation.
- Models part load system operation.
- Assigns electrical utility energy schedules.
- Enters 24-hour metered airflow or power data.
- Is not a substitute for an experienced auditor!

Energy Efficiency Measures

1. Reduce Air Leaks
2. Improve End Use Efficiency
3. Reduce System Air Pressure
4. Use Unloading Controls
5. Adjust Cascading Set Points
6. Use Automatic Sequencer
7. Reduce Run Time
8. Add Primary Receiver Volume

Why LogTool?

- LogTool is a public domain tool developed by SBW Consulting with support from the Compressed Air Challenge™.
- It is designed to assist in the analysis of compressed air system performance measurements.
- It is a companion tool for Airmaster+ available from the US DOE and CAC.

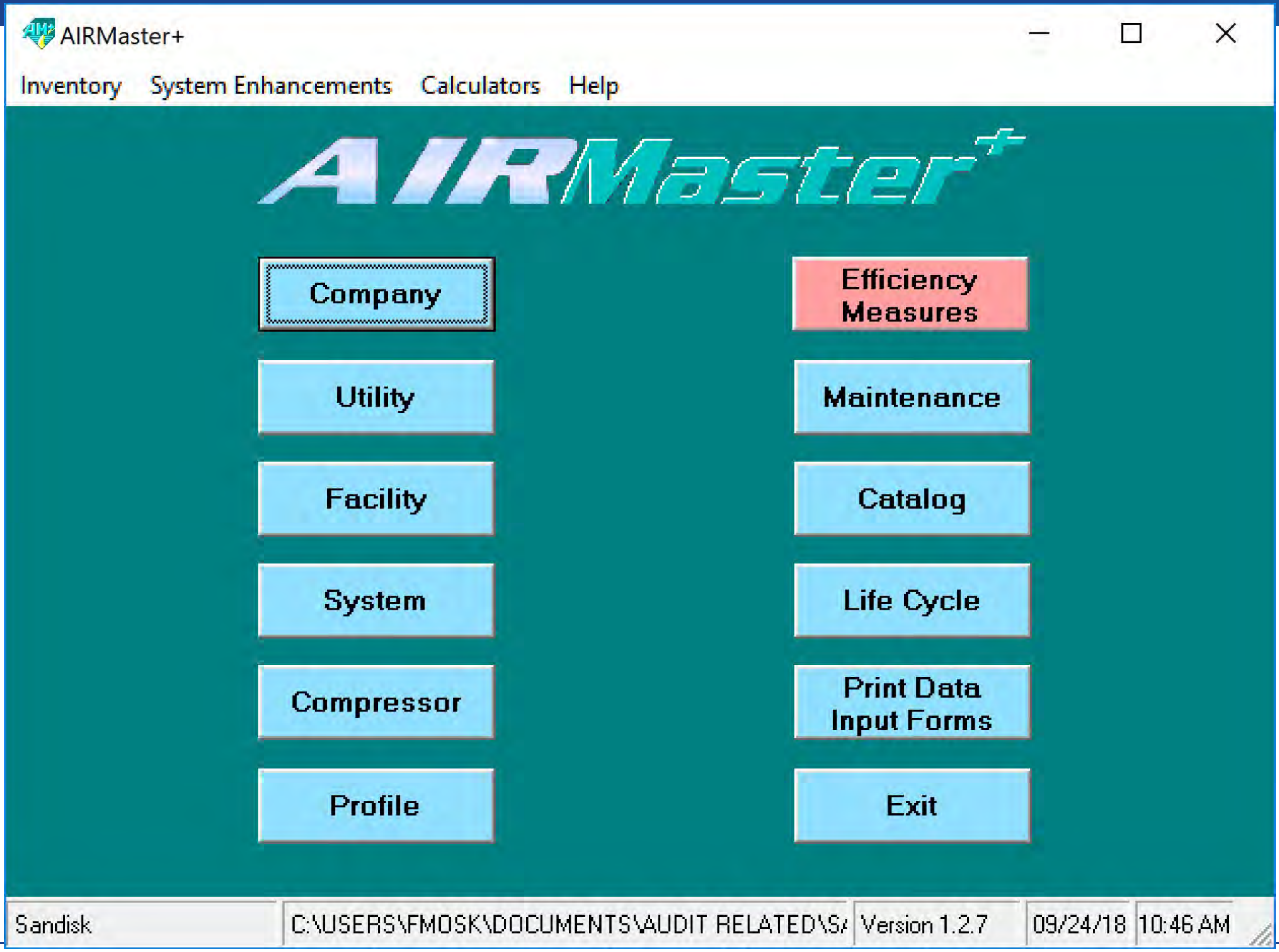
LogTool is Designed To:

- Import data which is exported from different types of data loggers.
- Select logger data channels and modify their properties.
  - e.g., name, type, units, etc.
- View data values for one or more logger channels.
- Display trend plots on one or two Y axis.
- Display scatter plots.
- Display Daytype plots in the format that is needed for AIRMaster+

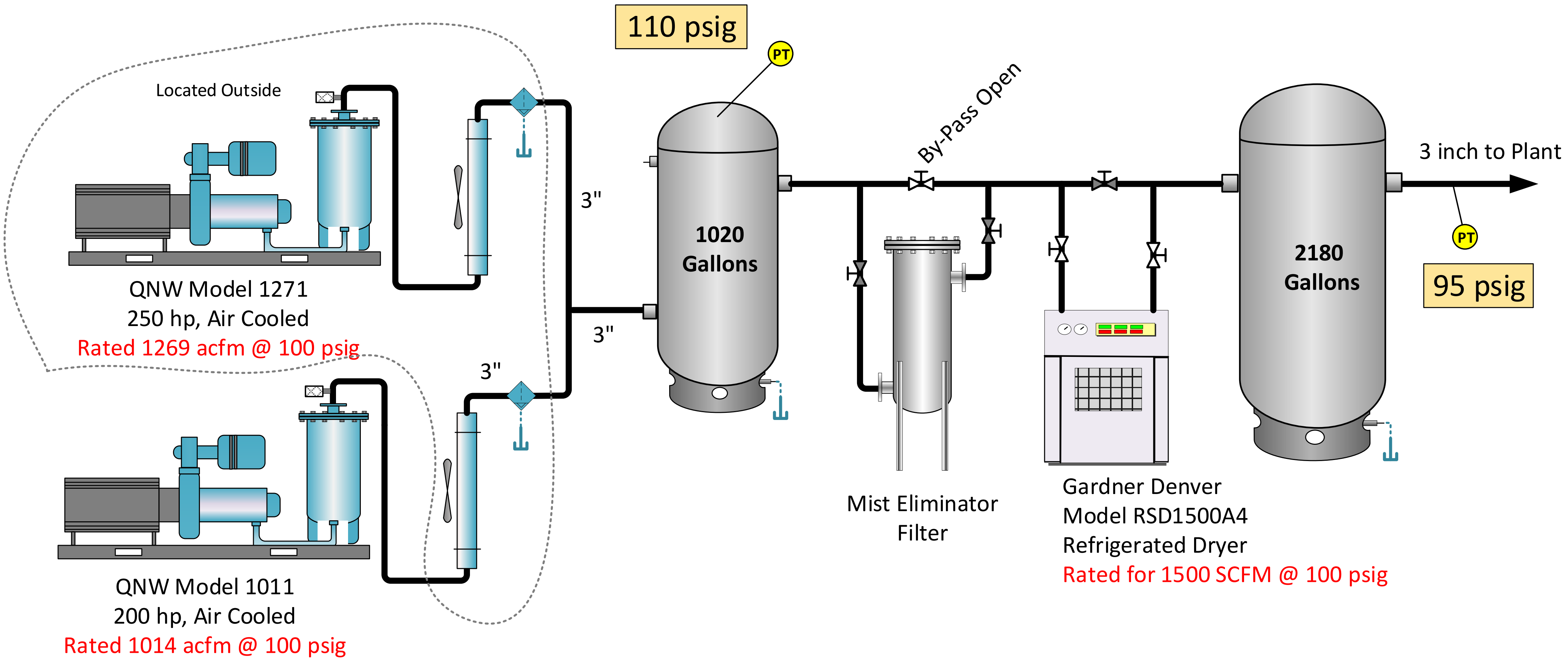
Enter LogTool Data Into AIRMaster

- Enter Utility and rate information
- Enter System information including Day Types
- Enter compressor Information
- Enter recorded data to establish the baseline
  - This data comes from LogTool
- Experiment with different EEM's

AIRMaster+ Main Menu



Box Plant Company Example



Baseline Info

- 200 hp baseloaded compressor rated 1014 acfm using modulated inlet control
- 250 hp trim compressor rated 1269 acfm using modulated inlet control operating at 40% output
- Production is 24/6 with Sundays off
- Average flow during Monday to Saturday is 1500 cfm
- Baseline energy is 2,587,516 kWh or $174,657 using $.0675/kWh
- Leakage is estimated to be about 600 cfm based on leak down test

Baseline Info

- Air Operated Diaphragm Pumps (AOD) are in use and can be replaced with electric driven pumps made to pump heavy viscous fluids such as glue
- 3-inch pipe is used in the compressor room to handle almost 1500 scfm of flow. This is borderline undersized and is creating additional pressure drop.
- Both compressors must run to support production. Neither one by itself can run production. There is no redundancy at this plant for compressed air.

Flow by Pipe Size and Velocity

PROJECT AIR VELOCITIES
DATE: August 26, 2021

INPUTS
INITIAL PRESSURE 100 PSIG
FLOW RATE 1600 SCFM

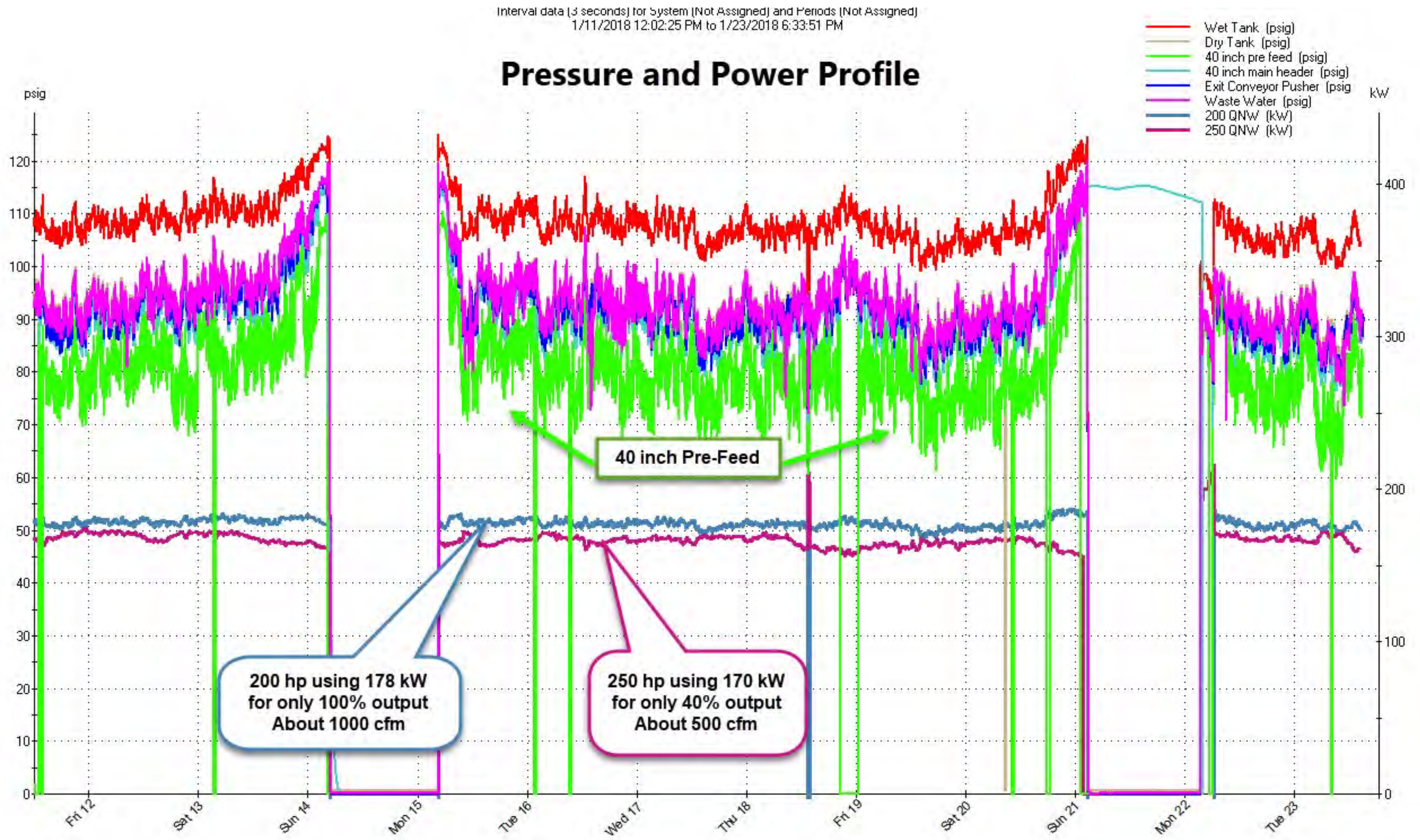
NOMINAL SCH 40 PIPE SIZE	PIPE ID, INCHES	CFM	PSIG	X AREA SQ FT	GAL STORAGE PER FOOT	VELOCITY FT/SEC	VELOCITY MPH	HEADERS MAX CFM @20'/SEC	FEEDERS MAX CFM @30'/SEC
0.5	0.500	1,600	100.00	0.0014	0.0102	2,506.430	1,708.93	12.8	19.2
0.75	0.75	1,600	100.00	0.0031	0.0229	1,113.969	759.52	28.7	43.1
1	1.04	1,600	100.00	0.0059	0.0441	579.334	395.00	55.2	82.9
1.5	1.610	1,600	100.00	0.0141	0.1057	241.737	164.82	132.4	198.6
2	2.067	1,600	100.00	0.0233	0.1743	146.661	100.00	218.2	327.3
2.5	2.469	1,600	100.00	0.0332	0.2487	102.791	70.08	311.3	467.0
3	3.068	1,600	100.00	0.0513	0.3840	66.571	45.39	480.7	721.0
4	4.026	1,600	100.00	0.0884	0.6613	38.659	26.36	827.8	1,241.6
5	5.047	1,600	100.00	0.1389	1.0392	24.600	16.77	1,300.8	1,951.2
6	6.065	1,600	100.00	0.2006	1.5007	17.035	11.61	1,878.5	2,817.8
8	7.981	1,600	100.00	0.3474	2.5986	9.837	6.71	3,252.9	4,879.3
10	10.020	1,600	100.00	0.5476	4.0960	6.241	4.26	5,127.3	7,691.0
12	11.938	1,600	100.00	0.7773	5.8142	4.397	3.00	7,278.1	10,917.1
14	13.13	1,600	100.00	0.940	7.033	3.635	2.48	8,804.1	13,206.1
16	15.00	1,600	100.00	1.227	9.179	2.785	1.90	11,490.4	17,235.7
18	16.88	1,600	100.00	1.554	11.624	2.199	1.50	14,551.2	21,826.8

NOTE: THE COMPRESSED AIR CHALLENGE RECOMMENDS A 20'/SEC MAXIMUM VELOCITY FOR HEADERS AND A 30'/SEC MAXIMUM VELOCITY FOR FEEDERS AND DROPS.

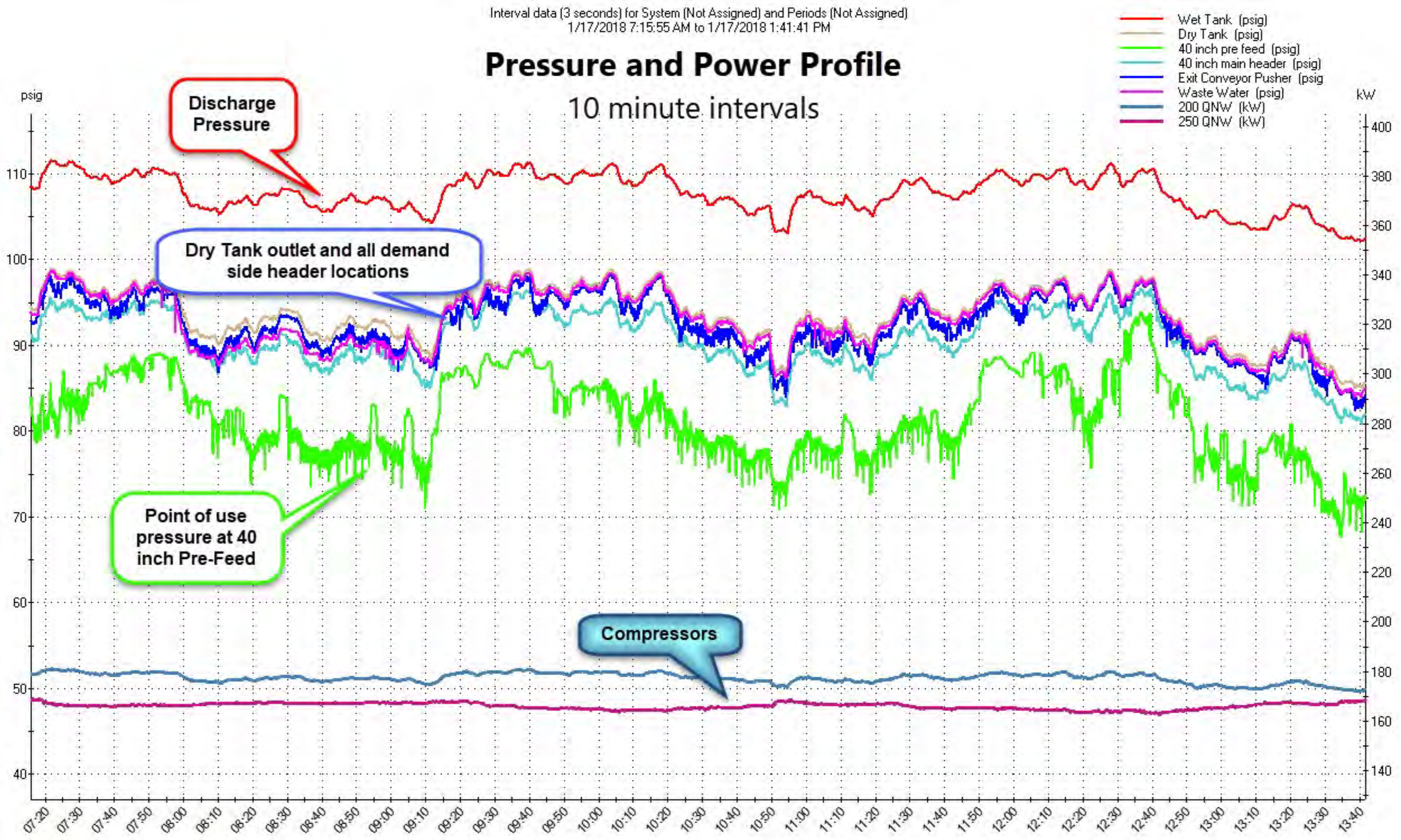
Table 4.7 Loss of Air Pressure Due to Friction

Cu ft Free Air Per Min	Equivalent Cu ft Compressed Air Per Min	Nominal Diameter, In.											
		1/2	3/4	1	1 1/4	1 1/2	2	3	4	6	8	10	12
10	1.28	6.50	.99	0.28									
20	2.56	25.9	3.90	1.11	0.25	0.11							
30	3.84	58.5	9.01	2.51	0.57	0.26							
40	5.12	....	16.0	4.45	1.03	0.46							
50	6.41	....	25.1	9.96	1.61	0.71	0.19						
60	7.68	....	36.2	10.0	2.32	1.02	0.28						
70	8.96	....	49.3	13.7	3.16	1.40	0.37						
80	10.24	....	64.5.	17.8	4.14	1.83	0.49						
90	11.52	....	82.8	22.6	5.23	2.32	0.62						
100	12.81	....	....	27.9	6.47	2.86	0.77						
125	15.82	....	....	48.6	10.2	4.49	1.19						
150	19.23	....	....	62.8	14.6	6.43	1.72	0.21					
175	22.40	....	....	....	19.8	8.72	2.36	0.28					
200	25.62	....	....	....	25.9	11.4	3.06	0.37					
250	31.64	....	....	....	40.4	17.9	4.78	0.58					
300	38.44	....	....	....	58.2	25.8	6.85	0.84	0.20				
350	44.80	....	....	....	....	35.1	9.36	1.14	0.27				
400	51.24	....	....	....	....	45.8	12.1	1.50	0.35				
450	57.65	....	....	....	....	58.0	15.4	1.89	0.46				
500	63.28	....	....	....	....	71.6	19.2	2.34	0.55				
600	76.88	....	....	....	....	....	27.6	3.36	0.79				
700	89.60	....	....	....	....	....	37.7	4.55	1.09				
800	102.5	....	....	....	....	....	49.0	5.89	1.42				
900	115.3	....	....	....	....	....	62.3	7.6	1.80				
1,000	128.1	....	....	....	....	....	76.9	9.3	2.21				
1,500	192.3	....	....	....	....	....	....	21.0	4.9	0.57			
2,000	256.2	....	....	....	....	....	....	37.4	8.8	0.99	0.24		

