Better Plants
U.S. DEPARTMENT OF ENERGY

In-Plant Trainings

Virtual Platform
Session 1
The Basics

U.S. DEPARTMENT OF ENERGY

What is an In-Plant Training?

- In-Plant Trainings (INPLTs) are system-specific workshops led by Better Plants experts that train participants on how to identify, implement, and replicate energy-saving projects.
- The goal is to help manufacturing plants reduce energy consumption and become more efficient.
- During Pre-Covid days, Better Plant partners hosted an on-site, three-day training at one of their facilities, and invited others to attend.
- Due to the challenges from Covid, we started training virtually using eight (8) 2-hour online training sessions. Now we are back to in person but still maintain the virtual sessions such as this one.
- Through Better Plants:
  - Industrial organizations commit to efficiency goals
  - Receive technical assistance and national recognition for their achievements

The Facilitator

- Frank Moskowitz – Draw Professional Services
  - Compressed Air Challenge Instructor for Fundamentals & Advanced Workshop as well as an Instructor for AIRMaster+ Qualified Specialist Workshop
  - DOE Compressed Air System Energy Expert
    - In-Plant Training & Save Energy Now Assessments
  - CAGI – Certified Compressed Air System Specialist
  - Co-Vice Chair ASME EA-4 Energy Assessment for Compressed Air Systems
  - International Standards Organization (ISO) Technical Advisory Group Member
    - Air compressors and compressed air systems energy management
  - Contact Information:
    - fmoskowitz@drawproservices.com
    - 602-809-4195

COMPRESSED AIR SYSTEM SPECIALIST
CAGI
Compressed Air & Gas Institute
CERTIFIED

TRAINING • EDUCATION • EFFICIENCY
COMPRESSED AIR
CHALLENGE
INSTRUCTOR

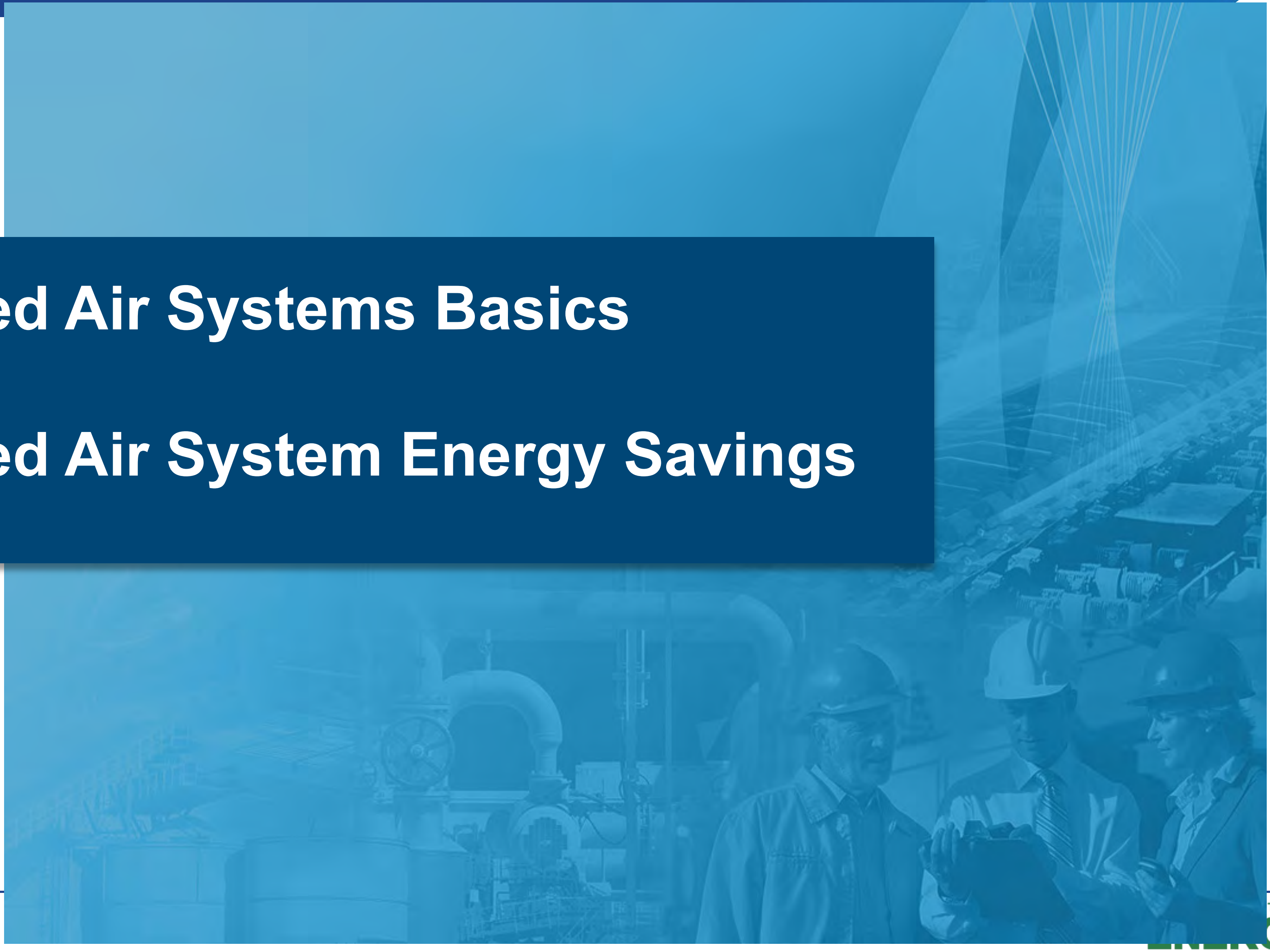
Assessment Process

- **Prepare**
  - Learn how to gather information
- **Participate**
  - Find out what to expect and how to make the most of the assessment through examples, quizzes, homework.
- **Implement**
  - Take action on the opportunities identified in this training and start saving energy.
- **Communicate**
  - Share the success from your assessment with other plants and multiply benefits throughout your company

Agenda

- Week 1 – Compressed Air Systems Basics
- Week 2 – Compressor Types and Ventilation
- Week 3 – Compressor Controls
- Week 4 - Air Treatment
- Week 5 – Distribution System
- Week 6 – Demand Side and Inappropriate Uses
- Week 7 – System Volume vs Storage
- Week 8 – Wrap Up Presentations

Week 1

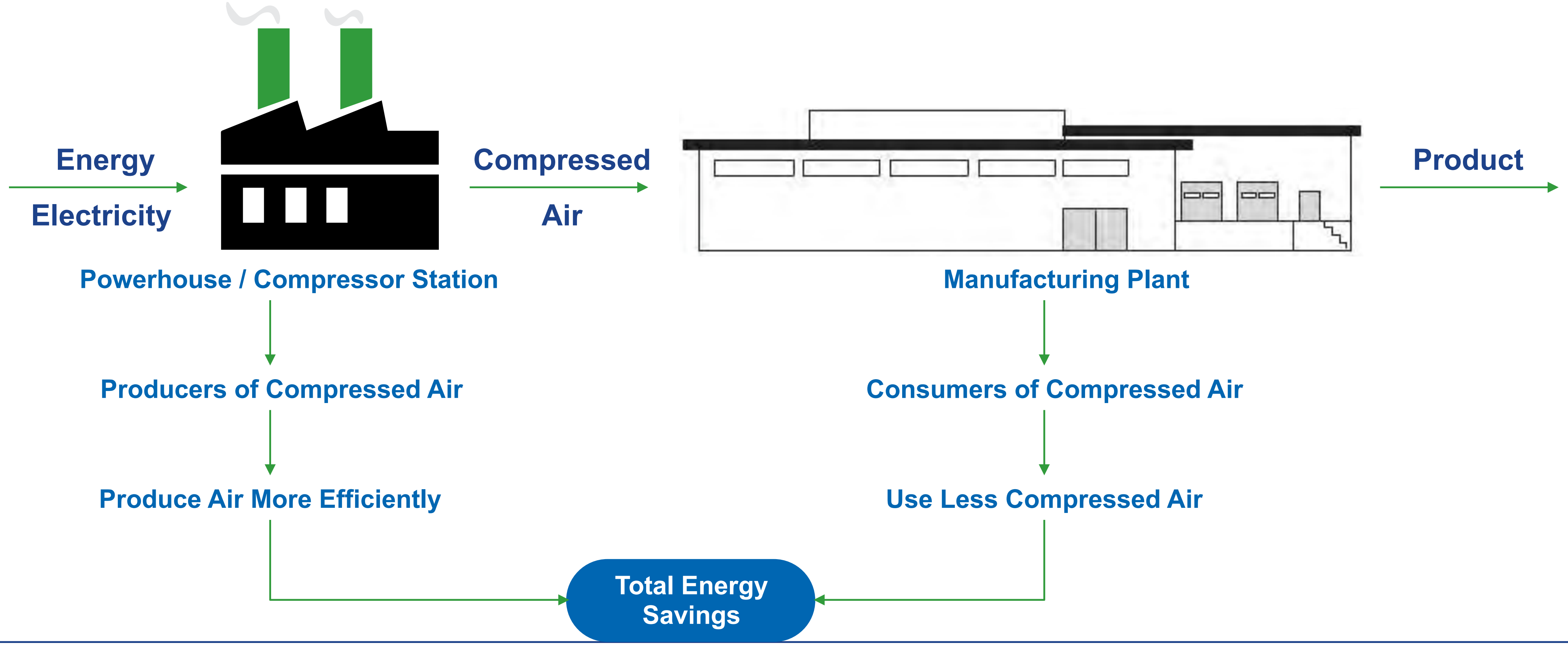


Compressed Air Systems Basics

Compressed Air System Energy Savings

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.



Treasure Hunt

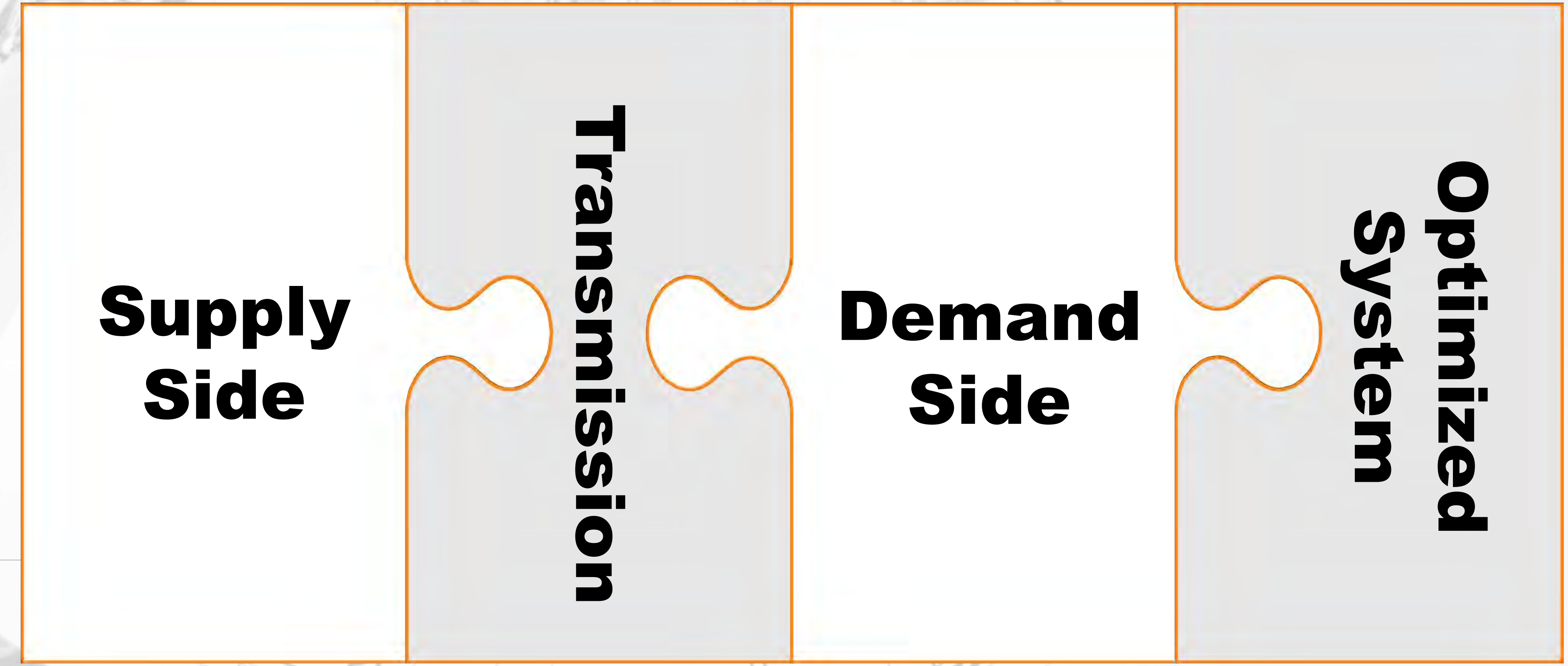
What am I looking for?

Treasure Hunt

The prime consideration for any compressed air system is the ability to generate air with the least amount of energy.

Having done this, the next consideration is to transmit energy from the point of generation to the point of use with the least loss.

The final consideration is to eliminate waste and use the least amount of air for the production process.



Look from the System Level Approach

Market research continues to make it clear that the majority of compressed air systems in use today are inefficient and because of this, often limit their own productivity.

The value trapped in poorly designed and operated air systems in the U.S. markets alone are estimated to range from a low of $1 billion to as much $3.2 billion in energy costs alone.

What Are My Goals?

Produce more efficiently

- Improve Compressor Control
- Discharge Pressure?

Use less compressed air

- Reduce Air Demand (Leaks, Inappropriate Uses, etc…)
- What is the Pressure at End Uses
- How does compressed air support production?

Understanding how compressed air is used is the single most important step to effective management.

Look from the System Level Approach

- Improve Compressor Control
- Reduce System Pressure
- Reduce Air Demand

What Do I Look For?

- Produce more efficiently
  - Improve Compressor Control response.
  - Discharge Pressure?
- Use less compressed air
  - Reduce Air Demand (Leaks, Inappropriate Uses, etc…)
  - What is the Pressure at End Uses
  - How does compressed air support production?
    - Understanding how compressed air is used is the single most important step to effective management.

Why Should You be Interested in Optimizing?

- Because compressed air optimization will have a huge impact on your bottom line.
- Compressed Air accounts for 10%-15% (at a minimum) of a company's electrical costs.

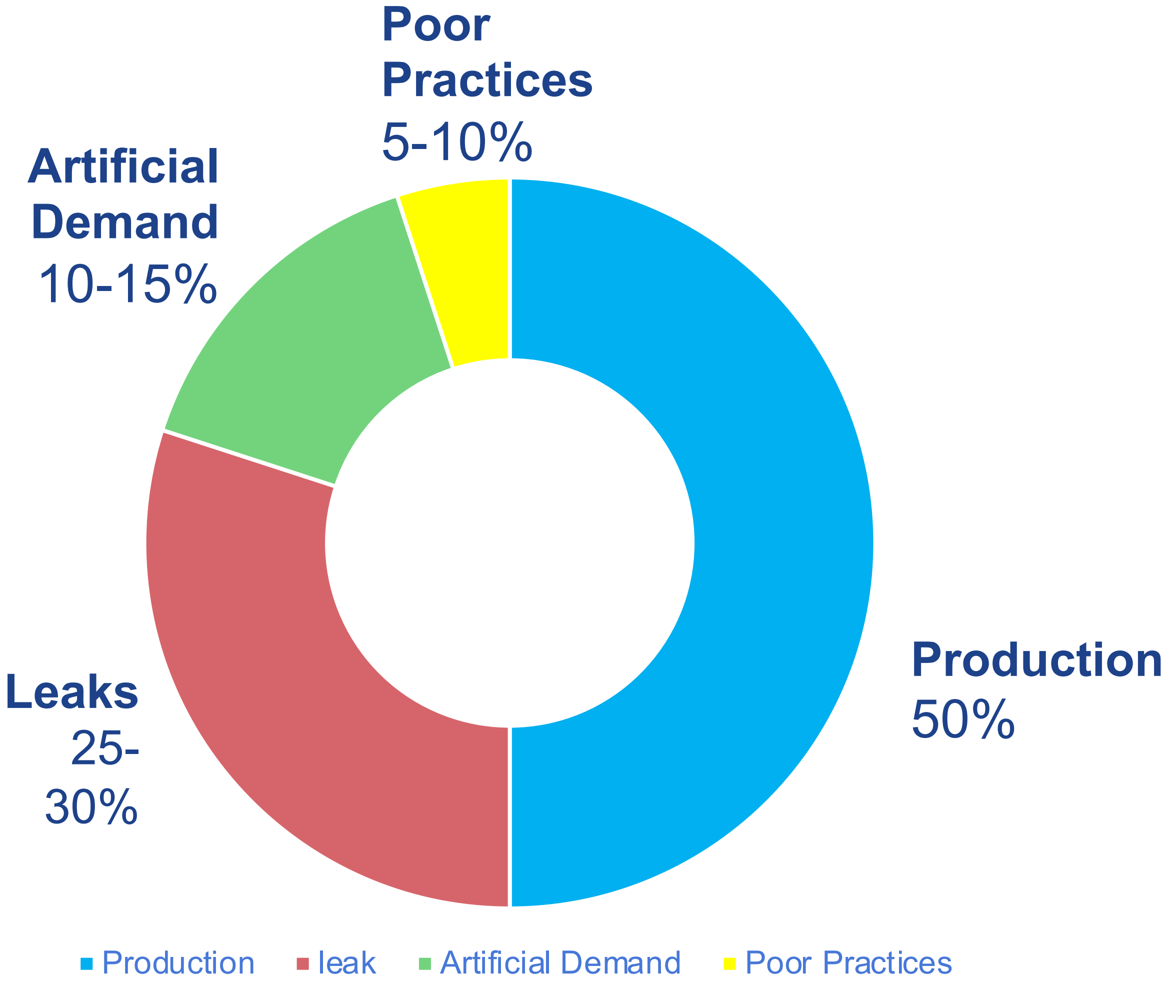
Compressed Air Versus Other Energy Sources

Where does the air go after it leaves the compressor room?

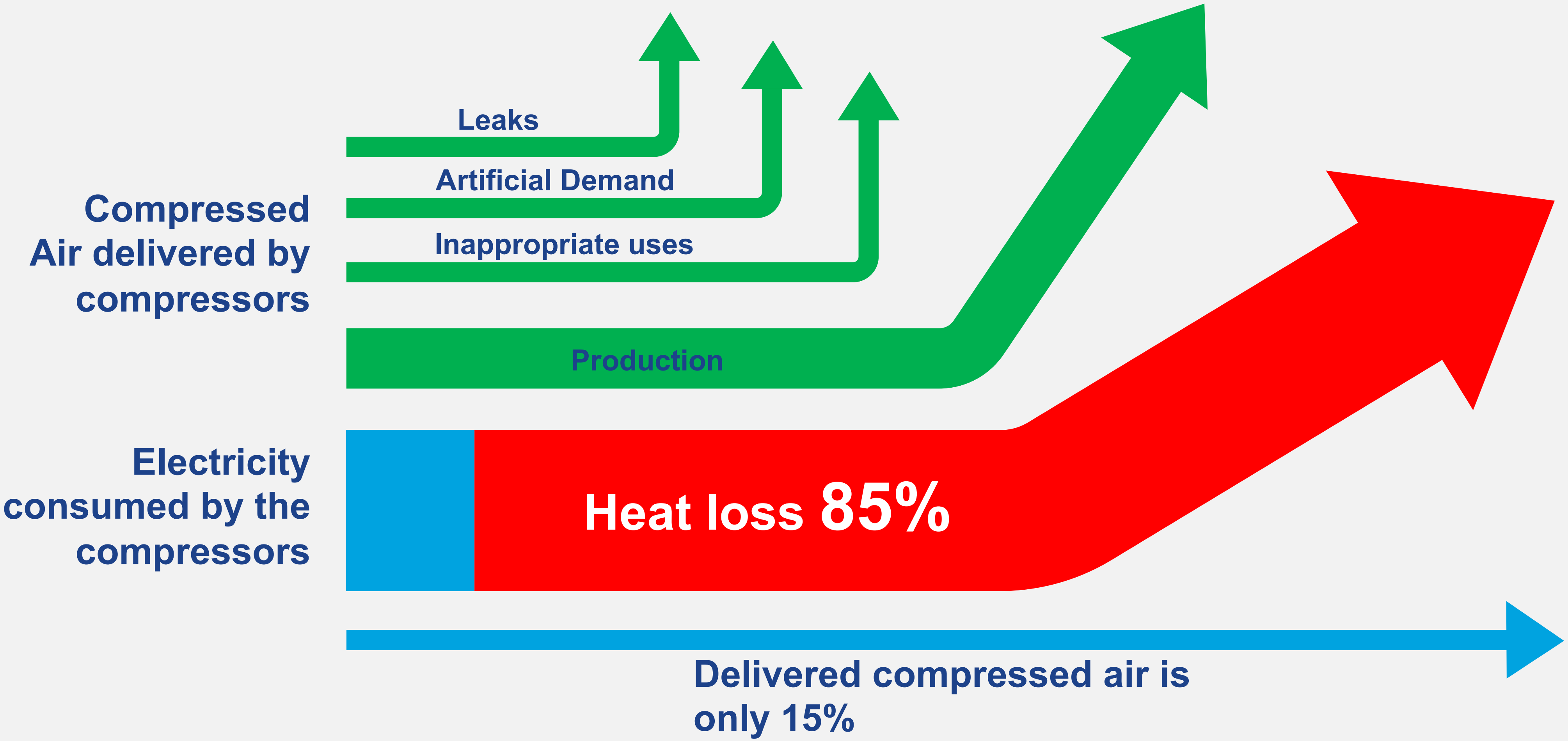
- You may be surprised, in most industrial plants, only 50% of the compressed air generated supplies productive air use.
- The other 50% is consumed by various losses.
- The losses are

Artificial Demand (10-15%)	Leakage (20-30%)	Poor Applications (5-10%)

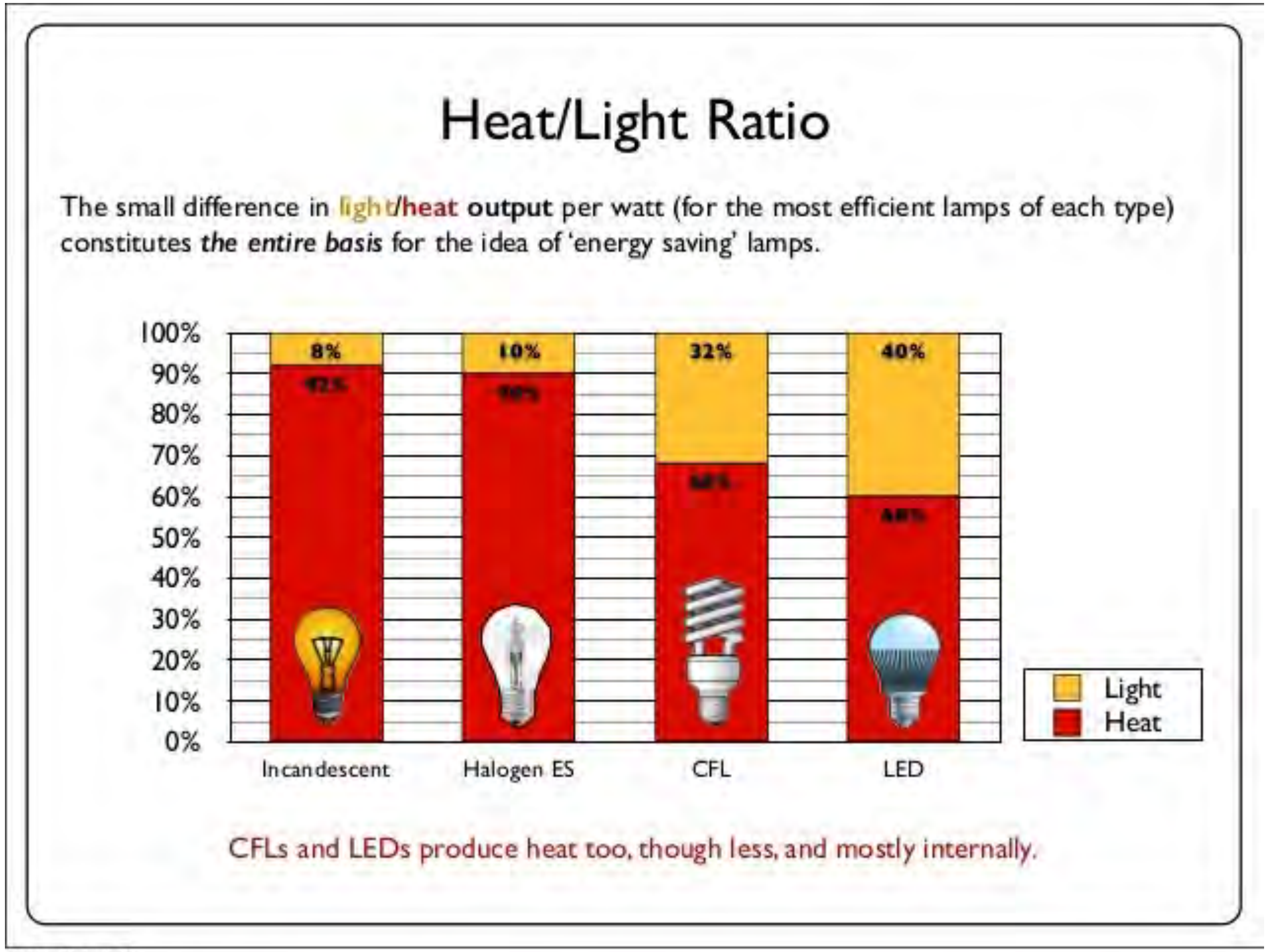
Where does the air go?



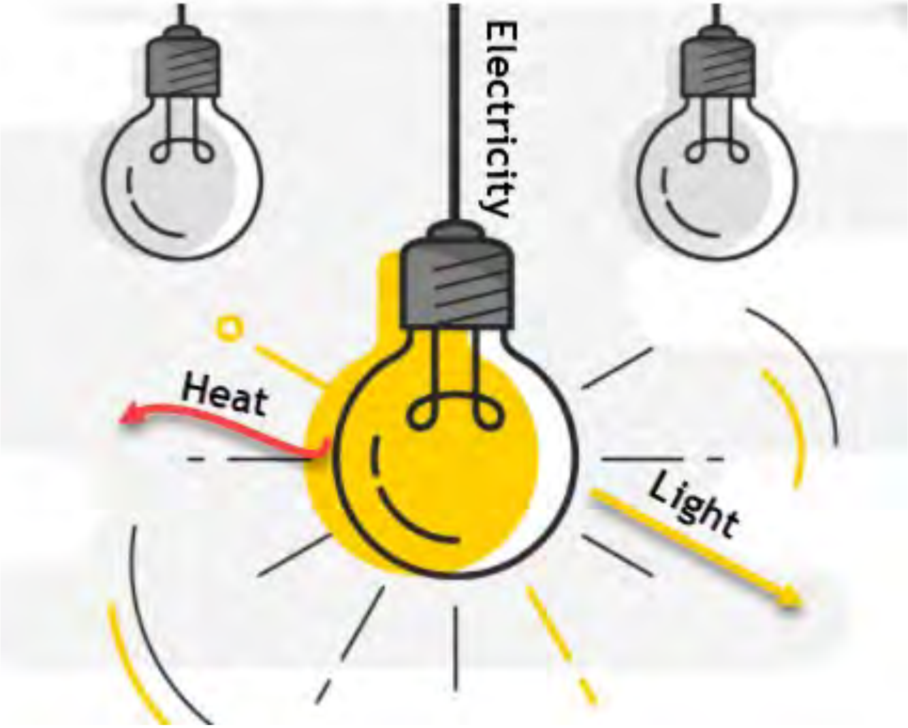
Not very efficient!



Not very efficient!



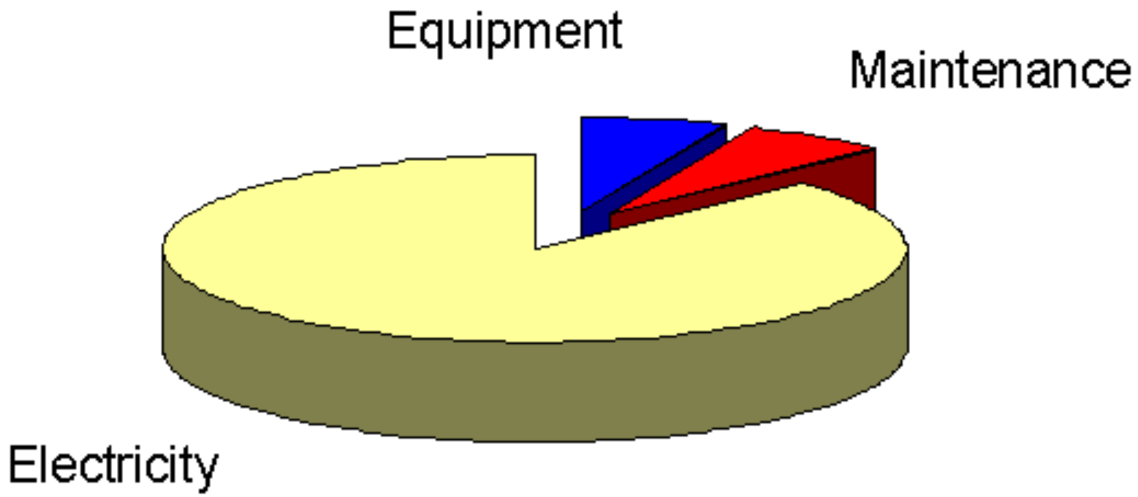
Friday 24 April 15



Compressed Air Systems
Total Cost of Ownership

Equipment cost and maintenance cost represent only a small part of the total cost of operating a compressed air system.

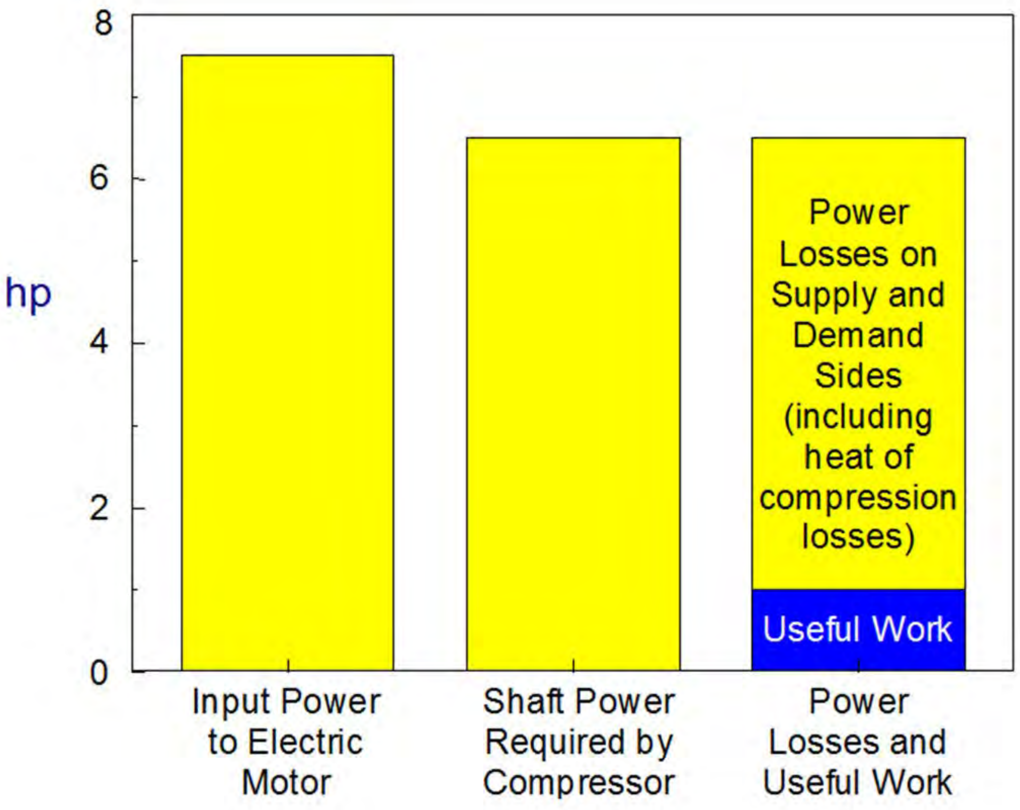
Electrical cost usually exceeds 75% of the total operating expense.



Source: Compressed Air Challenge®

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**



What Measurements Should I Record?

- Produce more efficiently
  - Improve Compressor Control
  - Discharge Pressure?
- Use less compressed air
  - Reduce Air Demand (Leaks, Inappropriate Uses, etc…)
  - What is the Pressure at End Uses
  - How does compressed air support production?
    - Understanding how compressed air is used is the single most important step to effective management.

Where Do I Start?

First, lets have a look at opportunities in the compressor room……

Centrifugal Controls

Blow off open

Warnings

Visual Maintenance Indicators

Proper Ducting

Poor Ducting Design

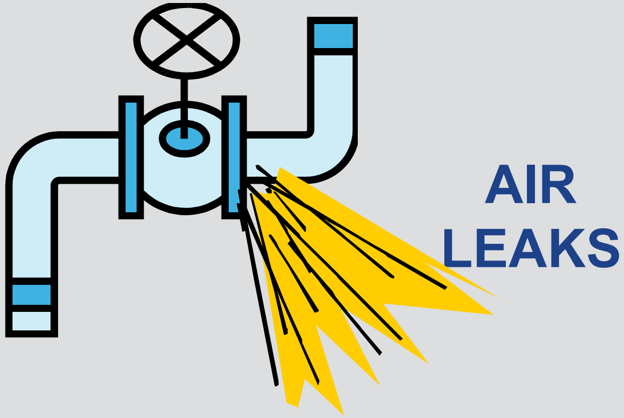
Reduce Pressure at Source

1. Yes, this can be determined visually during a walk through.
2. Every additional 2 psi costs 1% in energy.
3. Check the validity of compressor control settings.
4. Check pressure drops through dryers, filters and piping systems.
5. Artificial Demand is real flow.

Artificial Demand

A 1/16 inch equivalent diameter leak

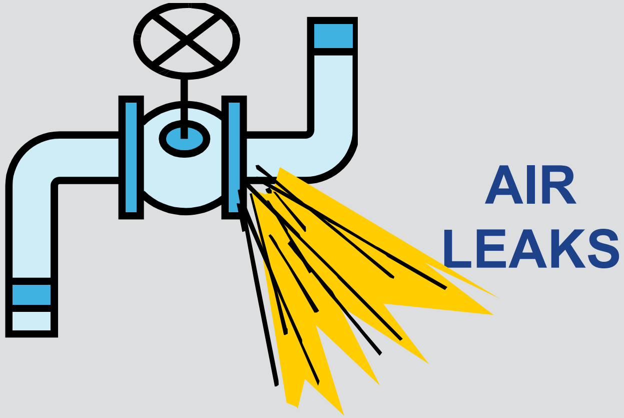
At 120PSIG



7.62 scfm FLOW

A 1/16 inch equivalent diameter leak

At 80PSIG



5.36 scfm FLOW

A leak consumes 42% more air at 120 psig than at 80 psig adding to the artificial demand on the system..

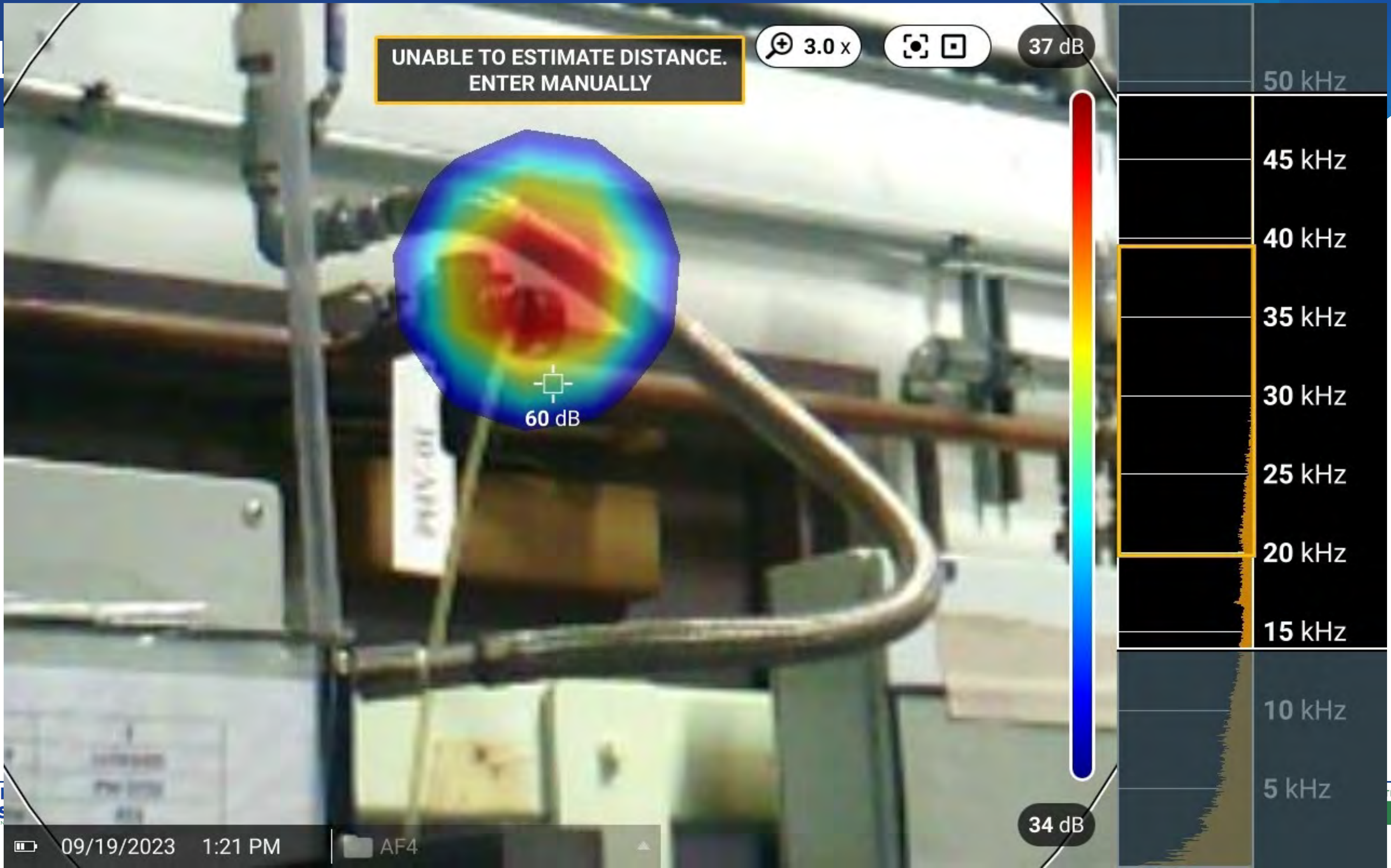
How Acoustic Camera Leak Detection Works

- The acoustic camera uses microphones and sophisticated signal processing and software to identify the loudest source of noise when many sources are present.
- It allows the user to pinpoint sound leaks in walls, doors, and floors and target the leak

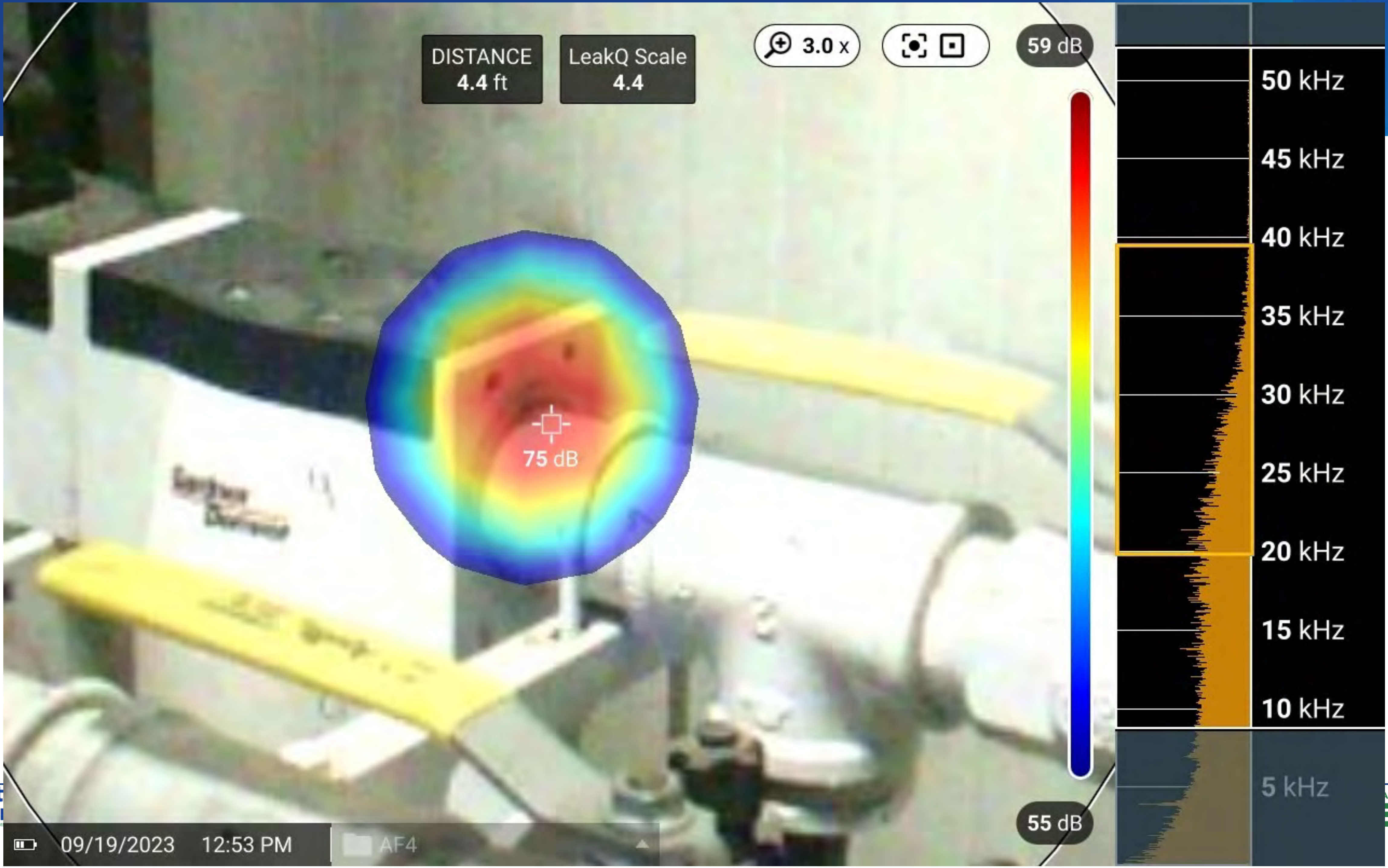
Imager Vs. Conventional Ultrasonic Leak Detector

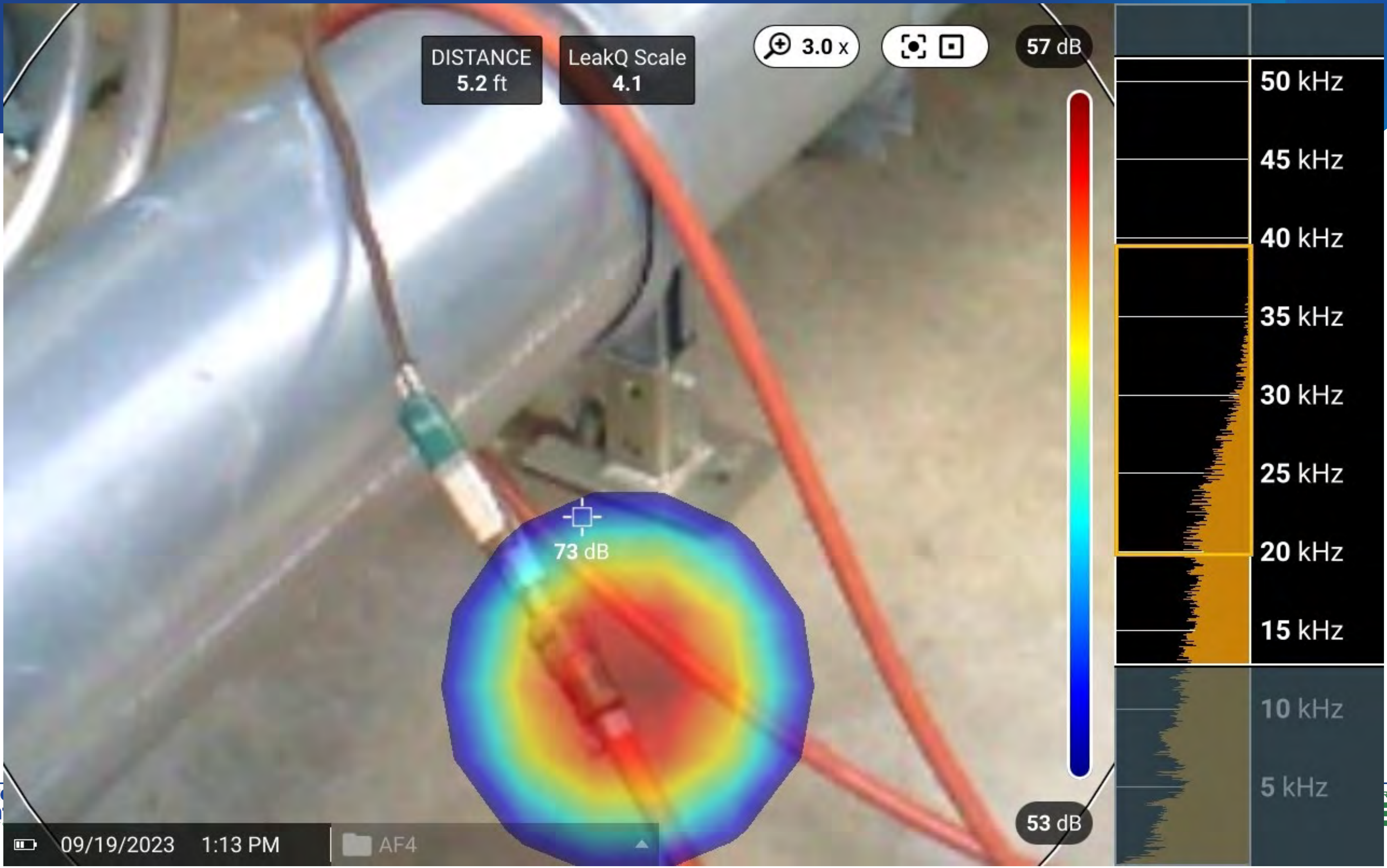
- With acoustic imager type, multiple microphones enable the inspection of an expansive area from a distance.
- A conventional Ultrasonic Leak Detector inspects plants point by point looking for leaks in each hose, coupling, trap, drain, valve and gasket.
  - What if I don't have an ultrasonic leak detector?

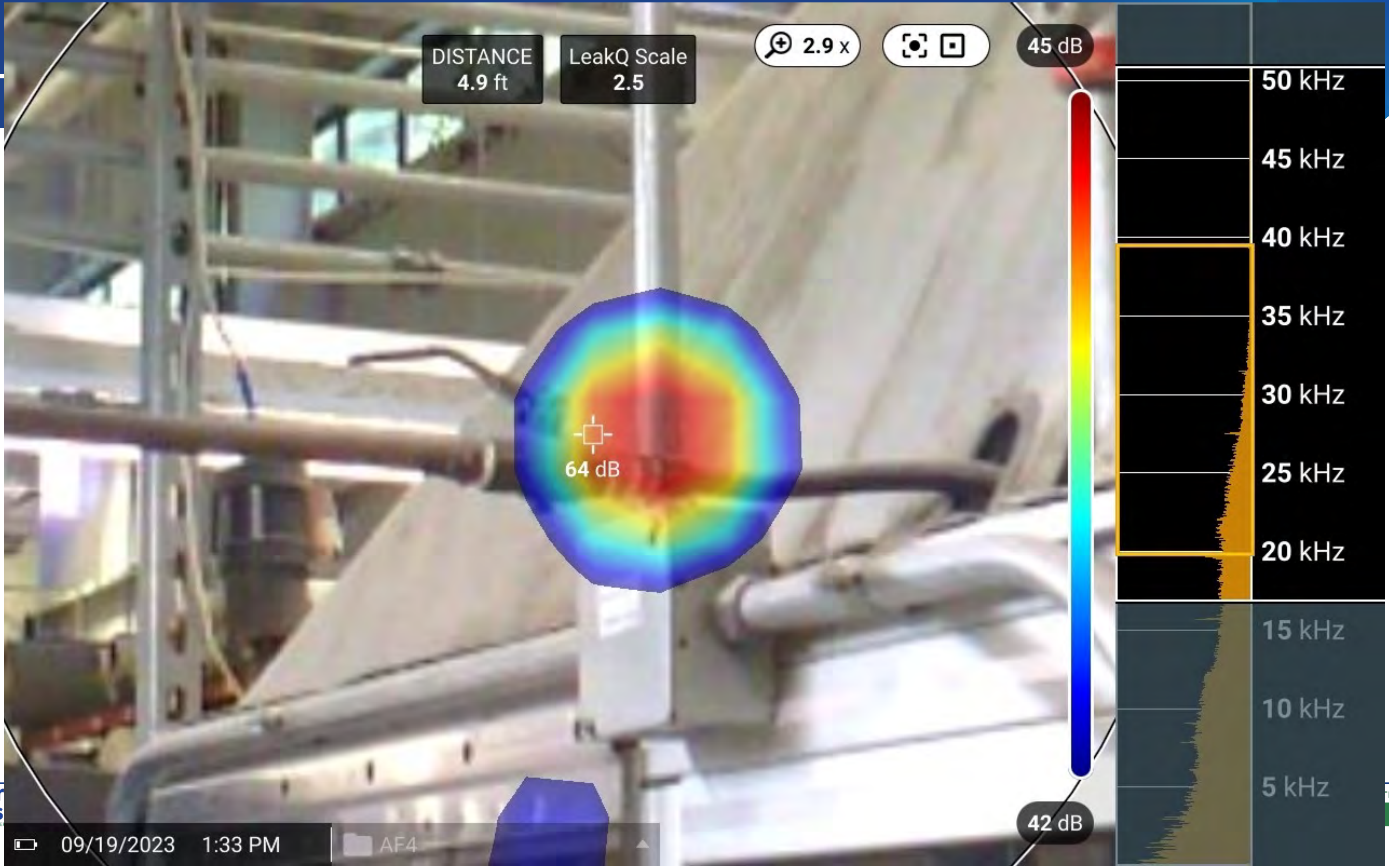

34 dB
50 kHz
45 kHz
40 kHz
35 kHz
30 kHz
25 kHz
20 kHz
15 kHz
10 kHz
M_22
0:10
0:00:00



UNABLE TO ESTIMATE DISTANCE.
ENTER MANUALLY
3.0 x
37 dB
60 dB
50 kHz
45 kHz
40 kHz
35 kHz
30 kHz
25 kHz
20 kHz
15 kHz
10 kHz
5 kHz
34 dB
09/19/2023
1:21 PM
AF4


DISTANCE
4.4 ft
LeakQ Scale
4.4
3.0 x
59 dB
75 dB
50 kHz
45 kHz
40 kHz
35 kHz
30 kHz
25 kHz
20 kHz
15 kHz
10 kHz
5 kHz
55 dB
09/19/2023
12:53 PM
AF4


DISTANCE
5.2 ft
LeakQ Scale
4.1
3.0 x
57 dB
50 kHz
45 kHz
40 kHz
35 kHz
30 kHz
25 kHz
20 kHz
15 kHz
10 kHz
5 kHz
73 dB
53 dB
09/19/2023
1:13 PM
AF4

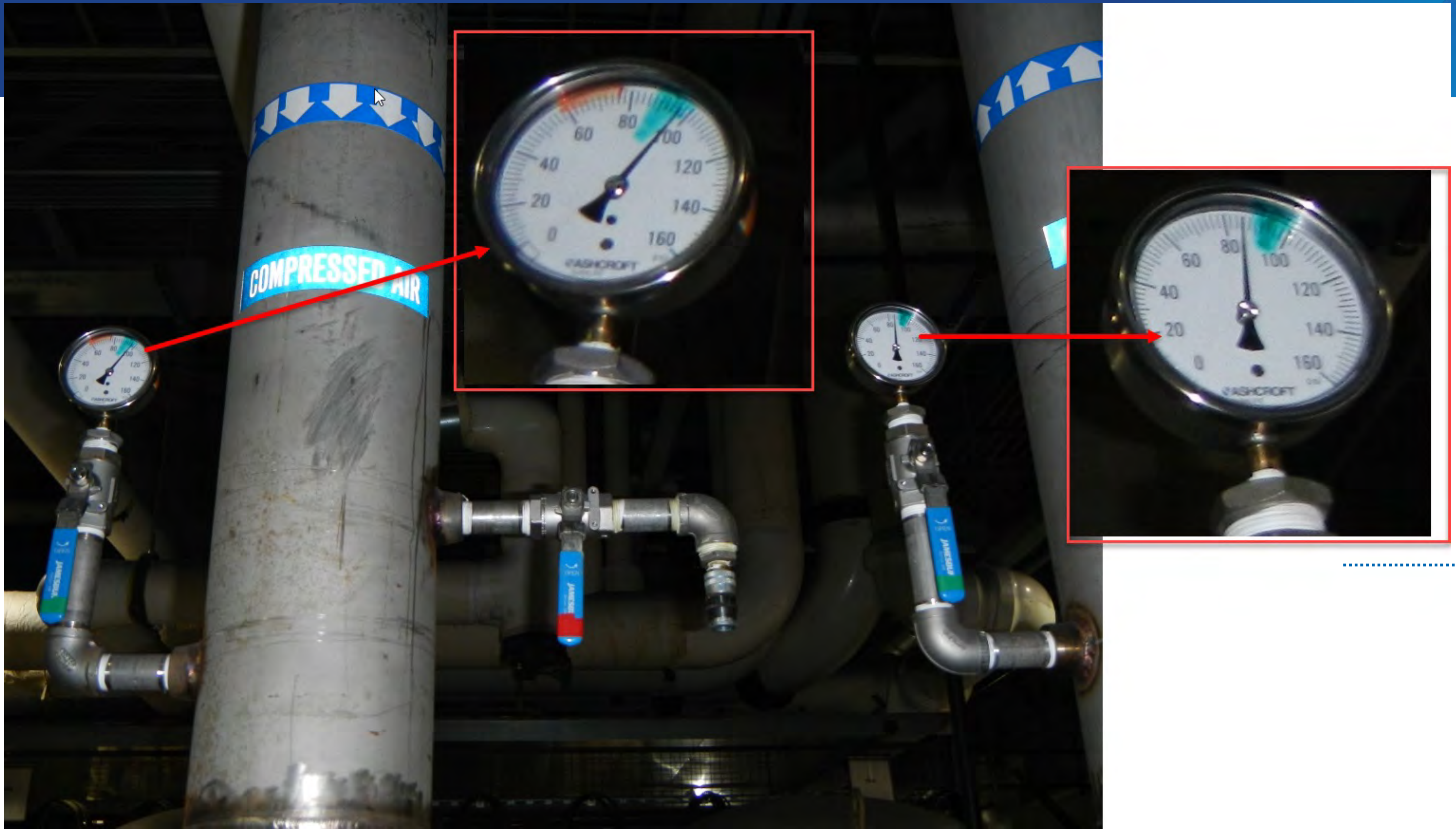


DISTANCE
4.9 ft
LeakQ Scale
2.5
2.9 x
45 dB
50 kHz
45 kHz
40 kHz
35 kHz
30 kHz
25 kHz
20 kHz
15 kHz
10 kHz
5 kHz
64 dB
42 dB
09/19/2023
1:33 PM
AF4


34 dB
50 kHz
45 kHz
40 kHz
35 kHz
30 kHz
25 kHz
20 kHz
15 kHz
10 kHz
M_22
0:10
0:00:00


51 dB
50 kHz
45 kHz
40 kHz
35 kHz
30 kHz
25 kHz
20 kHz
15 kHz
10 kHz
5 kHz
0:00:01
0:00:09

Reduce Pressure at Source (Cont'd)



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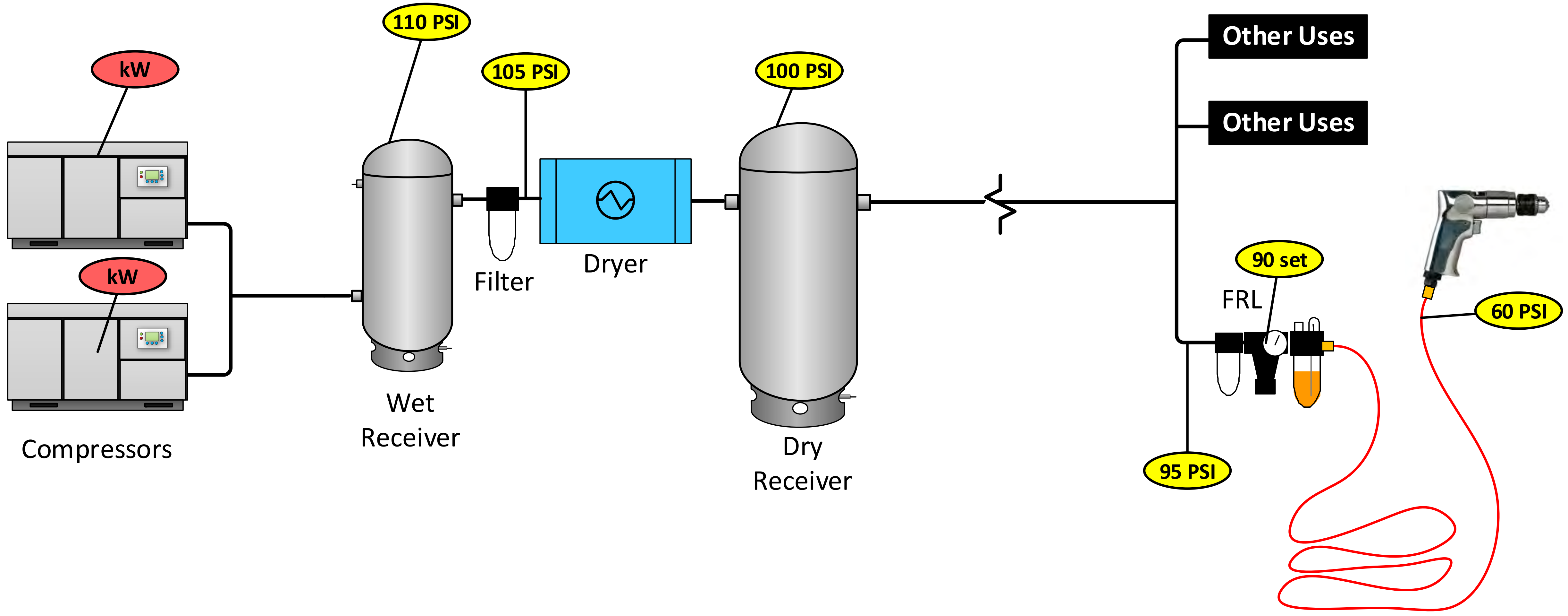
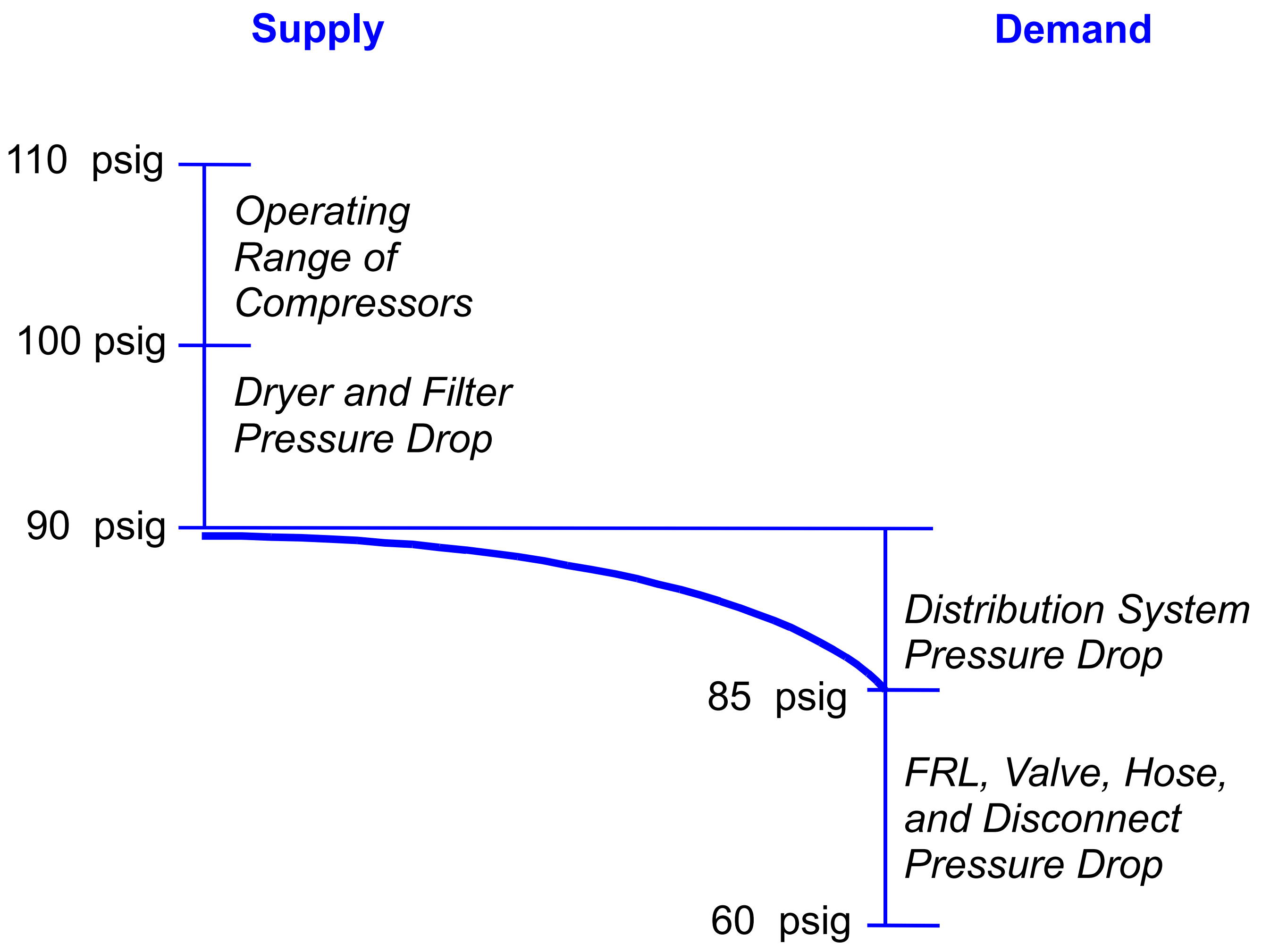
Reduce Pressure at Source (Cont'd)

What Measurements Should I Record?