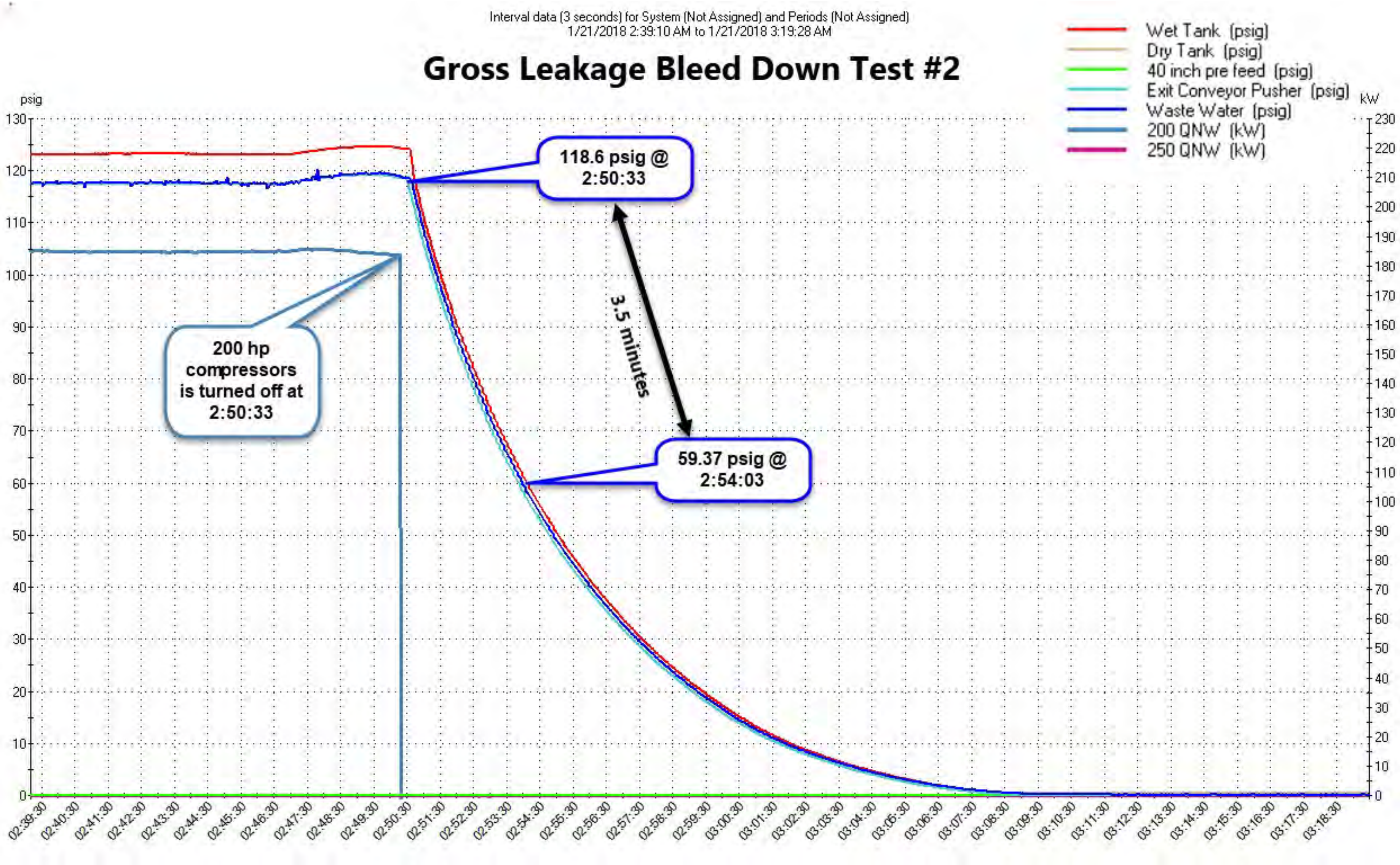
LogTool Trend Plot



LogTool Trend Plot



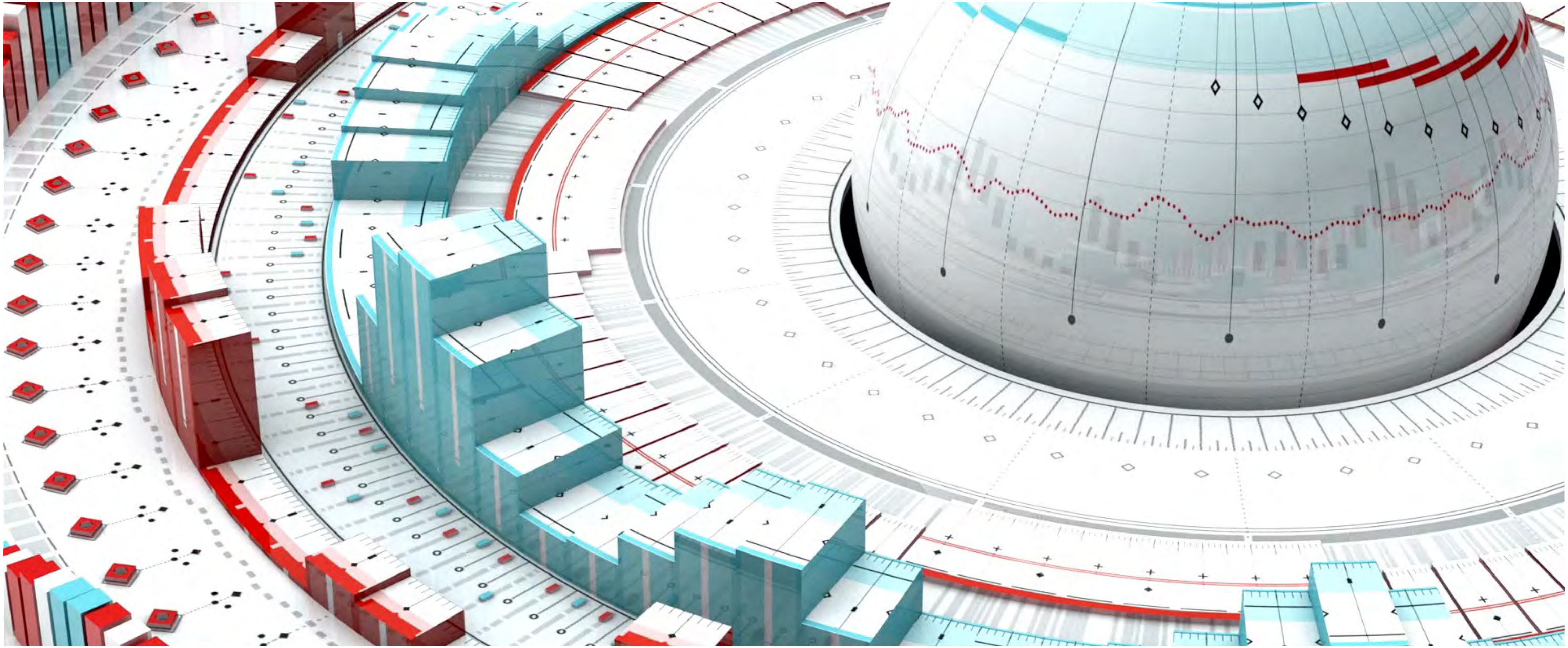
LogTool Trend Plot



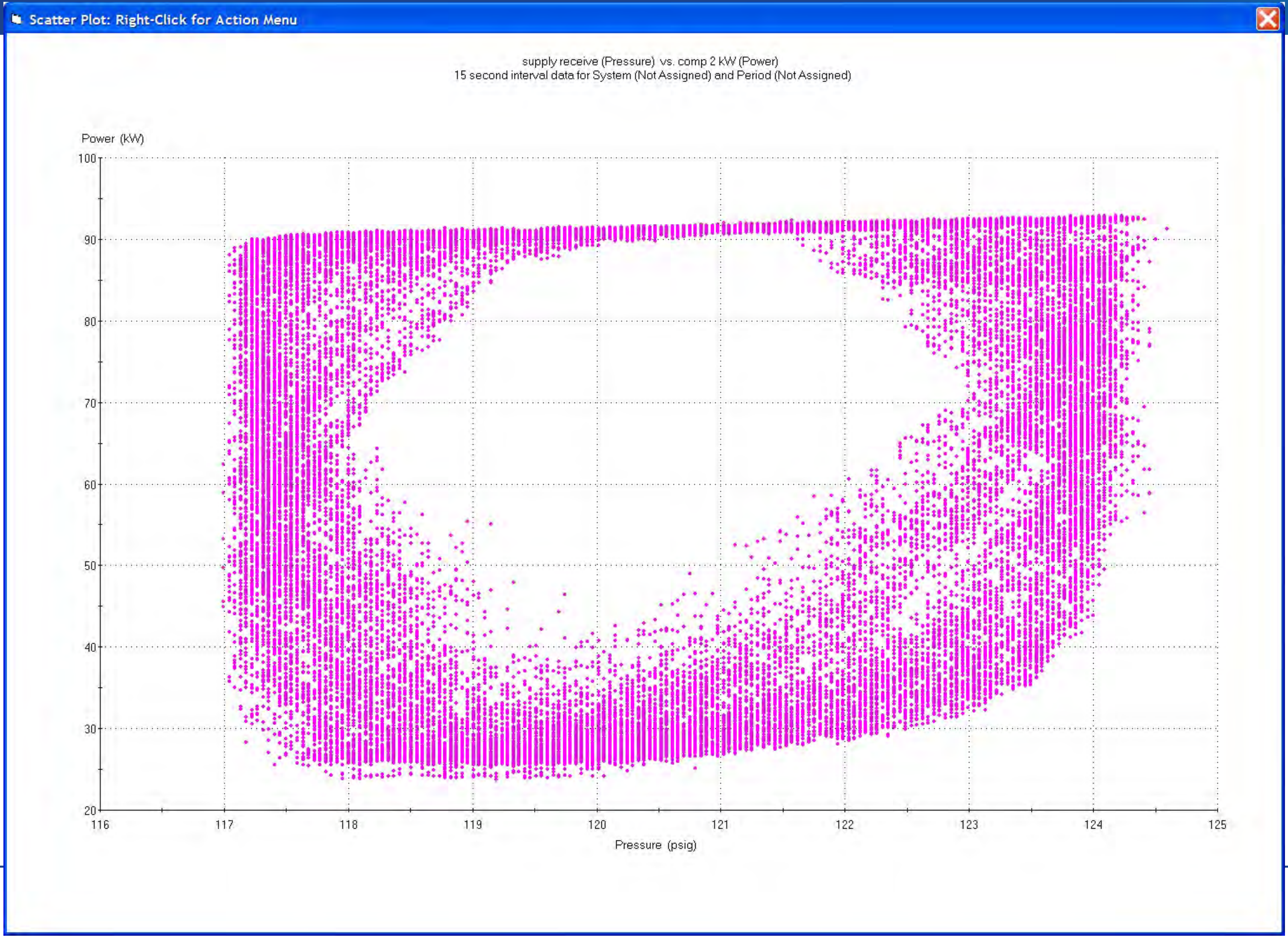
Bleed Down Test Calculation

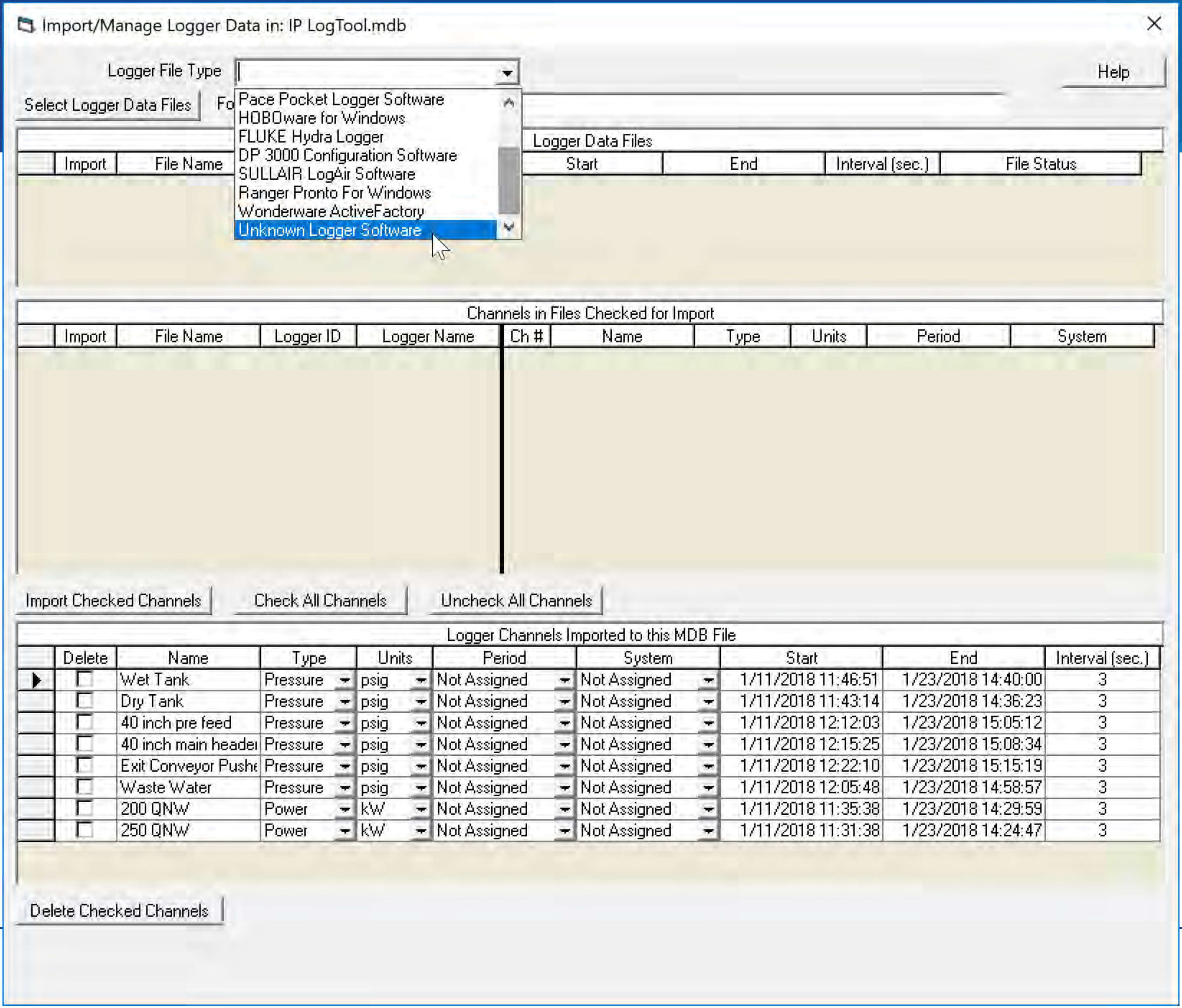
Cfm Leakage =	[V x (P1 - P2) x 1.25]/(T x 14.7)						
Where	V=	453.9	Cu ft				
	P1=	118.66	Psig				
	P2 =	59.33	Psig				
	T =	3.50	Minute				
Cfm Leakage =	654.34						
% Leakage =	Measured cfm leakage/total cfm output of plant compressors						
% Leakage =	**32.3%**	Assuming 4cfm/hp and total HP of 450					

LogTool Scatter Plot



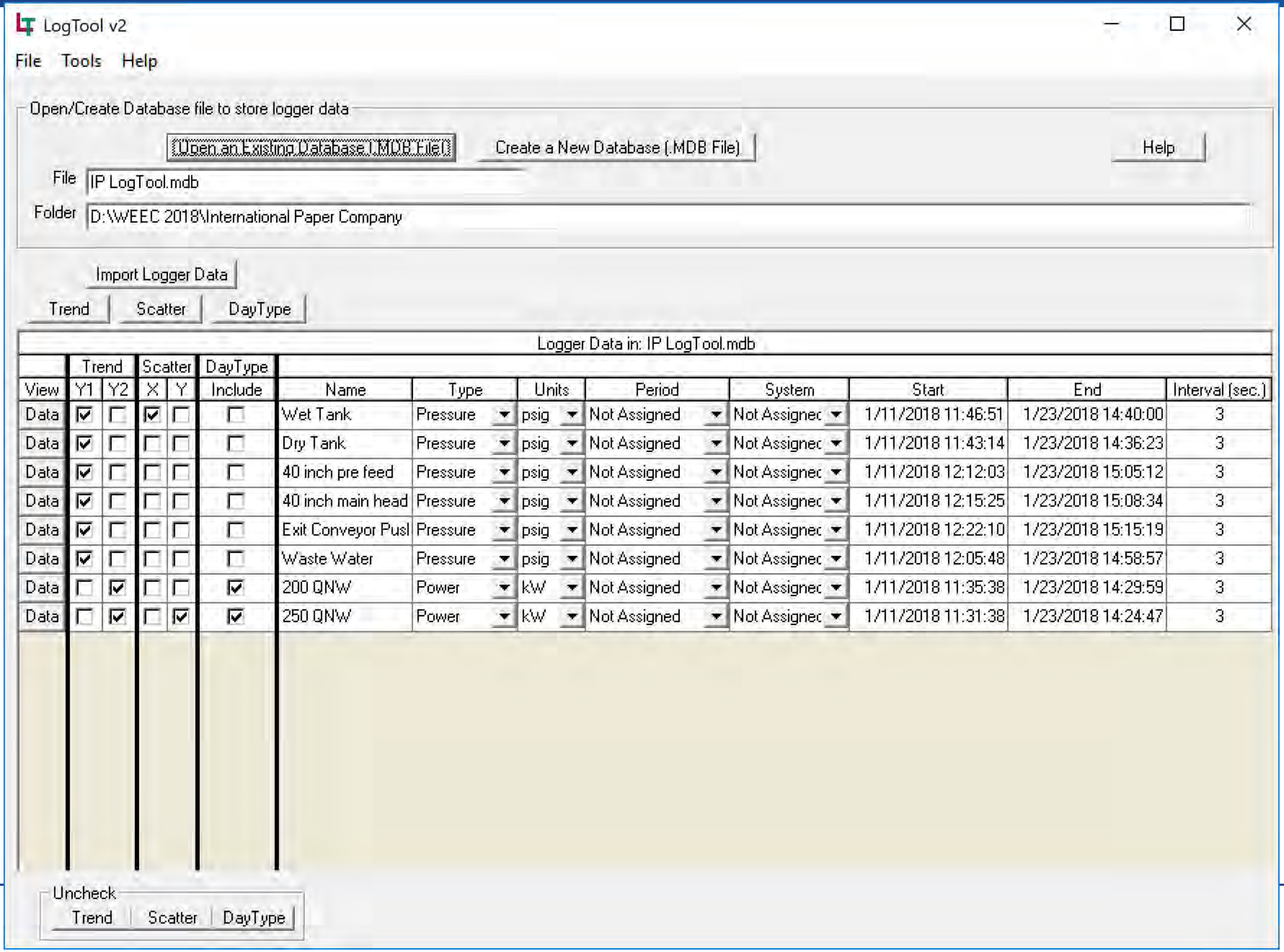
LogTool Scatter Plot





Import/Manage Logger Data in: IP LogTool.mdb
Logger File Type
Help
Select Logger Data Files
Pace Pocket Logger Software
HOBOware for Windows
FLUKE Hydra Logger
DP 3000 Configuration Software
SULLAIR LogAir Software
Ranger Pronto For Windows
Wonderware ActiveFactory
Unknown Logger Software
Logger Data Files
Import
File Name
Start
End
Interval (sec.)
File Status
Channels in Files Checked for Import
Import | File Name | Logger ID | Logger Name | Ch # | Name | Type | Units | Period | System
Import Checked Channels
Check All Channels
Uncheck All Channels
Logger Channels Imported to this MDB File
Delete | Name | Type | Units | Period | System | Start | End | Interval (sec.)
Wet Tank | Pressure | psig | Not Assigned | Not Assigned | 1/11/2018 11:46:51 | 1/23/2018 14:40:00 | 3
Dry Tank | Pressure | psig | Not Assigned | Not Assigned | 1/11/2018 11:43:14 | 1/23/2018 14:36:23 | 3
40 inch pre feed | Pressure | psig | Not Assigned | Not Assigned | 1/11/2018 12:12:03 | 1/23/2018 15:05:12 | 3
40 inch main header | Pressure | psig | Not Assigned | Not Assigned | 1/11/2018 12:15:25 | 1/23/2018 15:08:34 | 3
Exit Conveyor Pushe | Pressure | psig | Not Assigned | Not Assigned | 1/11/2018 12:22:10 | 1/23/2018 15:15:19 | 3
Waste Water | Pressure | psig | Not Assigned | Not Assigned | 1/11/2018 12:05:48 | 1/23/2018 14:58:57 | 3
200 QNW | Power | kW | Not Assigned | Not Assigned | 1/11/2018 11:35:38 | 1/23/2018 14:29:59 | 3
250 QNW | Power | kW | Not Assigned | Not Assigned | 1/11/2018 11:31:38 | 1/23/2018 14:24:47 | 3
Delete Checked Channels

LogTool Main Menu

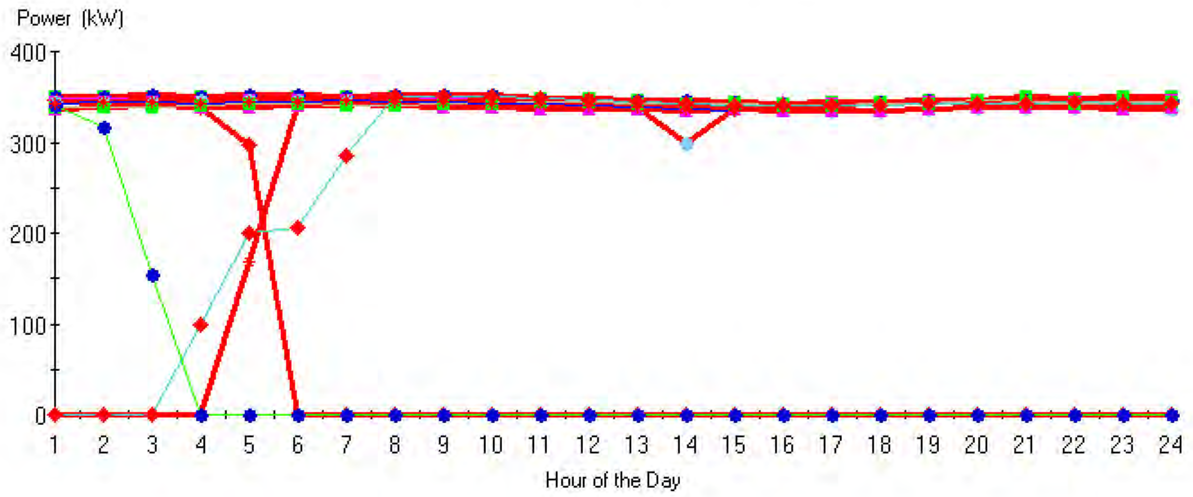


	Trend		Scatter		DayType								
View	Y1	Y2	X	Y	Include	Name	Type	Units	Period	System	Start	End	Interval (sec.)
Data	☑	☐	☑	☐	☐	Wet Tank	Pressure	psig	Not Assigned	Not Assignec	1/11/2018 11:46:51	1/23/2018 14:40:00	3
Data	☑	☐	☐	☐	☐	Dry Tank	Pressure	psig	Not Assigned	Not Assignec	1/11/2018 11:43:14	1/23/2018 14:36:23	3
Data	☑	☐	☐	☐	☐	40 inch pre feed	Pressure	psig	Not Assigned	Not Assignec	1/11/2018 12:12:03	1/23/2018 15:05:12	3
Data	☑	☐	☐	☐	☐	40 inch main head	Pressure	psig	Not Assigned	Not Assignec	1/11/2018 12:15:25	1/23/2018 15:08:34	3
Data	☑	☐	☐	☐	☐	Exit Conveyor Pusl	Pressure	psig	Not Assigned	Not Assignec	1/11/2018 12:22:10	1/23/2018 15:15:19	3
Data	☑	☐	☐	☐	☐	Waste Water	Pressure	psig	Not Assigned	Not Assignec	1/11/2018 12:05:48	1/23/2018 14:58:57	3
Data	☐	☑	☐	☐	☑	200 QNW	Power	kW	Not Assigned	Not Assignec	1/11/2018 11:35:38	1/23/2018 14:29:59	3
Data	☐	☑	☐	☑	☑	250 QNW	Power	kW	Not Assigned	Not Assignec	1/11/2018 11:31:38	1/23/2018 14:24:47	3

Enter LogTool Data Into AIRMaster

DayType Analysis

System: Not Assigned, Period: Not Assigned



Right click on data points to select day type. Left click to highlight the trace.

Click a date to highlight profile in graph.

Date	Day	Day Type
Jan-11-2018	Thu	Excluded Days
Jan-12-2018	Fri	Production
Jan-13-2018	Sat	Production
Jan-14-2018	Sun	Sunday
Jan-15-2018	Mon	Monday
Jan-16-2018	Tue	Production
Jan-17-2018	Wed	Production
Jan-18-2018	Thu	Production
Jan-19-2018	Fri	Production
Jan-20-2018	Sat	Production
Jan-21-2018	Sun	Excluded Days
Jan-22-2018	Mon	Excluded Days
Jan-23-2018	Tue	Excluded Days

Plot Day Type ... All Days

Remove Day Type...

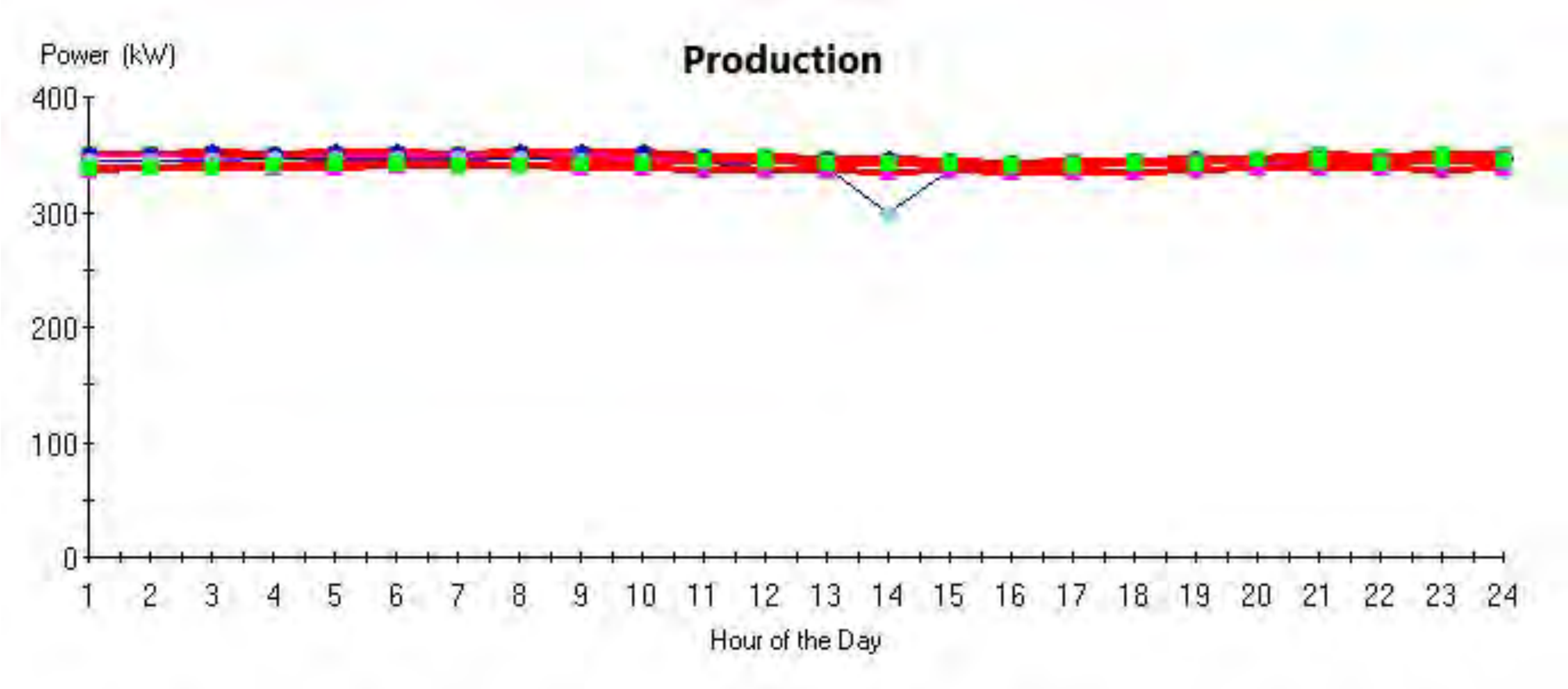
Caution: Day profiles can be similar even though different equipment, e.g., compressors, is operating. Use Trend Plots to examine the details of equipment operation before determining whether days should be assigned to the same daytype.