System Pressure Profile



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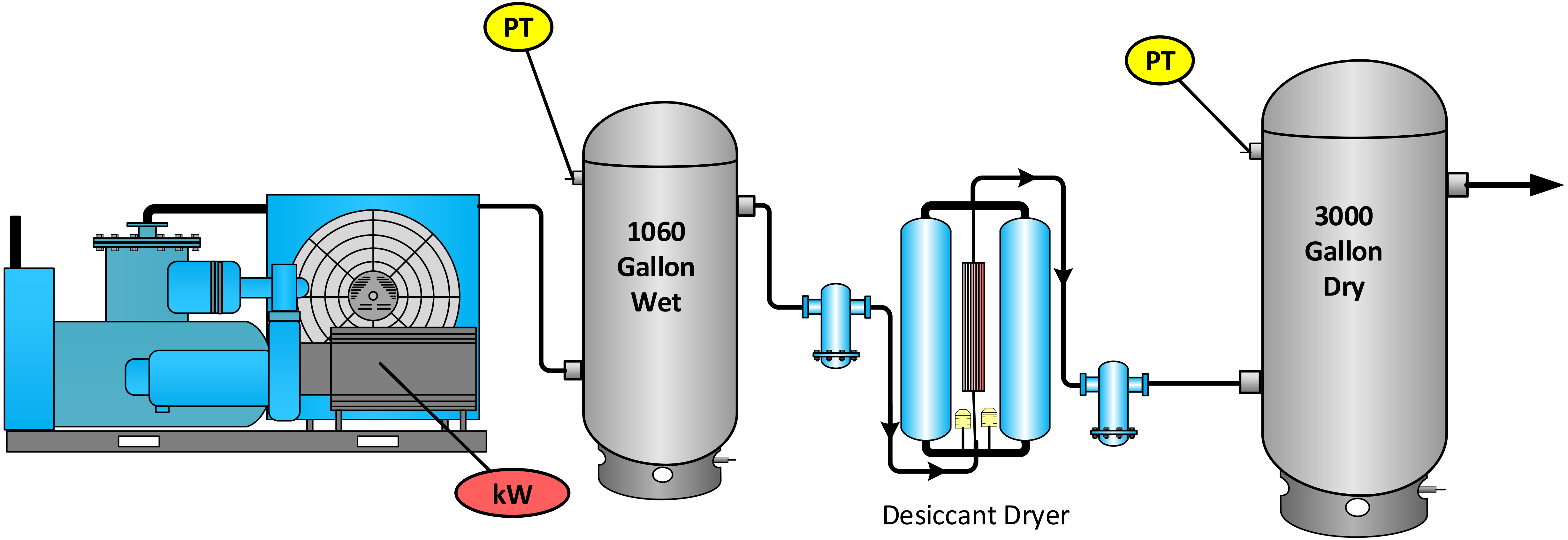

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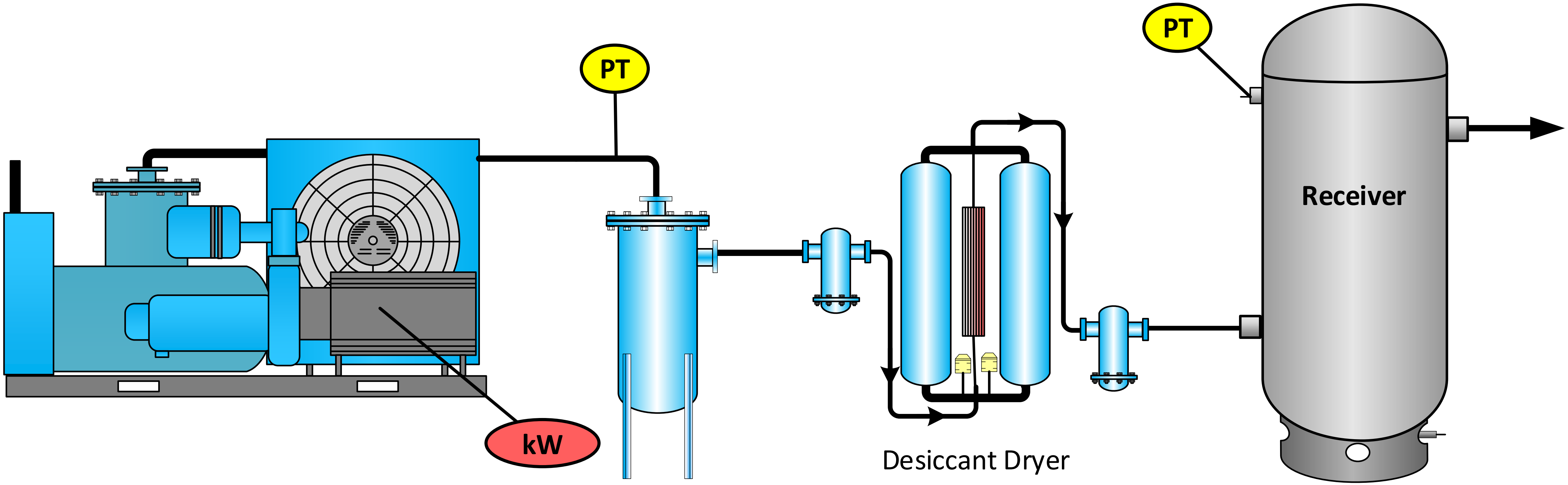
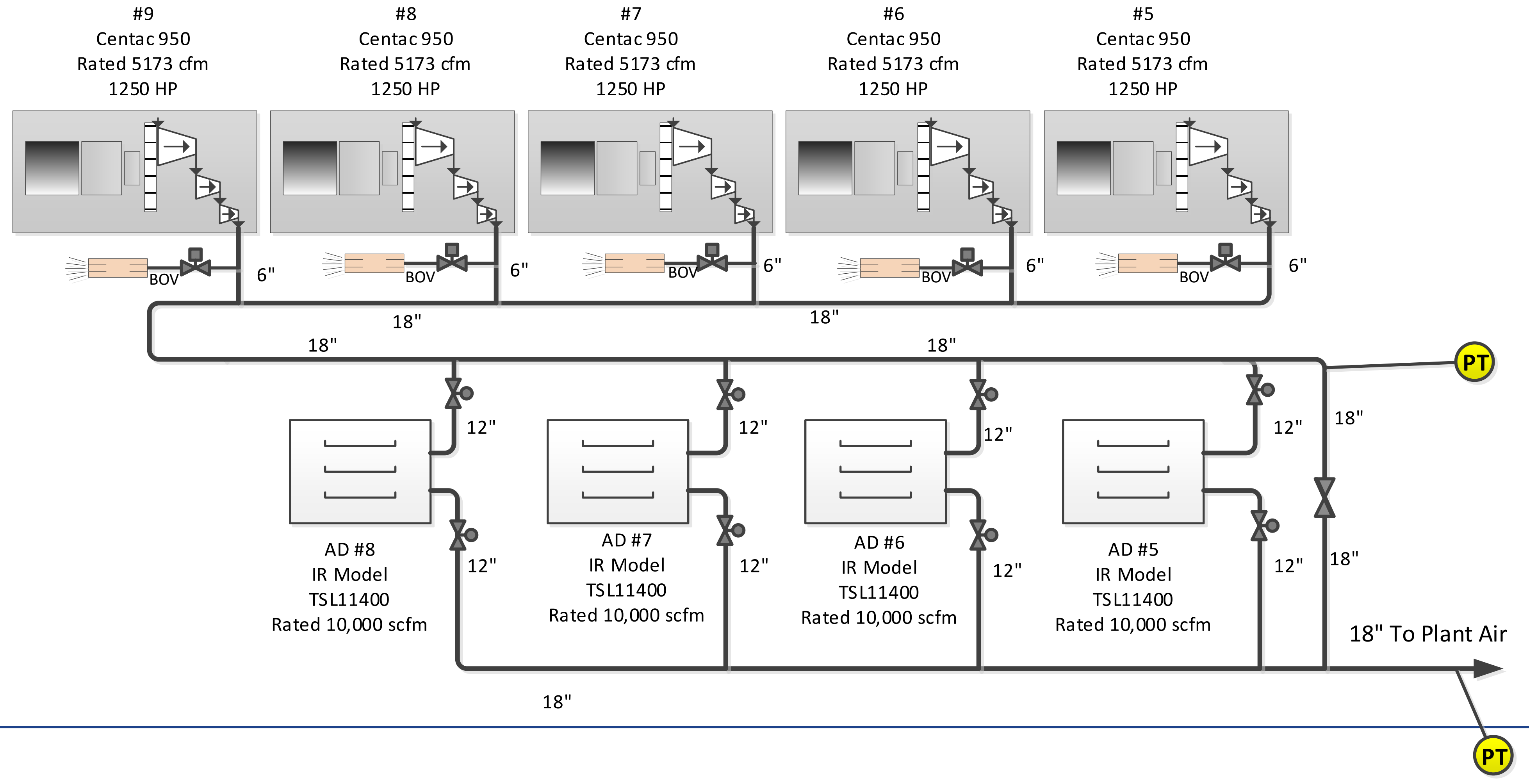
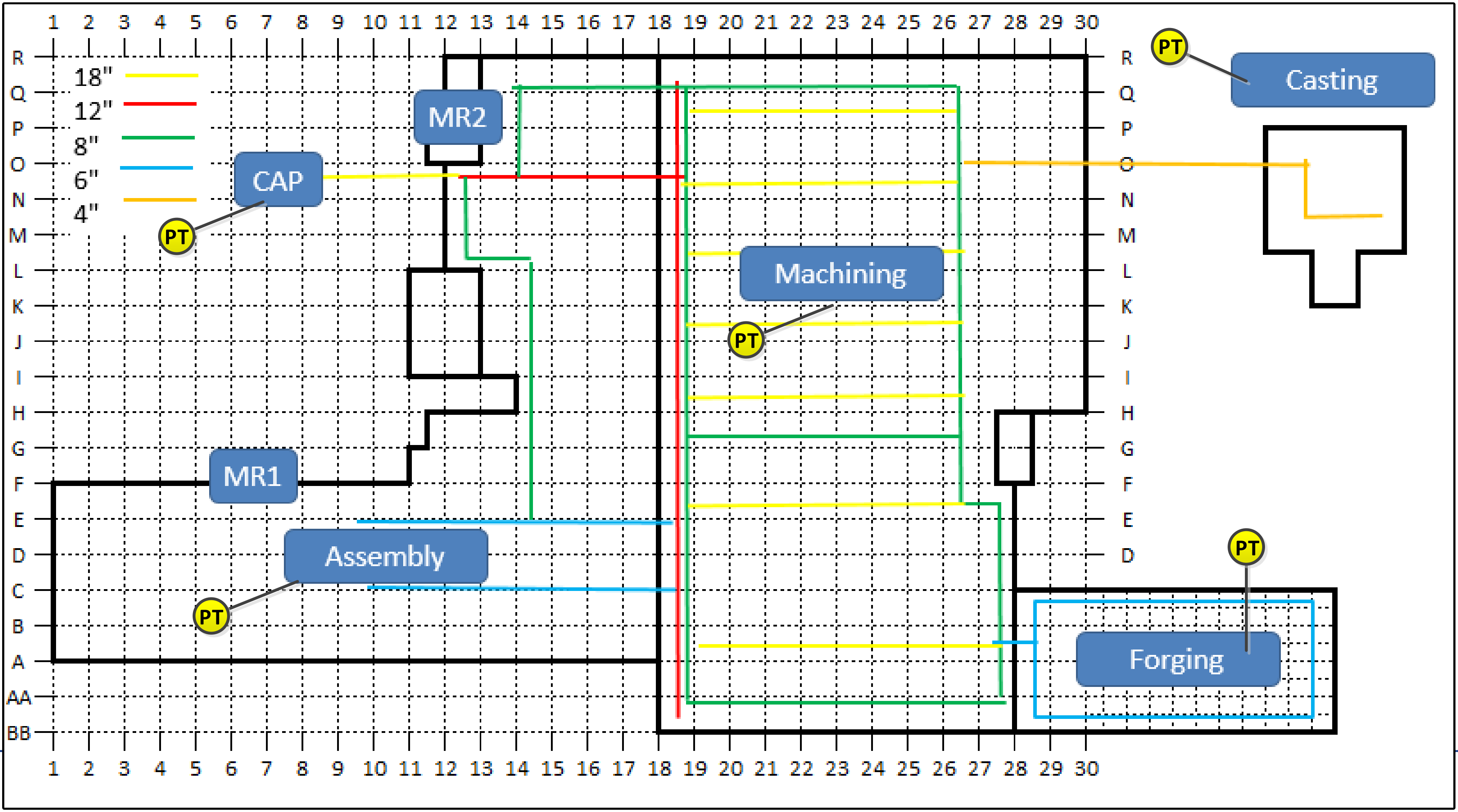


What Measurements Should I Record?

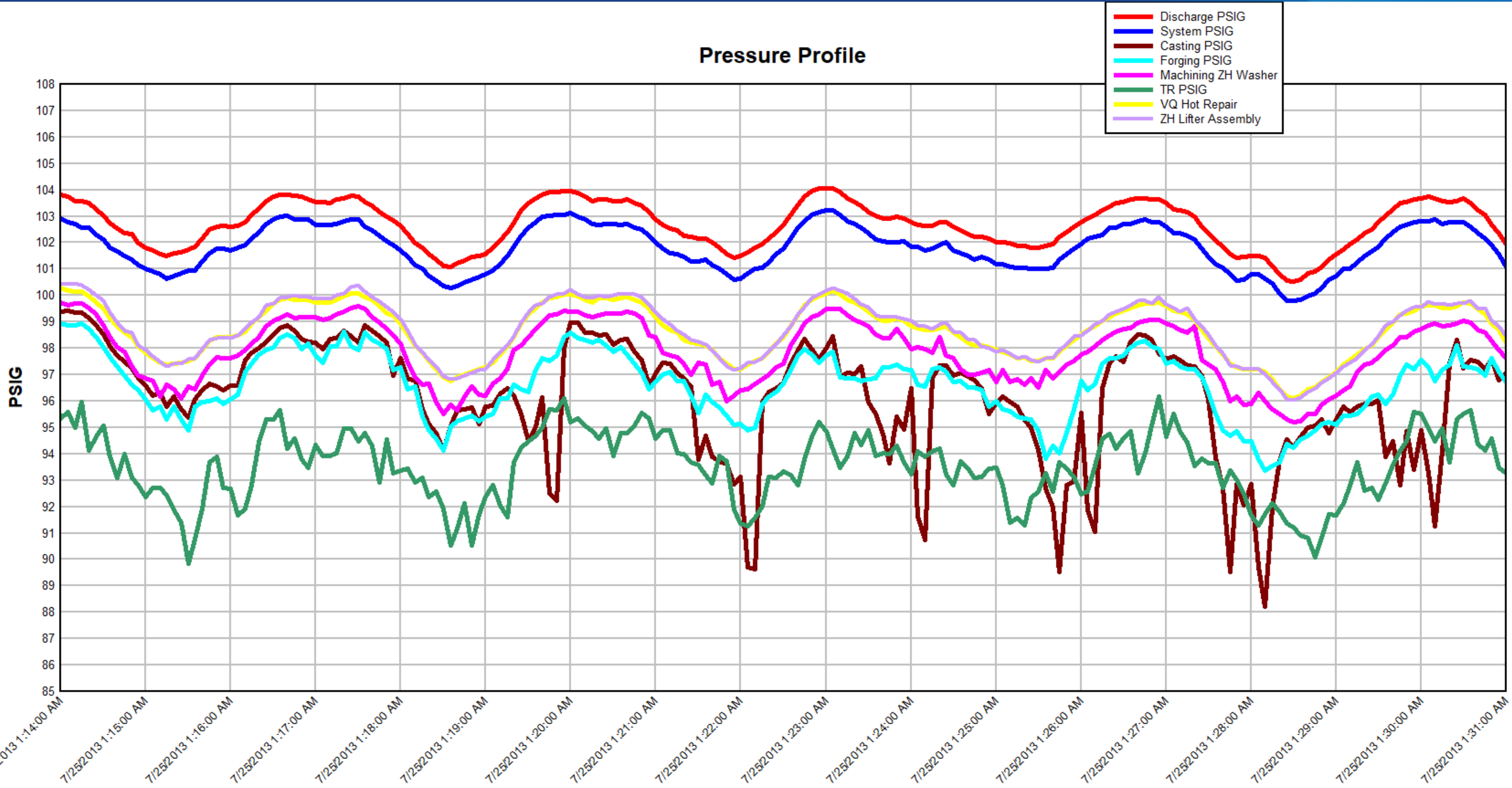
Compressed Air Plant



What Measurements Should I Record?



Data Collection Can Be Interpreted



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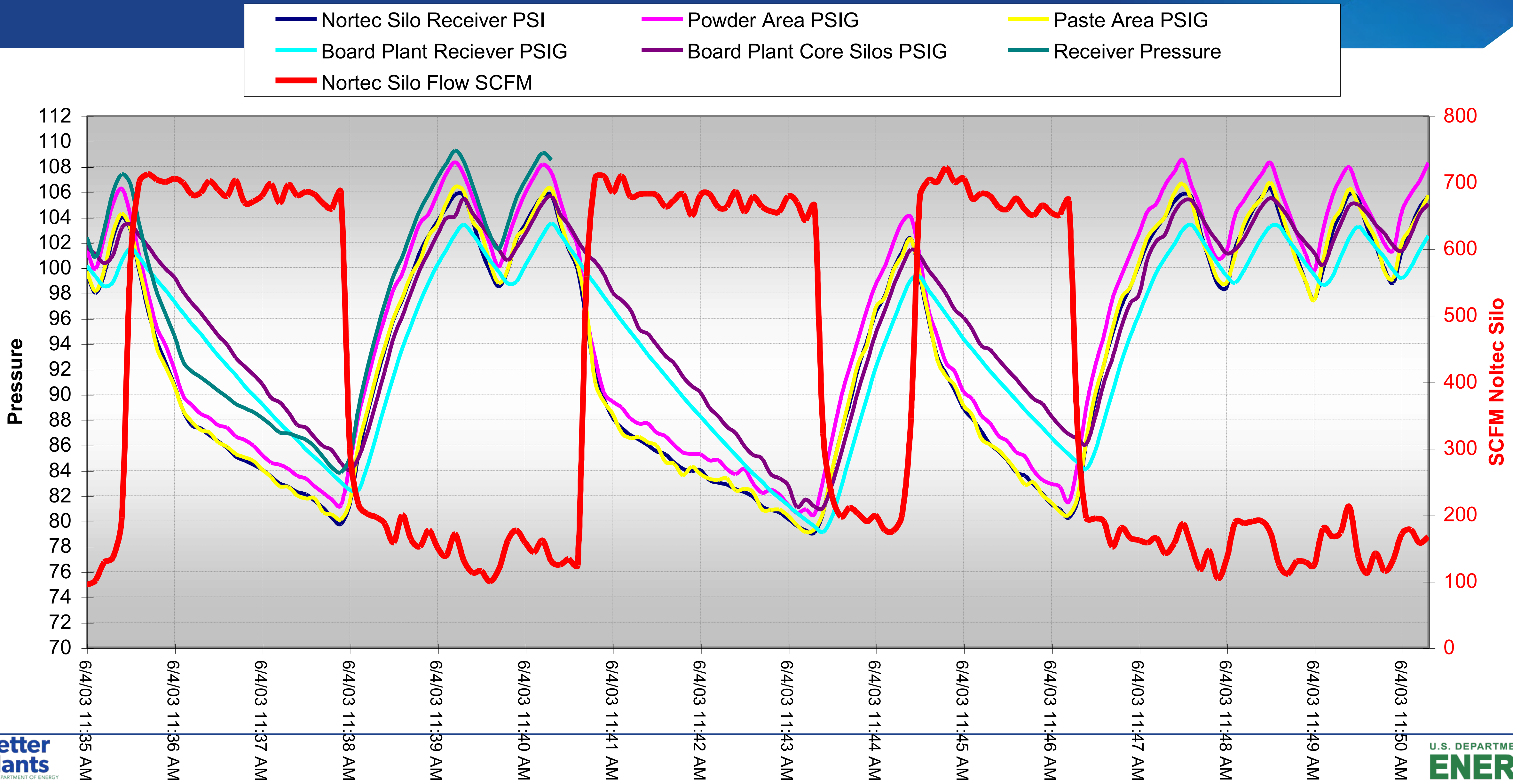
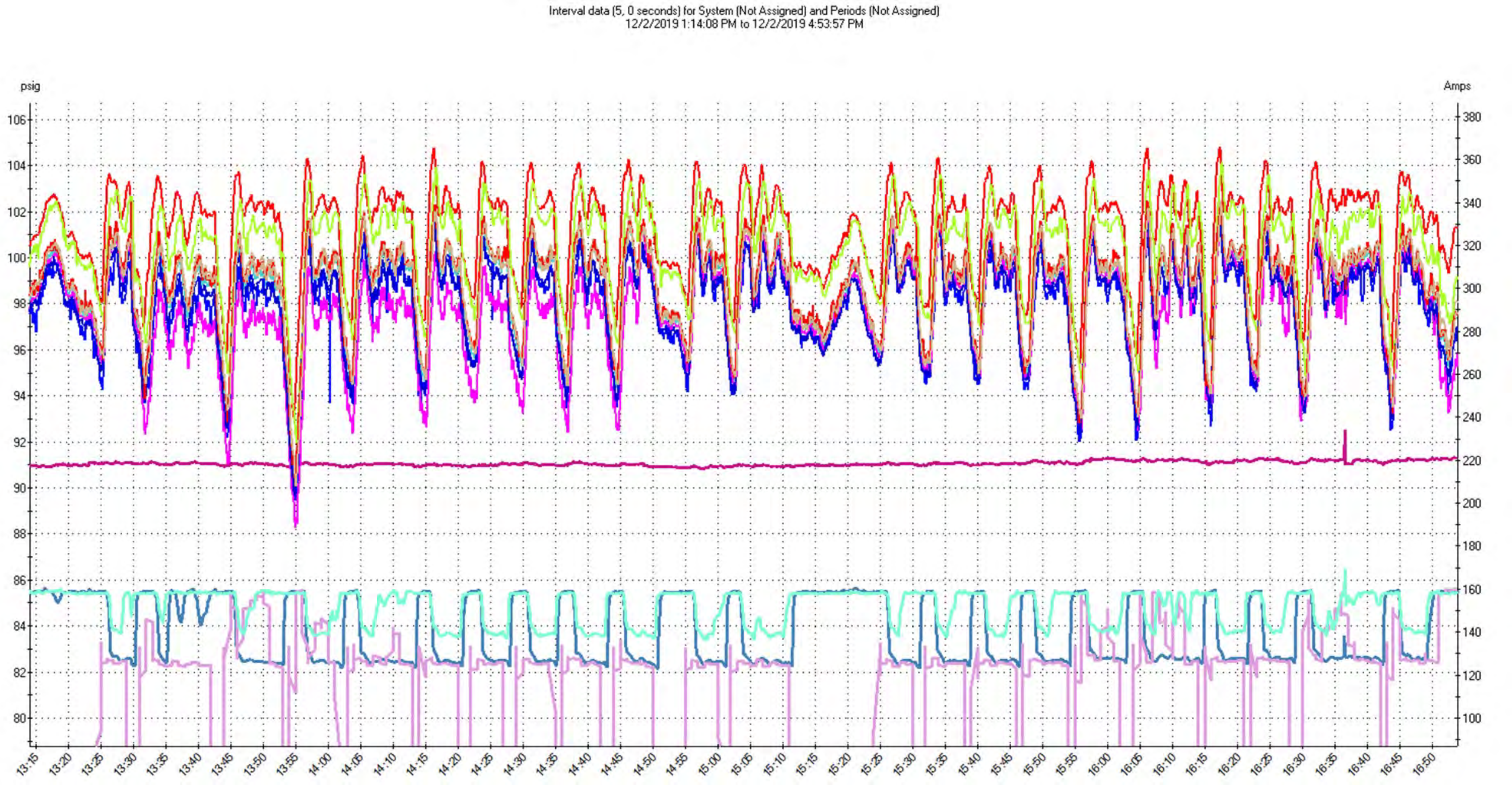
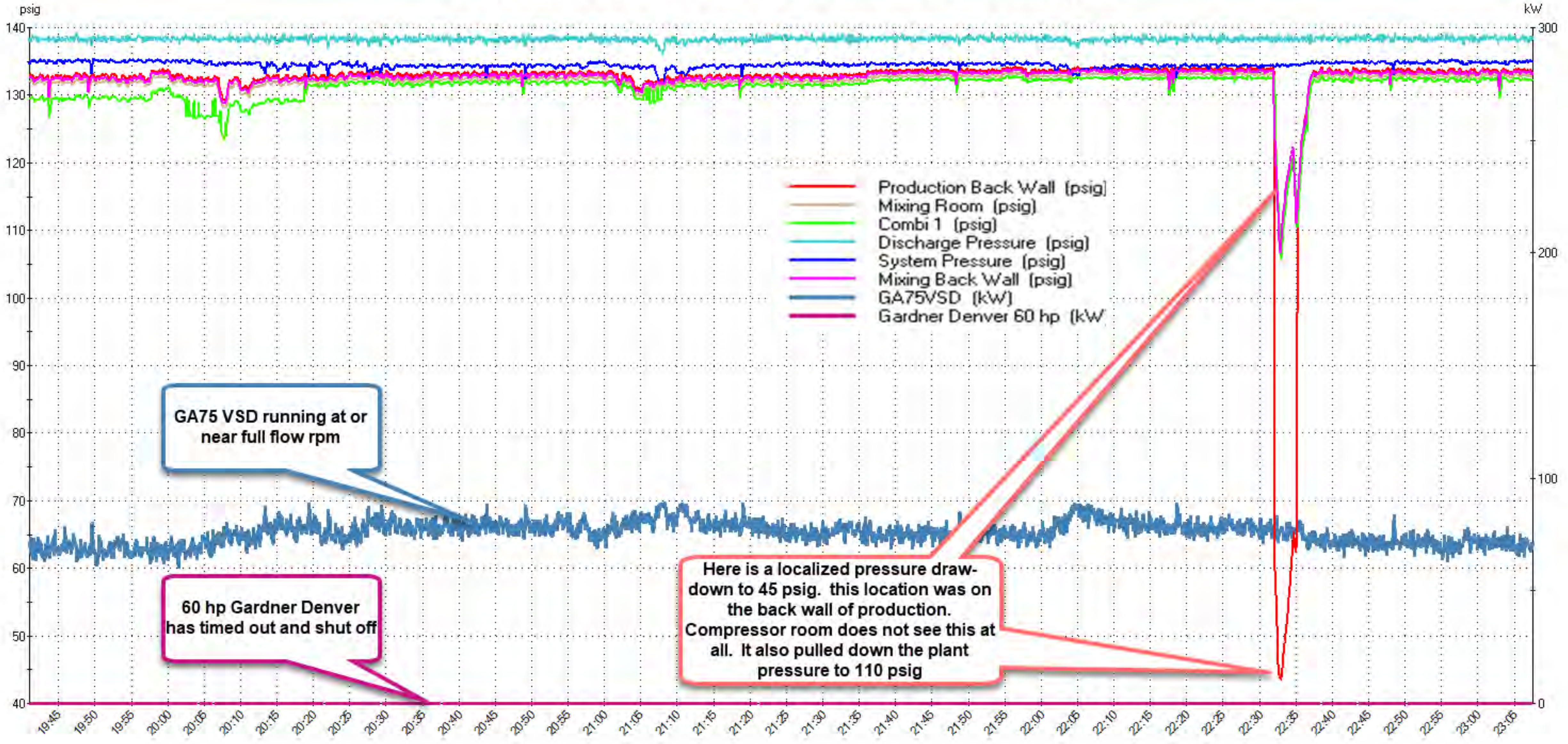


Comparing Pressure and Power

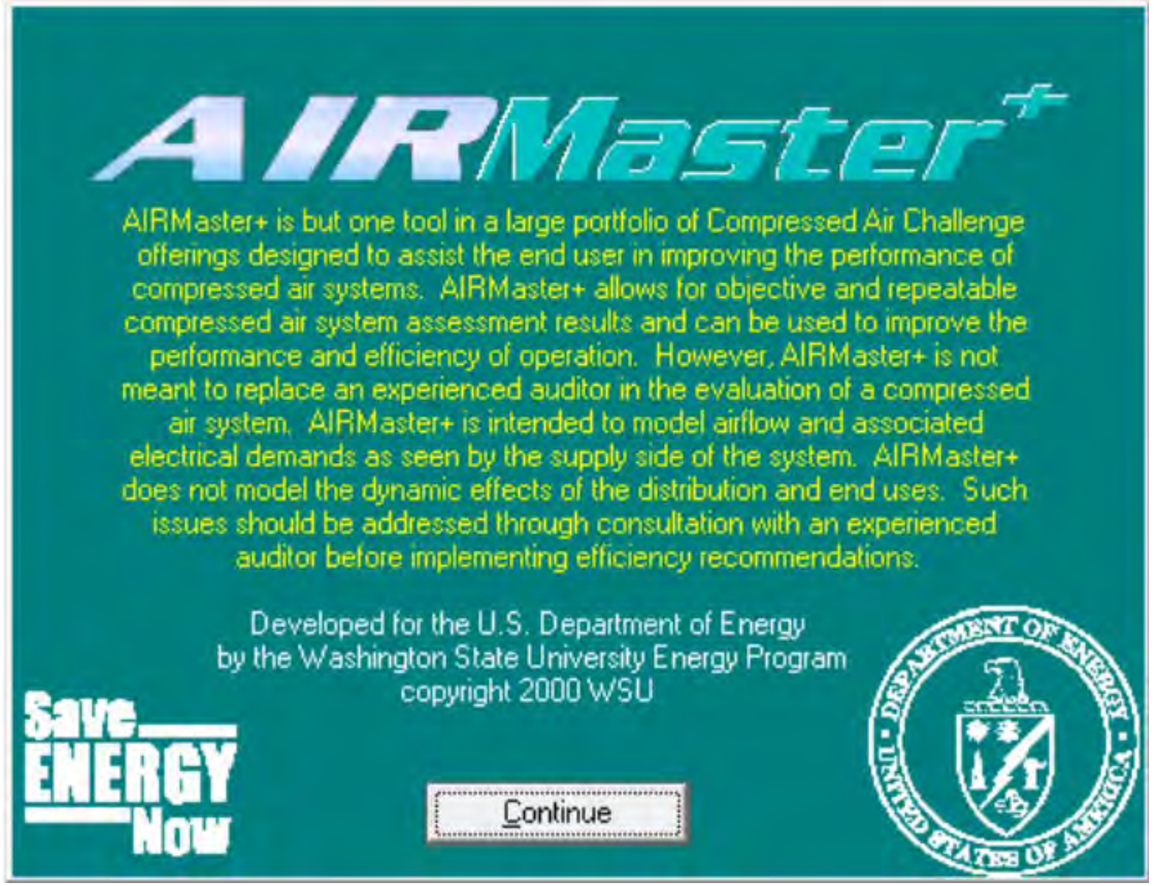


Interval data (4 seconds) for System (Not Assigned) and Periods (Baseline)
1/23/2022 7:41:01 PM to 1/23/2022 11:07:34 PM