Create System DayType Profiles | Copy Plot to ClipBoard | Copy Profiles to ClipBoard | Help

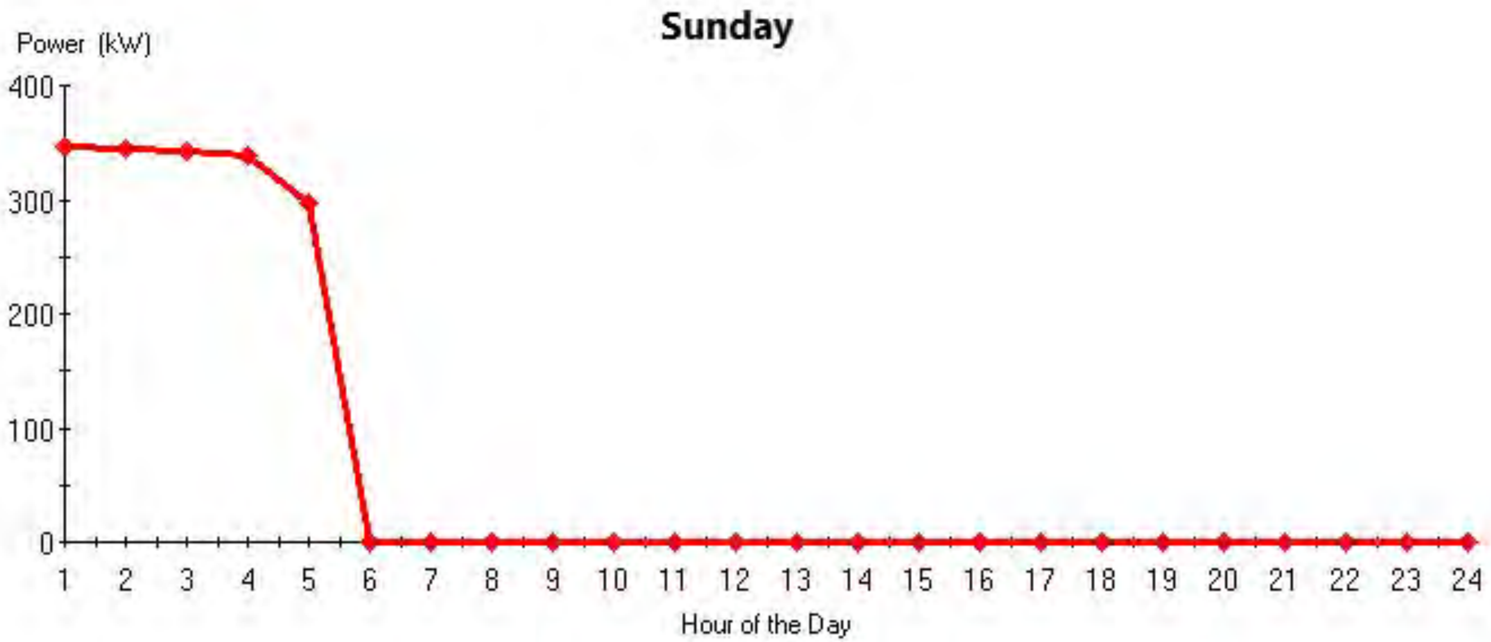
System DayType Profiles

DayTypeName	ChannelName	Hr_01	Hr_02	Hr_03	Hr_04	Hr_05	Hr_06	Hr_07
Monday	200 QNW	0.00	0.00	0.00	0.00	84.55	175.88	177.13
Monday	250 QNW	0.00	0.00	0.00	0.00	83.80	164.18	163.56
Production	200 QNW	178.12	178.25	177.86	177.11	177.67	178.09	177.97
Production	250 QNW	166.54	166.81	167.49	168.31	168.50	168.50	168.40
Sunday	200 QNW	181.76	180.51	179.20	176.98	154.17	0.00	0.00
Sunday	250 QNW	165.56	163.78	162.43	161.83	143.08	0.00	0.00

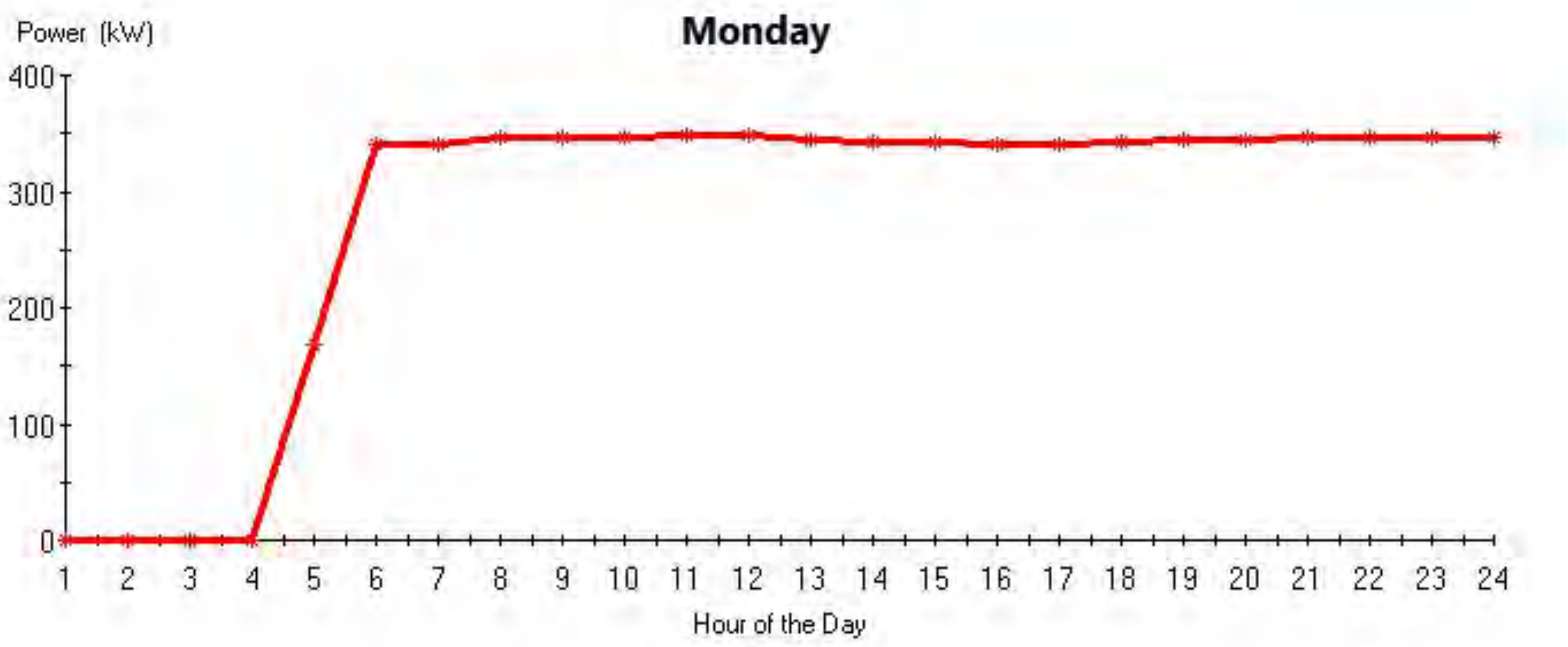
DayType Profiles



DayType Profiles



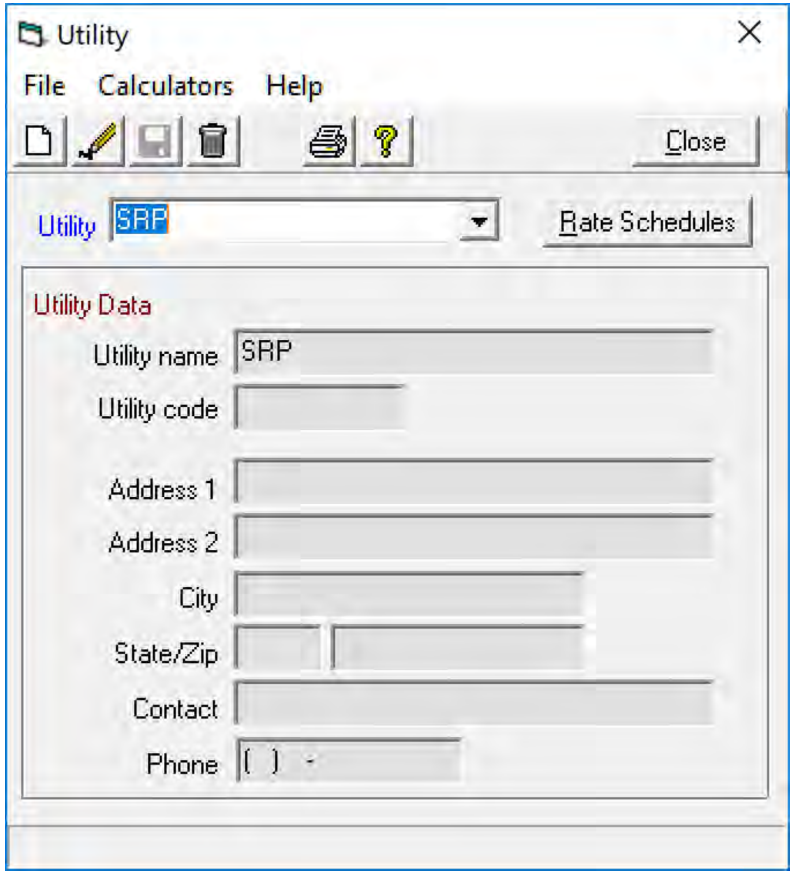
DayType Profiles

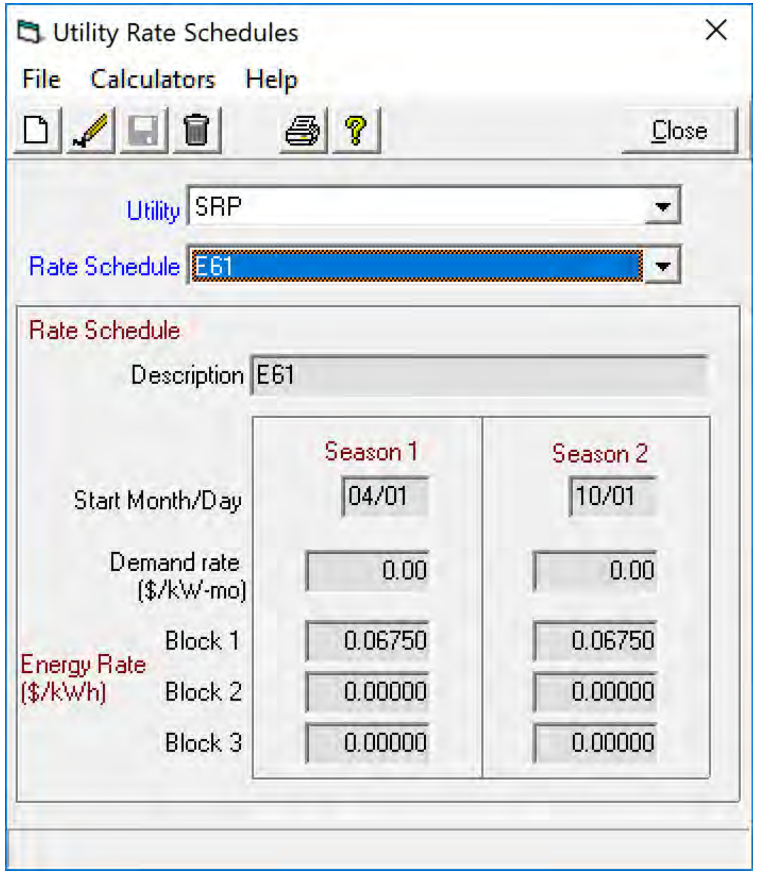


Enter LogTool Data Into AIRMaster

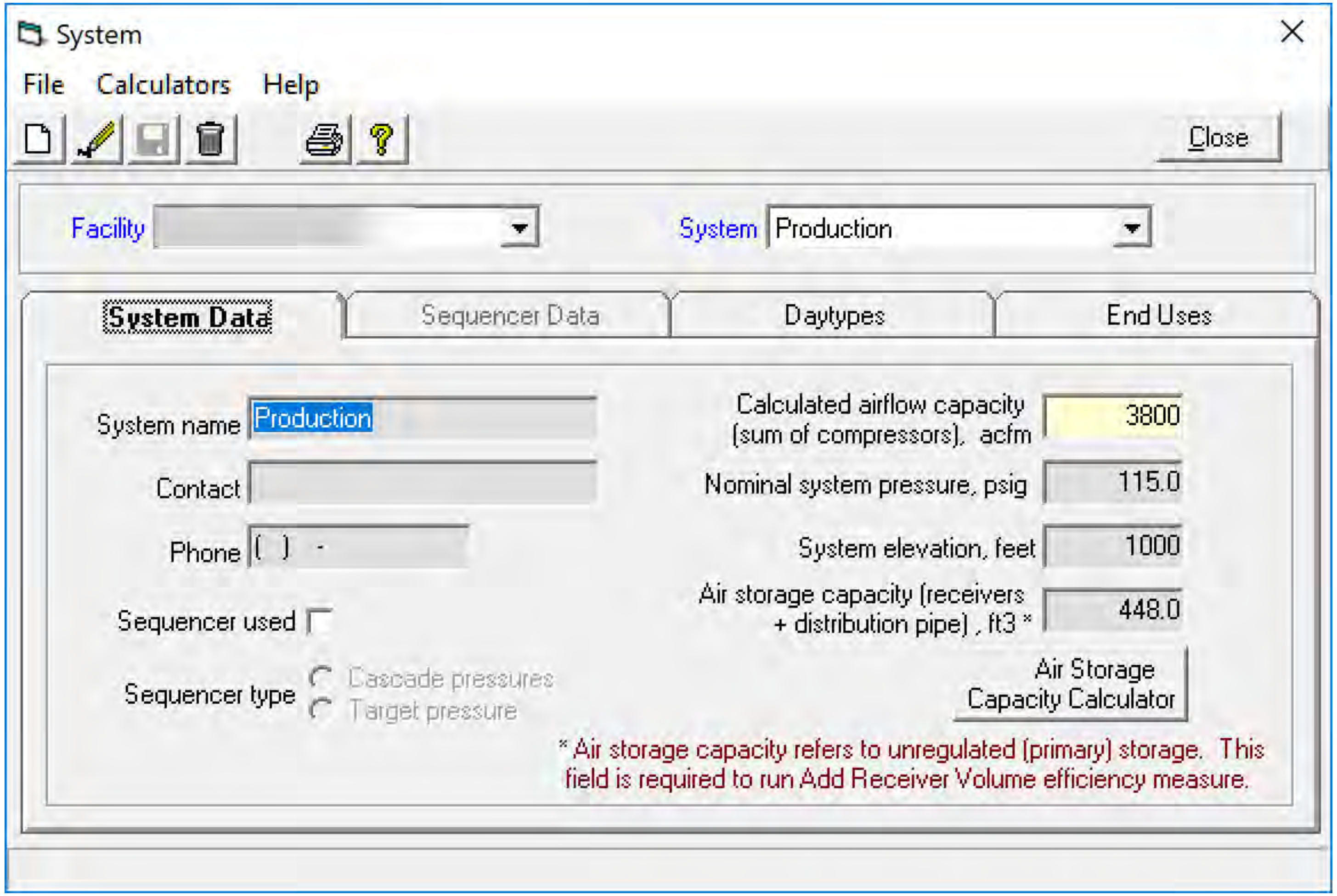
- Enter Utility and rate information
- Enter System information including Day Types
- Enter compressor Information
- Enter recorded data to establish the baseline
  - This data comes from LogTool
- Experiment with different EEM’s

Utility and Rate Information

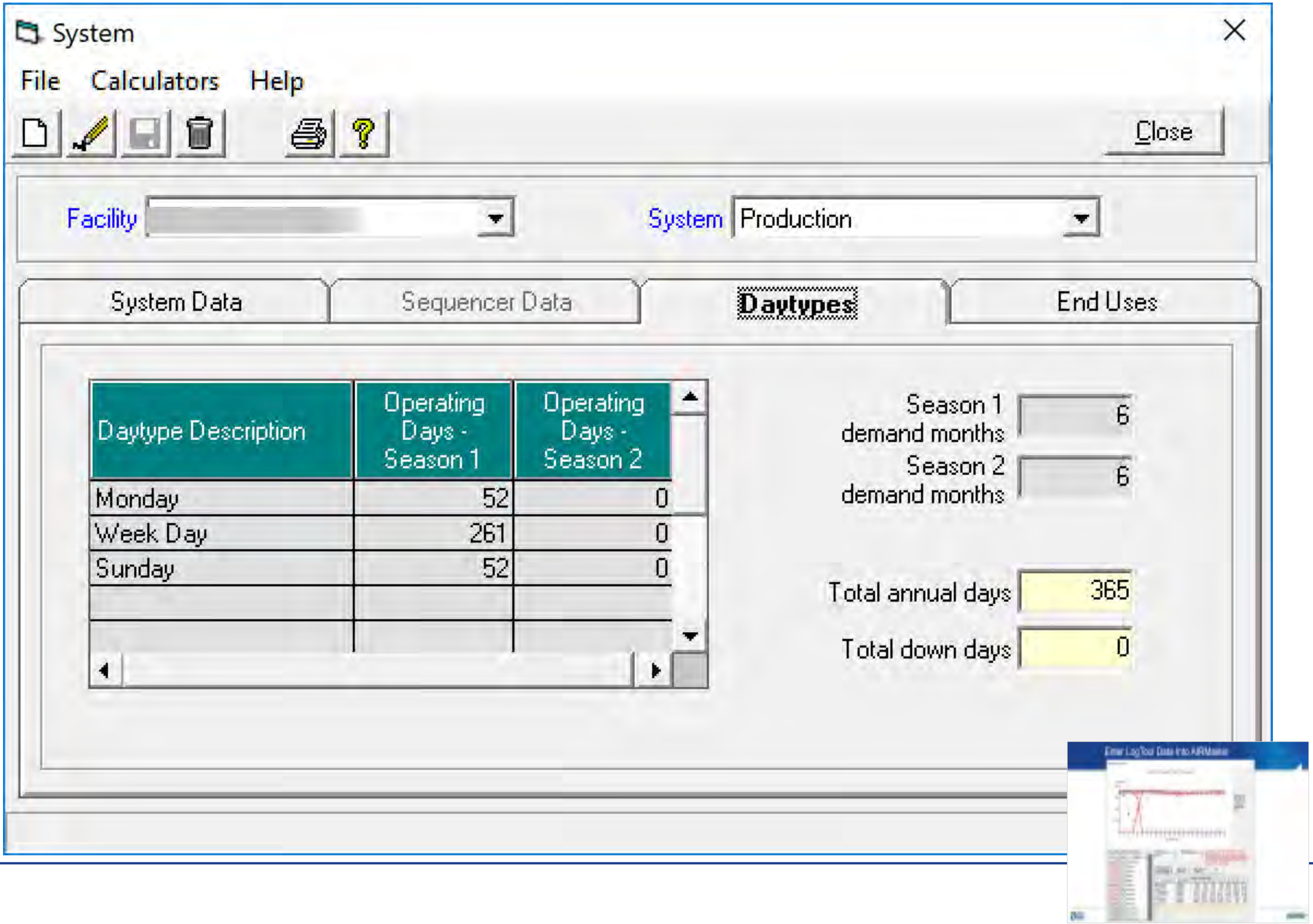




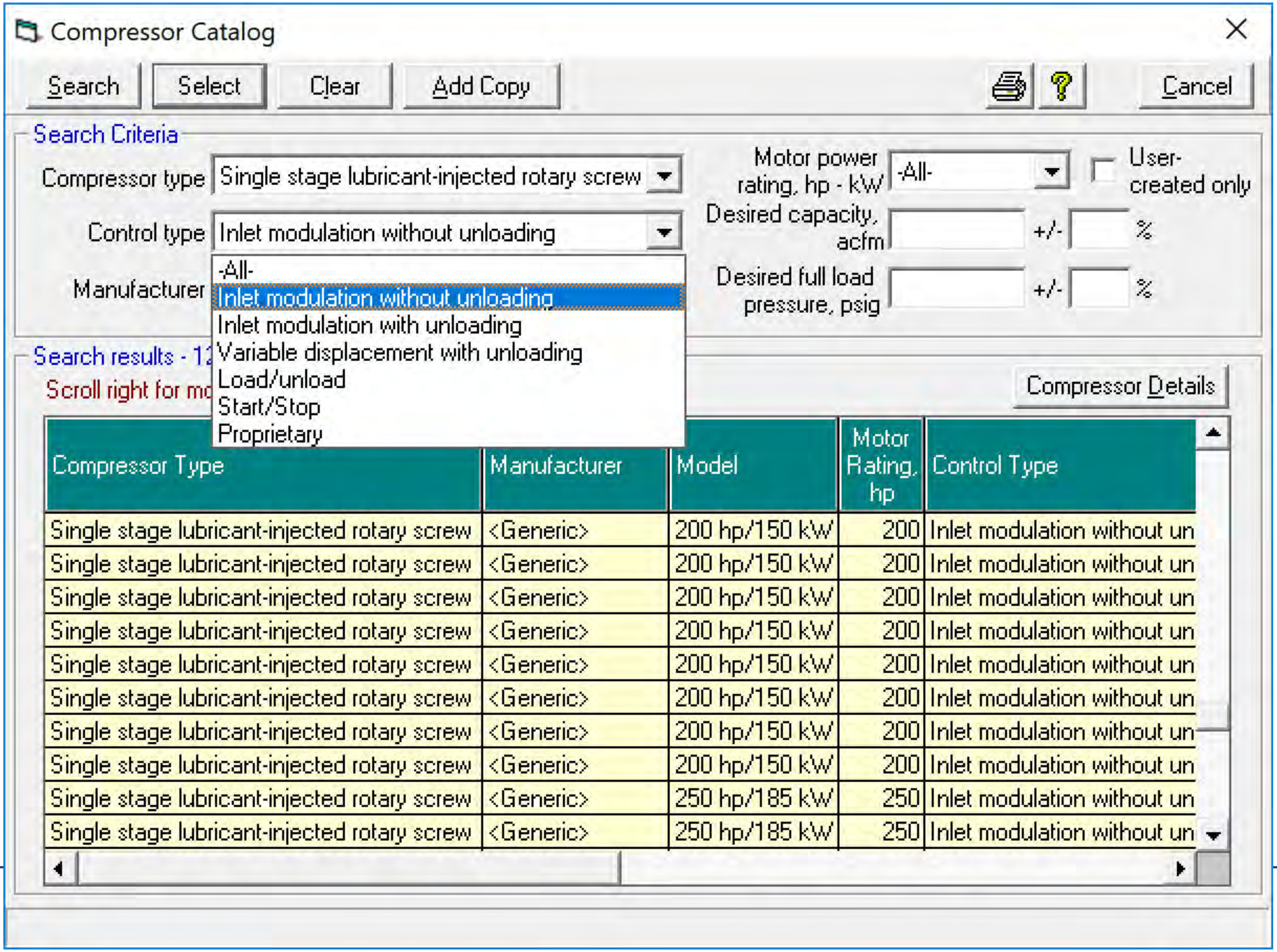
System Information



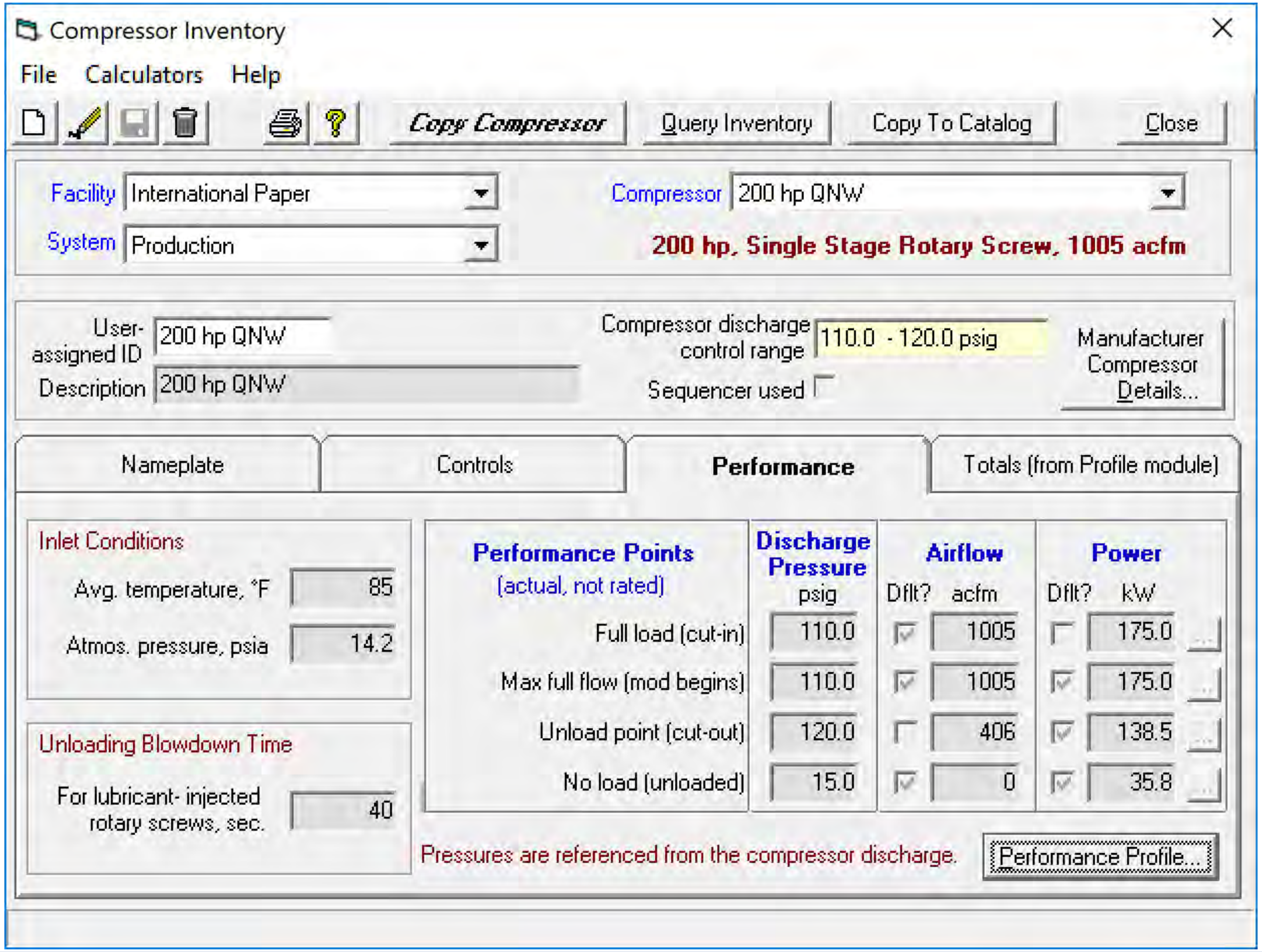
System Information Day Types



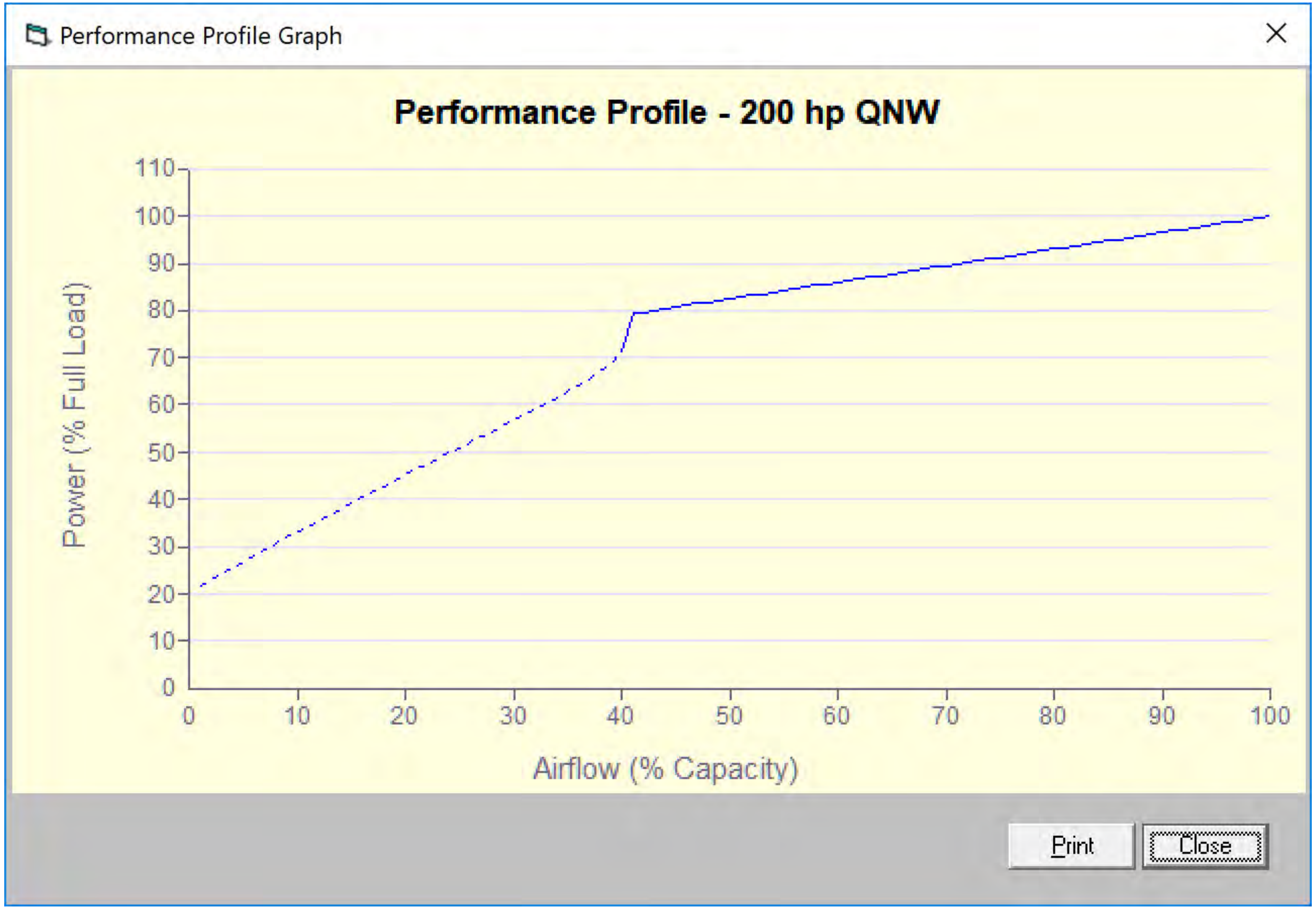
Compressor Information



Compressor Information



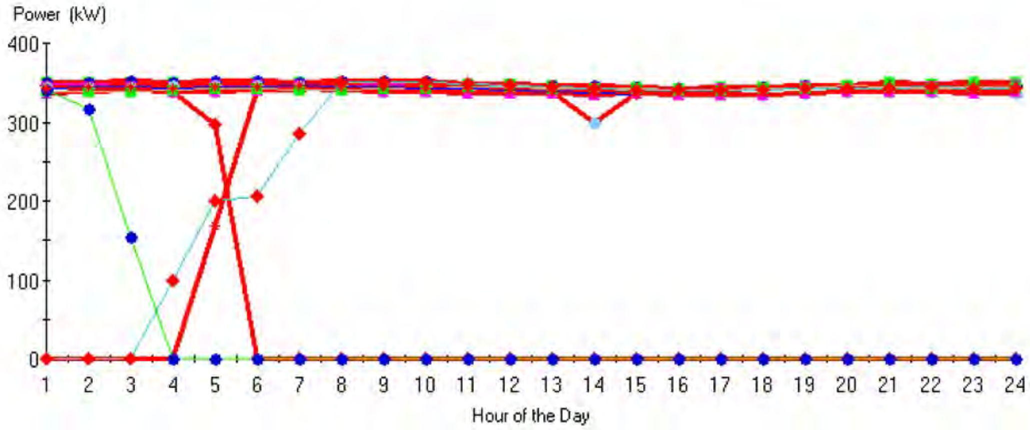
Compressor Information



Create the baseline from the Data

DayType Analysis

System: Not Assigned, Period: Not Assigned



Right click on data points to select day type. Left click to highlight the trace.

Click a date to highlight profile in graph.

Date	Day	Day Type
Jan-11-2018	Thu	Excluded Days
Jan-12-2018	Fri	Production
Jan-13-2018	Sat	Production
Jan-14-2018	Sun	Sunday
Jan-15-2018	Mon	Monday
Jan-16-2018	Tue	Production
Jan-17-2018	Wed	Production
Jan-18-2018	Thu	Production
Jan-19-2018	Fri	Production
Jan-20-2018	Sat	Production
Jan-21-2018	Sun	Excluded Days
Jan-22-2018	Mon	Excluded Days
Jan-23-2018	Tue	Excluded Days

Plot Day Type ... All Days

Remove Day Type...

Caution: Day profiles can be similar even though different equipment, e.g., compressors, is operating. Use Trend Plots to examine the details of equipment operation before determining whether days should be assigned to the same daytype.

Create System DayType Profiles | Copy Plot to ClipBoard | Copy Profiles to ClipBoard | Help

System DayType Profiles

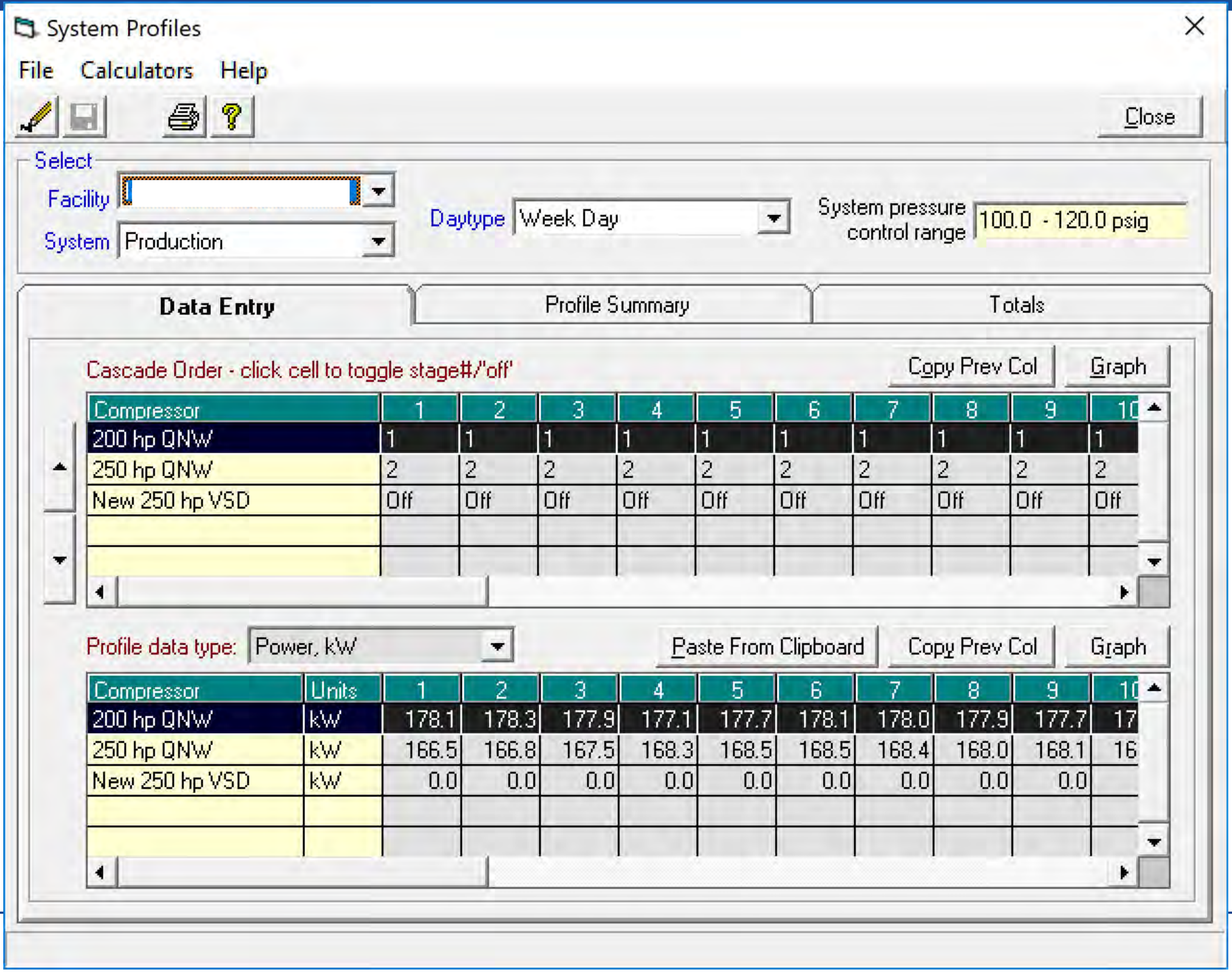
DayTypeName	ChannelName	Hr_01	Hr_02	Hr_03	Hr_04	Hr_05	Hr_06	Hr_07
Monday	200 QNW	0.00	0.00	0.00	0.00	84.55	175.88	177.13
Monday	250 QNW	0.00	0.00	0.00	0.00	83.80	164.18	163.56
Production	200 QNW	178.12	178.25	177.86	177.11	177.67	178.09	177.97
Production	250 QNW	166.54	166.81	167.49	168.31	168.50	168.50	168.40
Sunday	200 QNW	181.76	180.51	179.20	176.98	154.17	0.00	0.00
Sunday	250 QNW	165.56	163.78	162.43	161.83	143.08	0.00	0.00

Enter LogTool Data Into AIRMaster

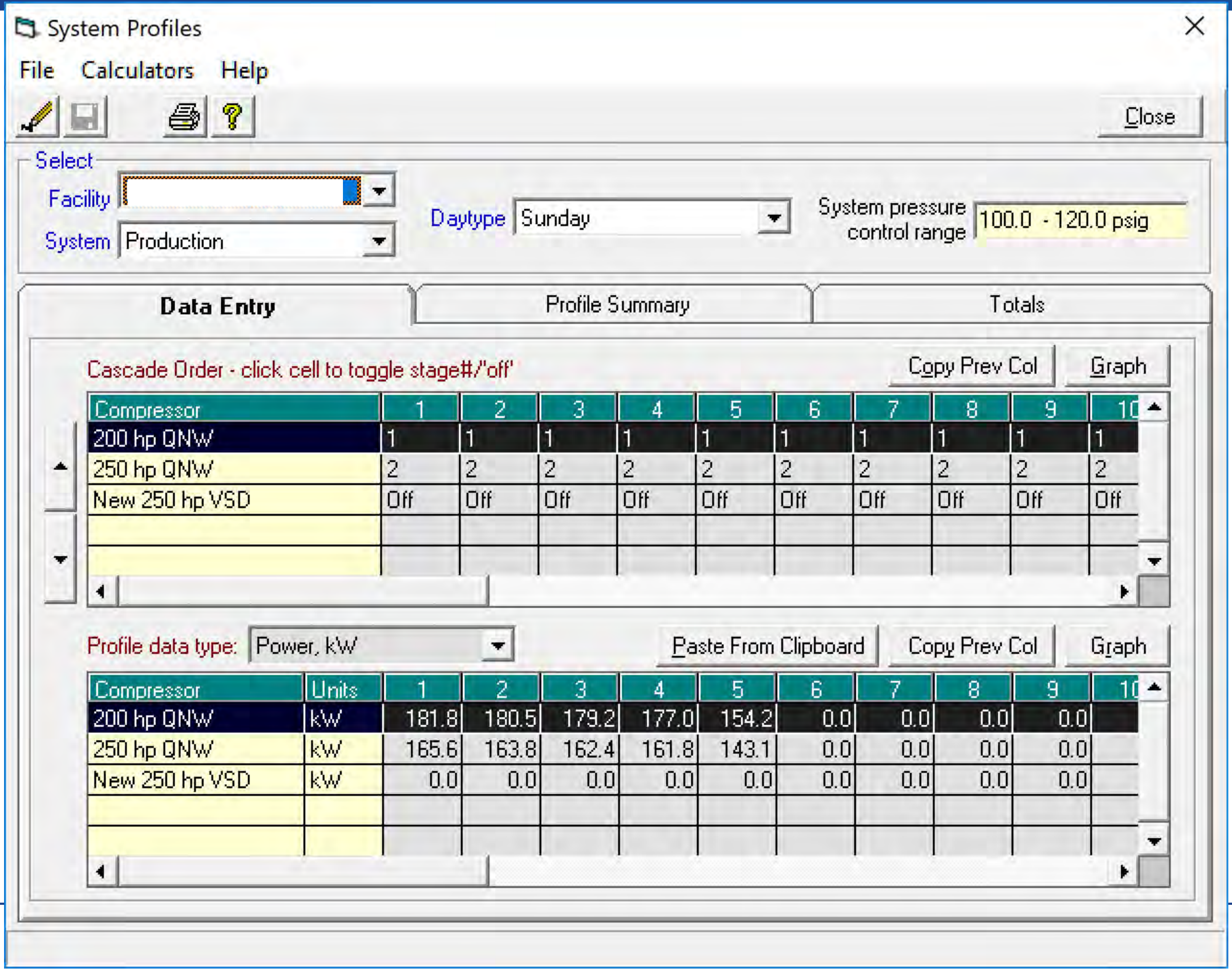
System	Type	Period	DayTypeNa	ChannelName	Hr_01	Hr_02	Hr_03	Hr_04	Hr_05	Hr_06	Hr_07	Hr_08	Hr_09	Hr_10	Hr_11	Hr_12	Hr_13	Hr_14	Hr_15	Hr_16	Hr_17	Hr_18	Hr_19	Hr_20	Hr_21	Hr_22	Hr_23	Hr_24
Not Assigne	Power	Not Assigne	Monday	200 QNW	0.0	0.0	0.0	0.0	84.6	175.9	177.1	181.6	182.2	180.8	177.2	177.7	177.0	178.6	178.7	178.7	176.9	177.0	178.2	177.2	178.7	179.6	180.1	179.3
Not Assigne	Power	Not Assigne	Monday	250 QNW	0.0	0.0	0.0	0.0	83.8	164.2	163.6	164.5	165.0	166.7	171.6	169.9	168.1	164.9	163.3	162.5	163.6	164.8	165.6	167.1	167.1	167.0	166.2	166.9
Not Assigne	Power	Not Assigne	Production	200 QNW	178.1	178.3	177.9	177.1	177.7	178.1	178.0	177.9	177.7	178.1	177.3	177.2	177.2	168.0	174.9	175.7	175.7	175.8	177.5	177.4	178.4	179.0	179.1	179.8
Not Assigne	Power	Not Assigne	Production	250 QNW	166.5	166.8	167.5	168.3	168.5	168.5	168.4	168.0	168.1	167.1	166.4	166.1	165.0	167.1	165.9	164.7	164.5	165.2	165.0	165.8	165.3	164.5	164.2	164.4
Not Assigne	Power	Not Assigne	Sunday	200 QNW	181.8	180.5	179.2	177.0	154.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Not Assigne	Power	Not Assigne	Sunday	250 QNW	165.6	163.8	162.4	161.8	143.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Date	Day	Day Type
Jan-11-201	Thu	Excluded Days
Jan-12-201	Fri	Production
Jan-13-201	Sat	Production
Jan-14-201	Sun	Sunday
Jan-15-201	Mon	Monday
Jan-16-201	Tue	Production
Jan-17-201	Wed	Production
Jan-18-201	Thu	Production
Jan-19-201	Fri	Production
Jan-20-201	Sat	Production
Jan-21-201	Sun	Excluded Days
Jan-22-201	Mon	Excluded Days
Jan-23-201	Tue	Excluded Days