Localized Pressure Drawdown During CIP



AIRMaster+ and LogTool



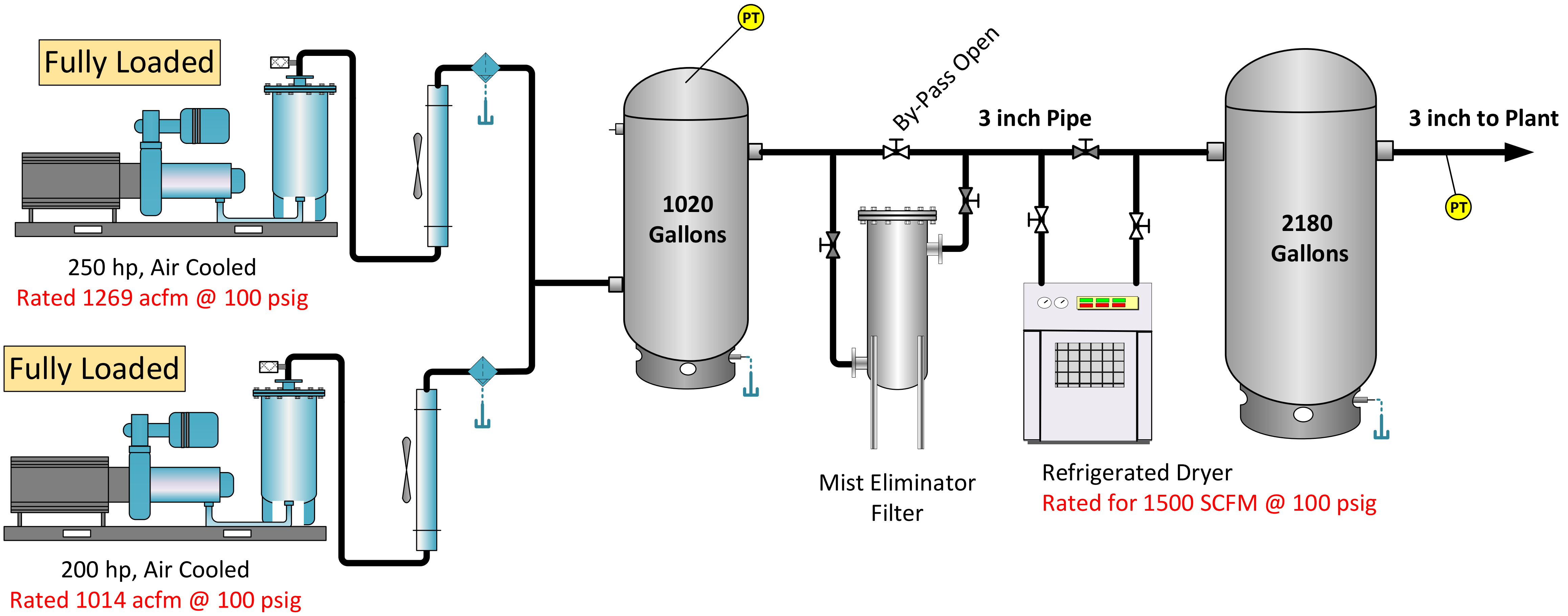
AIRMaster+ Features

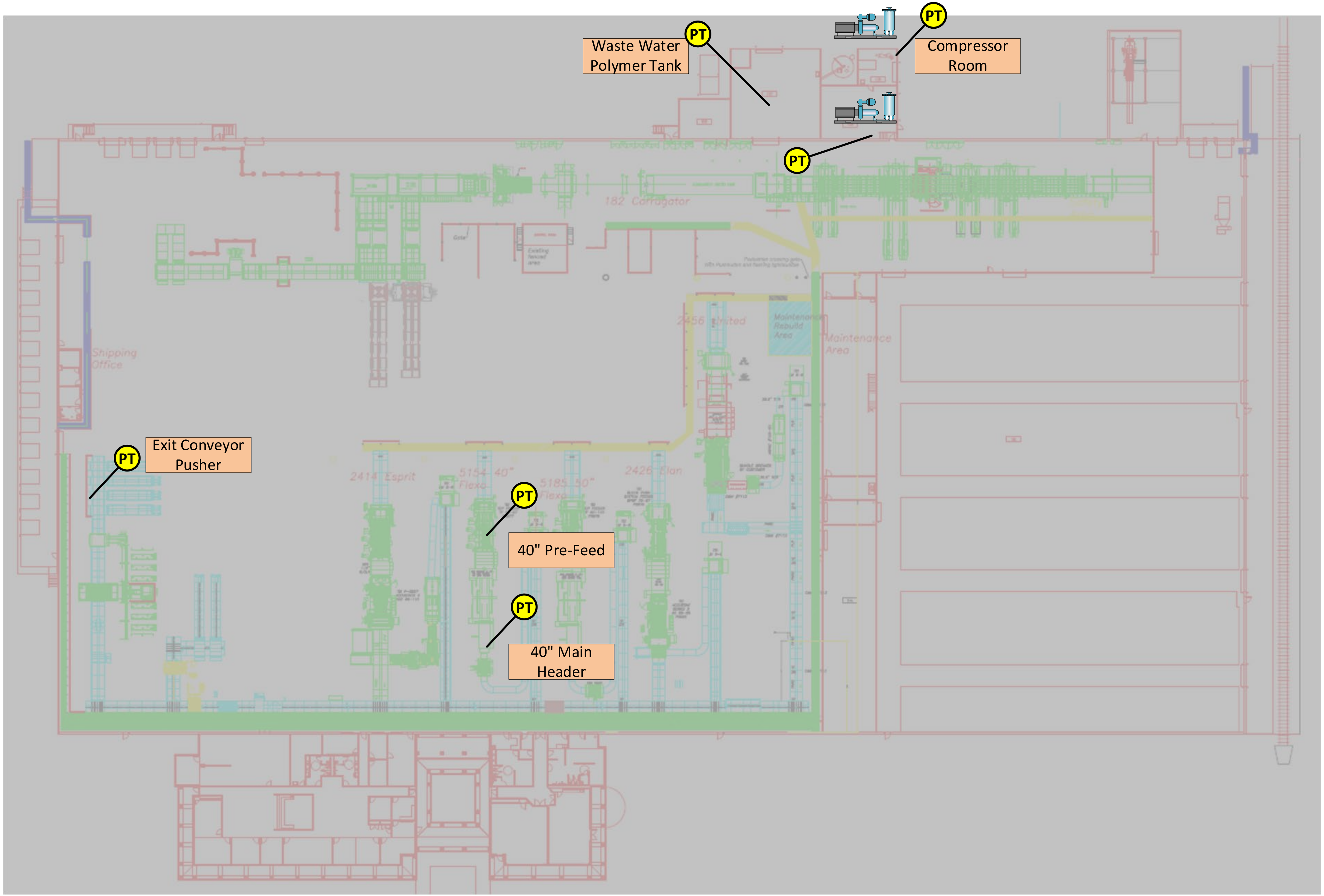
- AIRMaster+ is a Windows-based software tool used to analyze industrial compressed air systems:
- Simulates existing and modified compressed air system operation
- Models part load system operation
- Assigns electrical utility energy schedules
- Enters 24-hour metered airflow or power data
- Is not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

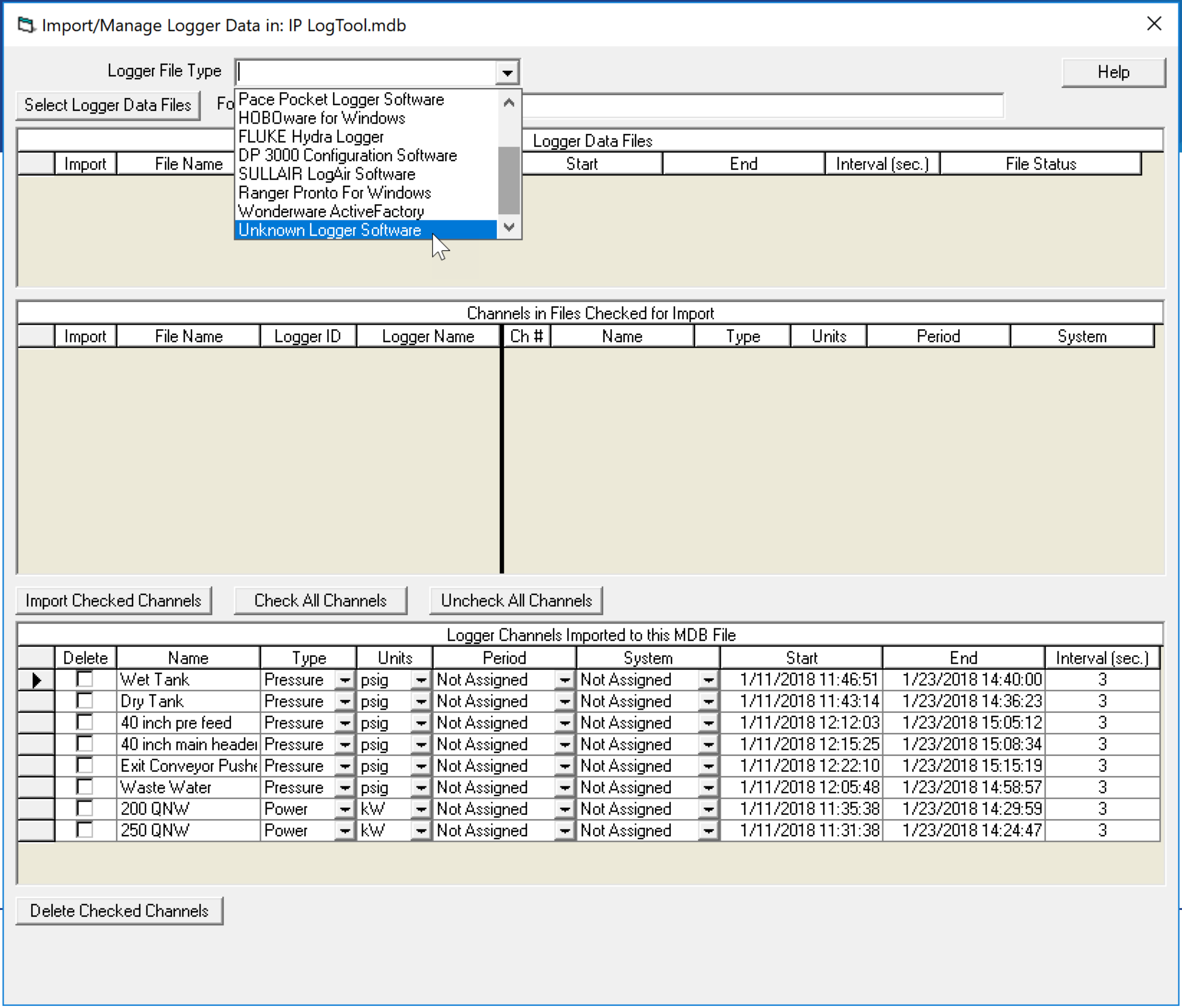
LogTool is Designed To:

- 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+
- The previous charts were all created from LogTool

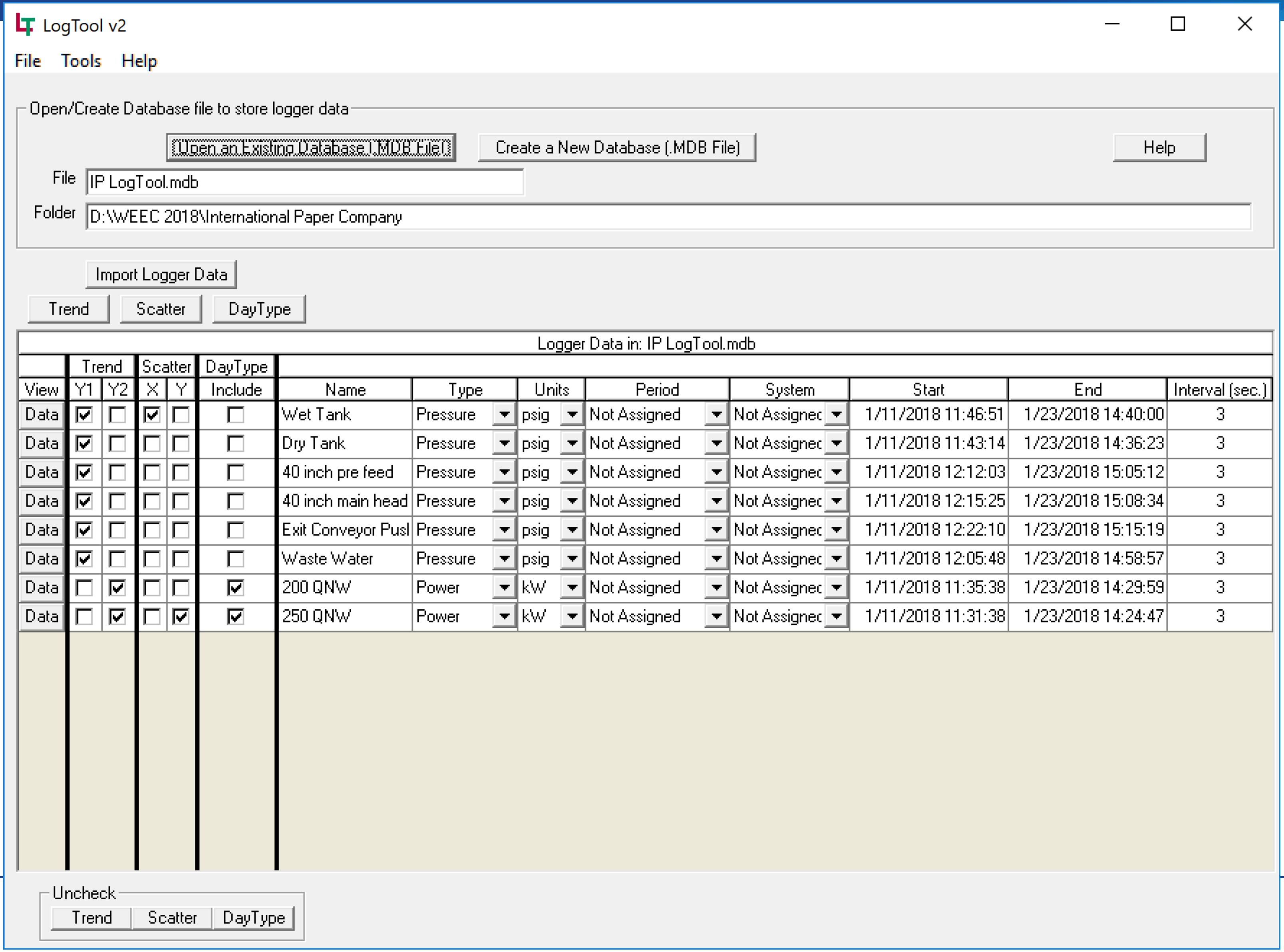
Box Plant Example:




Waste Water Polymer Tank
PT
PT
Compressor Room
PT
182 Corrugator
Shipping Office
2456 United
Maintenance Rebuild Area
Maintenance Area
Exit Conveyor Pusher
PT
2414 Esprit
5154 40" Flexo
5185 50" Flexo
2426 Elan
PT
40" Pre-Feed
PT
40" Main Header


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

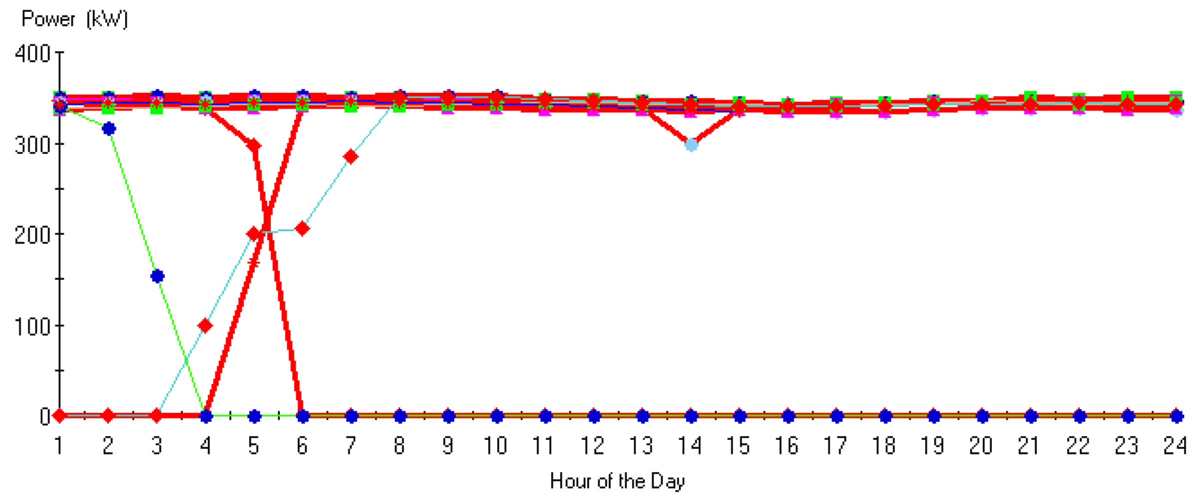
LogTool Main Menu



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...

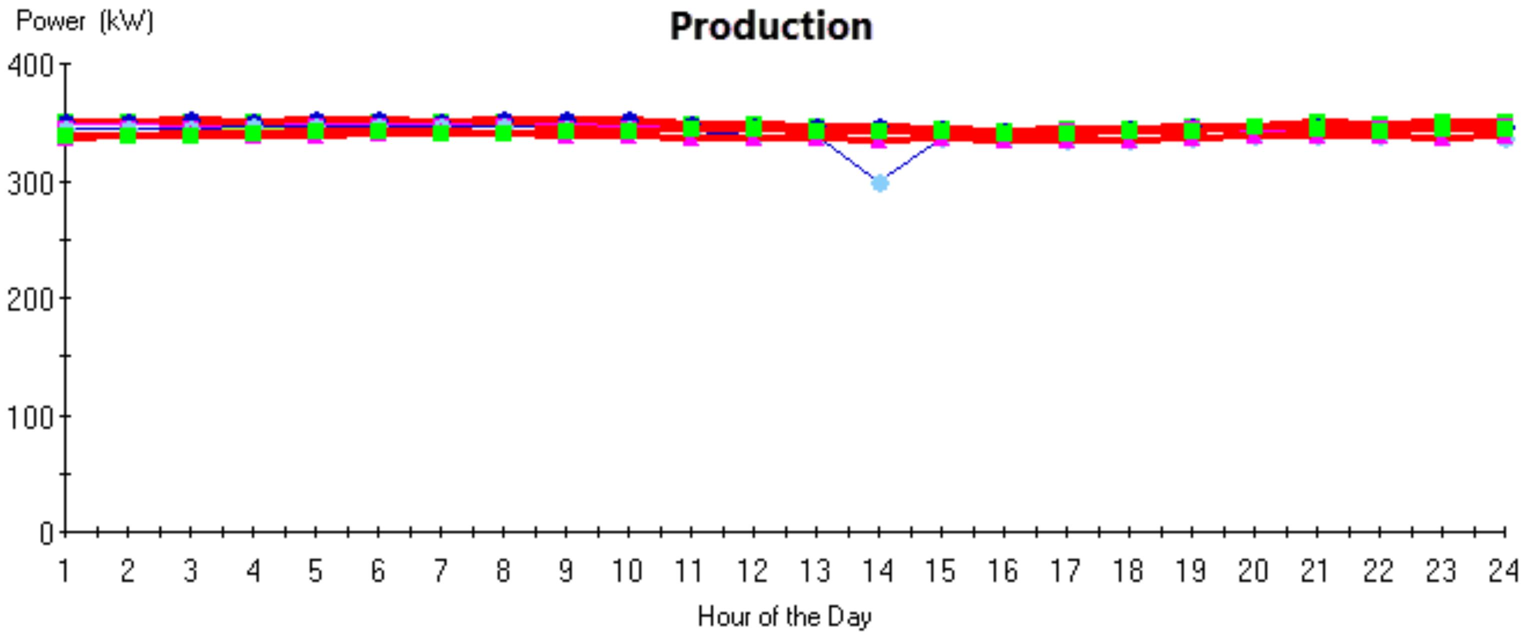
Caution: Day profiles can be similar even though different equipment, e.g., compressors, is operating. Use Trend Plots to examine the details of equipment operation before determining whether days should be assigned to the same daytype.

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

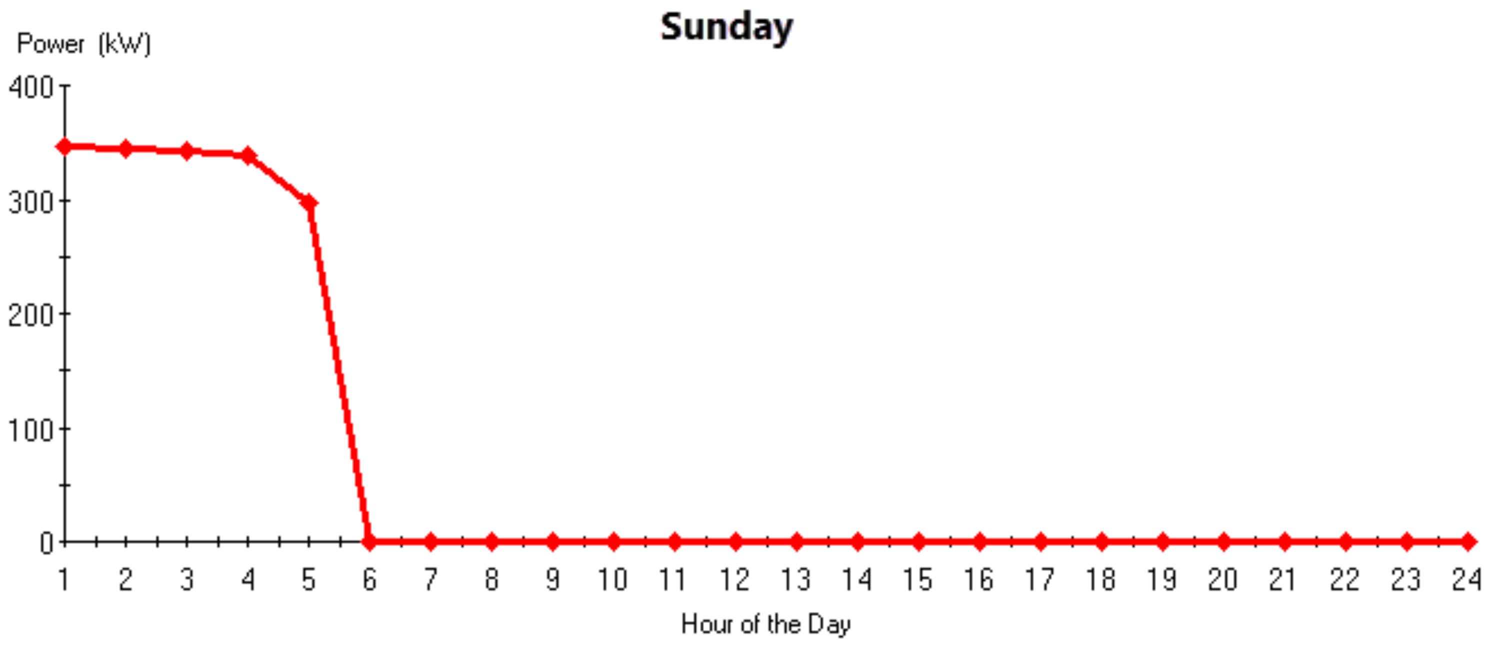
System DayType Profiles

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

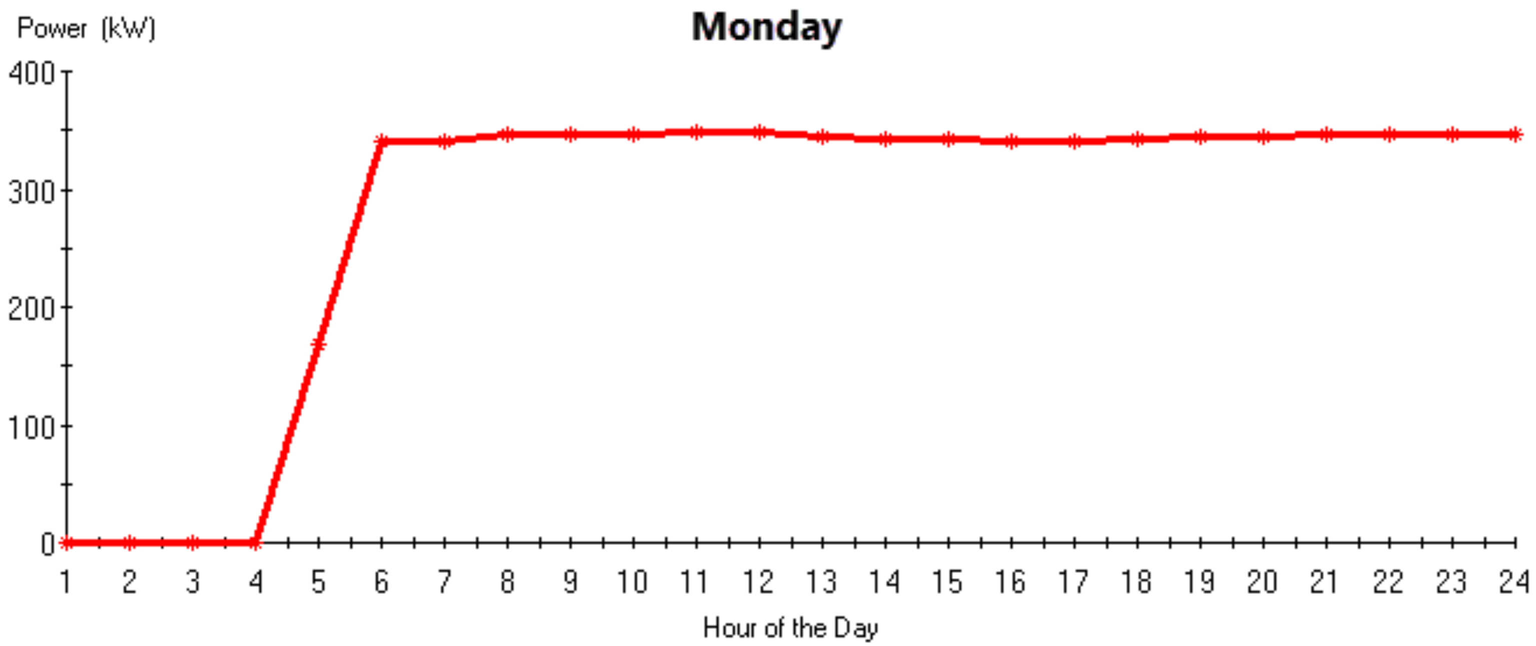
DayType Profiles



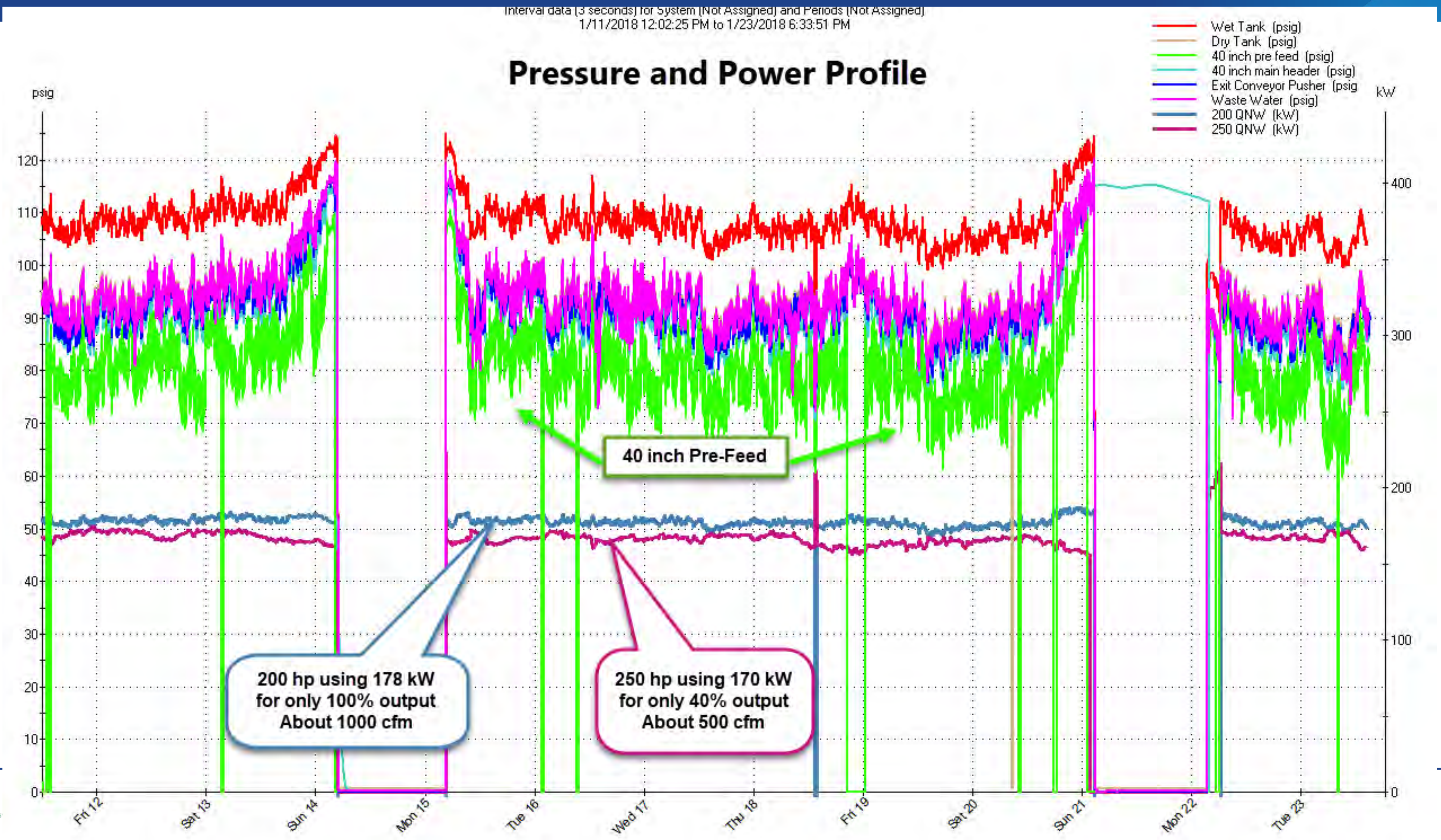
DayType Profiles



DayType Profiles



LogTool Trend Plot



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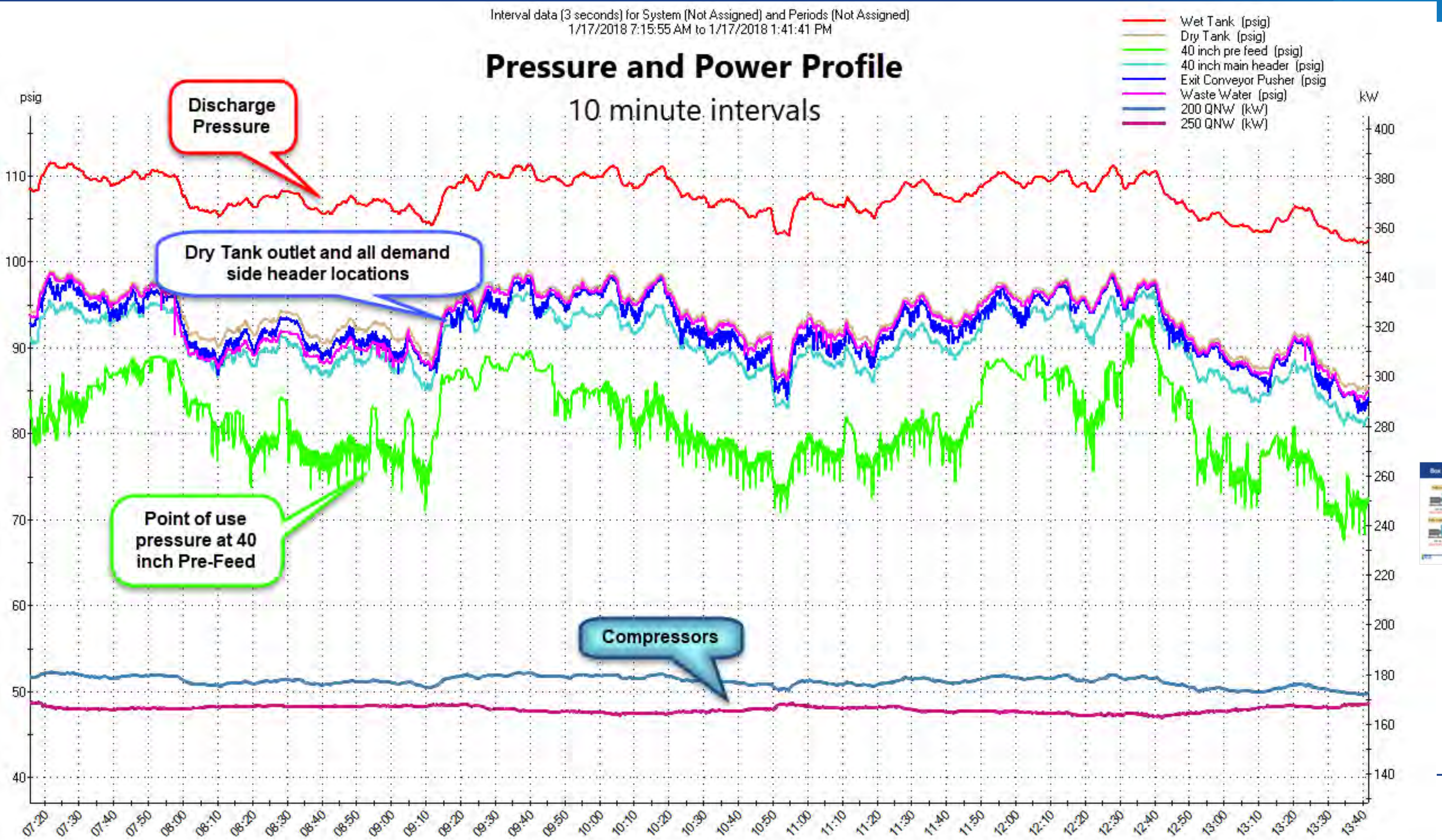
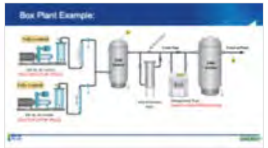
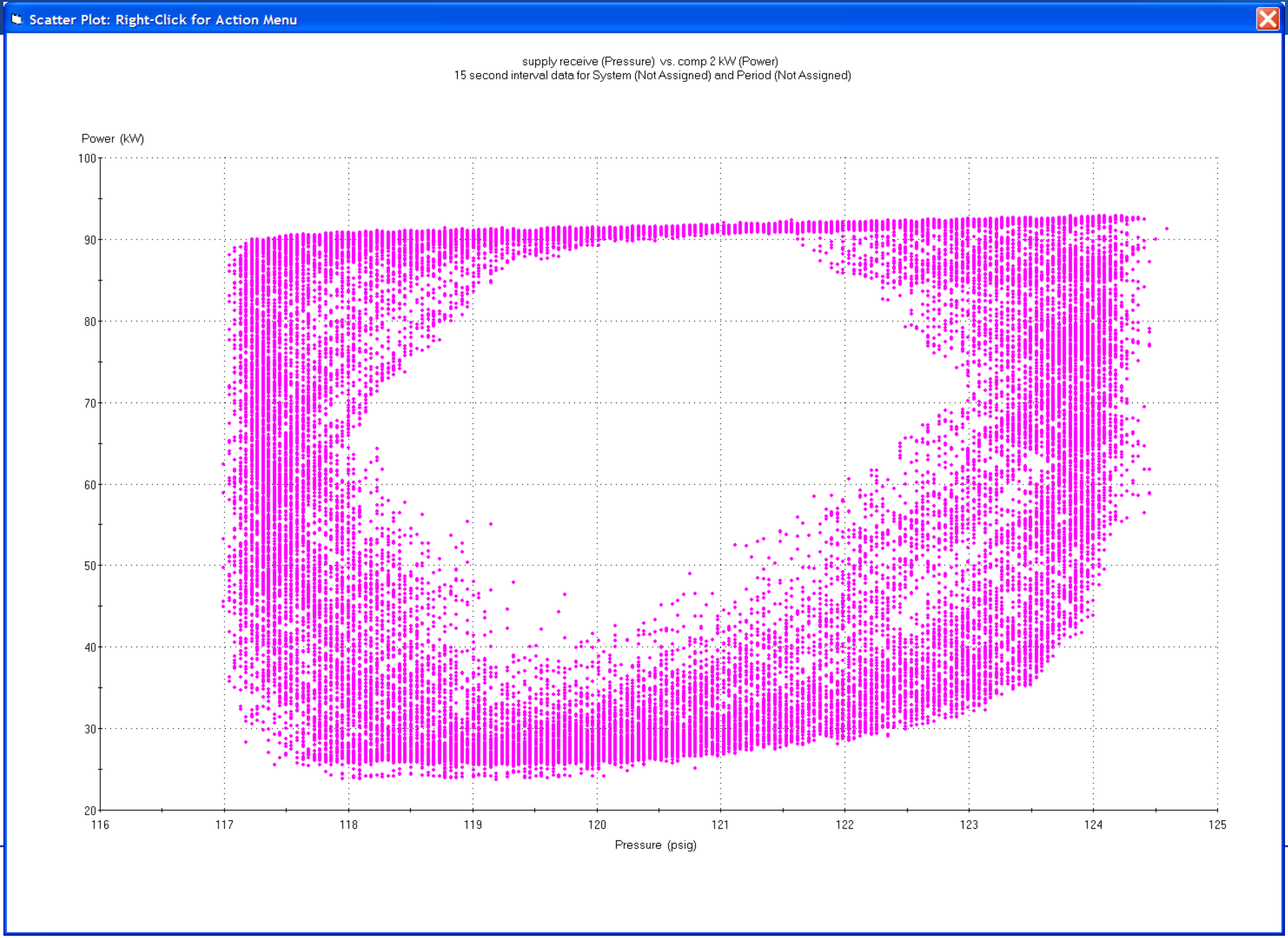
LogTool Trend Plot

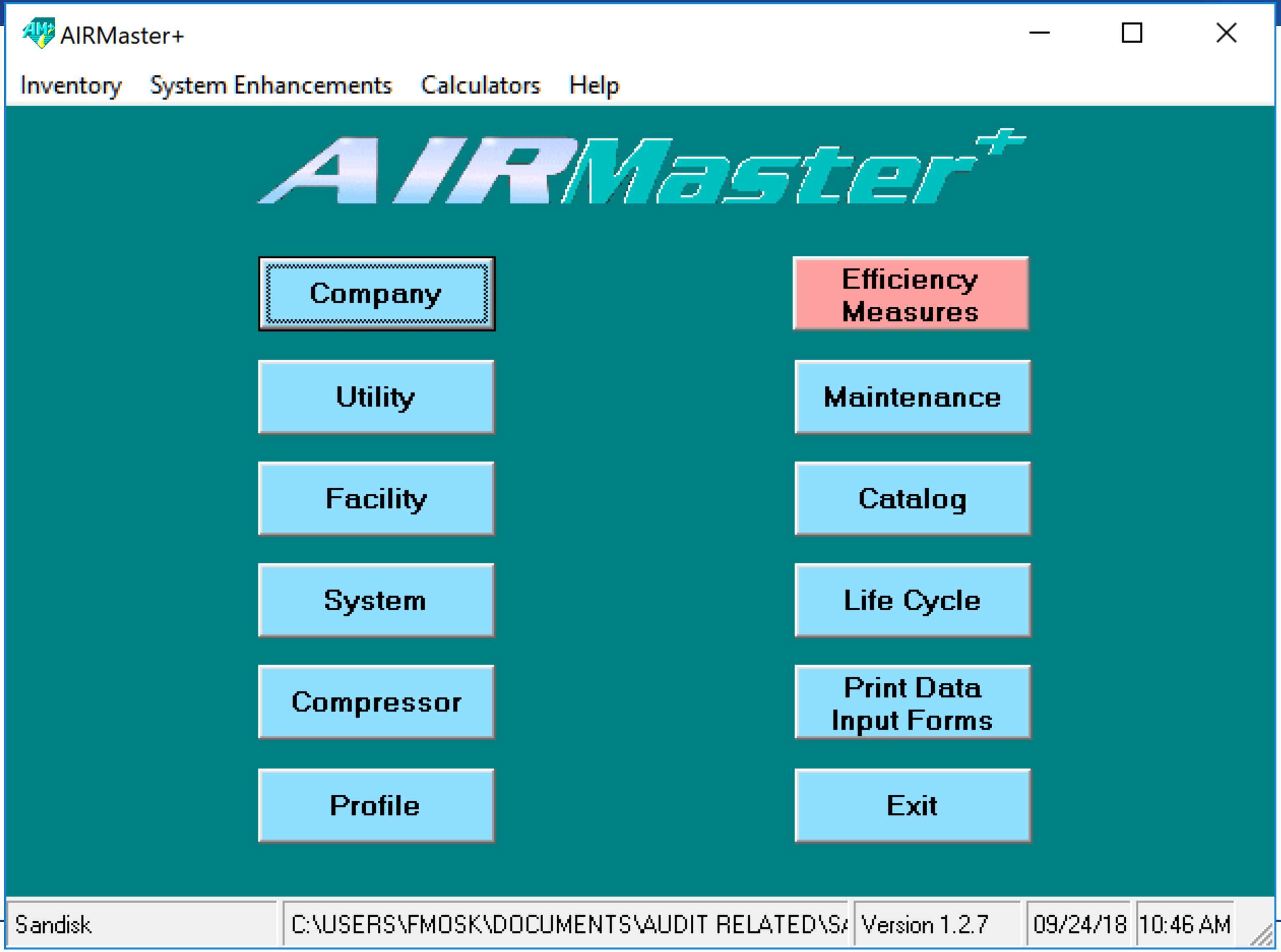




LogTool Scatter Plot

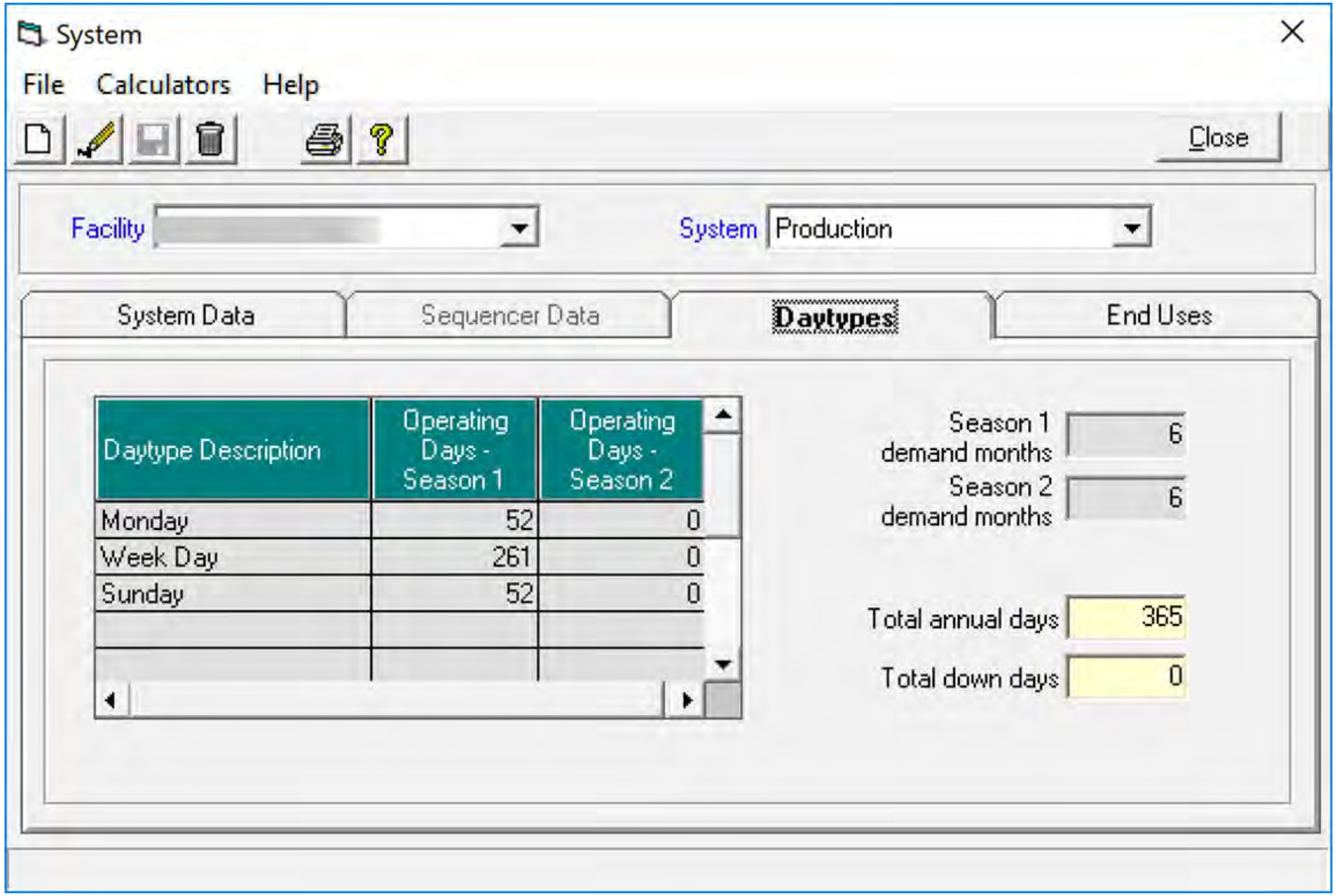


AIRMaster+ Main Menu

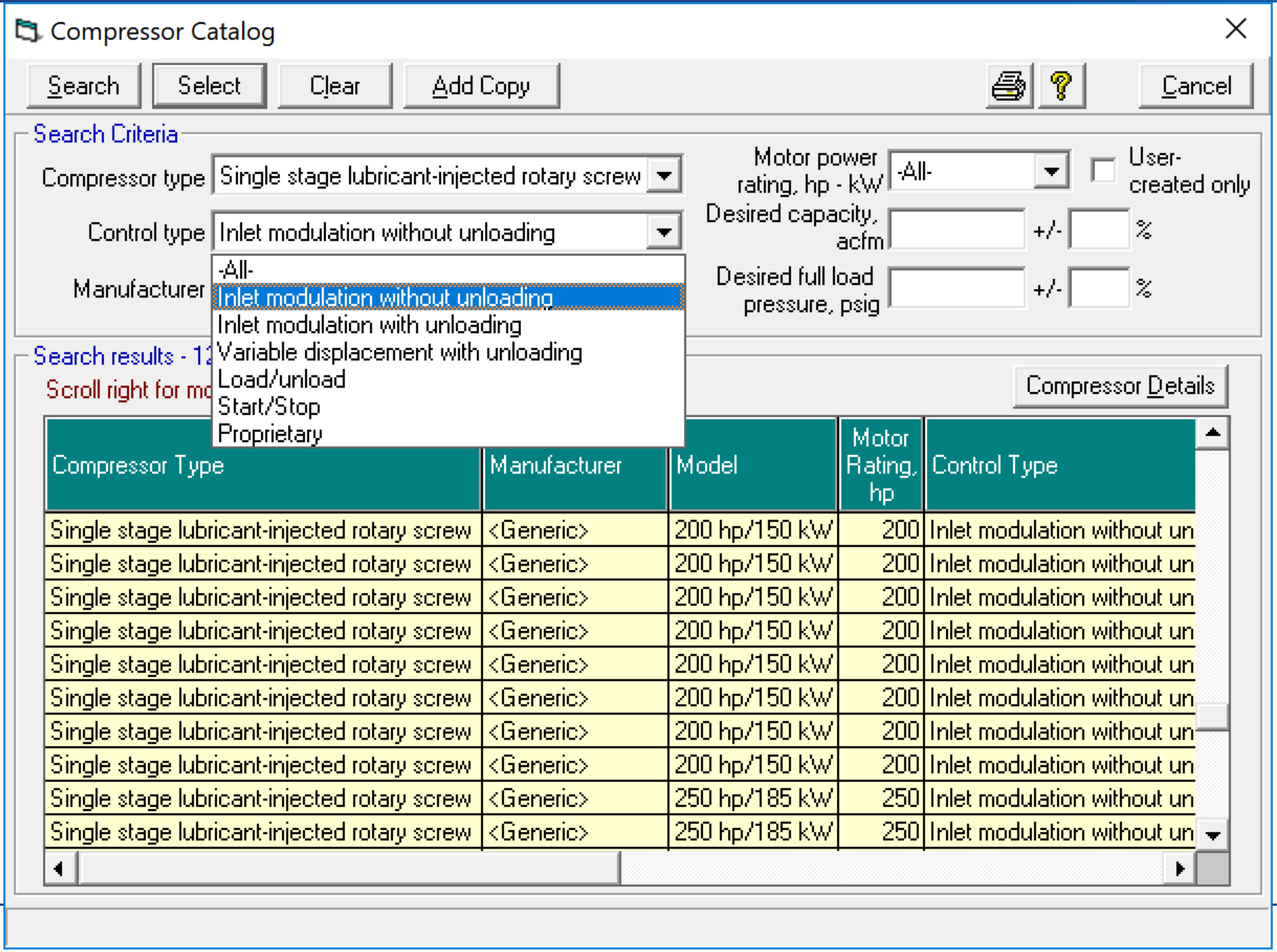


AIRMaster+ Energy Efficiency Measures

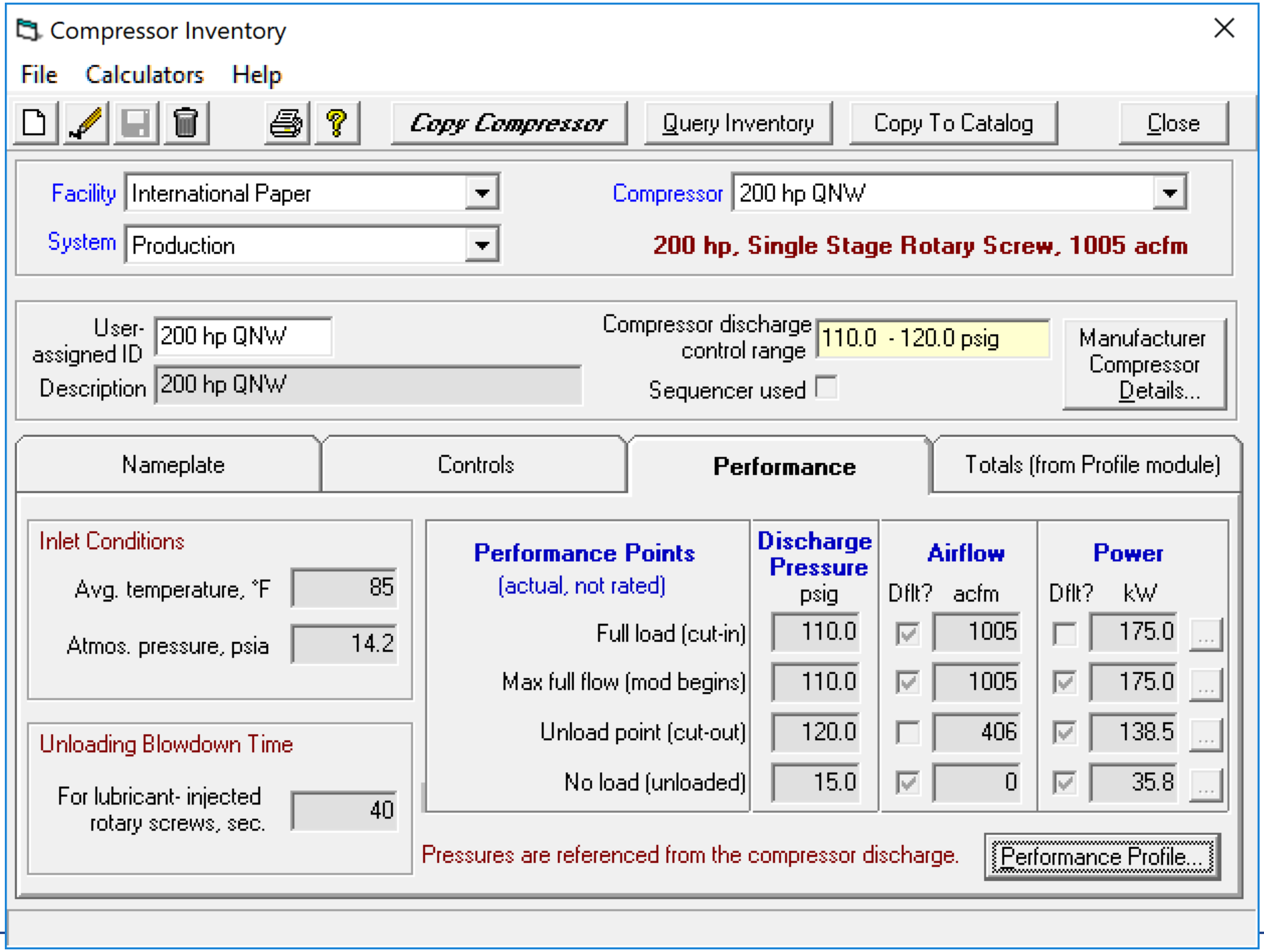
1. Reduce Air Leaks
2. Improve End Use Efficiency
3. Reduce System Air Pressure
4. Use Unloading Controls
5. Adjust Cascading Set Points
6. Use Automatic Sequencer
7. Reduce Run Time
8. Add Primary Receiver Volume



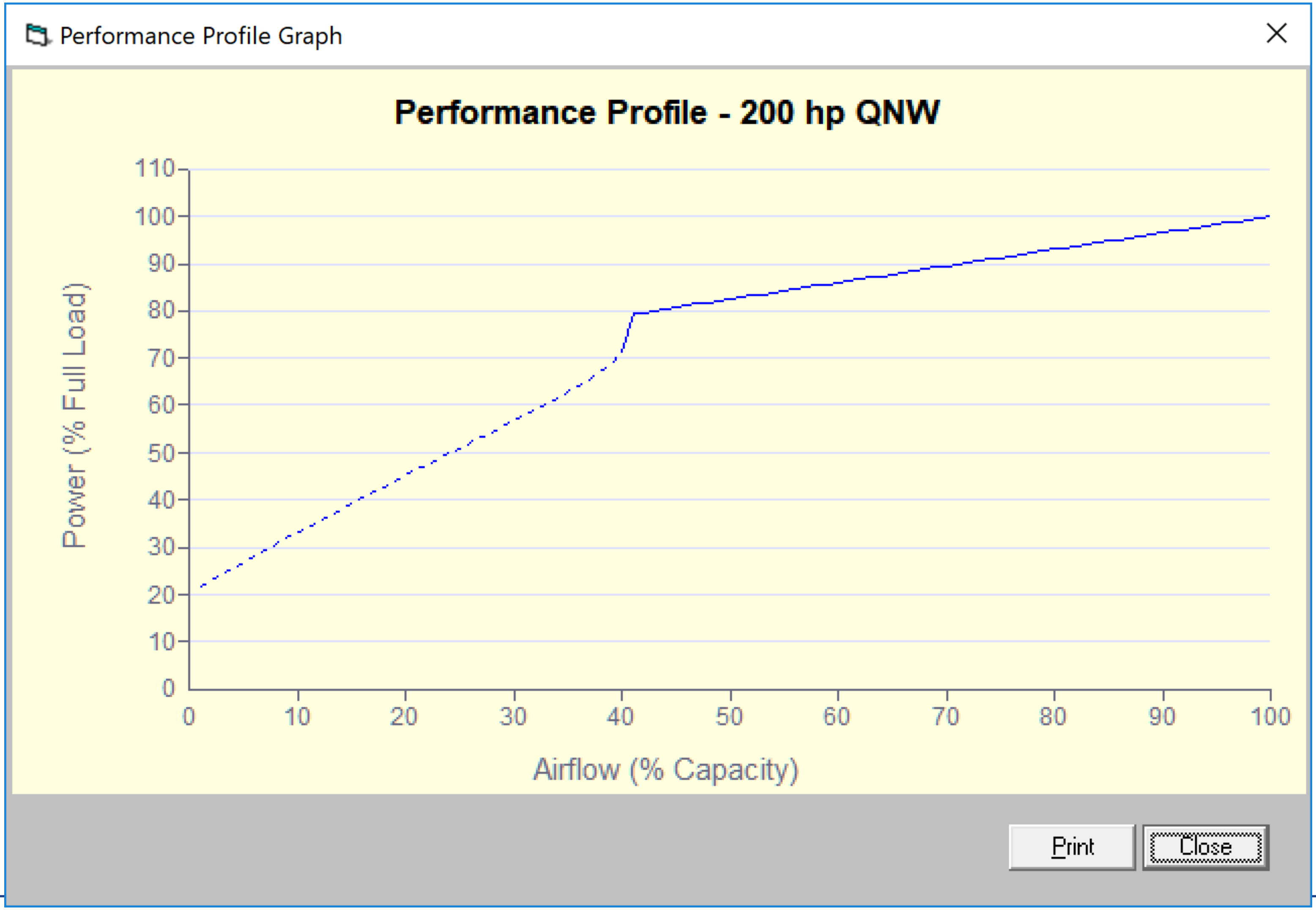
Compressor Information



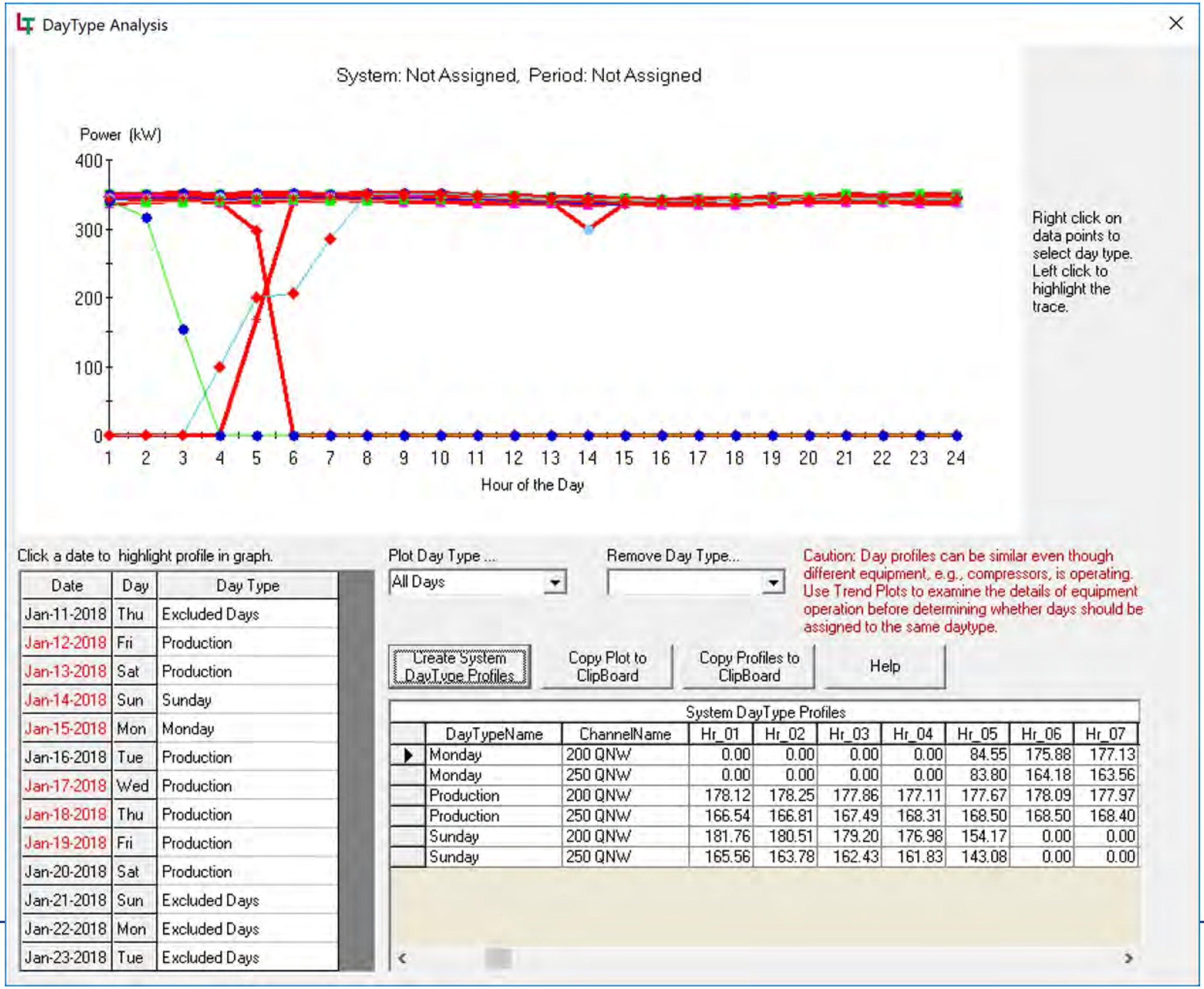
Compressor Information



Compressor Information



Create the baseline from the Data



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

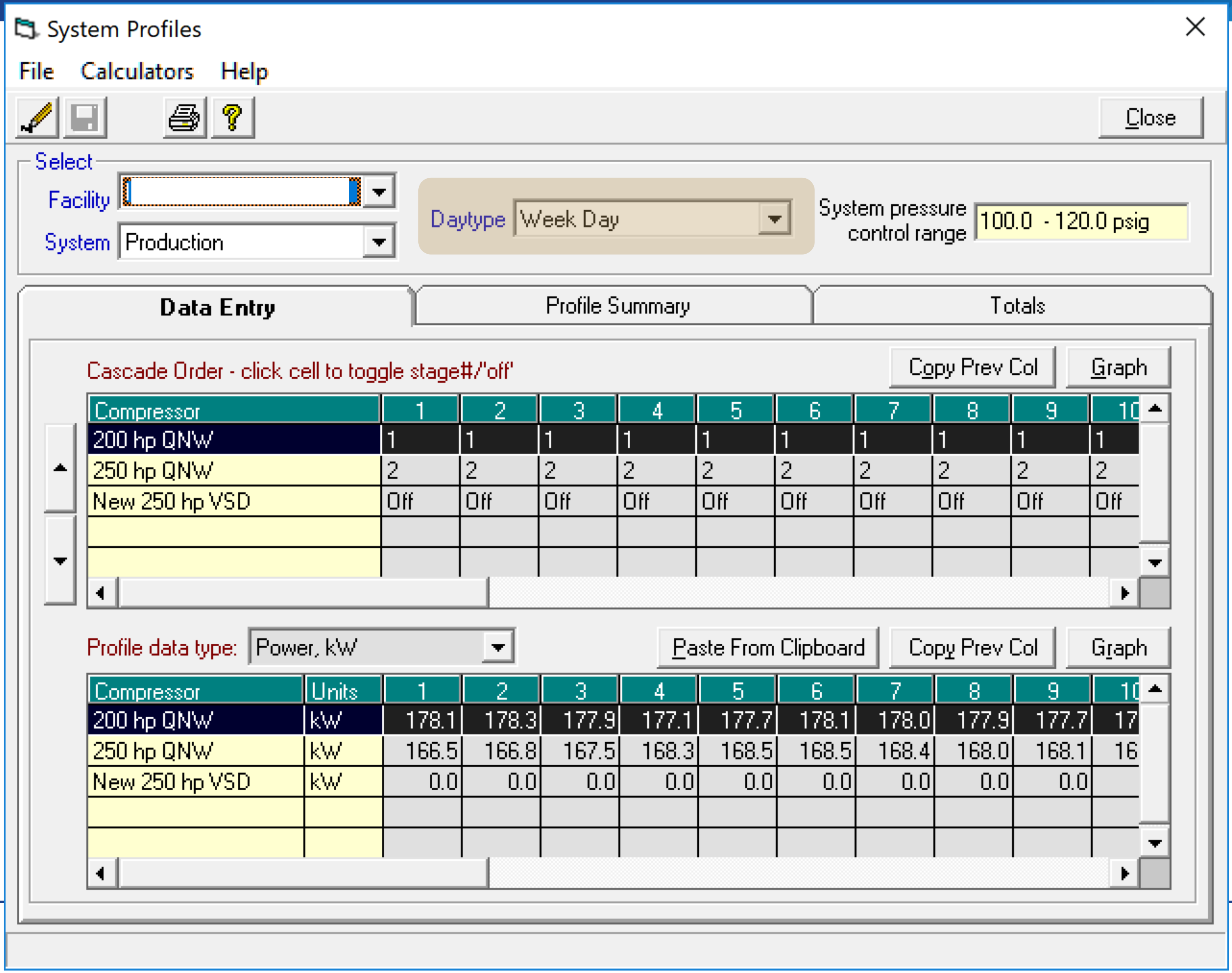
DayTypeName	ChannelName	Hr_01	Hr_02	Hr_03	Hr_04	Hr_05	Hr_06	Hr_07
Monday	200 QNW	0.00	0.00	0.00	0.00	84.55	175.88	177.13
Monday	250 QNW	0.00	0.00	0.00	0.00	83.80	164.18	163.56
Production	200 QNW	178.12	178.25	177.86	177.11	177.67	178.09	177.97
Production	250 QNW	166.54	166.81	167.49	168.31	168.50	168.50	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