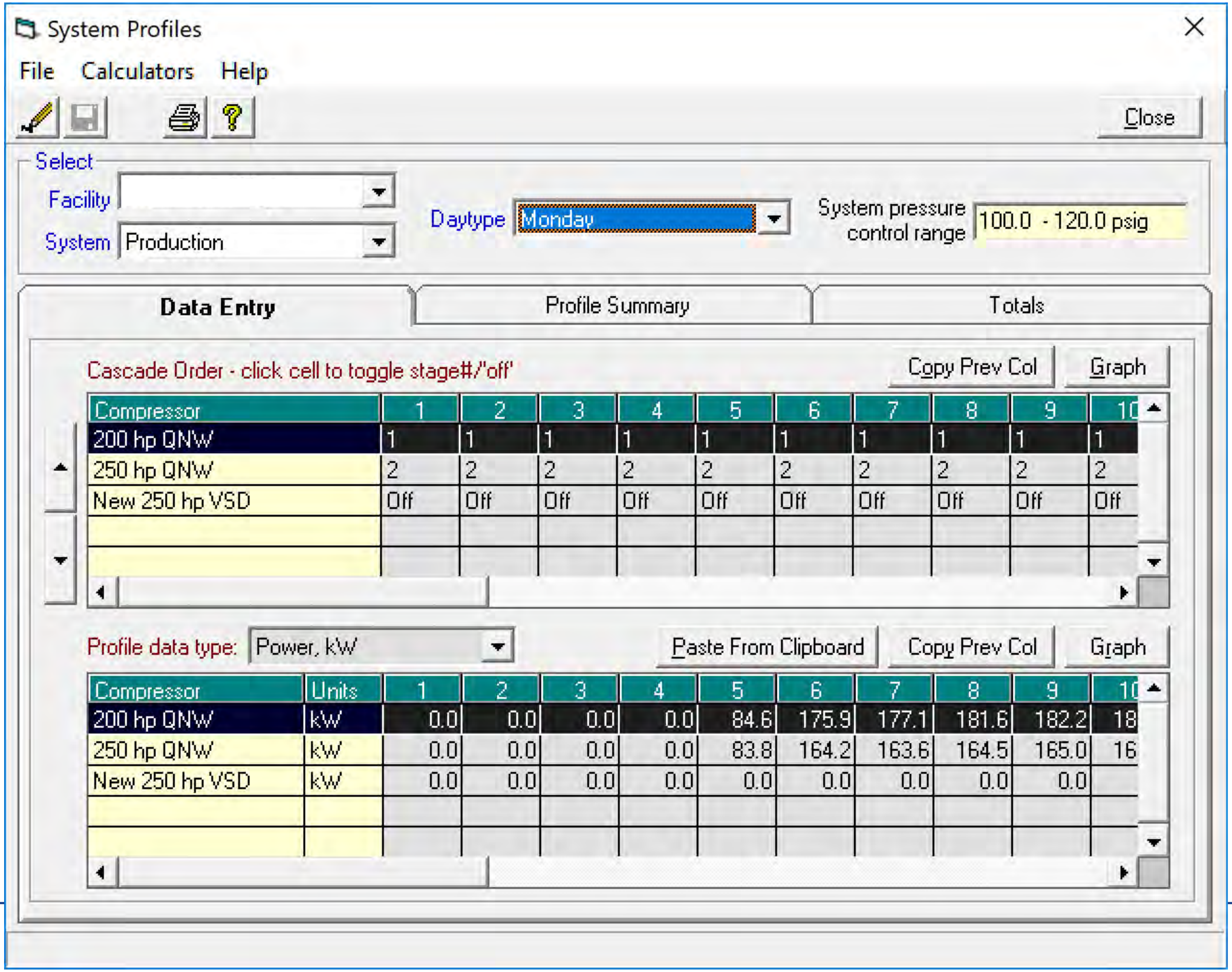
Enter LogTool Data Into AIRMaster



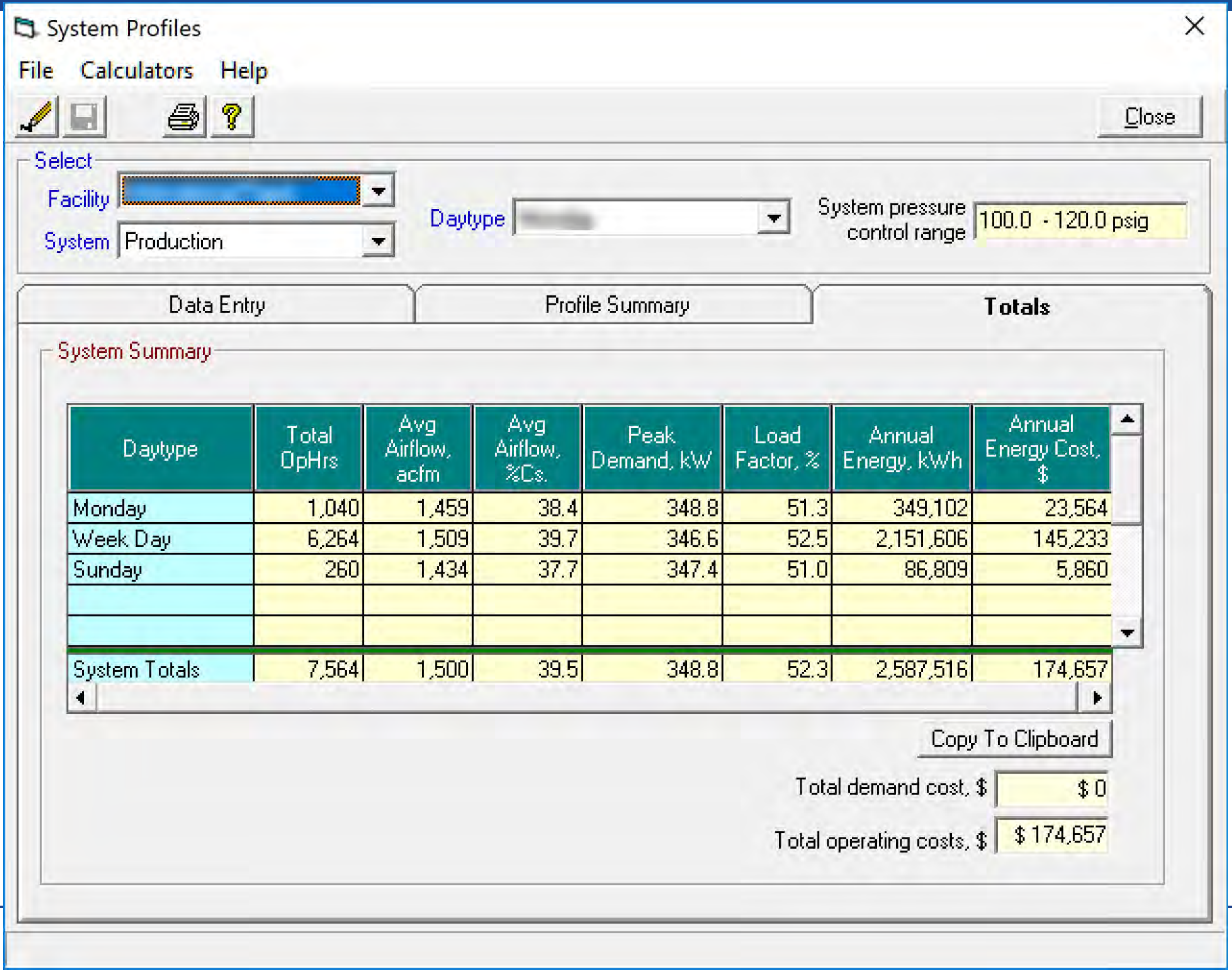
Enter LogTool Data Into AIRMaster



Enter LogTool Data Into AIRMaster

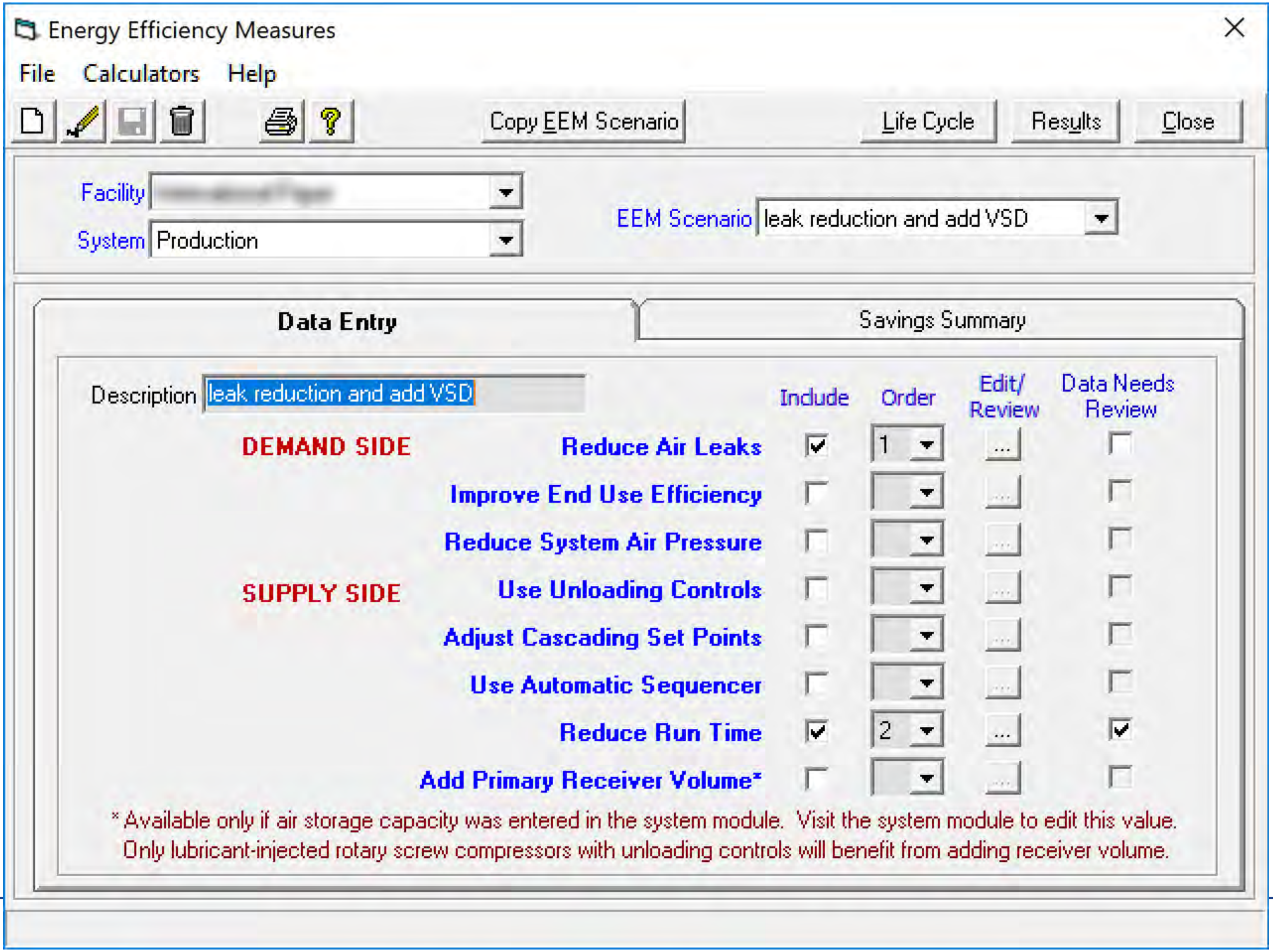


The Baseline



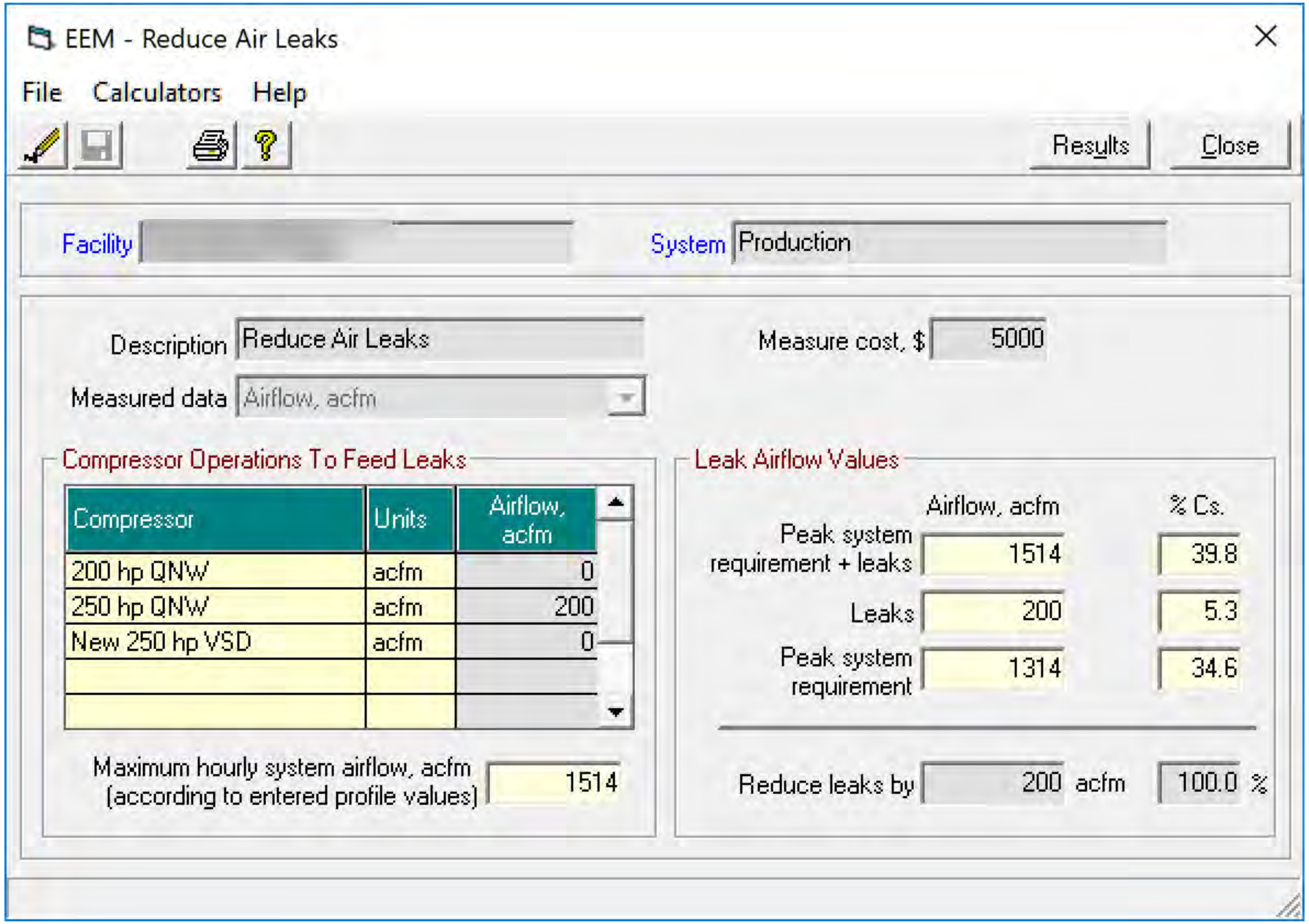
Daytype	Total OpHrs	Avg Airflow, acfm	Avg Airflow, %Cs.	Peak Demand, kW	Load Factor, %	Annual Energy, kWh	Annual Energy Cost, $
Monday	1,040	1,459	38.4	348.8	51.3	349,102	23,564
Week Day	6,264	1,509	39.7	346.6	52.5	2,151,606	145,233
Sunday	260	1,434	37.7	347.4	51.0	86,809	5,860
System Totals	7,564	1,500	39.5	348.8	52.3	2,587,516	174,657

EEM's



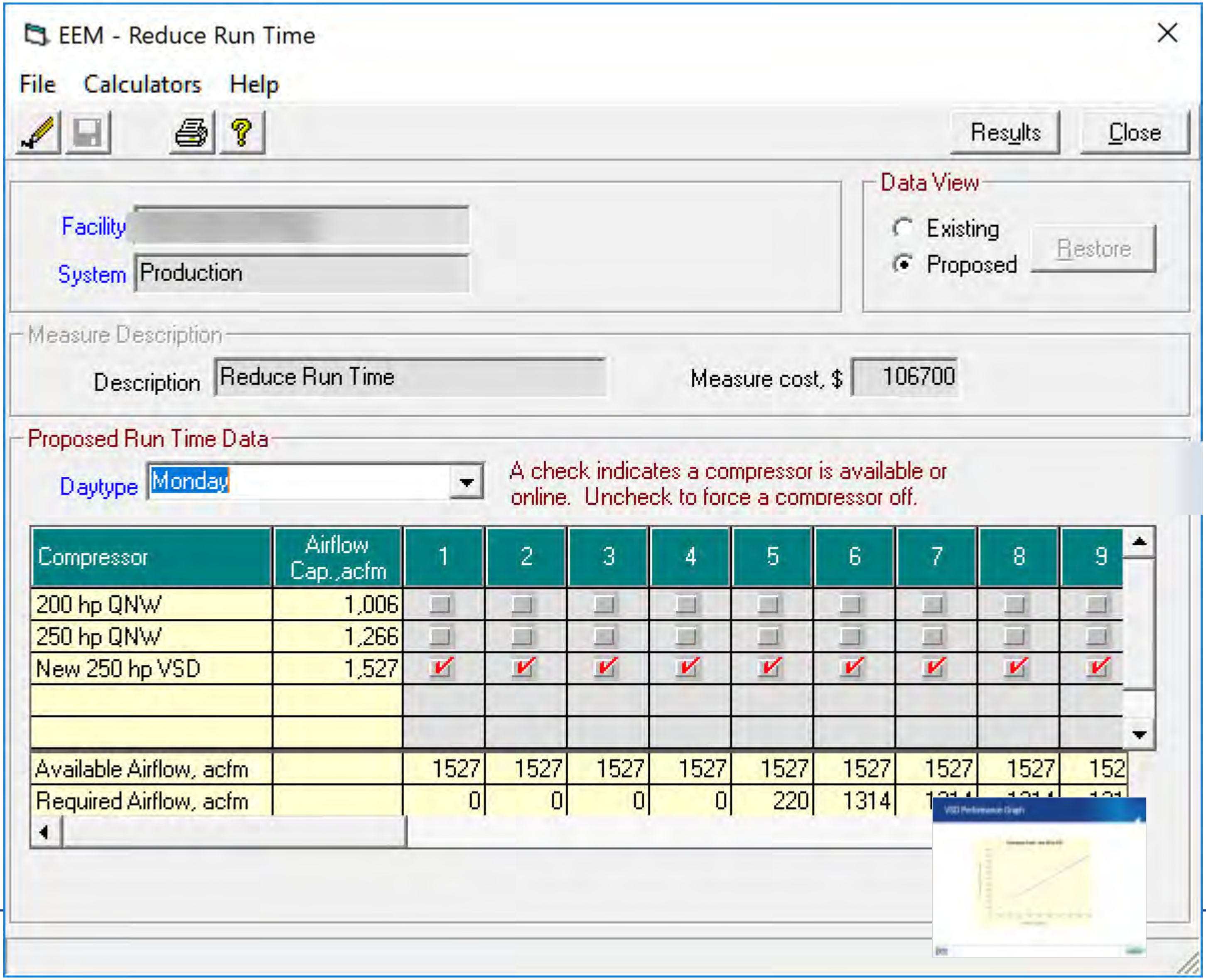
Energy Efficiency Measures
File
Calculators
Help
Copy EEM Scenario
Life Cycle
Results
Close
Facility
System
Production
EEM Scenario
leak reduction and add VSD
Data Entry
Savings Summary
Description
leak reduction and add VSD
Include
Order
Edit/ Review
Data Needs Review
DEMAND SIDE
Reduce Air Leaks
1
Improve End Use Efficiency
Reduce System Air Pressure
SUPPLY SIDE
Use Unloading Controls
Adjust Cascading Set Points
Use Automatic Sequencer
Reduce Run Time
2
Add Primary Receiver Volume*
* Available only if air storage capacity was entered in the system module. Visit the system module to edit this value.
Only lubricant-injected rotary screw compressors with unloading controls will benefit from adding receiver volume.

EEM’s



EEM - Reduce Air Leaks
File
Calculators
Help
Results
Close
Facility
System
Production
Description
Reduce Air Leaks
Measure cost, $
5000
Measured data
Airflow, acfm
Compressor Operations To Feed Leaks
Compressor
Units
Airflow, acfm
200 hp QNW
acfm
0
250 hp QNW
acfm
200
New 250 hp VSD
acfm
0
Maximum hourly system airflow, acfm (according to entered profile values)
1514
Leak Airflow Values
Airflow, acfm
% Cs.
Peak system requirement + leaks
1514
39.8
Leaks
200
5.3
Peak system requirement
1314
34.6
Reduce leaks by
200
acfm
100.0
%

EEM’s


EEM - Reduce Run Time
File
Calculators
Help
Results
Close
Data View
Existing
Proposed
Restore
Facility
System
Production
Measure Description
Description
Reduce Run Time
Measure cost, $
106700
Proposed Run Time Data
Daytype
Monday
A check indicates a compressor is available or online. Uncheck to force a compressor off.
Compressor
Airflow Cap.,acfm
1
2
3
4
5
6
7
8
9
200 hp QNW
1,006
250 hp QNW
1,266
New 250 hp VSD
1,527
Available Airflow, acfm
1527
1527
1527
1527
1527
1527
1527
1527
152
Required Airflow, acfm
0
0
0
0
220
1314

EEM's

Energy Efficiency Measures

File Calculators Help

Copy EEM Scenario | Life Cycle | Results | Close

Facility: International Paper

System: Production

EEM Scenario: leak reduction and add VSD

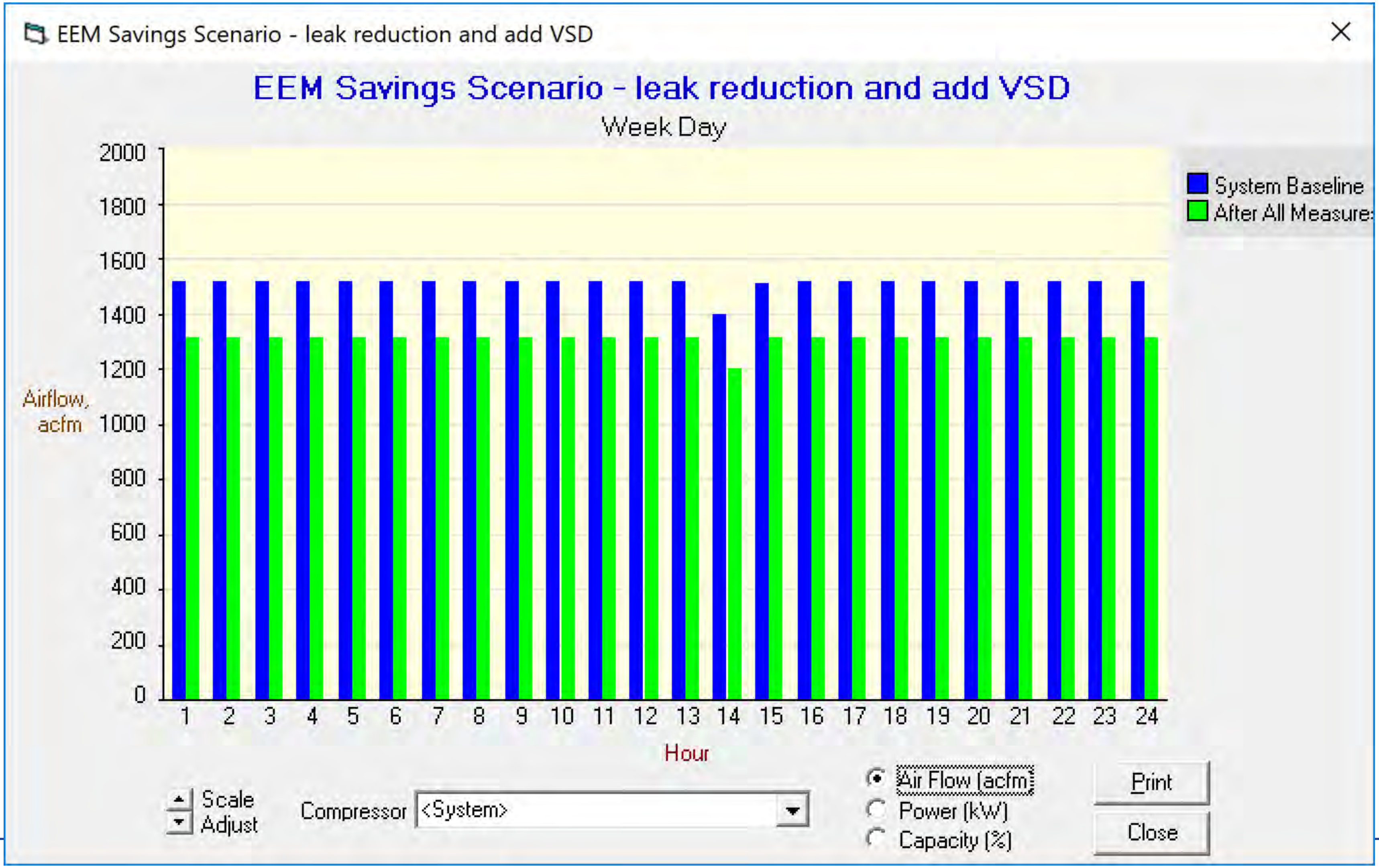
Data Entry | **Savings Summary**

Description	Energy Savings, kWh	Energy Savings, $	Energy Savings, %	Demand Savings, kW	Demand Savings, $	Installed Cost, $	Total Savings, $	Simple Payback, years
Reduce Air Leaks	457,487	30,880	17.7	64.1	0	5,000	30,880	0.2
Reduce Run Time	484,848	32,727	18.7	64.9	0	106,700	32,727	3.3
TOTALS	942,335	63,608	36.4	129.0	0	111,700	63,608	1.8

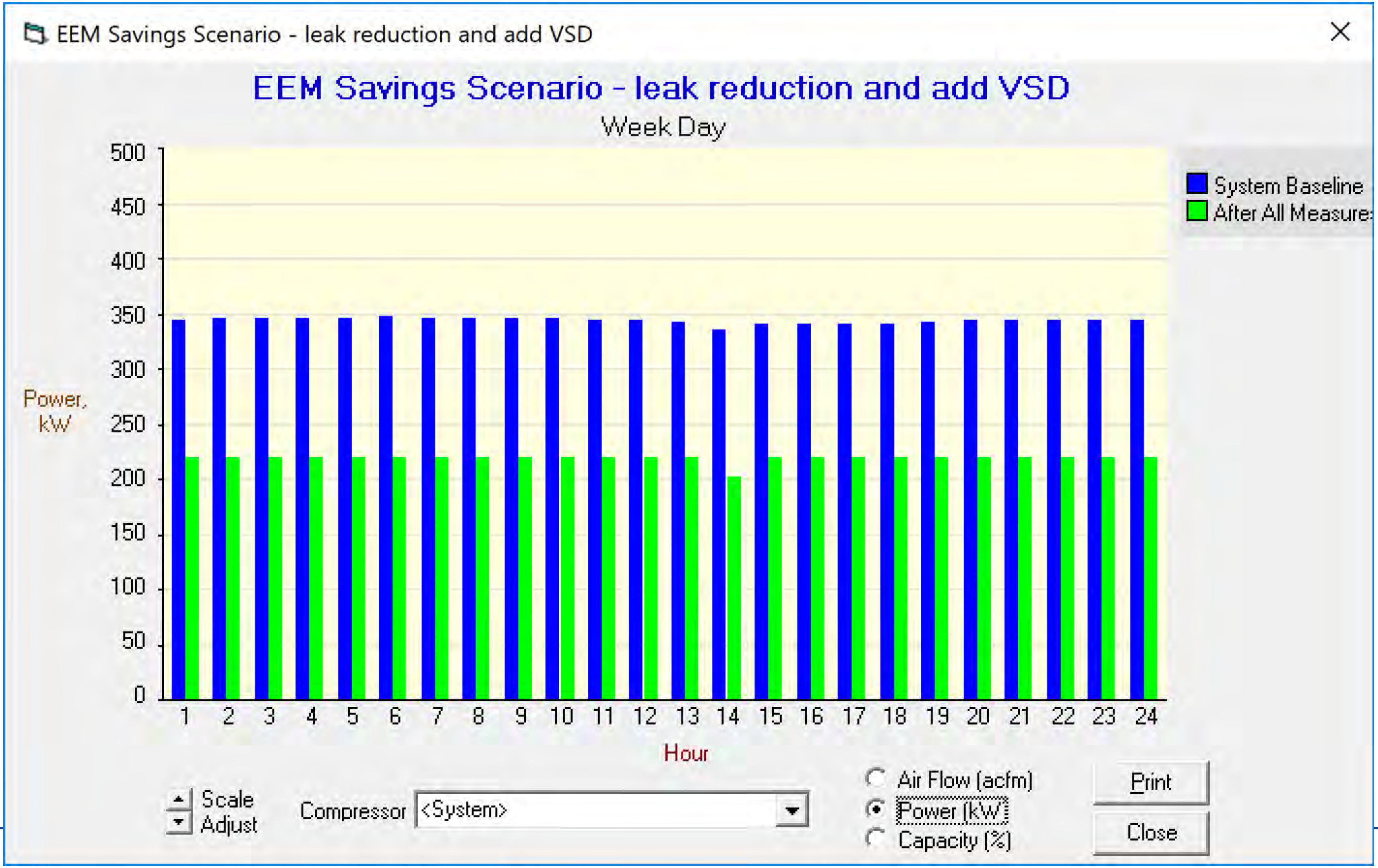
Double-click row to view corresponding measure input data

Copy To Clipboard

Bar Graphs

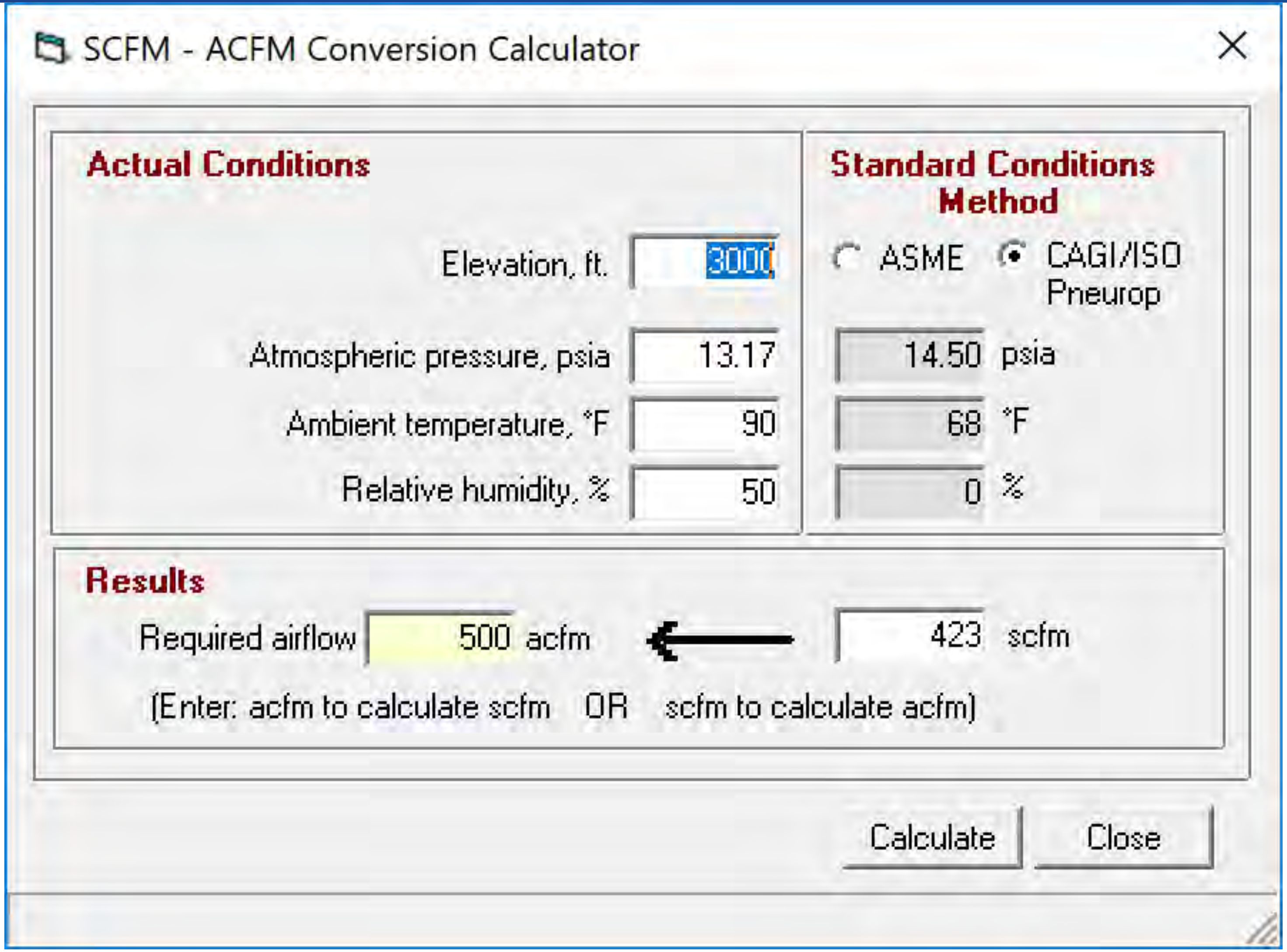

EEM Savings Scenario - leak reduction and add VSD
EEM Savings Scenario - leak reduction and add VSD
Week Day
System Baseline
After All Measures
Airflow, acfm
2000
1800
1600
1400
1200
1000
800
600
400
200
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Hour
Scale Adjust
Compressor
<System>
Air Flow (acfm)
Power (kW)
Capacity (%)
Print
Close

Bar Graphs

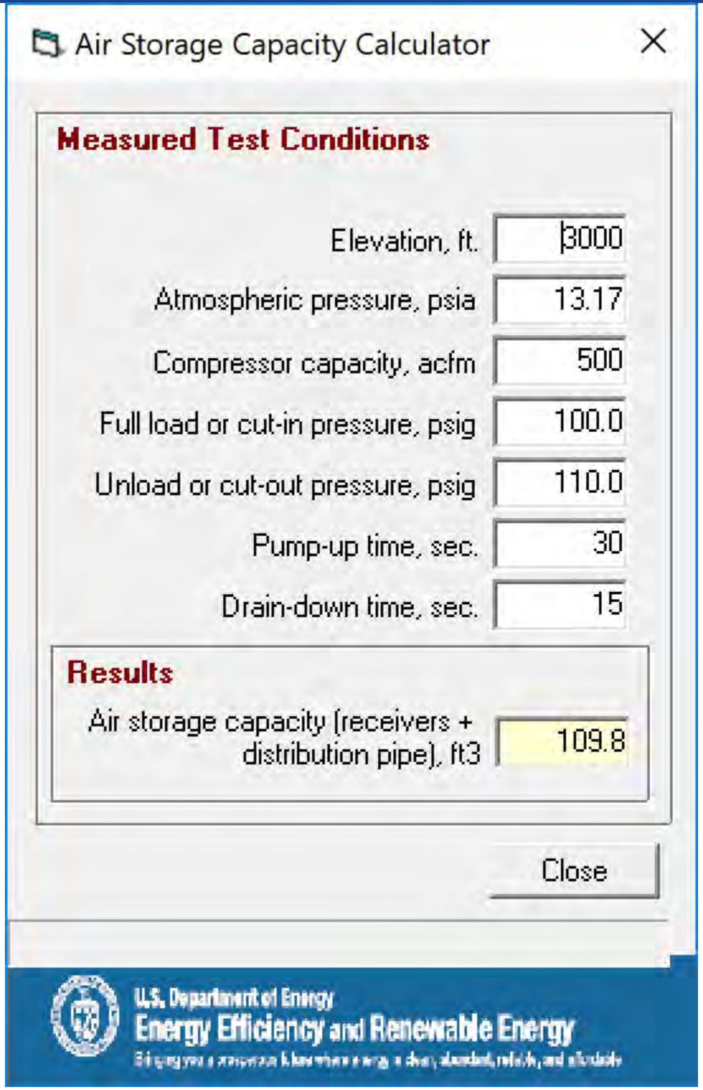


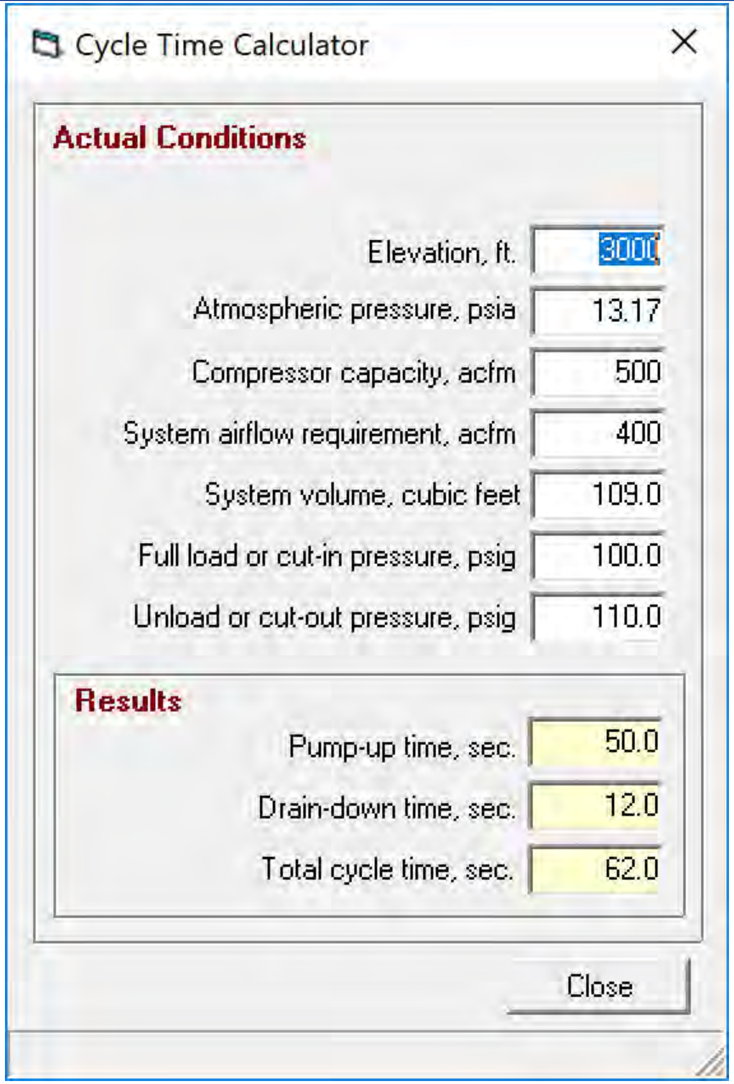
EEM Savings Scenario - leak reduction and add VSD
EEM Savings Scenario - leak reduction and add VSD
Week Day
500
450
400
350
300
250
200
150
100
50
0
Power, kW
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Hour
System Baseline
After All Measures
Scale Adjust
Compressor
<System>
Air Flow (acfm)
Power (kW)
Capacity (%)
Print
Close

Calculators



Calculators

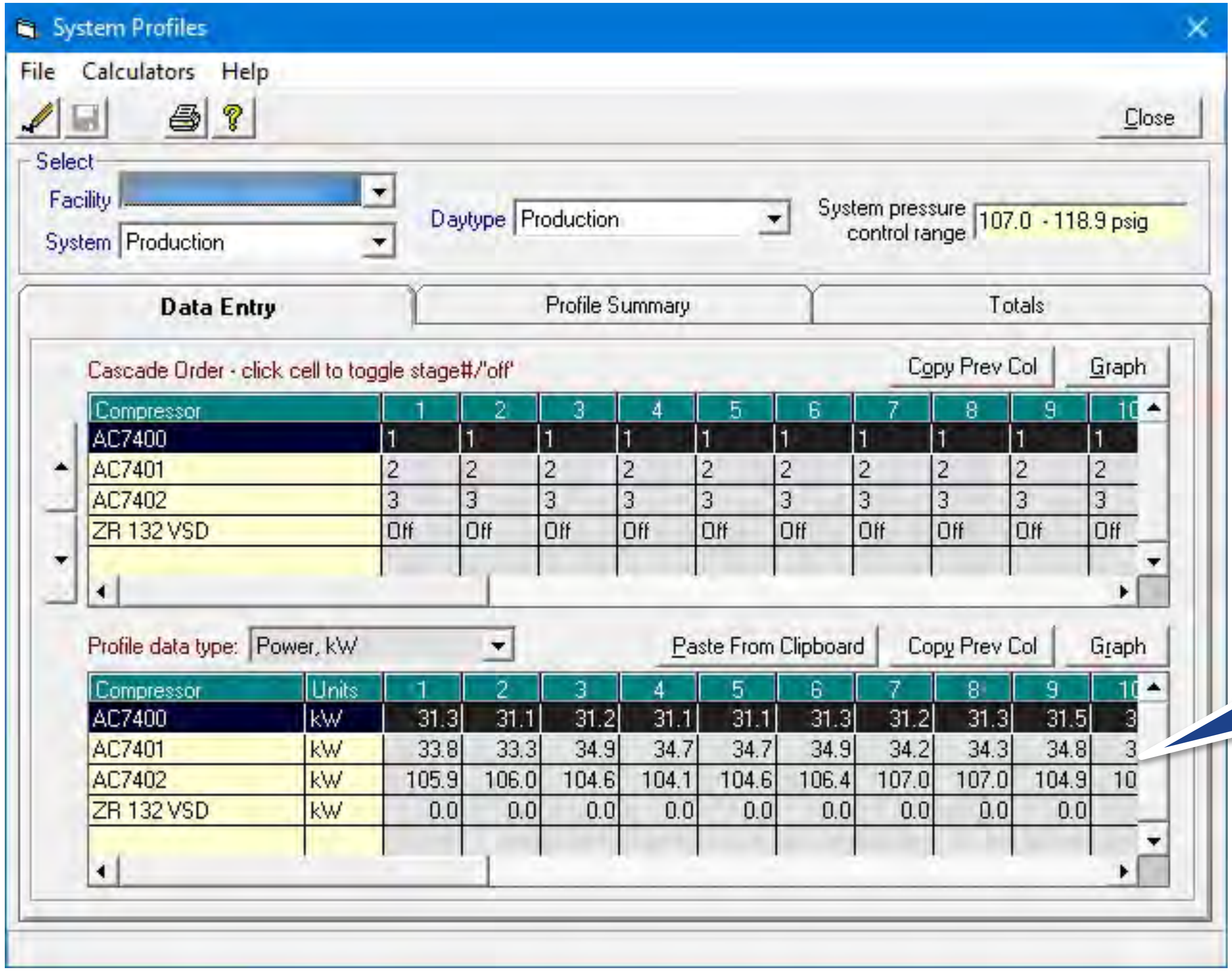




Performance Profile Graph

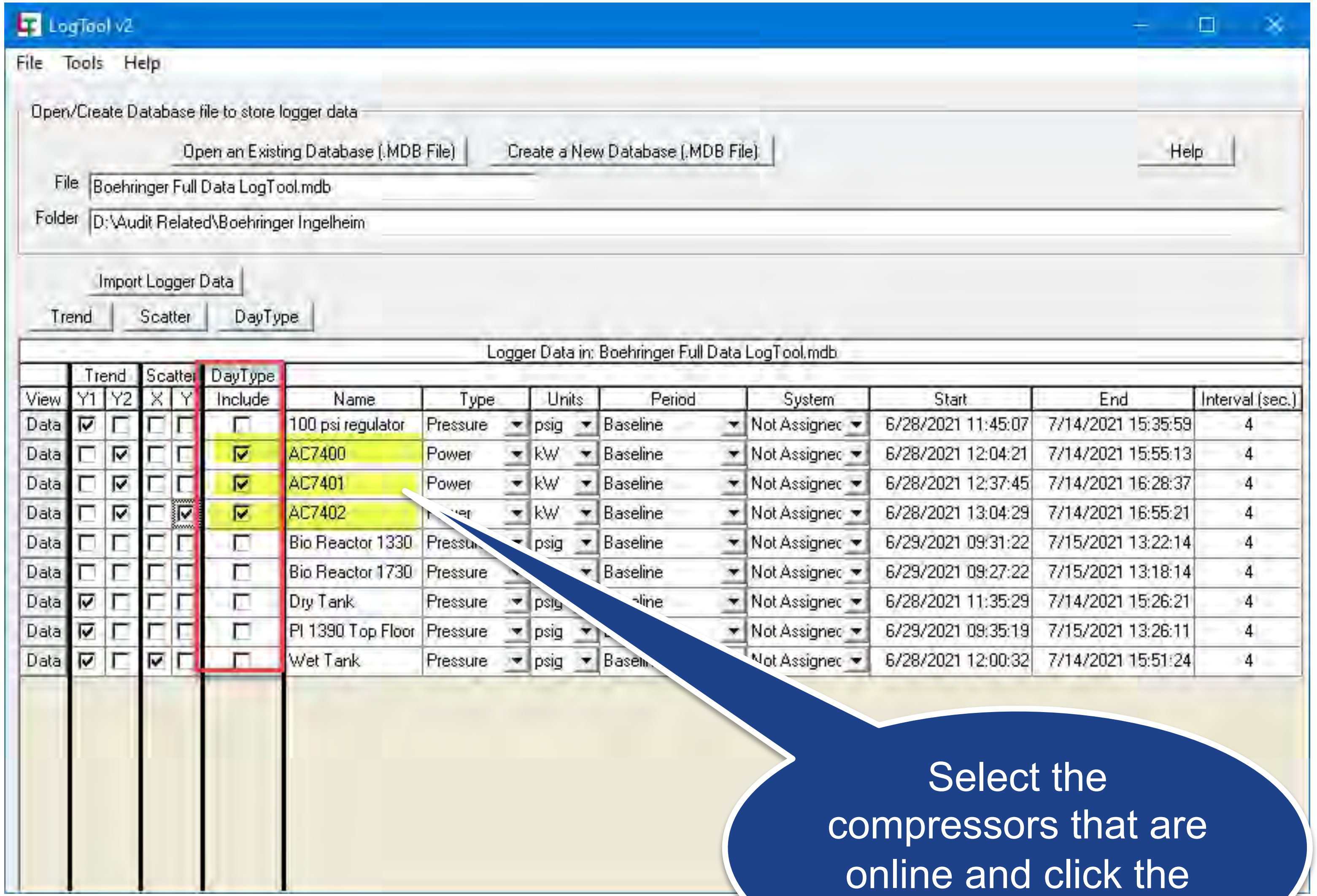
VSD Performance Graph

Another Airmaster+ Example Profile Data



Where did this data come from?

Another Airmaster+ Example Day Type From Log Tool

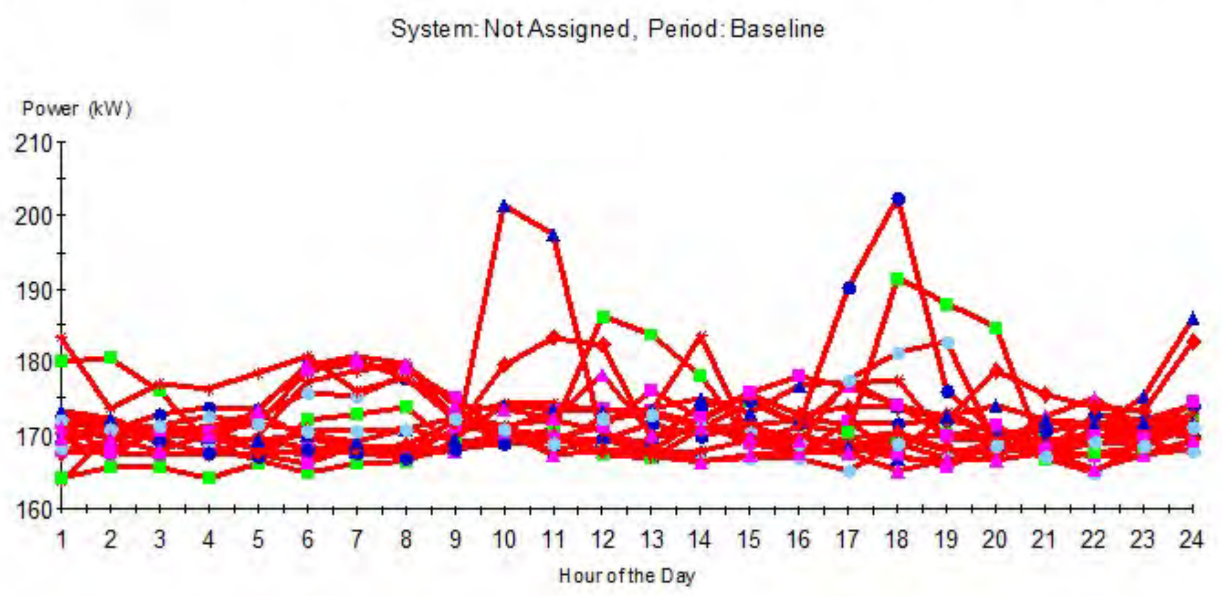


Select the compressors that are online and click the Day Type Button

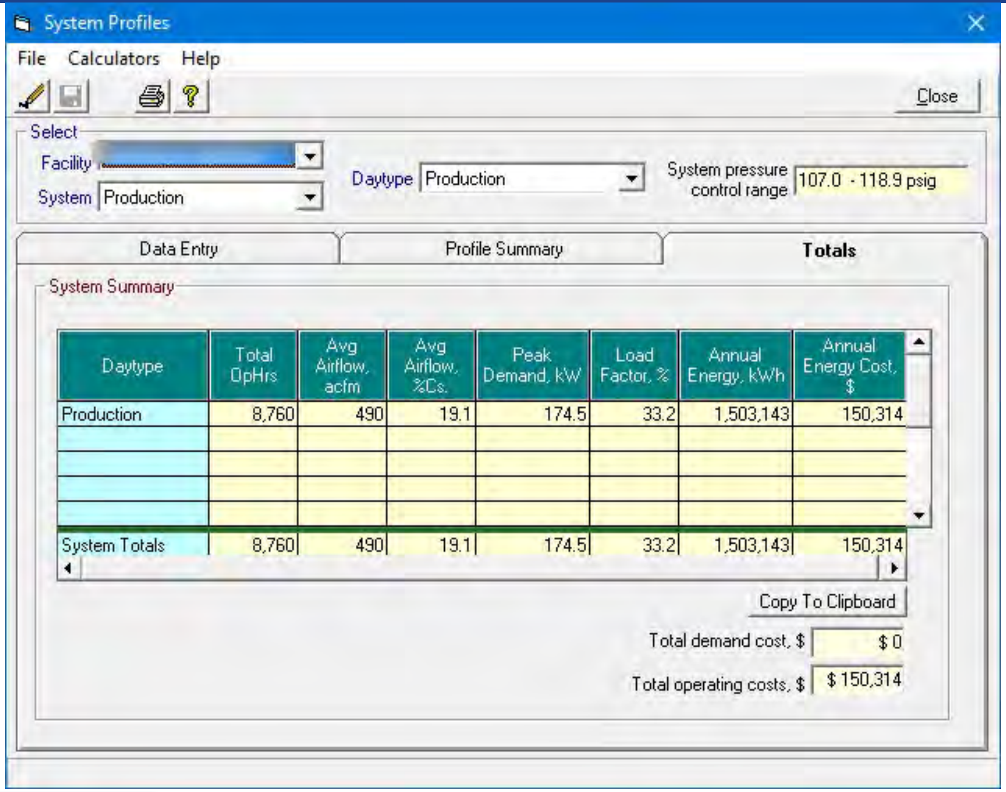
Another Airmaster+ Example

System	Type	Period	DayTypeName	ChannelName	Hr_01	Hr_02	Hr_03	Hr_04	Hr_05	Hr_06	Hr_07	Hr_08	Hr_09	Hr_10	Hr_11	Hr_12	Hr_13	Hr_14	Hr_15	Hr_16	Hr_17	Hr_18	Hr_19	Hr_20	Hr_21	Hr_22	Hr_23	Hr_24
Not Assigi	Power	Baseline	Production	AC7400	31.3	31.1	31.2	31.1	31.1	31.3	31.2	31.3	31.5	31.7	31.4	31.1	30.6	31.3	30.9	30.8	31.6	32.4	31.6	31.2	30.9	31.1	31.3	31.7
Not Assigi	Power	Baseline	Production	AC7401	33.8	33.3	34.9	34.7	34.7	34.9	34.2	34.3	34.8	34.1	33.9	34.5	33.4	34.0	34.0	34.5	34.0	33.5	32.7	34.1	33.7	34.0	35.0	34.6
Not Assigi	Power	Baseline	Production	AC7402	105.9	106.0	104.6	104.1	104.6	106.4	107.0	107.0	104.9	107.7	107.7	107.1	107.1	106.4	106.2	105.1	107.1	108.6	107.5	105.9	105.0	104.9	104.3	106.8