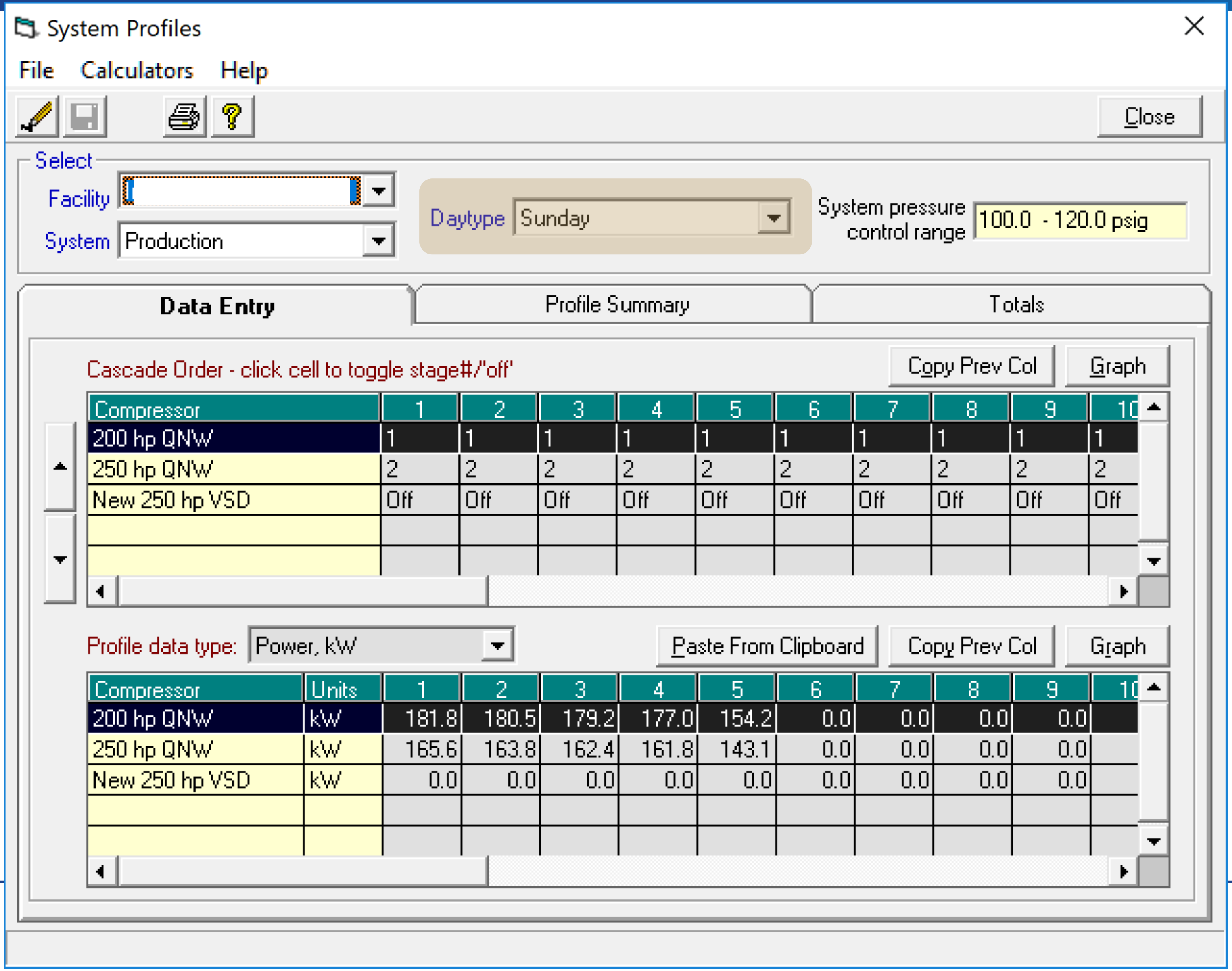
DayTypeName	ChannelName	Hr_01	Hr_02	Hr_03	Hr_04	Hr_05	Hr_06	Hr_07	Hr_08	Hr_09	Hr_10	Hr_11	Hr_12	Hr_13	Hr_14	Hr_15	Hr_16	Hr_17	Hr_18	Hr_19	Hr_20	Hr_21	Hr_22	Hr_23	Hr_24
Monday	200 QNW	0.0	0.0	0.0	0.0	84.6	175.9	177.1	181.6	182.2	180.8	177.2	177.7	177.0	178.6	178.7	178.7	176.9	177.0	178.2	177.2	178.7	179.6	180.1	179.3
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
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
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
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
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-11-2018	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

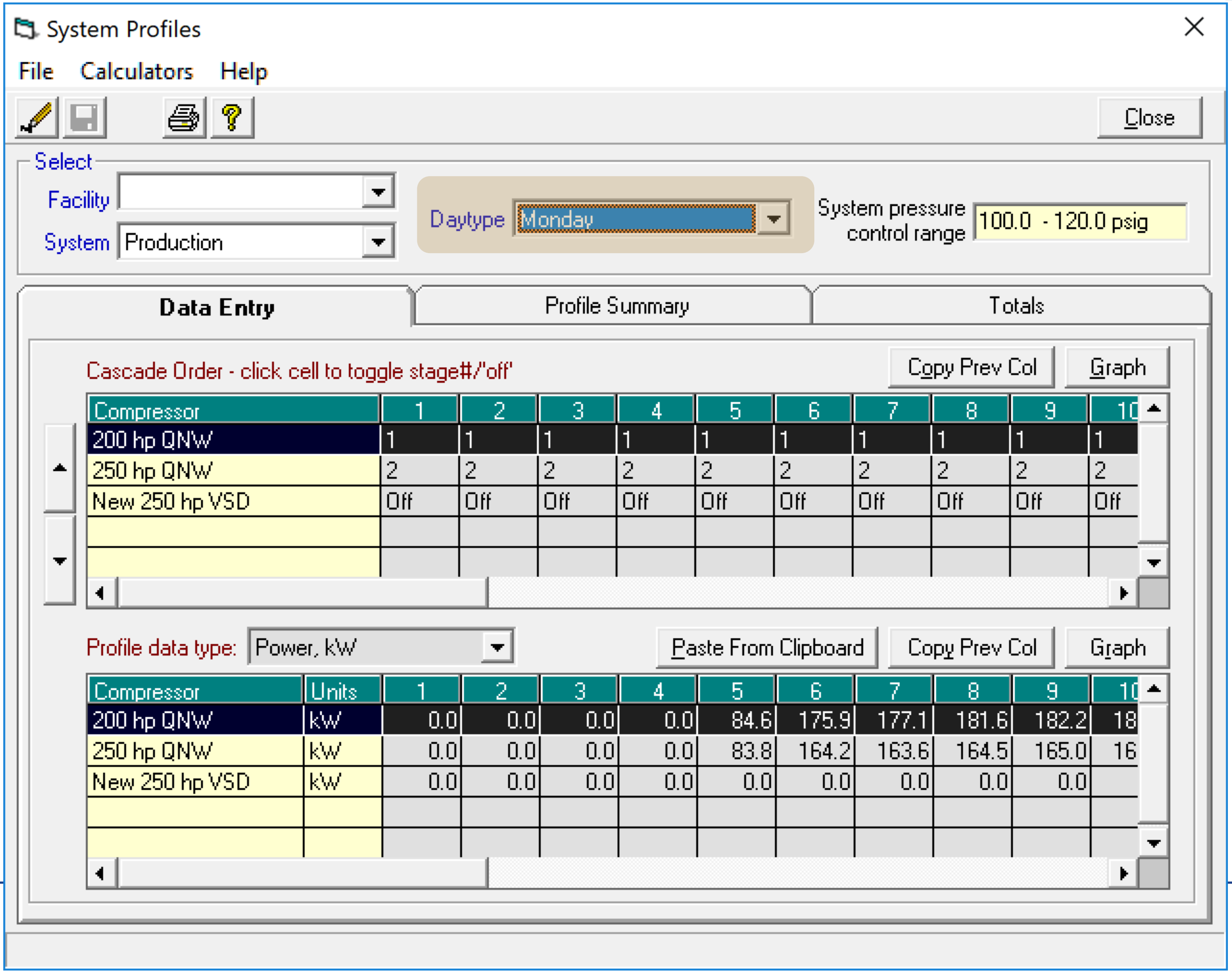
Enter LogTool Data Into AIRMaster



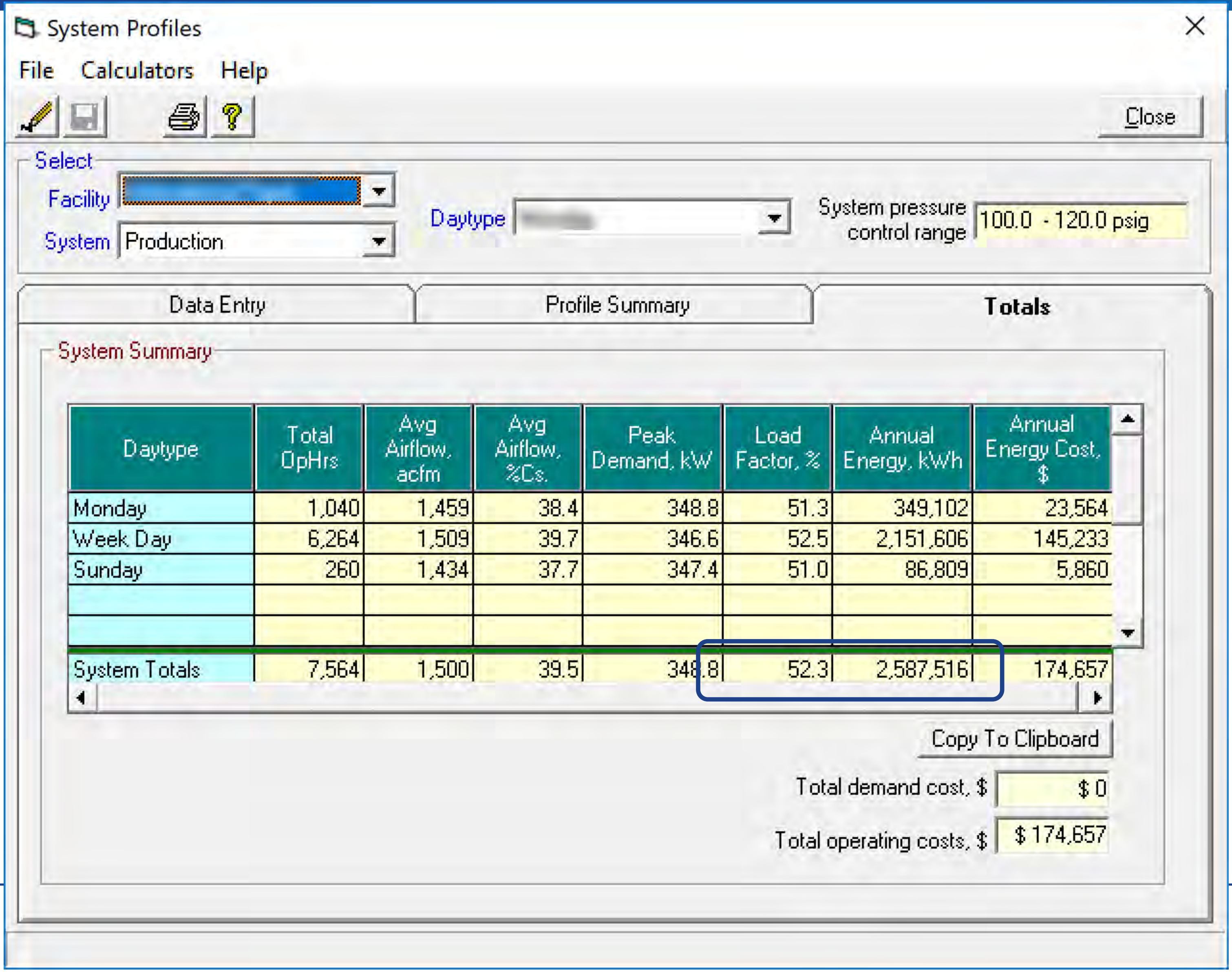
Enter LogTool Data Into AIRMaster



Enter LogTool Data Into AIRMaster

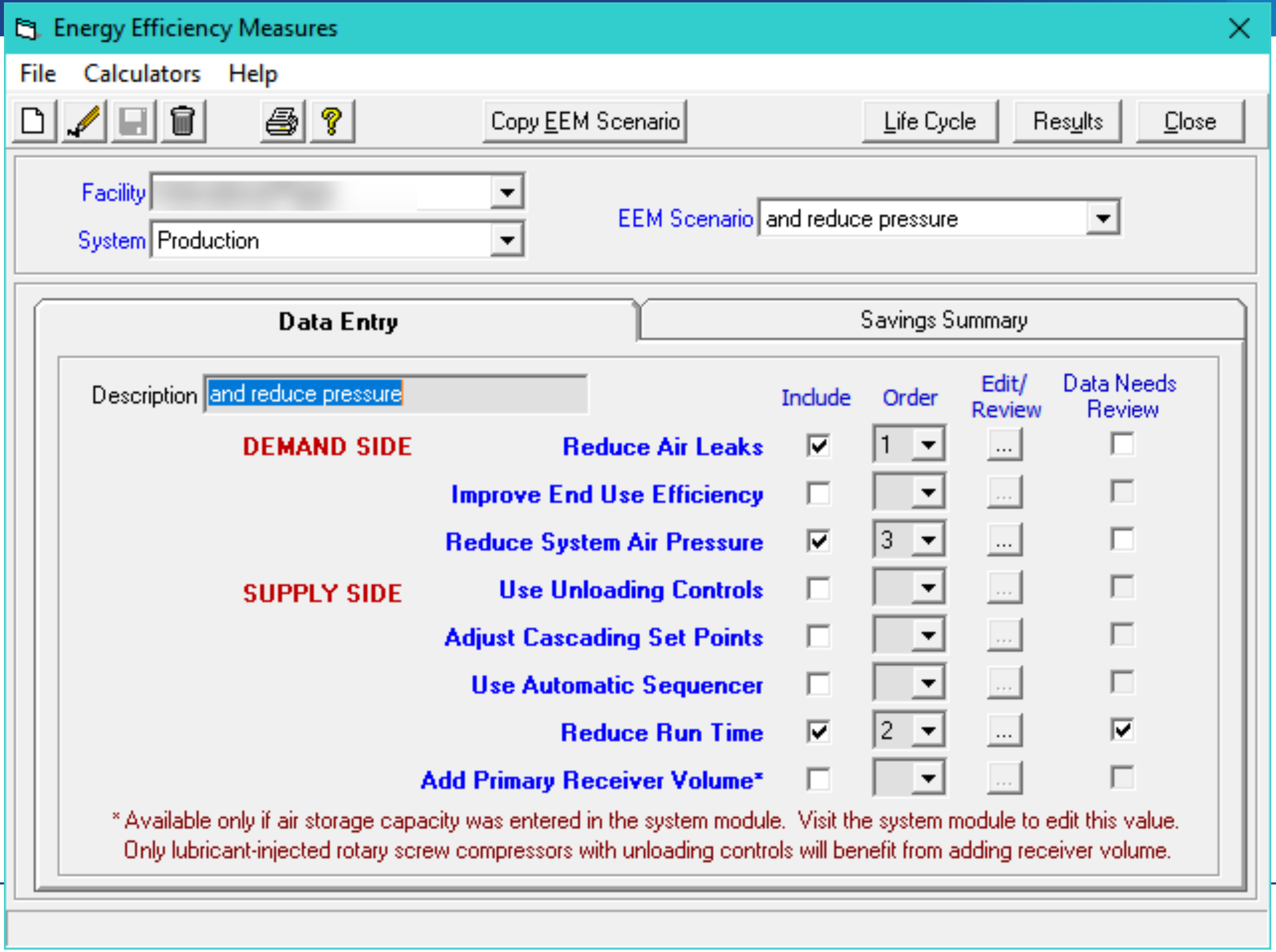


The Baseline

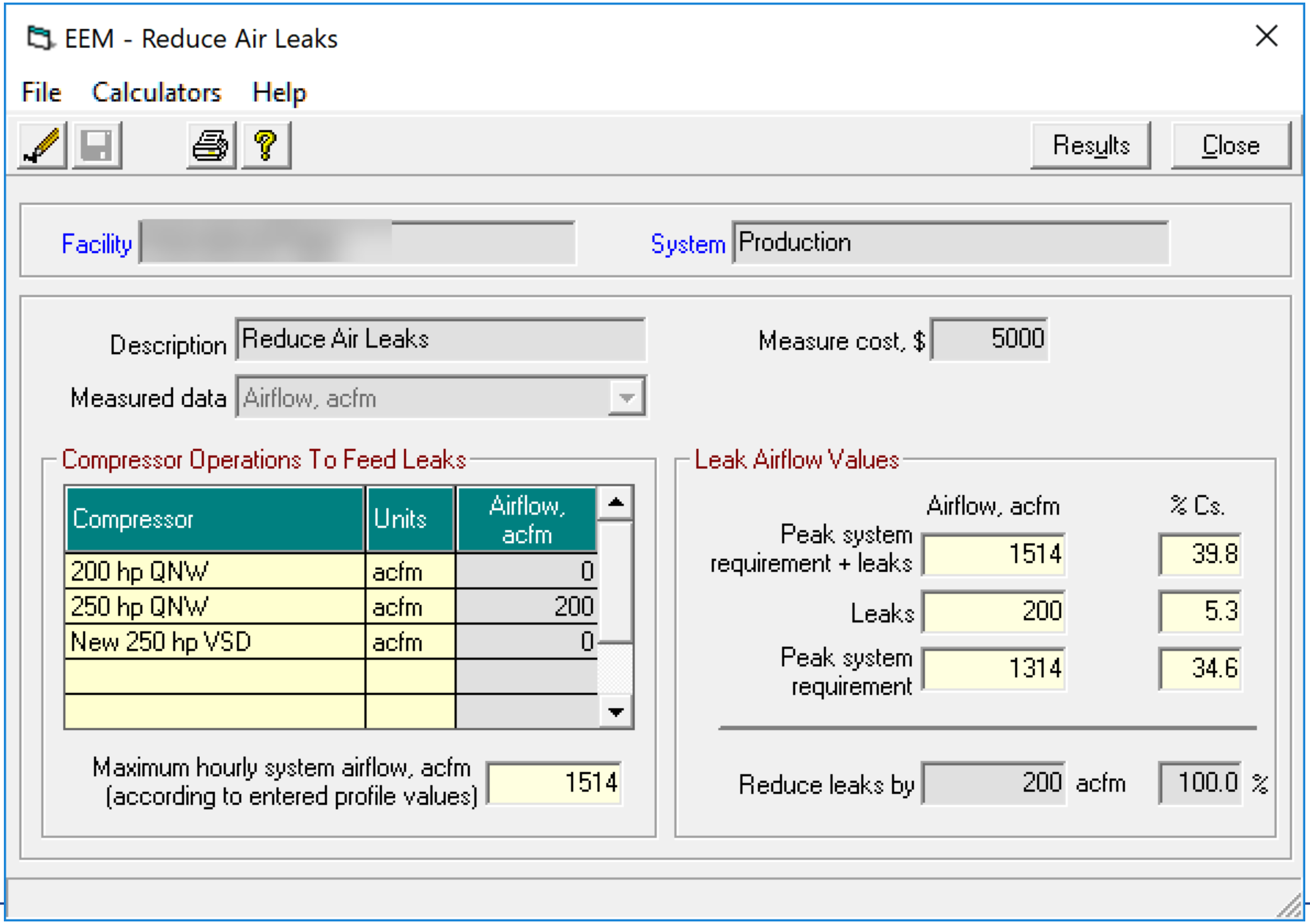


Daytype	Total OpHrs	Avg Airflow, acfm	Avg Airflow, %Cs	Peak Demand, kW	Load Factor, %	Annual Energy, kWh	Annual Energy Cost, $
Monday	1,040	1,459	38.4	348.8	51.3	349,102	23,564
Week Day	6,264	1,509	39.7	346.6	52.5	2,151,606	145,233
Sunday	260	1,434	37.7	347.4	51.0	86,809	5,860
System Totals	7,564	1,500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

EEM’s

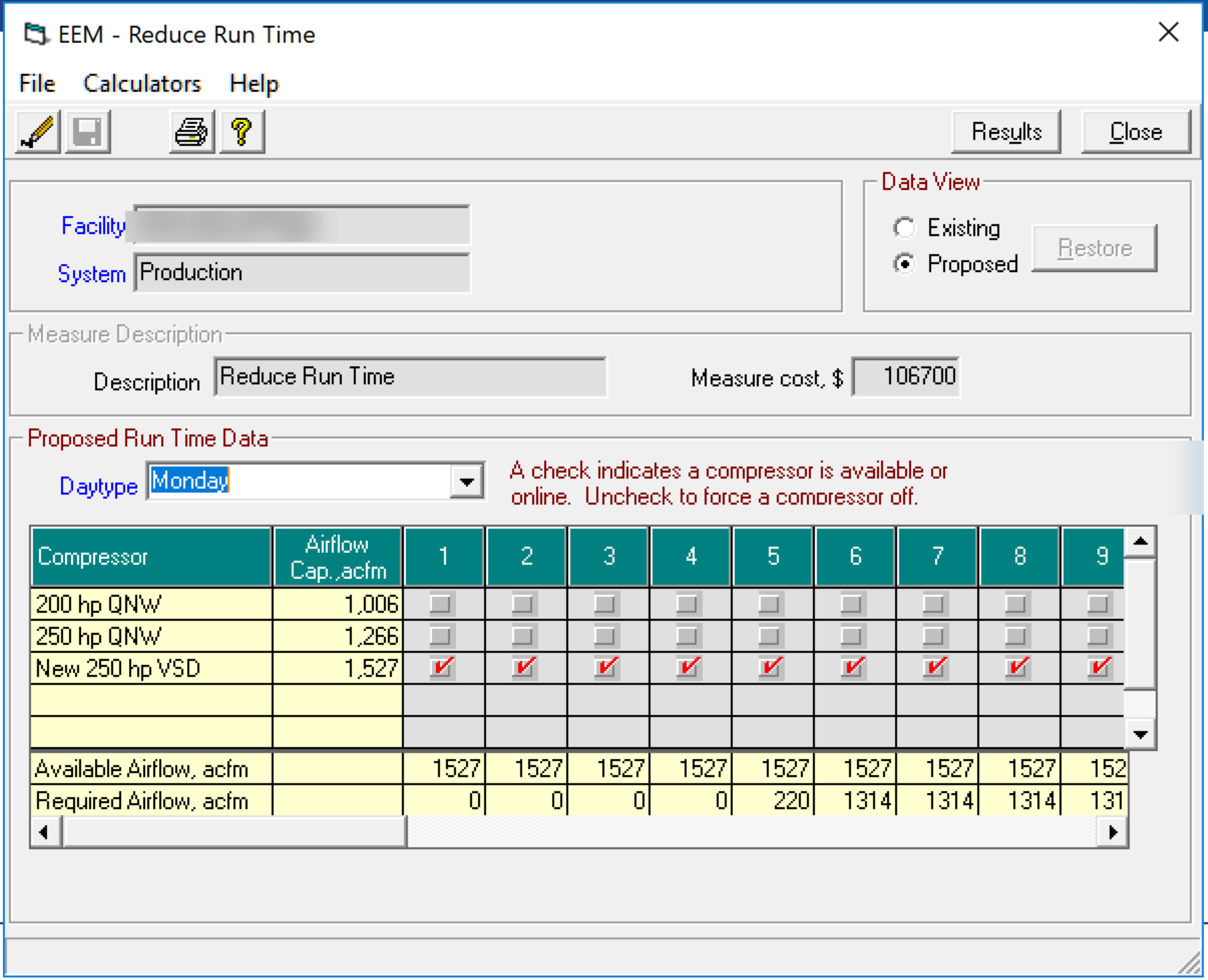

Energy Efficiency Measures
File
Calculators
Help
Copy EEM Scenario
Life Cycle
Results
Close
Facility
System
Production
EEM Scenario
and reduce pressure
Data Entry
Savings Summary
Description
and reduce pressure
Include
Order
Edit/ Review
Data Needs Review
DEMAND SIDE
Reduce Air Leaks
1
Improve End Use Efficiency
Reduce System Air Pressure
3
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

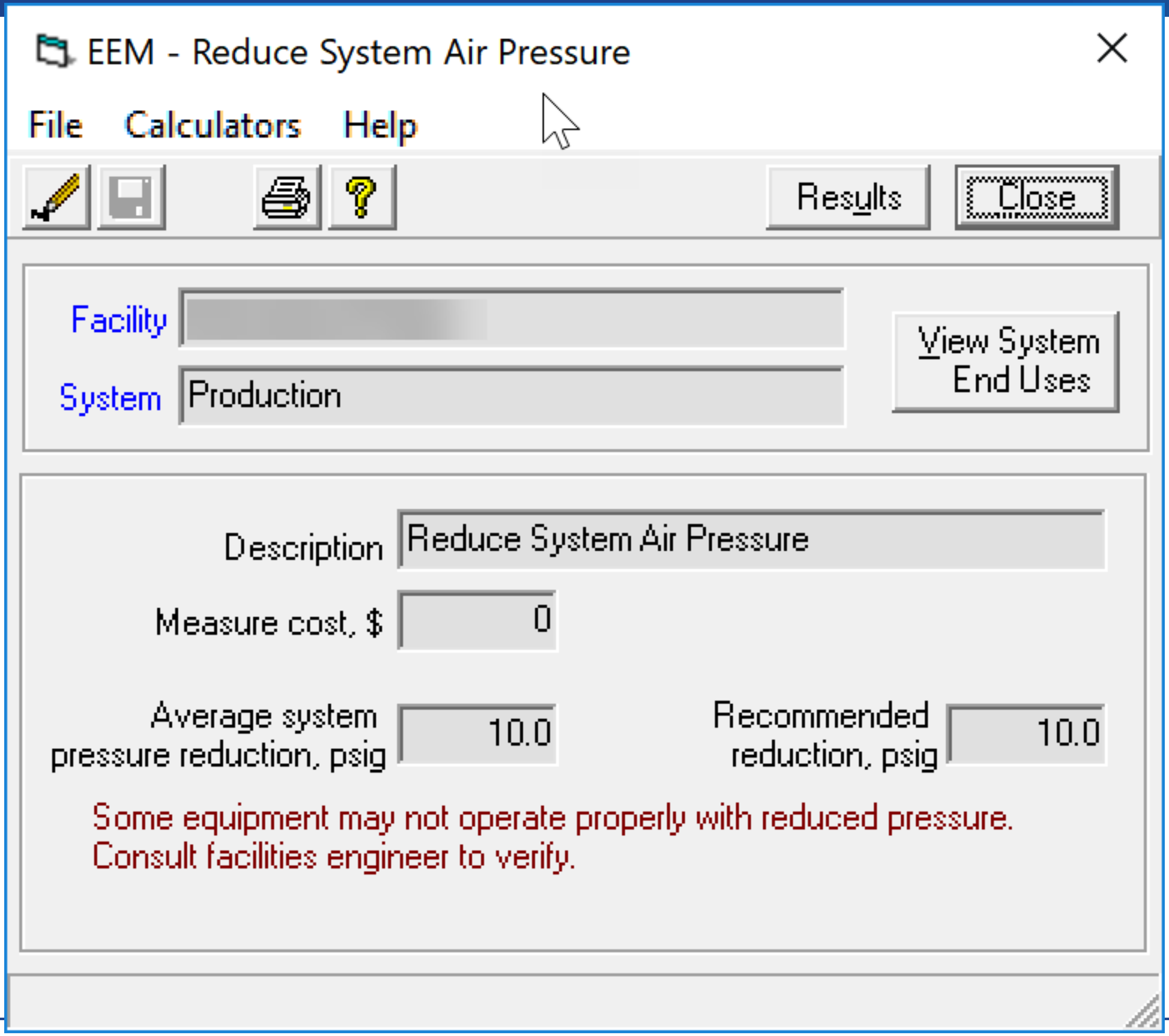


EEM - Reduce Air Leaks
File
Calculators
Help
Results
Close
Facility
System
Production
Description
Reduce Air Leaks
Measure cost, $
5000
Measured data
Airflow, acfm
Compressor Operations To Feed Leaks
Compressor
Units
Airflow, acfm
200 hp QNW
acfm
0
250 hp QNW
acfm
200
New 250 hp VSD
acfm
0
Maximum hourly 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
Facility
System
Production
Data View
Existing
Proposed
Restore
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
1314
1314
131

EEM’s


EEM - Reduce System Air Pressure
File
Calculators
Help
Results
Close
Facility
System
Production
View System End Uses
Description
Reduce System Air Pressure
Measure cost, $
0
Average system pressure reduction, psig
10.0
Recommended reduction, psig
10.0
Some equipment may not operate properly with reduced pressure.
Consult facilities engineer to verify.