Date	Day	Day Type
Jun-28-20	Mon	Production
Jun-29-20	Tue	Production
Jun-30-20	Wed	Production
Jul-01-202	Thu	Production
Jul-02-202	Fri	Production
Jul-03-202	Sat	Production
Jul-04-202	Sun	Production
Jul-05-202	Mon	Production
Jul-06-202	Tue	Production
Jul-07-202	Wed	Production
Jul-08-202	Thu	Production
Jul-09-202	Fri	Production
Jul-10-202	Sat	Production
Jul-11-202	Sun	Production
Jul-12-202	Mon	Production
Jul-13-202	Tue	Production
Jul-14-202	Wed	Production

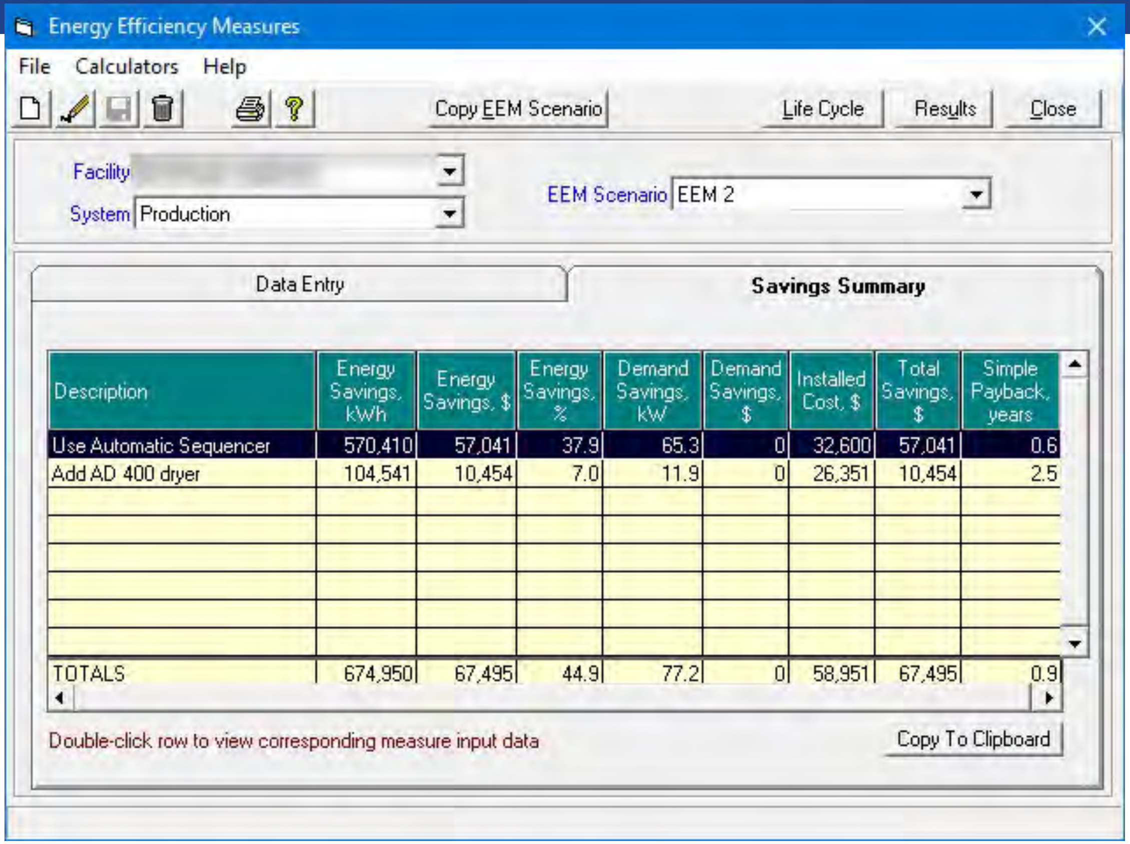


Another Airmaster+ Example



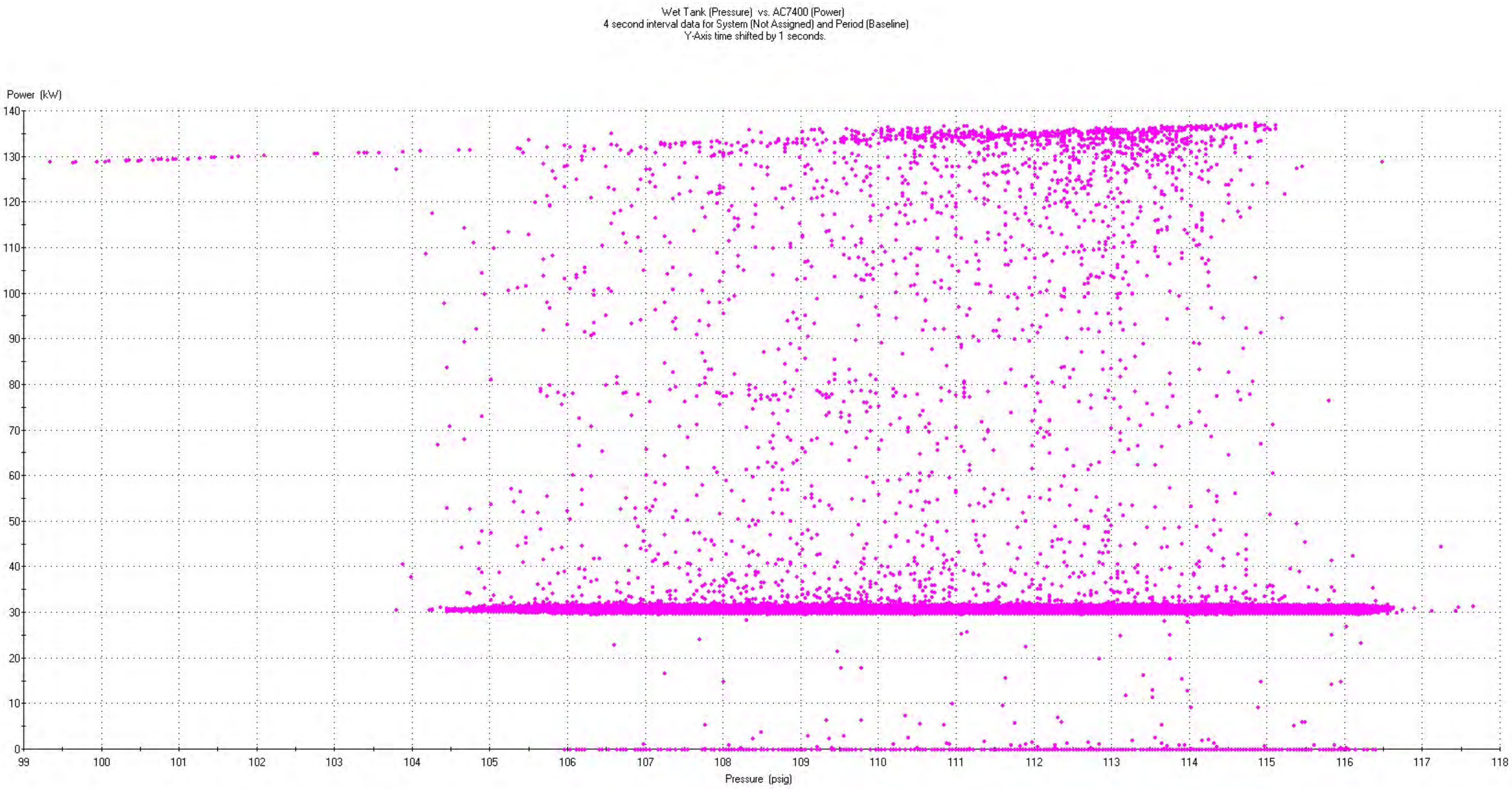
Compressed Air Baseline Energy using $0.10/kWh							
Daytype	Total OpHrs	Avg Airflow, acfm	Avg Airflow, %Cs.	Peak Demand, kW	Load Factor, %	Annual Energy, kWh	Annual Energy Cost, $
Production	8,760	490	19.1	174.5	33.2	1,503,143	$150,314
System Totals	**8,760**	**490**	**19.1**	**174.50**	**33.2**	**1,503,143**	**$150,314**

Another Airmaster+ Example

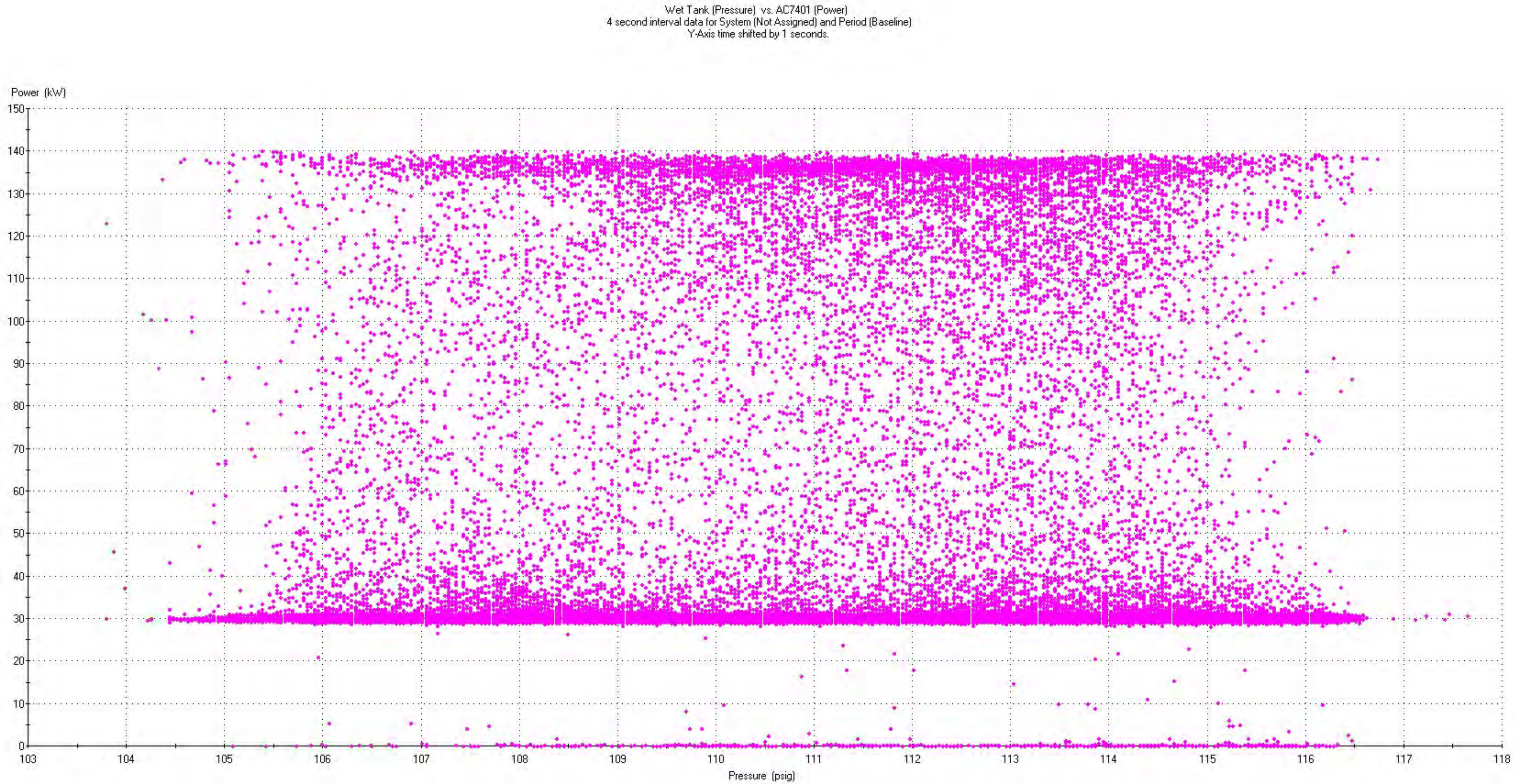


EEM -- Sequence Compressors purchase AD400 dryer							
Description	Energy Savings, kWh	Energy Savings, $	Energy Savings, %	Demand Savings, kW	Installed Cost, $	Total Savings, $	Simple Payback, years
Use Automatic Sequencer	570,410	$57,041.00	37.9	65.3	$32,600.00	$57,041.00	0.6
Add AD 400 dryer	104,541	$10,454.00	7	11.9	$26,351.00	$10,454.00	2.5
TOTALS	**674,950**	**$67,495.00**	**44.9**	**77.2**	**$58,951.00**	**$67,495.00**	**0.9**

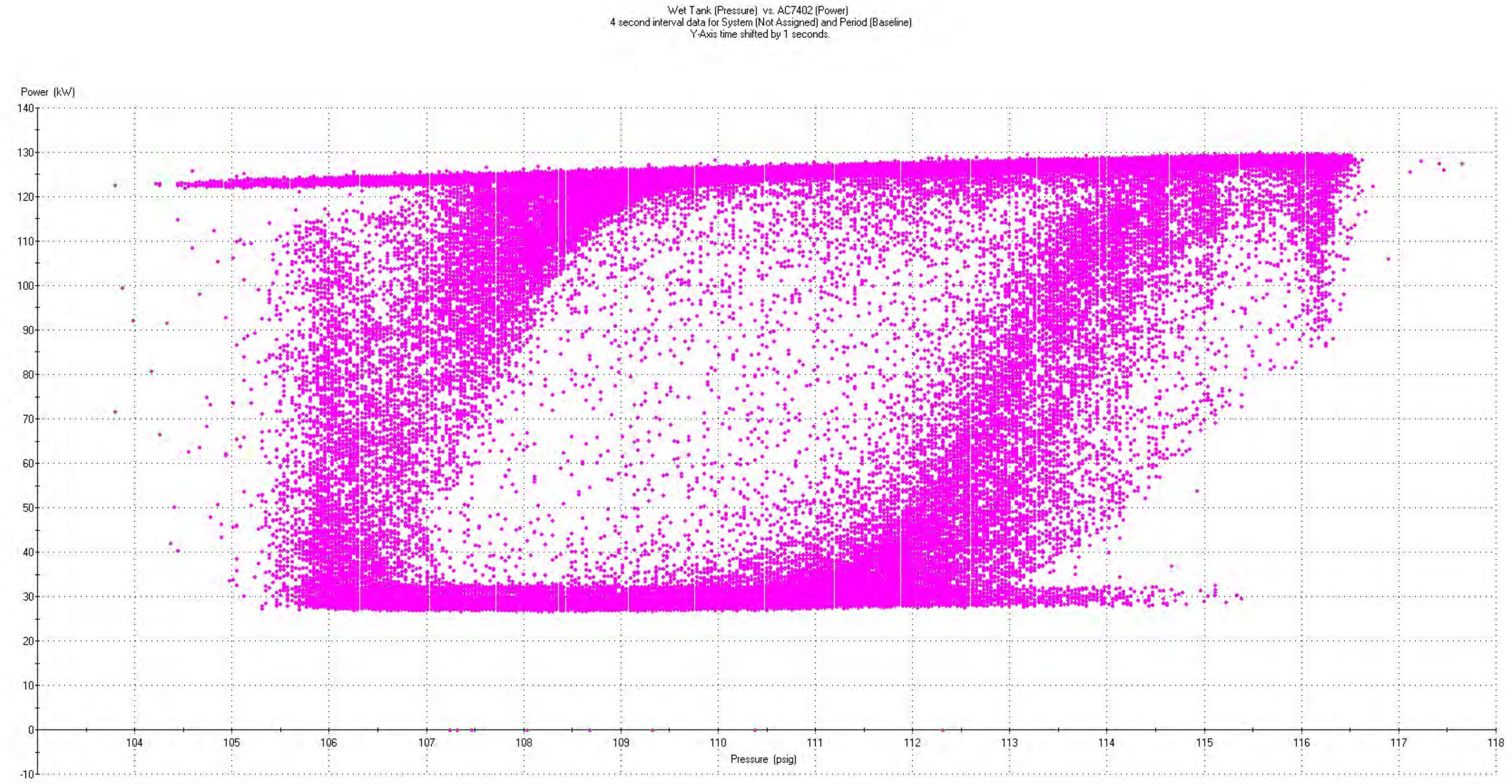
LogTool Scatter Plot



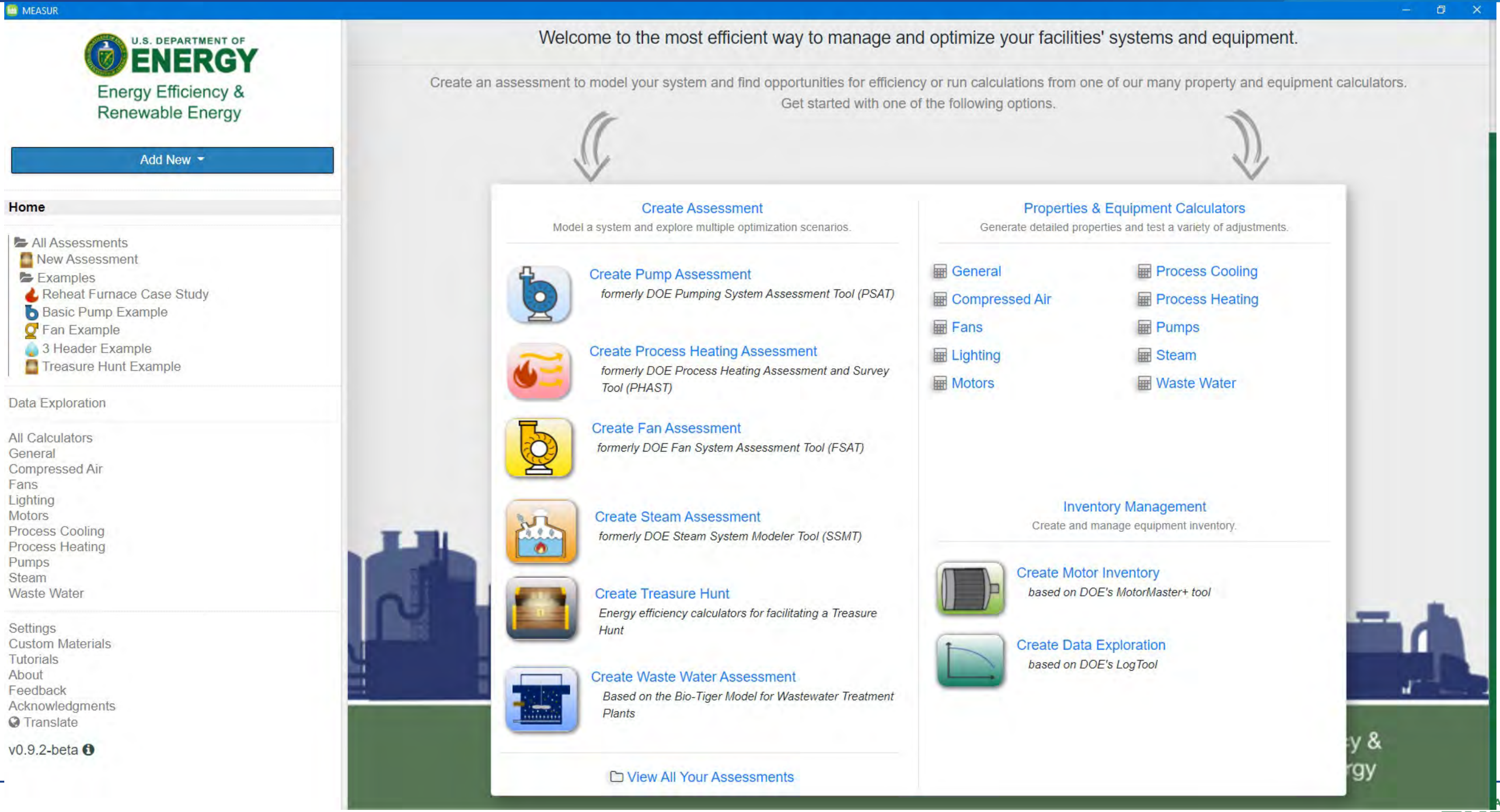
LogTool Scatter Plot



LogTool Scatter Plot



MEASUR Tool


MEASUR
U.S. DEPARTMENT OF ENERGY
Energy Efficiency & Renewable Energy
Add New
Home
All Assessments
New Assessment
Examples
Reheat Furnace Case Study
Basic Pump Example
Fan Example
3 Header Example
Treasure Hunt Example
Data Exploration
All Calculators
General
Compressed Air
Fans
Lighting
Motors
Process Cooling
Process Heating
Pumps
Steam
Waste Water
Settings
Custom Materials
Tutorials
About
Feedback
Acknowledgments
Translate
v0.9.2-beta
Welcome to the most efficient way to manage and optimize your facilities' systems and equipment.
Create an assessment to model your system and find opportunities for efficiency or run calculations from one of our many property and equipment calculators.
Get started with one of the following options.
Create Assessment
Model a system and explore multiple optimization scenarios.
Create Pump Assessment
formerly DOE Pumping System Assessment Tool (PSAT)
Create Process Heating Assessment
formerly DOE Process Heating Assessment and Survey Tool (PHAST)
Create Fan Assessment
formerly DOE Fan System Assessment Tool (FSAT)
Create Steam Assessment
formerly DOE Steam System Modeler Tool (SSMT)
Create Treasure Hunt
Energy efficiency calculators for facilitating a Treasure Hunt
Create Waste Water Assessment
Based on the Bio-Tiger Model for Wastewater Treatment Plants
View All Your Assessments
Properties & Equipment Calculators
Generate detailed properties and test a variety of adjustments.
General
Compressed Air
Fans
Lighting
Motors
Process Cooling
Process Heating
Pumps
Steam
Waste Water
Inventory Management
Create and manage equipment inventory.
Create Motor Inventory
based on DOE's MotorMaster+ tool
Create Data Exploration
based on DOE's LogTool

MEASUR Tool

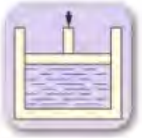
Compressed Air Calculators

Compressed Air Reduction
This calculator is used to quantify the energy savings associated with reducing compressed air usage.

Compressed Air Pressure Reduction
This calculator is used to quantify the energy savings associated with reducing compressed air system pressure.

Actual to Standard Airflow
The calculator converts ACFM (Actual cubic feet per minute) to SCFM (Standard cubic feet per minute) and vice versa for the given conditions using either ASME standard conditions or CAGI/ISO standard conditions.

Leak Loss Estimator - Bag Method
Estimates the leakage losses in a compressed air system using the bag method



Pneumatic Air Requirement
Estimate the quantity of air required by a specific single acting or a double acting piston cylinder compressor

Compressed Air - Leak Survey
Used to quantify the energy savings associated with reducing compressed air leaks.

MEASUR Tool

Receiver Tank Sizing
Calculate the required size of the receiver tank

Usable Air Capacity
Estimate the quantity of compressed air that is available for use

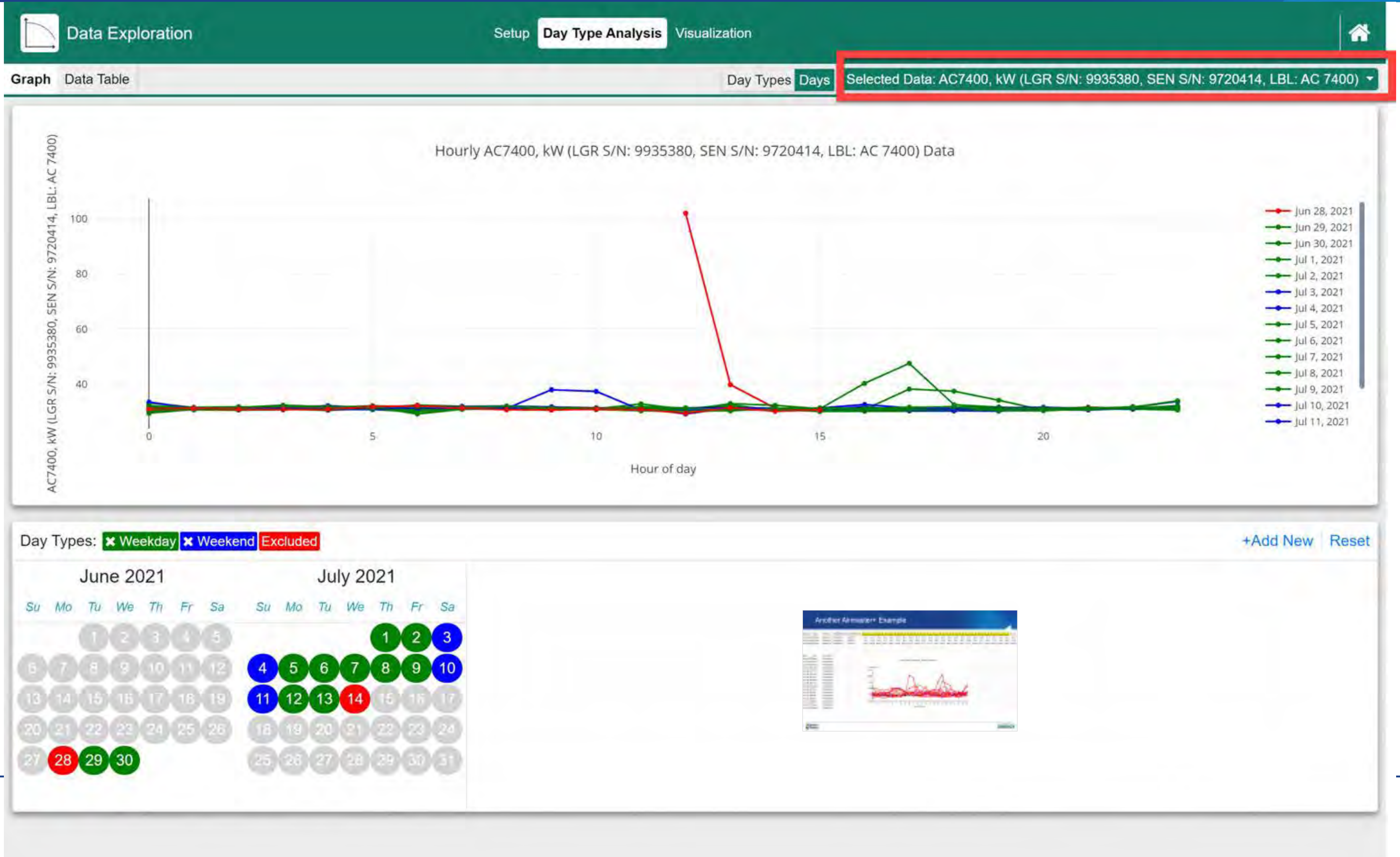
Pipe Sizing
Determine pipe diameter when the volumetric flow velocity, pressure, and design velocity are known

Velocity in the Piping
Estimate the velocity of compressed air throughout system piping

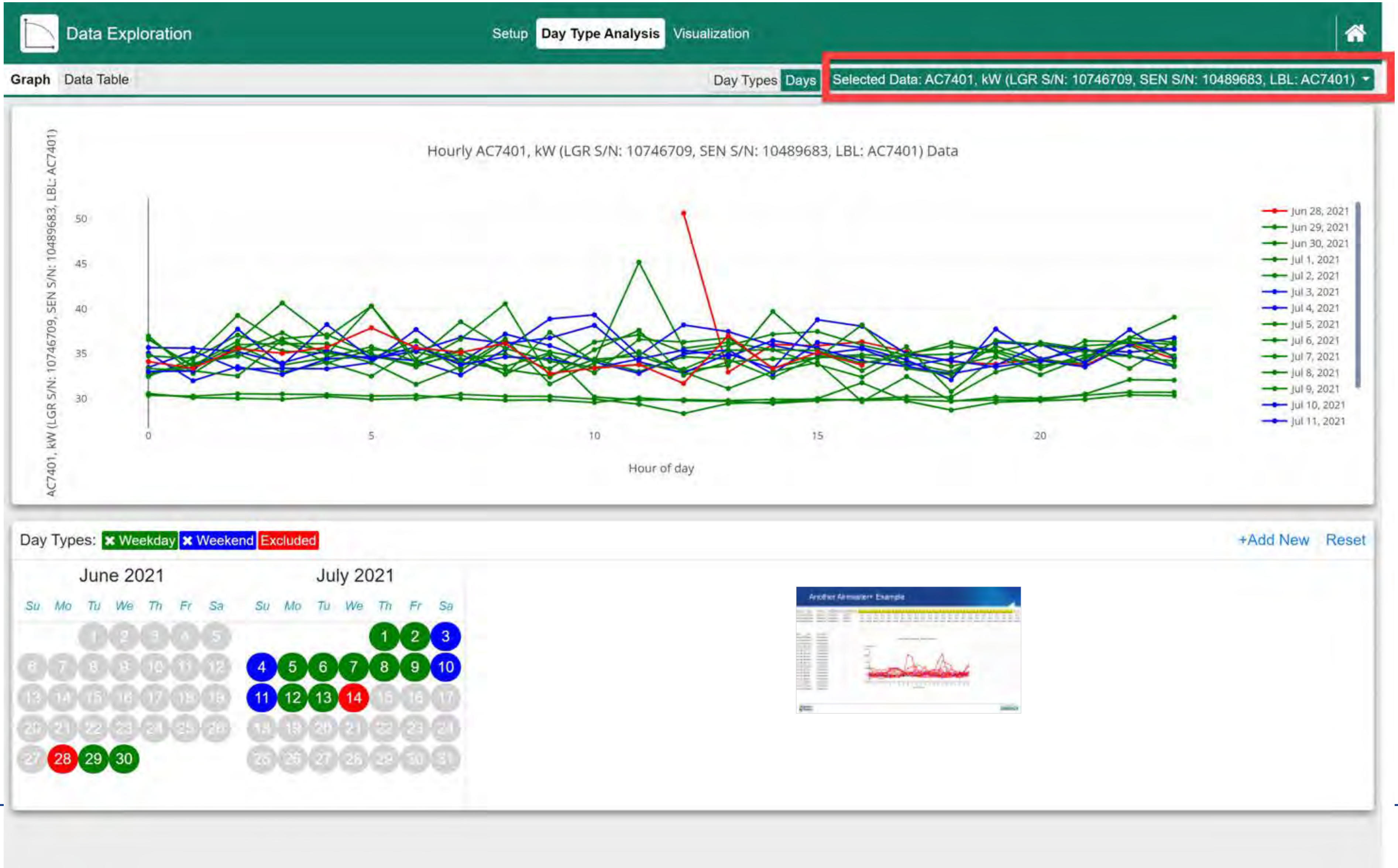
System Capacity
Determine total capacity of compressed air system or specific pipes and receiver tanks

Operation Costs
Estimate the cost of operation of the compressor in both fully and partially loaded instances

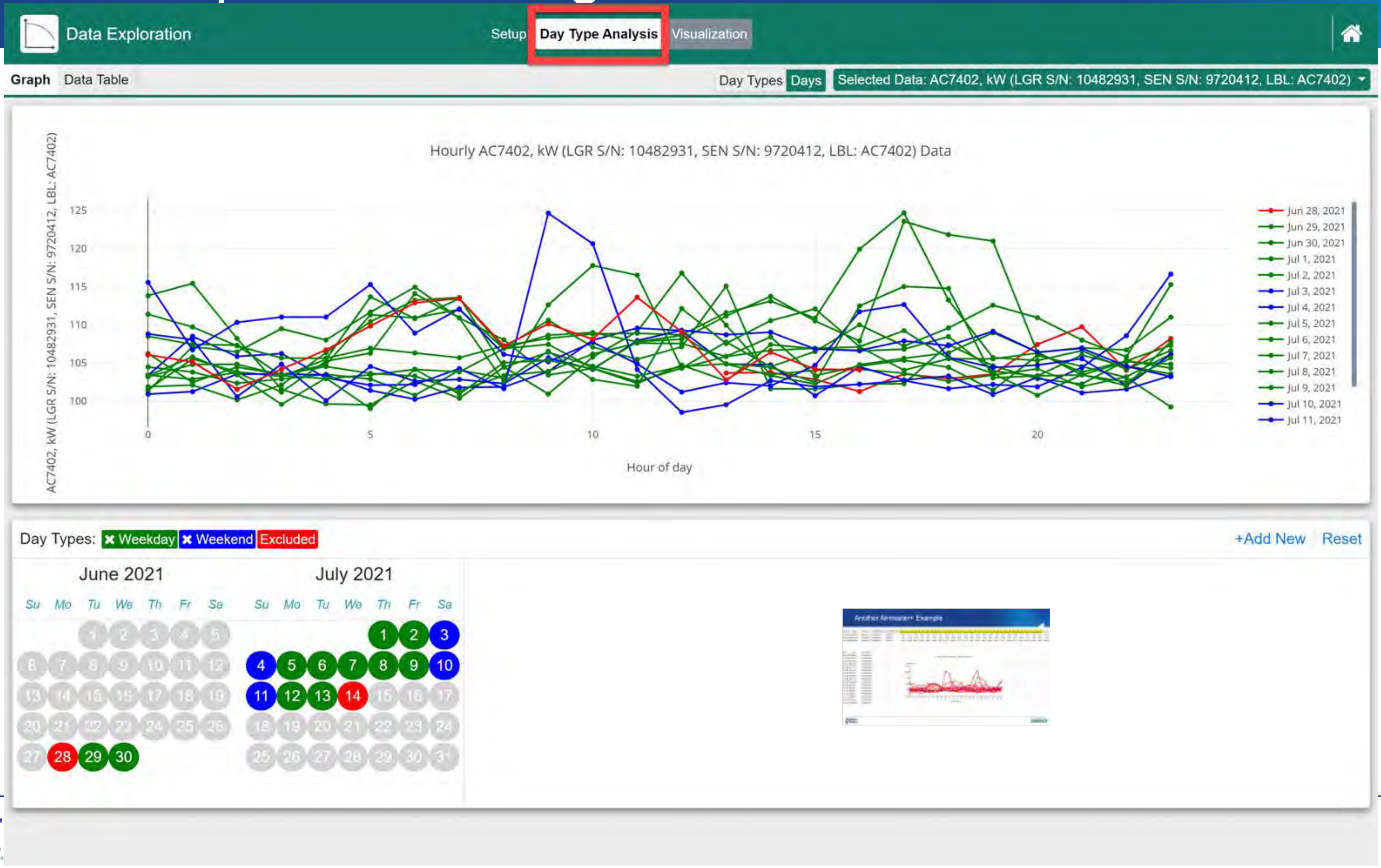
Lets compare to old Log Tool



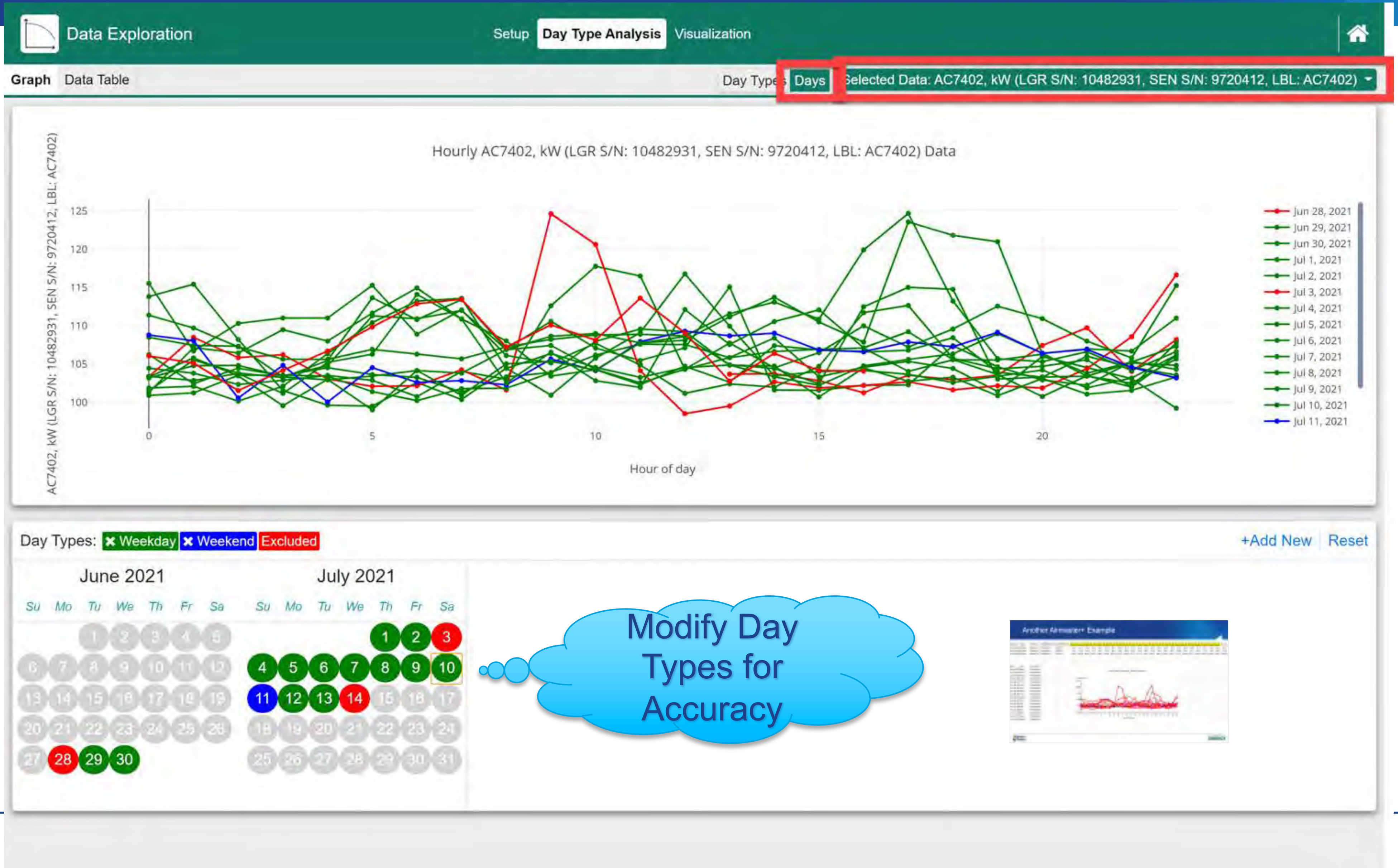
Lets compare to old Log Tool



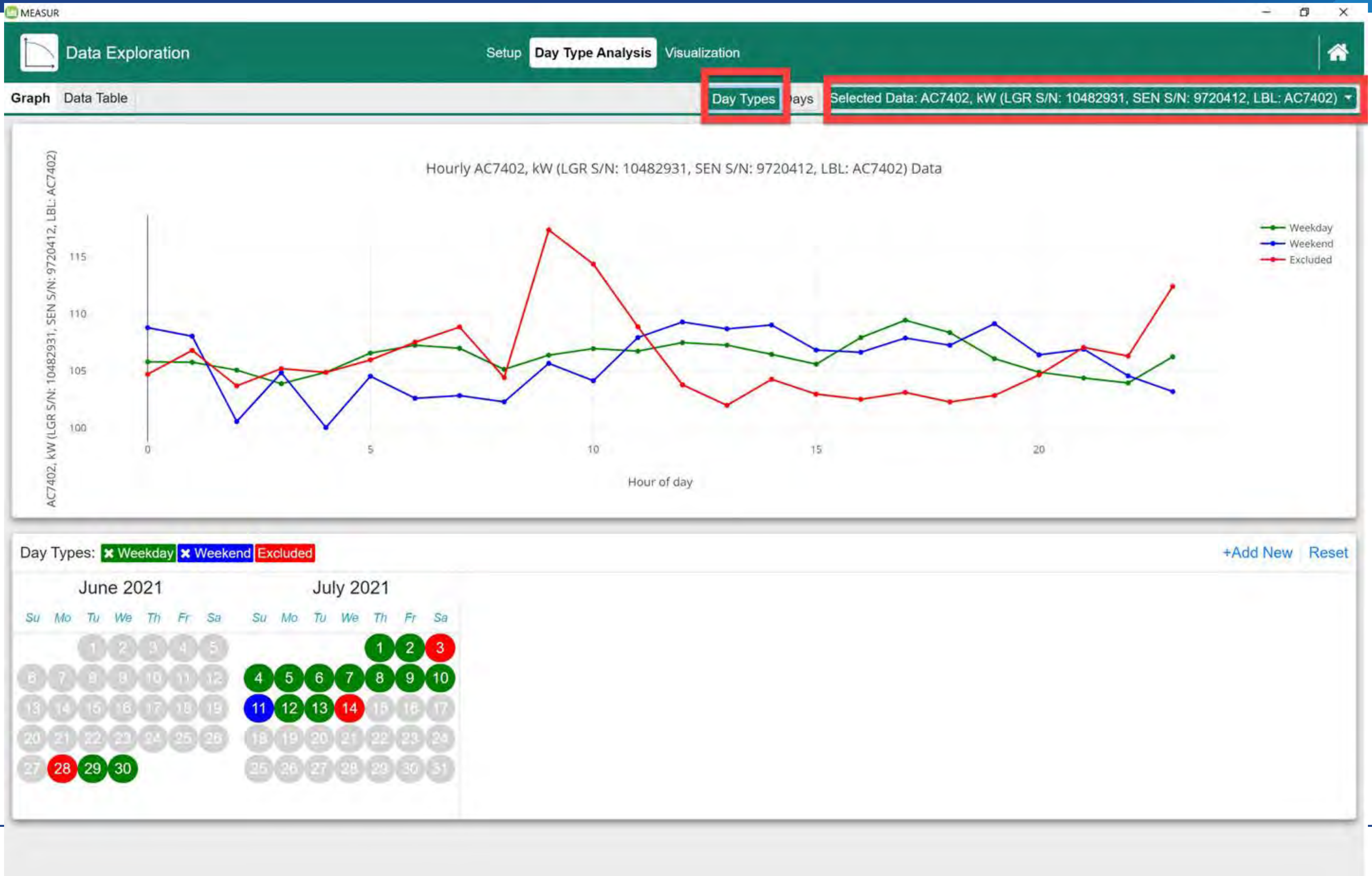
Lets compare to old Log Tool



Lets compare to old Log Tool



Lets compare to old Log Tool



Let's compare to old Log Tool

Data Exploration   Setup   **Day Type Analysis**   Visualization

Graph   **Data Table**   Display Selected   Display All   Day Types   Days

Weekday

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
AC7400, kW (LGR S/N: 9935380, SEN S/N: 9720414, LBL: AC 7400)	31.303	31.116	31.203	31.173	31.166	31.283	31.136	31.35	31.535	31.253	31.028	31.097	30.634	31.141	30.967	30.808	31.639	32.755	31.714	31.197	30.837	31.05	31.292	31.554
AC7401, kW (LGR S/N: 10746709, SEN S/N: 10489683, LBL: AC7401)	33.783	33.435	34.717	34.868	34.407	34.706	34.041	34.168	34.484	33.625	33.242	34.602	33.238	33.589	33.783	33.954	33.397	33.292	32.326	33.96	33.433	33.945	34.775	34.39
AC7402, kW (LGR S/N: 10482931, SEN S/N: 9720412, LBL: AC7402)	105.799	105.762	105.063	103.874	104.879	106.562	107.252	106.98	105.135	106.381	106.954	106.732	107.475	107.255	106.447	105.589	107.916	109.441	108.359	106.077	104.89	104.376	103.946	106.238

Copy Table

Weekend

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
AC7400, kW (LGR S/N: 9935380, SEN S/N: 9720414, LBL: AC 7400)	31.63	31.308	31.555	31.371	31.206	31.297	31.316	31.316	31.288	31.66	31.404	31.409	31.384	31.415	30.871	31.326	32.615	31.362	31.242	31.393	31.592	31.171	31.417	31.65
AC7401, kW (LGR S/N: 10746709, SEN S/N: 10489683, LBL: AC7401)	33.019	33.065	37.74	33.694	38.244	34.431	35.282	36.799	36.14	36.744	38.152	34.097	32.839	34.999	33.307	38.779	38.053	34.985	34.236	33.534	34.226	33.532	36.01	36.755
AC7402, kW (LGR S/N: 10482931, SEN S/N: 9720412, LBL: AC7402)	108.79	108.04	100.56	104.836	100.043	104.53	102.602	102.836	102.287	105.659	104.137	107.923	109.284	108.682	109.024	106.825	106.632	107.88	107.251	109.136	106.403	106.904	104.565	103.187

Copy Table

Excluded

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
AC7400, kW (LGR S/N: 9935380, SEN S/N: 9720414, LBL: AC 7400)	31.169	31.05	30.895	30.813	30.827	31.302	31.875	31.121	30.986	34.306	34.141	30.731	54.042	34.084	30.745	30.835	30.929	30.939	30.742	30.81	30.826	31.223	31.369	32.636
AC7401, kW (LGR S/N: 10746709, SEN S/N: 10489683, LBL: AC7401)	34.593	32.684	34.566	33.868	35.067	36.28	34.948	33.887	35.822	35.837	36.353	34.302	40.172	35.804	35.099	35.318	35.197	34.442	34.278	35.036	35.236	34.558	35.633	34.982
AC7402, kW (LGR S/N: 10482931, SEN S/N: 9720412, LBL: AC7402)	104.704	106.798	103.689	105.197	104.867	105.96	107.515	108.846	104.42	117.36	114.356	108.863	103.781	101.982	104.264	102.963	102.506	103.115	102.281	102.843	104.645	107.059	106.302	112.405

Copy Table

Day Types: Weekday Weekend Excluded   +Add New   Reset

June 2021   July 2021

Summary

- Know how your controls work
- Realize the pros and cons of different controls
- Recognize how controls affect part load efficiency
- Understand how storage affects the effectiveness of control strategies
- Measure power, energy, pressure and leak load
- Estimate energy consumption and correlate to production levels
- Maintain system pressure at the lowest possible levels
- Avoid part load operation, which is usually inefficient

Next Session #4, will be in two weeks on Friday September 10th
We will be skipping next week September 3rd.

Review of Air Treatment

Homework for Week 3 – Compressor Controls

- Explain each of the following control methods:
  - Start/Stop
  - Load/Unload
  - Modulating
  - Variable Displacement
  - Variable Speed
  - Sequencer
  - Master Compressor Controller?
  - Pressure Flow Control?

Thank You!