LogTool Trend Plot

EEM's

Energy Efficiency Measures

File Calculators Help

Copy EEM Scenario | Life Cycle | Results | Close

Facility

System: Production

EEM Scenario: and reduce pressure

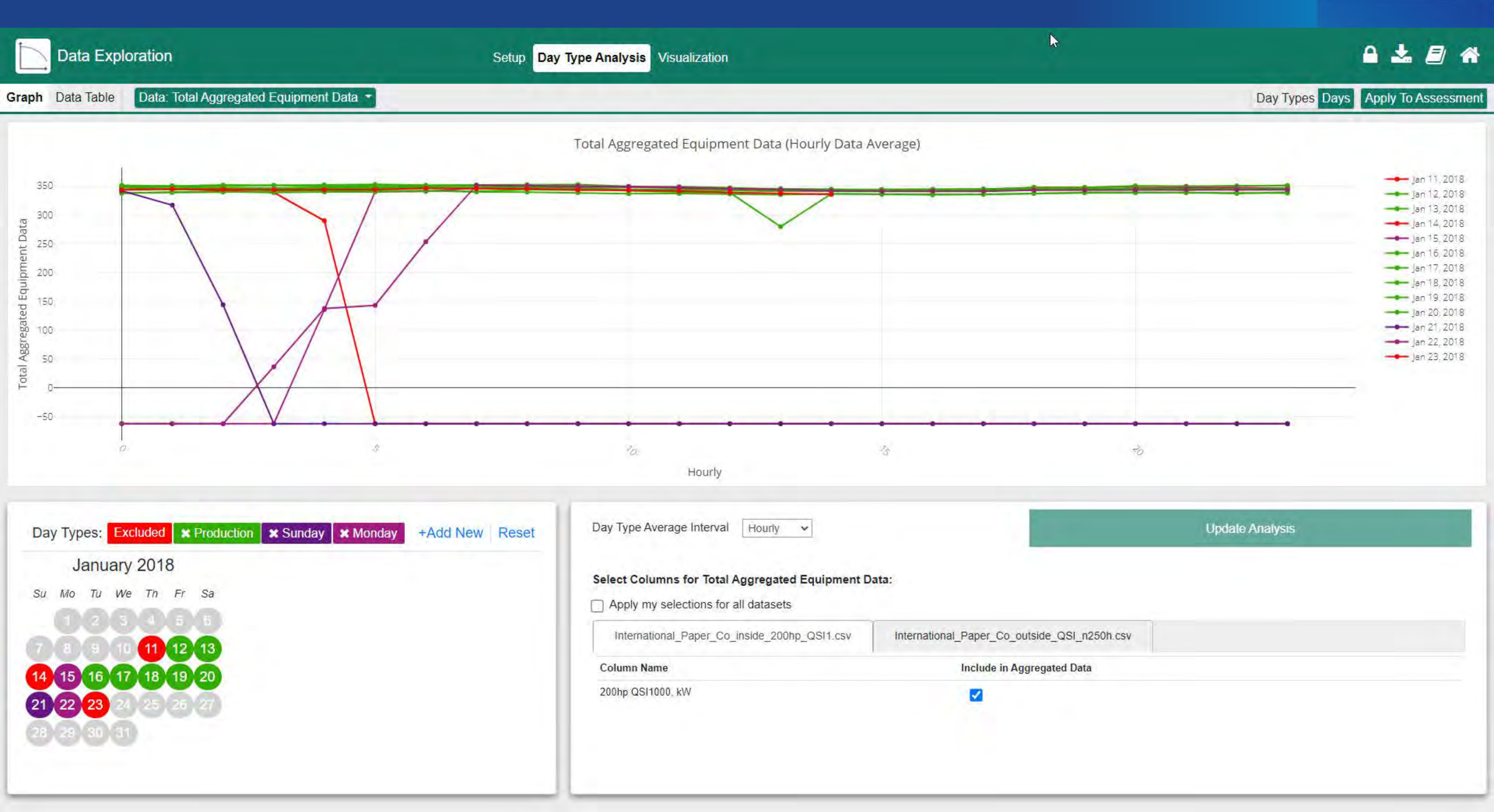
Data Entry | **Savings Summary**

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
Reduce System Air Pressure	179,769	12,134	6.9	24.0	0	0	12,134	0.0
TOTALS	1,122,104	75,742	43.4	153.0	0	111,700	75,742	1.5

Double-click row to view corresponding measure input data

Copy To Clipboard

International Paper
Hon
Fujifilm
Fuji
Coming Inc
Coming Inc
SRP
Examples
Compressed Air Example
Waste Water Example
Treasure Hunt Example
Steam Example
Fan Example
Pump Example
Process Heating - Fuel E...
Toy Factory
Data Exploration
All Calculators
General
Compressed Air
Fans
Lighting
Motors
Process Cooling
Process Heating
Pumps
Steam
Wastewater
Settings
Custom Materials
User Manuals
About
Feedback
Privacy Notice
Acknowledgments
v1.4.0
MEASUR
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.
If you need help at any point along the way, click on a User Manual icon.
View Assessments
Equipment Calculators
Pump Assessment
Compressed Air Assessment
Process Heating Assessment
Fan Assessment
Steam Assessment
Treasure Hunt
Wastewater Assessment
Motor Inventory
Pump Inventory
Data Exploration
U.S. DEPARTMENT OF ENERGY
Energy Efficiency & Renewable Energy



Data Exploration
Setup
Day Type Analysis
Visualization
Graph
Data Table
Data: Total Aggregated Equipment Data
Day Types
Days
Apply To Assessment
Total Aggregated Equipment Data (Hourly Data Average)
Total Aggregated Equipment Data
350
300
250
200
150
100
50
0
−50
0
5
10
15
20
Hourly
Jan 11, 2018
Jan 12, 2018
Jan 13, 2018
Jan 14, 2018
Jan 15, 2018
Jan 16, 2018
Jan 17, 2018
Jan 18, 2018
Jan 19, 2018
Jan 20, 2018
Jan 21, 2018
Jan 22, 2018
Jan 23, 2018
Day Types:
Excluded
Production
Sunday
Monday
+Add New
Reset
January 2018
Su Mo Tu We Th Fr Sa
1 2 3 4 5 6
7 8 9 10 11 12 13
14 15 16 17 18 19 20
21 22 23 24 25 26 27
28 29 30 31
Day Type Average Interval
Hourly
Update Analysis
Select Columns for Total Aggregated Equipment Data:
Apply my selections for all datasets
International_Paper_Co_inside_200hp_QSI1.csv
International_Paper_Co_outside_QSI_n250h.csv
Column Name
Include in Aggregated Data
200hp QSI1000, kW

MEASUR

Data Exploration

Setup | **Day Type Analysis** | Visualization

Graph | **Data Table** | Data: Total Aggregated Equipment Data

Display Selected | Display All | Day Types | Days | Apply To Assessment

Day Type Summaries (Total Aggregated Equipment Data)

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Excluded	345.233	344.441	342.737	341.011	316.626	140.599	141.751	141.474	141.22	140.354	140.009	208.291	207.075	206.017	205.018	140.7	140.813	140.648	142.405	142.431	143.513	143.433	143.463	144.12
Production	344.656	345.067	345.346	345.418	346.18	346.584	346.363	345.848	345.827	345.186	343.719	343.299	342.132	332.419	340.844	340.385	340.169	340.974	342.559	343.259	343.725	343.441	343.333	344.144
Sunday	341.5	316.585	143.837	-62.476	-62.479	-62.478	-62.478	-62.48	-62.48	-62.478	-62.48	-62.48	-62.477	-62.479	-62.481	-62.48	-62.481	-62.478	-62.479	-62.48	-62.476	-62.48	-62.479	-62.48
Monday	-62.479	-62.48	-62.48	-13.16	136.523	241.439	296.894	348.648	349.049	348.693	348.558	347.426	345.133	343.489	341.657	340.832	340.753	341.281	343.225	343.56	344.614	345.199	344.928	344.662

Copy Table

Day Summaries (Total Aggregated Equipment Data)

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Excluded																								
Jan 11, 2018												346.218	345.07	343.465	342.276	343.887	344.11	343.776	347.291	347.341	349.506	349.346	349.406	350.719
Jan 23, 2018	343.151	344.6	343.84	343.205	343.652	343.678	345.983	345.427	344.92	343.188	342.499	341.135	338.636	337.064	335.257									
Jan 14, 2018	347.315	344.282	341.634	338.817	289.6	-62.48	-62.481	-62.479	-62.48	-62.48	-62.482	-62.481	-62.48	-62.48	-62.48	-62.488	-62.483	-62.48	-62.48	-62.479	-62.479	-62.48	-62.48	-62.48
Production																								
Jan 12, 2018	350.503	350.457	349.767	350.922	349.444	350.735	350.126	349.697	348.726	347.911	348.143	348.613	346.908	343.422	343.798	343.359	343.994	344.688	346.835	347.03	350.133	349.088	350.24	350.696
Jan 13, 2018	351.026	349.585	351.782	351.001	351.894	352.74	351.297	351.961	352.383	352.372	349.311	346.937	345.905	345.548	344.381	343.145	343.407	344.375	346.107	344.937	346.216	345.54	345.22	346.343
Jan 16, 2018	347.61	347.97	347.122	346.248	347.541	347.869	347.655	346.948	347.811	345.907	343.795	343.826	342.966	340.637	341.396	342.32	341.424	341.937	343.92	343.374	343.997	345.062	343.421	344.827
Jan 17, 2018	344.128	344.633	344.586	344.258	346.296	347.187	345.95	346.432	344.017	345.032	342.959	343.33	341.718	340.763	341.098	341.488	341.749	342.284	344.047	344.131	344.641	344.578	344.717	345.682
Jan 18, 2018	344.129	344.662	345.205	345.692	346.339	346.123	346.506	345.632	345.089	344.363	341.707	339.446	338.237	279.357	336.221	335.939	335.253	335.215	337.038	338.875	338.816	338.304	338.122	337.499
Jan 19, 2018	337.229	339.573	339.789	338.727	339.595	339.627	341.793	339.637	339.3	338.219	336.391	336.754	336.199	334.947	336.405	335.468	334.589	335.592	337.082	337.984	338.112	338.727	336.751	339.25
Jan 20, 2018	337.969	338.586	339.17	341.079	342.147	341.811	341.216	340.627	343.462	342.497	343.729	344.185	342.992	342.259	342.607	340.974	340.766	342.729	342.885	346.484	344.162	342.792	344.86	344.712
Sunday																								
Jan 21, 2018	341.5	316.585	143.837	-62.476	-62.479	-62.478	-62.478	-62.48	-62.48	-62.478	-62.48	-62.48	-62.477	-62.479	-62.481	-62.48	-62.481	-62.478	-62.479	-62.48	-62.476	-62.48	-62.479	-62.48
Monday																								
Jan 15, 2018	-62.48	-62.481	-62.479	-62.48	135.607	340.068	340.692	346.157	347.243	347.519	348.732	347.609	345.048	343.513	341.95	341.139	340.554	341.815	343.719	344.359	345.83	346.652	346.369	346.135
Jan 22, 2018	-62.479	-62.48	-62.48	36.16	137.439	142.81	253.096	351.139	350.856	349.867	348.384	347.243	345.219	343.466	341.363	340.524	340.952	340.747	342.73	342.761	343.397	343.746	343.488	343.188

Copy Table

Day Types: Excluded | ✖ Production | ✖ Sunday | ✖ Monday | +Add New | Reset

Day Type Average Interval: Hourly

Update Analysis

MEASUR Tool Energy Efficiency Measures

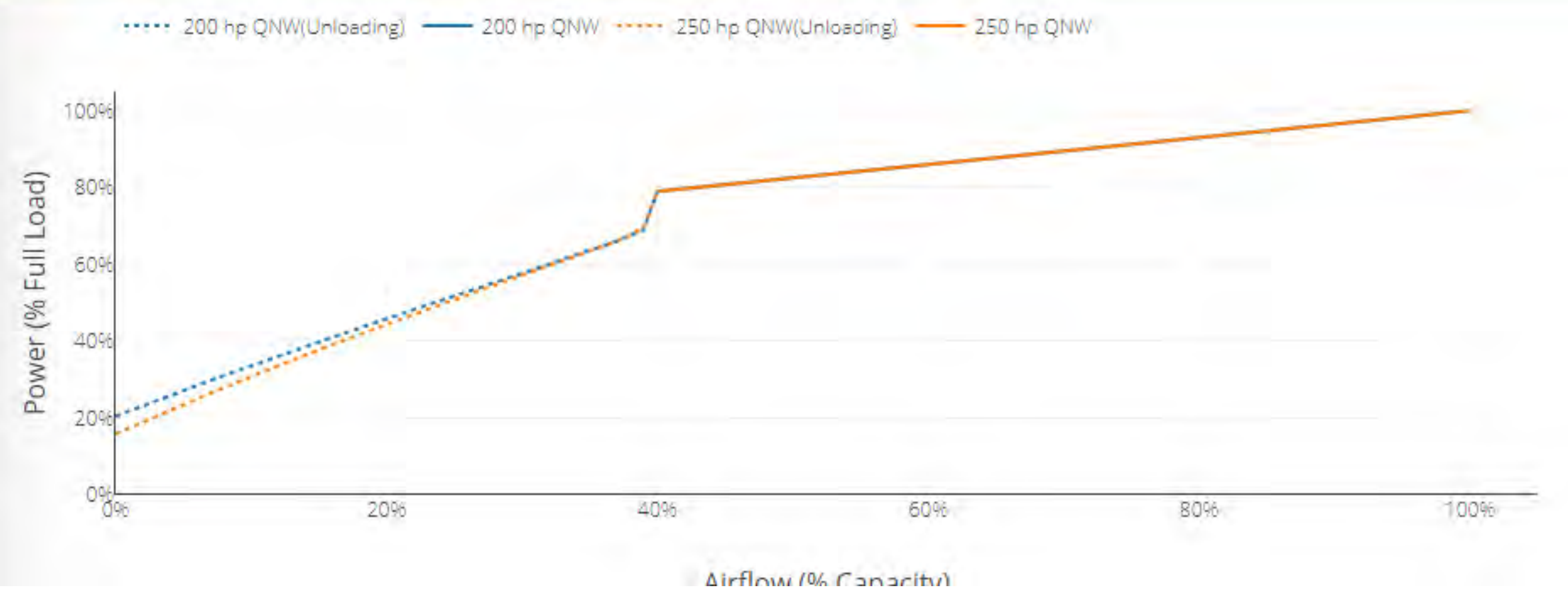
CURRENT INVENTORY | HELP

Name	Compressor Type	Control Type	Pressure Range
200 hp QNW	Single stage lubricant-injected rotary screw	Inlet modulation with unloading	110 - 120 psig
250 hp QNW	Single stage lubricant-injected rotary screw	Inlet modulation with unloading	105 - 115 psig

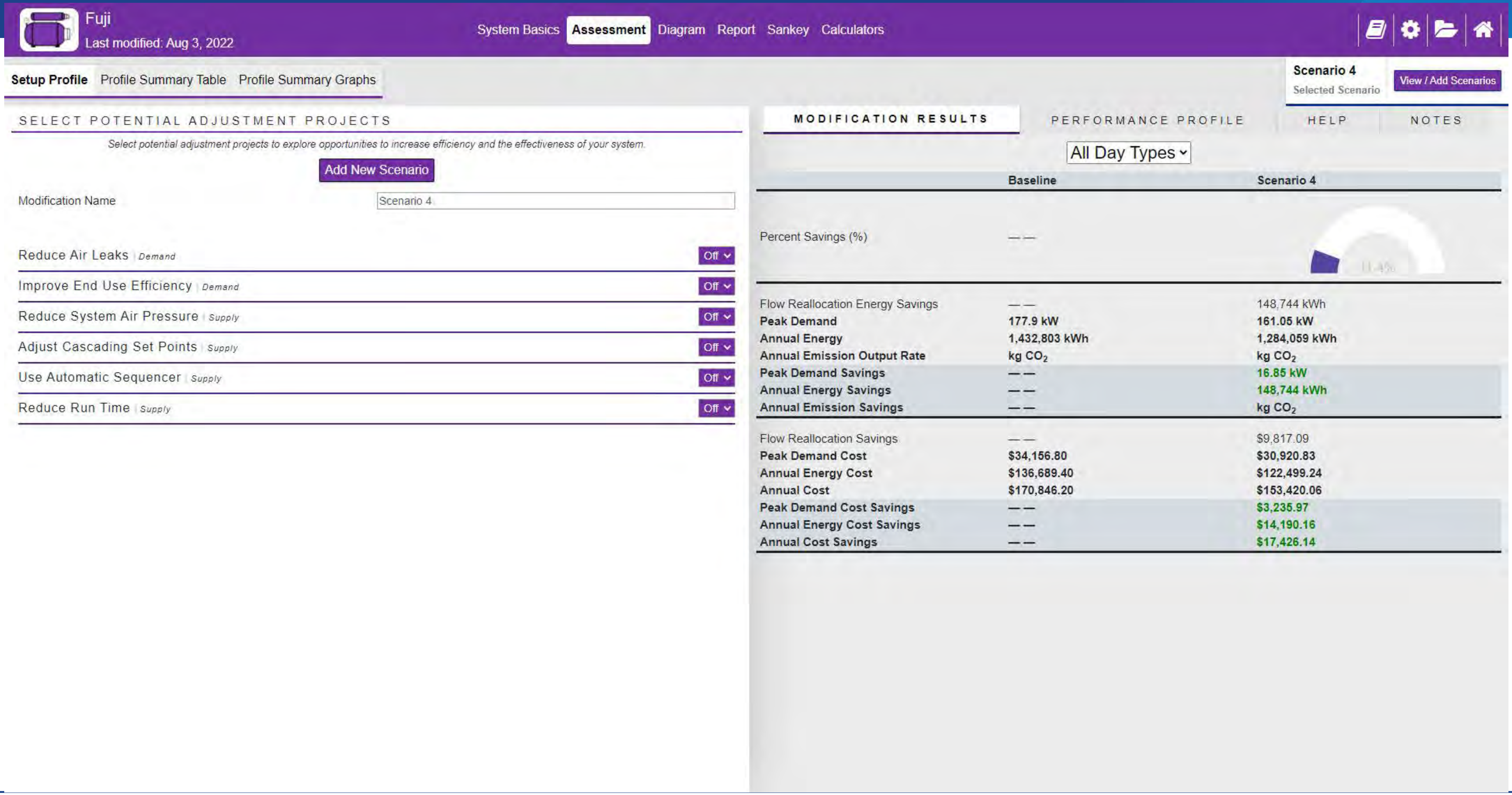
+Add New Compressor

Performance Profile

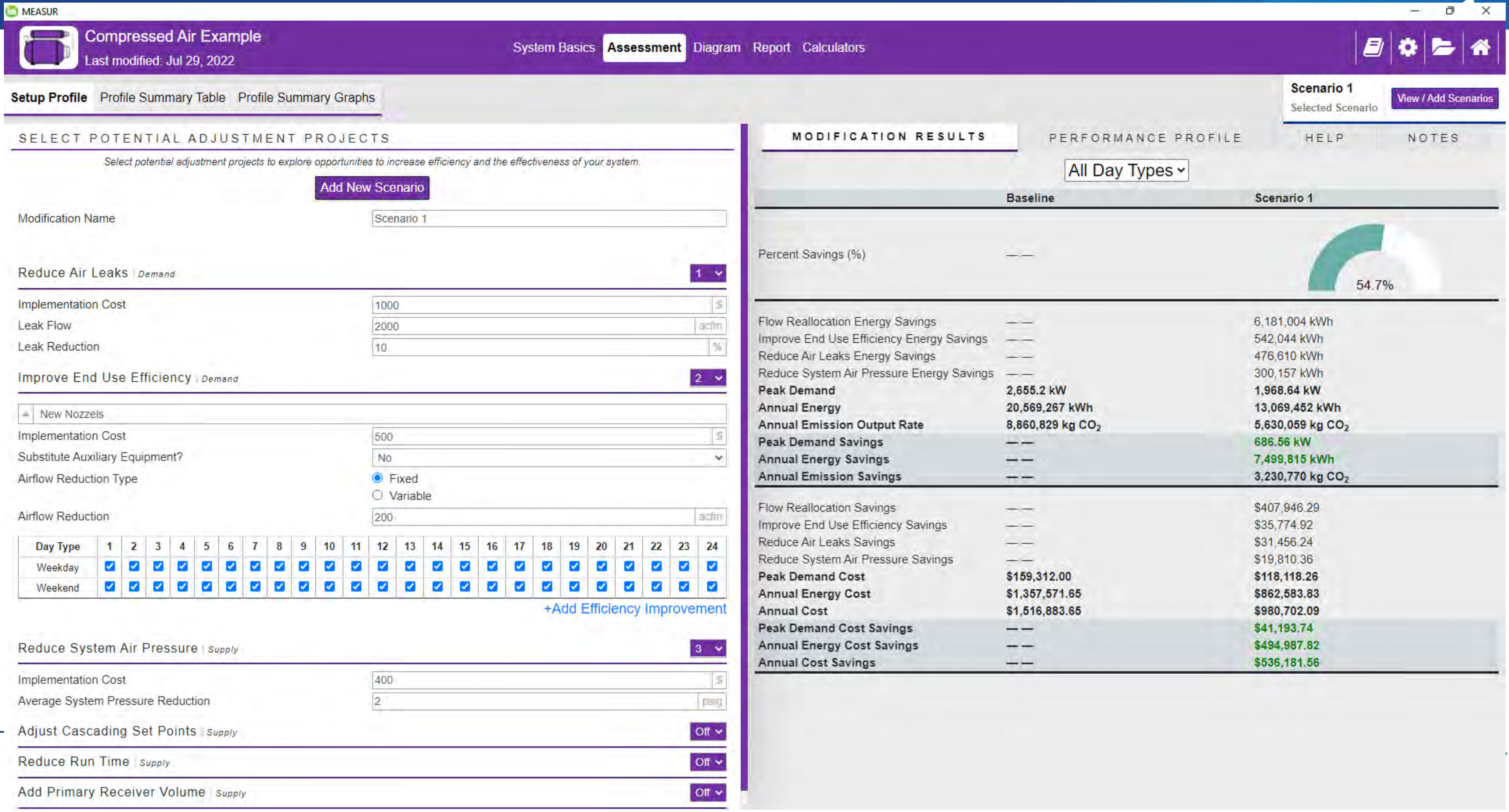
- [x] Graph All Compressors
- [ ] Graph Average Operating Points



MEASUR Tool Energy Efficiency Measures

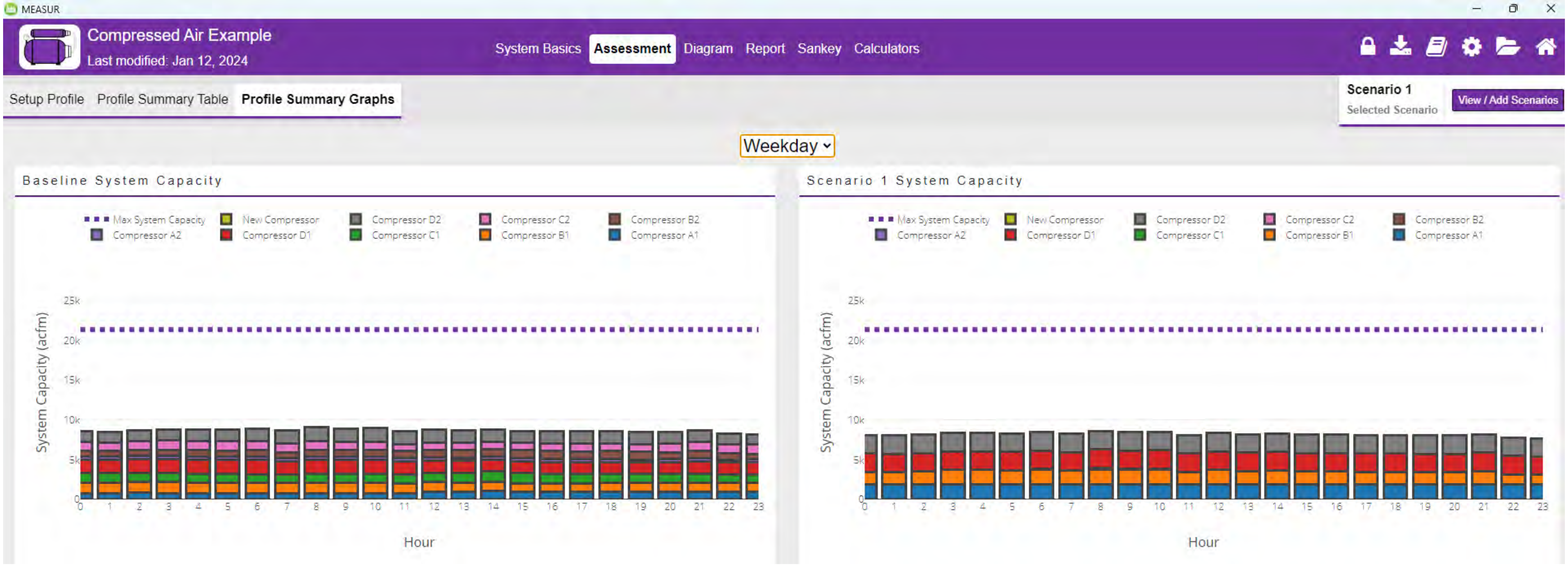


MEASUR Tool



Better Plants
U.S. DEPARTMENT OF ENERGY

MEASUR Tool


MEASUR
Compressed Air Example
Last modified: Jan 12, 2024
System Basics
Assessment
Diagram
Report
Sankey
Calculators
Setup Profile
Profile Summary Table
Profile Summary Graphs
Scenario 1
Selected Scenario
View / Add Scenarios
Weekday
Baseline System Capacity
Scenario 1 System Capacity
Max System Capacity
New Compressor
Compressor D2
Compressor C2
Compressor B2
Compressor A2
Compressor D1
Compressor C1
Compressor B1
Compressor A1
System Capacity (acfm)
25k
20k
15k
10k
5k
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Hour

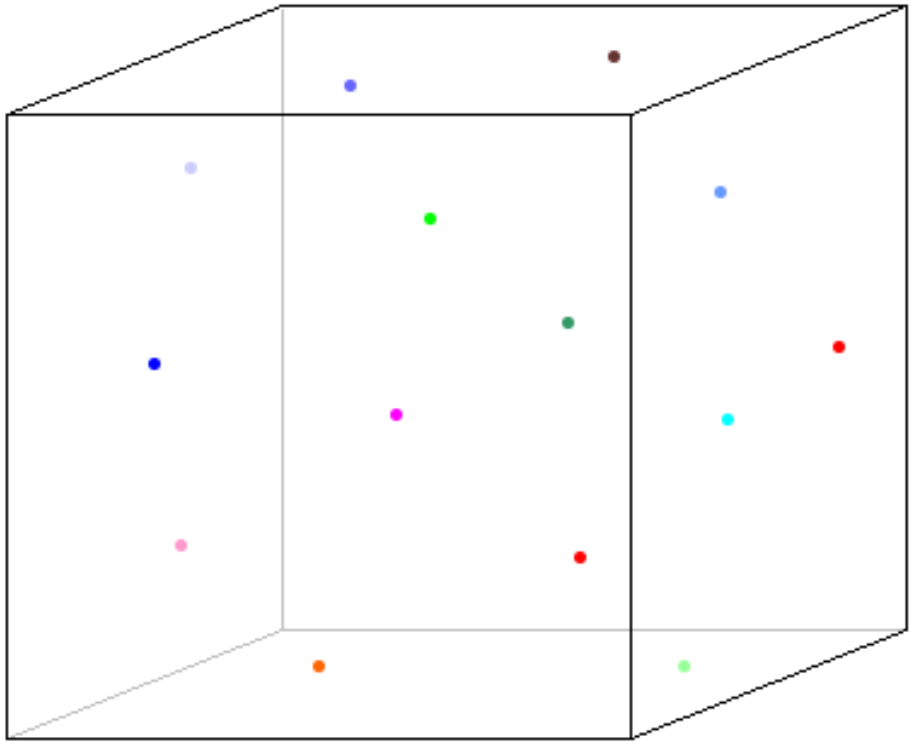
Virtual Session 1 – The Basics

Let's leave the compressor room and have a look out in the demand……

You'll have to keep coming back each week for this session and more……

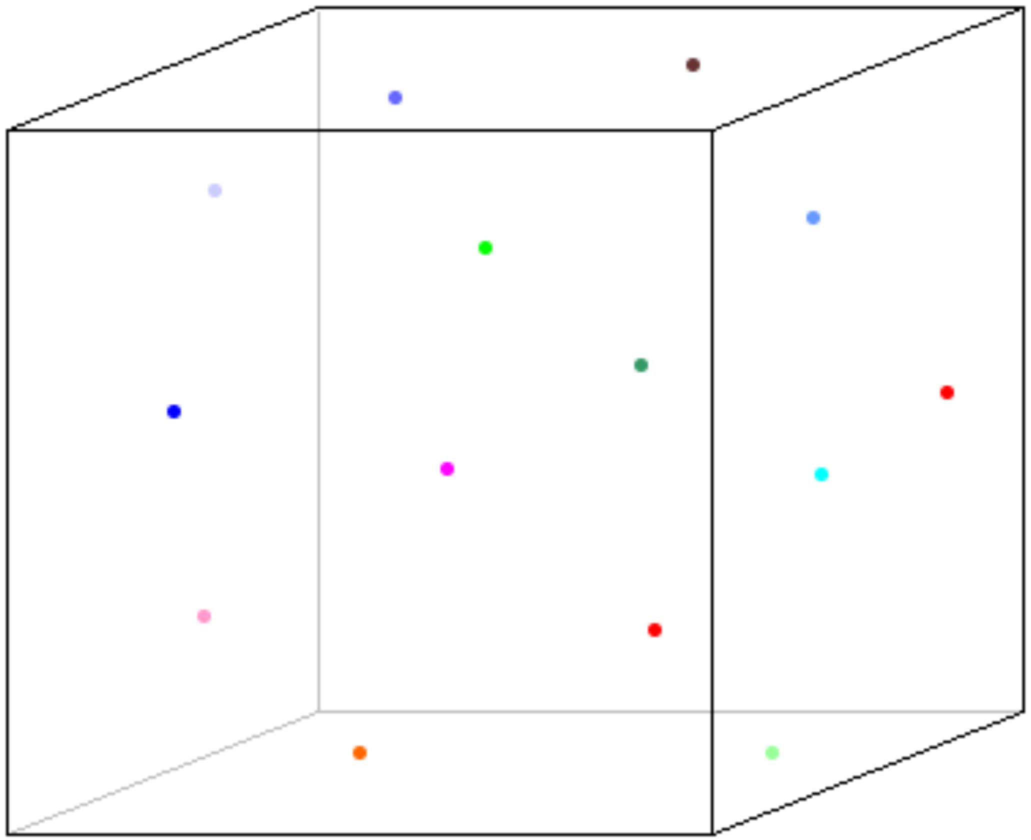
Compressed Air Fundamentals

Pressure?



- Imagine a closed container with air inside.
- Air, as a gas, is composed of molecules that you can imagine as round elastic balls.
- Molecules move in straight lines until they collide with neighboring molecules or the container wall.
- Molecules of gas hitting the wall impose a force on the wall.
- The amount of this impact force per area of the container inner walls is called pressure.

Gas Theory



On a square inch of surface there are over two sextillion molecular impacts per second....that's 2 followed by 21 zeros!!!

ALL THIS TRANSLATES TO PRESSURE. AT SEA LEVEL THIS PRESSURE WOULD BE -- 14.69 PSIA; 29.92”HgA; 1013mBar; or 760 Torr

Gas Theory

- Air pressure is explained by three scientific laws:
  - Boyle's Law explains that if air volume halves during compression, the pressure is doubled.
  - Charles' Law states that the volume of air changes in direct proportion to the temperature.
  - The First Law of Thermodynamics tells us that an increase in pressure equals a rise in heat and that compressing air creates a proportional increase in heat.
  - Collectively, these three laws explain that pressure, volume, and temperature are proportional. If you change one variable, then one or two of the others will also change, according to this equation:

$$\frac{P_1 \times V_1}{T_1} = \frac{P_2 \times V_2}{T_2}$$

Compressed Air Fundamentals

- At sea level, atmospheric pressure is 14.7 psia
- psia stands for pounds per square inch (Absolute)

Compressed Air Fundamentals

- In Death Valley, which is 500 feet below sea level, The air pressure is 14.94 psia

Compressed Air Fundamentals

- On top of a 5,000-foot mountain, air pressure is only 12.2 psia
- Mount Everest is 29,000 feet above sea level, and the air pressure is 4.56 psia

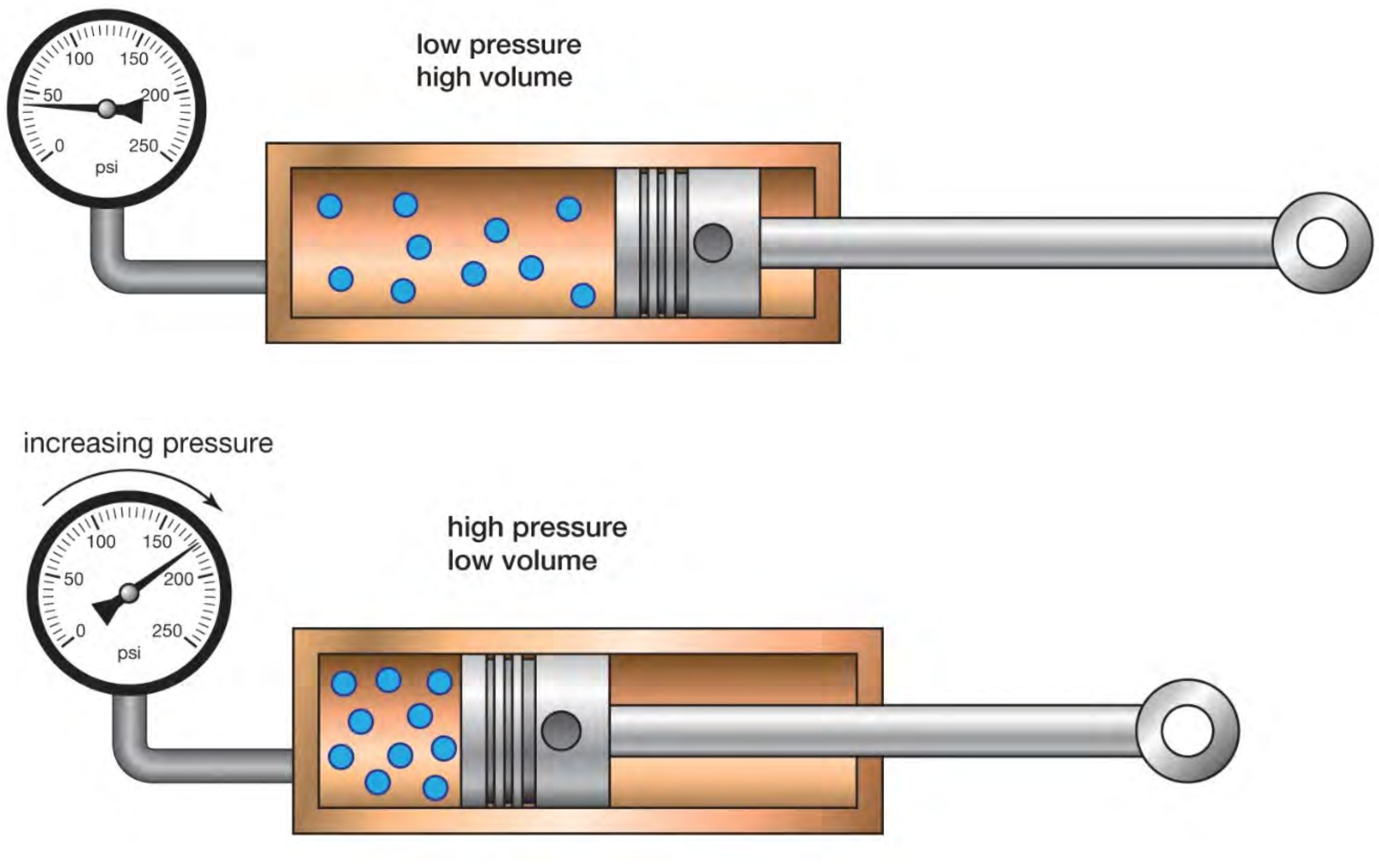
Pressure Terms

- psig is pounds per square inch gauge - the pressure on the gauge or digital readout of the compressor's controller.
- At zero gauge, the pressure is at atmospheric pressure. If the gauge reads 100 psig, then that means the pressure is 100 pounds above ambient atmospheric pressure.
- psia is pounds per square inch absolute. This is the sum of the existing gauge pressure plus the atmospheric pressure. At sea level, a gauge showing 95 psig would have an absolute pressure of 109.5 psia.
- 14.5 + 95 = 109.5 psia

Compressed Air Fundamentals

- Compress: To press together or force into a smaller space; condense
- Air: A colorless, odorless, tasteless gaseous mixture, mainly nitrogen (78%) and oxygen (21%) and 1-2% water vapor and, carbon dioxide and other gases
- When controlled, compressed air can be used to perform work.

Compressed Air Fundamentals



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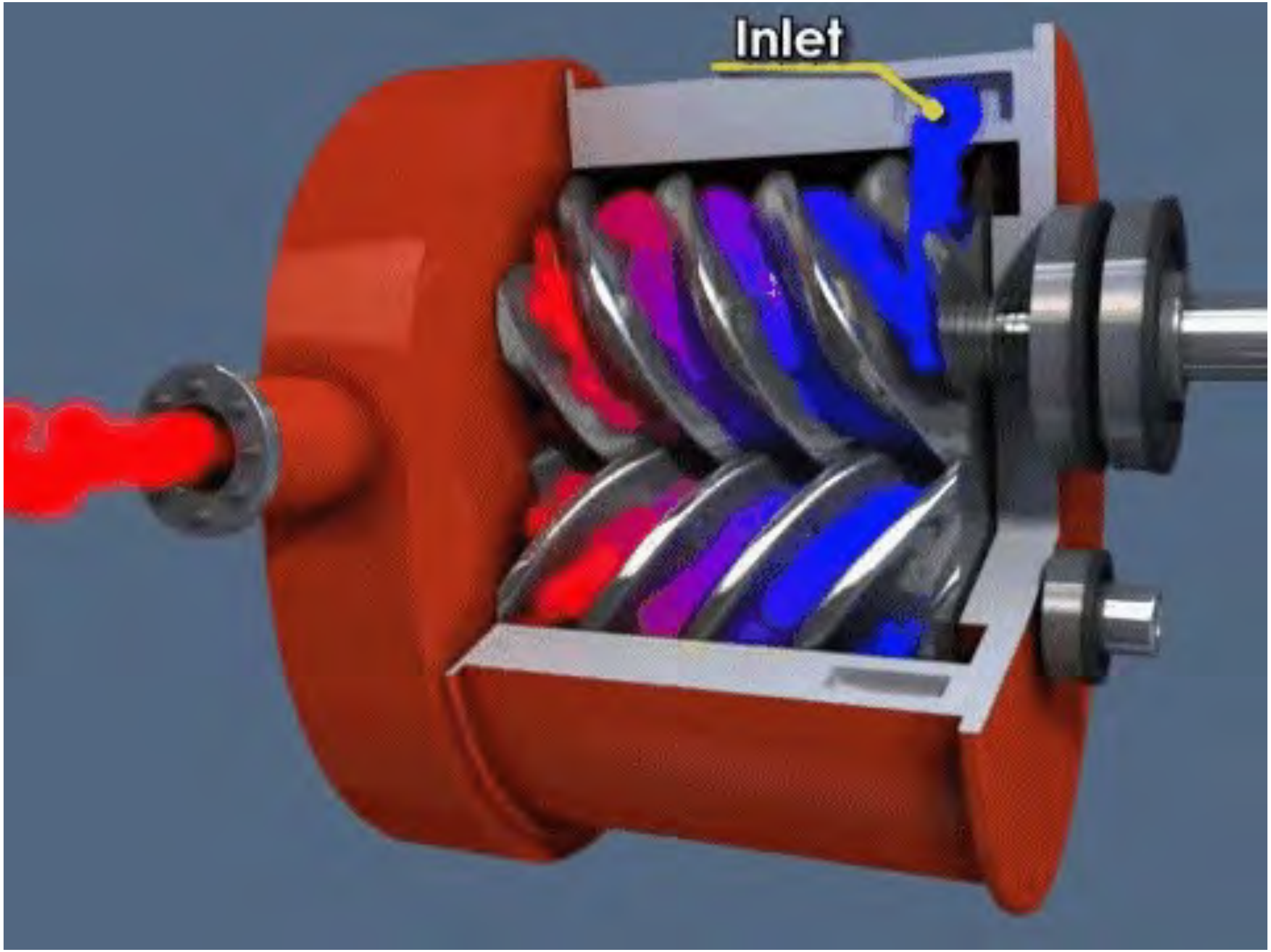
- Step 1: Air is trapped in a cylinder, tank, or similar container
- Step 2: The space in that tank becomes smaller, which forces the air molecules closer together
- The now-compressed air remains trapped in this smaller state, waiting to expand again until it's ready for use.

Compressed Air Fundamentals

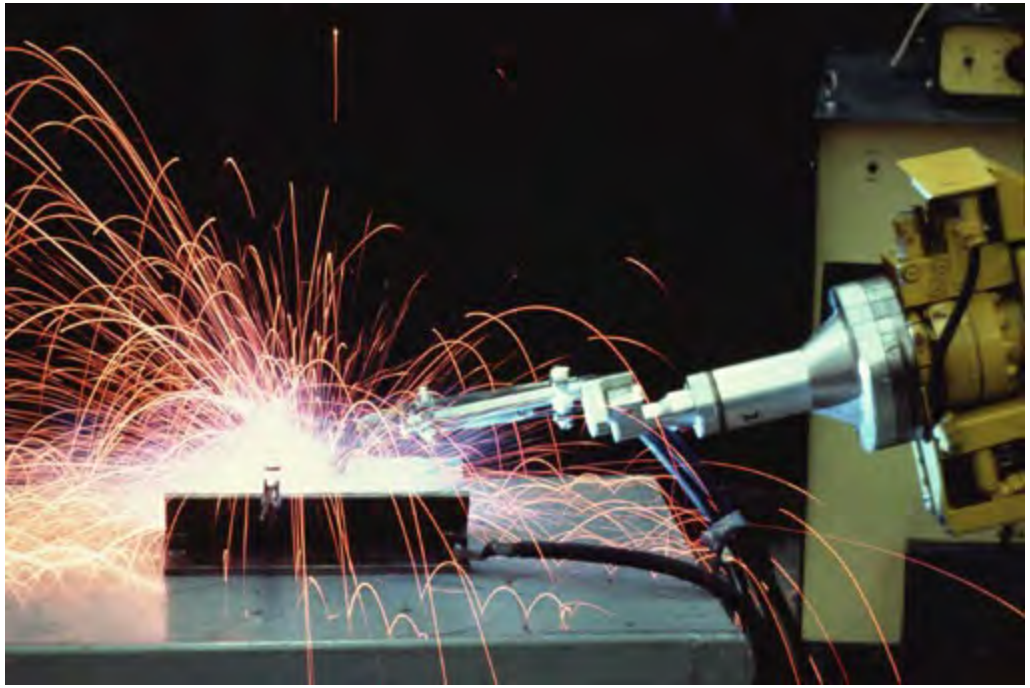
- But pistons aren't the only way to force air into a smaller space. There are numerous styles of air compressors on the market, each with its advantages and disadvantages.
- For example, rotary screw air compressors use dual spinning screws to push air down and compress it:

Compressed Air Fundamentals

- Rotary screw air compressors are chosen over reciprocating because they are compact, powerful, and can run continuously.
- Regardless of the mechanism used, air is always compressed by taking atmospheric air and squishing it down, so the molecules are condensed and pressurized.


Inlet

Compressed Air Fundamentals

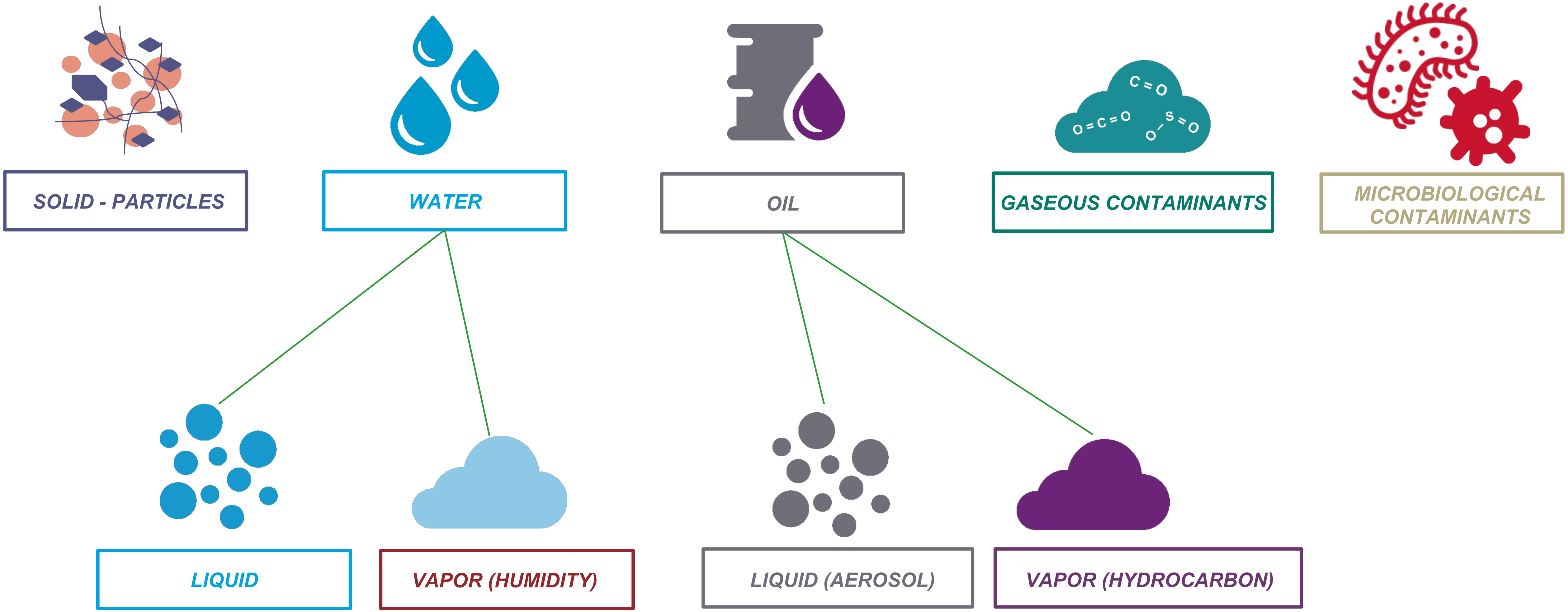


- Energy from compressed air is used to power pneumatic production equipment.
  - E.G.--air motors, actuators, instrumentation, tools, etc.
- To cool components or parts during fabrication
- To blow off waste material

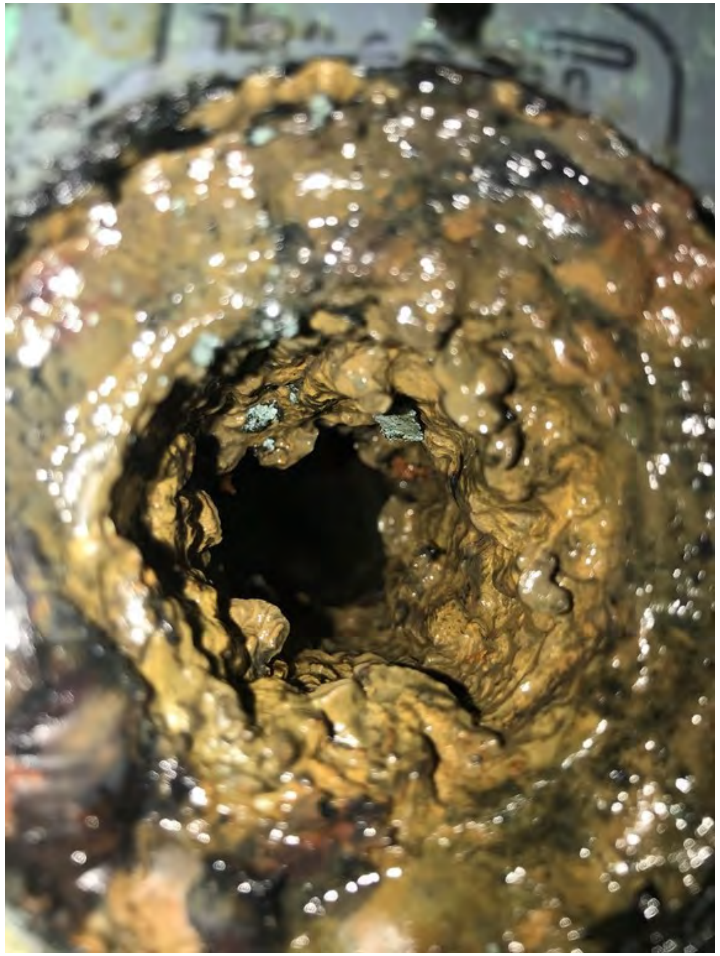
Compressed Air Fundamentals

- Process Air
- Compressed air is an integral part of a process, and/or comes in contact with product.
  - Chemicals
  - Pharmaceuticals
  - Food & Beverage
  - Aeration and agitation
  - Semiconductor & Electronics
  - Medical Breathing Air
- CDA Quality--means Clean, Dry, Air

Which Contaminants do we find in compressed air?



Which Contaminants do we find in compressed air?



Compressed Air Quality

- As illustrated in the following table, a number of different air quality levels can be achieved.
- Care should be taken when using these terms and actual specifications for air quality should always be given.

Quality	Applications
Plant Air	Air tools, general plant air
Instrument Air	Laboratories, some paint spraying, powder coating, climate control
Process Air	Food and pharmaceutical process air, electronics
Breathing Air	Some hospital air systems, diving tank refill stations, respirators for cleaning and/or grit blasting

ISO 8573-1 Compressed Air Quality Classes

- ISO 8573 provides detailed standards on air-quality classes for various levels of particulate, moisture, and lubricant contaminants.

ISO 8573-1:2010 Compressed Air Quality Classes

Class	Max. Particle Size		Pressure dewpoint		Max Oil Content
	(µm)	(mg/m^3)	(°C/°F)	(g/m^3)	(mg/m^3)
0	Specified by the equipment manufacturer/supplier and greater than class 1				
1	0.1	0.1	-70/-94	0.003	0.01
2	1	1	-40/-40	0.12	0.1
3	5	5	-20/-4	0.88	1
4	15	8	3/37	6	5
5	40	10	7/45	7.8	25
6	--	--	10/50	9.4	--
7	--	--	Not Specified		--

Note: the Class 0 certification was created in response to industry needs for oil-free air. Stating Class 0 without an agreed specification will mean it is not in accordance with the standard. Class 0 air purity is best achieved at the point of use to minimize cost.

Air Quality

- The air quality level required is a function of the dryness and contaminant level required by the end-uses, and is accomplished with separating, filtering and drying equipment.
- For certain applications, more than one class may be considered.
- Ambient conditions will influence the selection, especially dew point.
- Point of use equipment manufacturers should be consulted to determine their specific needs.

Capacity Ratings and Corrections

- Before beginning a discussion of compressor ratings, a couple of often misused terms need to be understood.
- SCFM - Standard Cubic Feet per Minute
  - A standard cubic foot of air is the amount of air in one cubic foot of volume when the air is at standard conditions of pressure, temperature and relative humidity.
  - There are a number of different standards:
  - The most common is air at sea level (14.5 PSIA)
  - 68° F and a relative humidity of 0%

Capacity Ratings and Corrections

- ASME Standard
  - Pressure 14.7 PSIA
  - Temperature 68° F
  - R/H 36%

- ISO, CAGI, Pneurop Standard
  - Pressure 14.5 PSIA
  - Temperature 68° F
  - R/H 0%

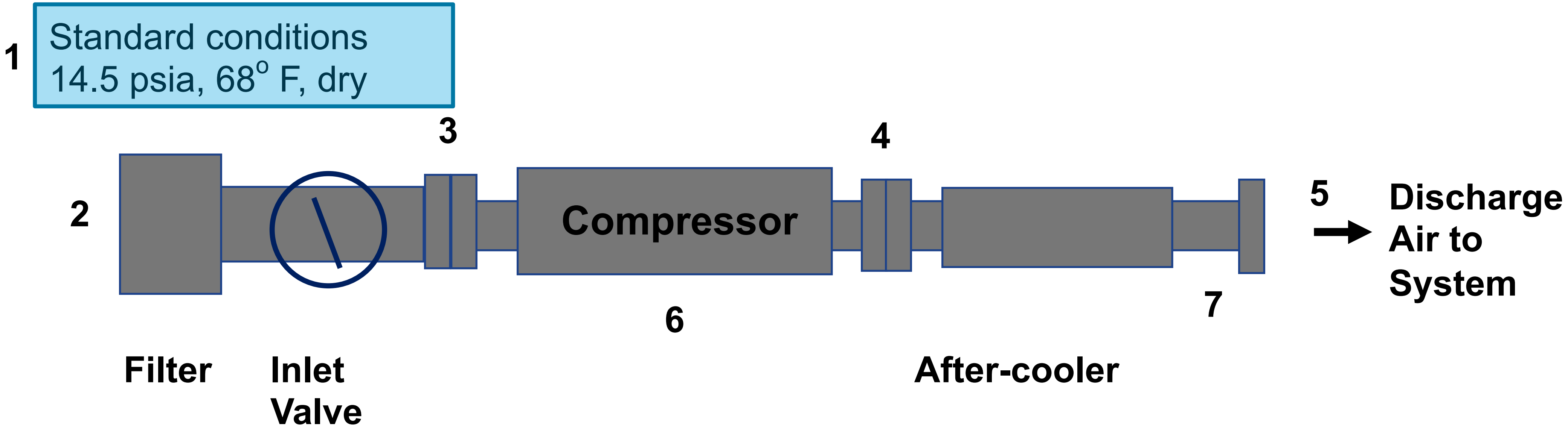
Ratings

- In the industry, there are four different capacity definitions for CFM.
  - Free Air Delivery (FAD CFM)
  - Actual Cubic Feet per Minute (ACFM)
  - Inlet Cubic Feet per Minute (ICFM)
  - Standard Cubic Feet per Minute (SCFM)

Definitions and Formulas

- Capacity calculations (Positive-Displacement)
  - **Golden rule**: FAD, ACFM, and ICFM are fixed volume flow rates which do not change with respect to atmospheric conditions.
  - In other words, a given compressor, when operating at rated speed and discharge pressure will essentially deliver the same volume flow rate regardless of inlet conditions.
  - **SCFM delivery** of an air compressor is calculated from the unit's FAD volume flow rate.
  - SCFM delivery will vary, depending on how the actual atmospheric conditions deviate from the "standard" reference set of conditions.
  - In winter, the SCFM delivery of a given air compressor is greater than during the summer, and vice versa.

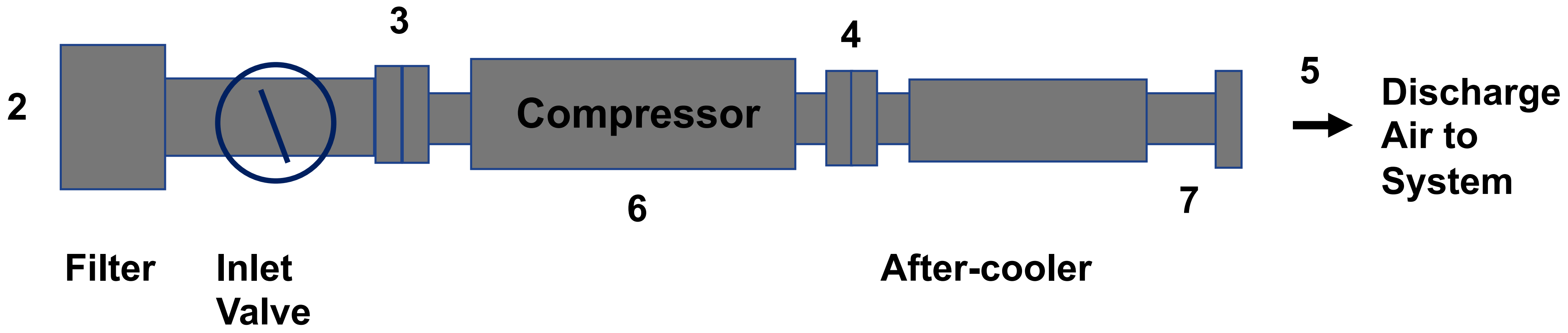
Definitions



1 = Standard conditions 14.5 psia, 68^{o} F, dry
2 = Ambient conditions, example 14.5 psia, 95^{o} F, 90% RH
3 = Inlet flange of compressor
4 = Discharge flange of compressor
5 = Compressed air to system
6 = Seal losses
7 = Condensate losses from intercoolers and after-cooler separators

Definitions

1 Standard conditions
14.5 psia, 68^o F, dry



F.A.D.	=	amount of compressed air measured at 5 referred back to ambient conditions 2
SCFM	=	amount at 5 referred back to standard conditions 1
ACFM	=	amount at 5 referred back to inlet flange 3
ICFM	=	amount of air flowing by inlet flange, 3 (used primarily by dynamic compressors, centrifugal)

Formulas

- To convert the required scfm to the flow that will be required at a specific geographic location with acfm, the formula below can be used.

$$acfm = scfm \times \frac{P_s}{\left[P_a - \left(PP_{wv} \times Rh\right)\right]} \times \frac{\left(T_a + 460\right)}{\left(T_s + 460\right)}$$

  - Where:
    - P_s = standard pressure, psia
    - P_a = Atmospheric pressure, psia
    - PP_{wv} = Partial Pressure water vapor at ambient temperature
    - Rh = Relative Humidify
    - T_a = Ambient Temperature, °F
    - T_s = Standard Temperature,°F

Formulas

Partial Pressure of Moisture at Various Temperatures

Temp. °F	Ambient Pressure Lb/Sq.In.	Temp. °F	Ambient Pressure Lb/Sq.In.	Temp. °F	Ambient Pressure Lb/Sq.In.	Temp. °F	Ambient Pressure Lb/Sq.In.	Temp. °F	Ambient Pressure Lb/Sq.In.	Temp. °F	Ambient Pressure Lb/Sq.In.
32	0.008854	49	0.1716	67	0.3276	85	0.5959	103	1.0382	121	1.7400
33	0.0922	50	0.1781	68	0.3390	86	0.6152	104	1.0695	122	1.7888
34	0.0960	51	0.1849	69	0.3509	87	0.6351	105	1.1016	123	1.8387
35	0.1000	52	0.1918	70	0.3631	88	0.6556	106	1.1345	124	1.8897
36	0.1040	53	0.1990	71	0.3756	89	0.6766	107	1.1683	125	1.9420
37	0.1082	54	0.2064	72	0.3886	90	0.6982	108	1.2029	126	1.9955
38	0.1126	55	0.2141	73	0.4019	91	0.7204	109	1.2384	127	2.0503
39	0.1171	56	0.2220	74	0.4156	92	0.7432	110	1.2748	128	2.1064
40	0.1217	57	0.2302	75	0.4298	93	0.7666	111	1.3121	129	2.1638
41	0.1265	58	0.2386	76	0.4443	94	0.7906	112	1.3504	130	2.2225
42	0.1315	59	0.2473	77	0.4593	95	0.8153	113	1.3896	131	2.2826
43	0.1367	60	0.2563	78	0.4747	96	0.8407	114	1.4298	132	2.3440
44	0.1420	61	0.2655	79	0.4906	97	0.8668	115	1.4709	133	2.4069
45	0.1475	62	0.2751	80	0.5069	98	0.8935	116	1.5130	134	2.4712
46	0.1532	63	0.2850	81	0.5237	99	0.9210	117	1.5563	135	2.5370
47	0.1591	64	0.2951	82	0.5410	100	0.9492	118	1.6006	136	2.6042
48	0.1653	65	0.3056	83	0.5588	101	0.9781	119	1.6459	137	2.6729
		66	0.3160	84	0.5771	102	1.0078	120	1.6924		

Example

- Requirement.
  - 1000 scfm using ISO standard (68°F, 0% RH, 14.5 psig (1 bar))
  - Altitude 5000 ft above sea level
  - Maximum ambient temperature 100°F
  - Maximum Relative Humidity 50%

  - Ambient pressure at 5000 ft. = 12.2 psia
  - Partial pressure of moisture at 100°F from vapor pressure chart = 0.95 psia
  - Partial pressure at 50% RH = 0.95 x 0.50

$$acfm = scfm \times \frac{P_s}{\left[P_a - \left(PP_{wv} \times Rh_a\right)\right]} \times \frac{\left(T_a + 460\right)}{\left(T_s + 460\right)}$$

$$acfm = 1000\,scfm \times \frac{\left(14.5 - 0Rh\right)}{\left[12.2 - \left(0.95 \times .50\right)\right]} \times \frac{\left(100 + 460\right)}{\left(68 + 460\right)}$$

$$acfm = \frac{14.5}{11.725} \times \frac{560}{528} = 1312\,acfm$$

Ps = standard pressure, psia
Pa = Atmospheric pressure, psia
PPwv = Partial Pressure water vapor at ambient temperature
Rh = Relative Humidify
Ta = Ambient Temperature, °F
Ts = Standard Temperature,°F

Example using the MEASUR Tool

ACTUAL TO STANDARD AIRFLOW

Convert to Standard Airflow | **Convert to Actual Airflow**

Actual Atmospheric Pressure Auto Calculate From Elevation	12.2 psia
Actual Ambient Temperature	100 °F
Actual Relative Humidity	50 %
Standard Atmospheric Pressure	14.5 psia
Standard Ambient Temperature	68 °F
Standard Relative Humidity	0 %
Standard Airflow	1000 scfm

Results

Airflow **1,311.7 acfm**

MEASUR

Formulas

- The example on the previous page demonstrates the need for accurate requirement specifications.
- In this case, the actual compressor capacity required at the prevalent ambient conditions is one-third greater than the stated scfm.
- Consideration also must be given to the fact that the temperature at this site will not always be as high as 100 degrees Fahrenheit, and relative humidity also may be lower.
- Some geographic locations have wide changes in ambient temperature from day to night and from season to season.
- This will result in less volume being required from the compressor.
- The right compressor with the proper controls will help to manage the supply for these various demands.

Taking Measurements

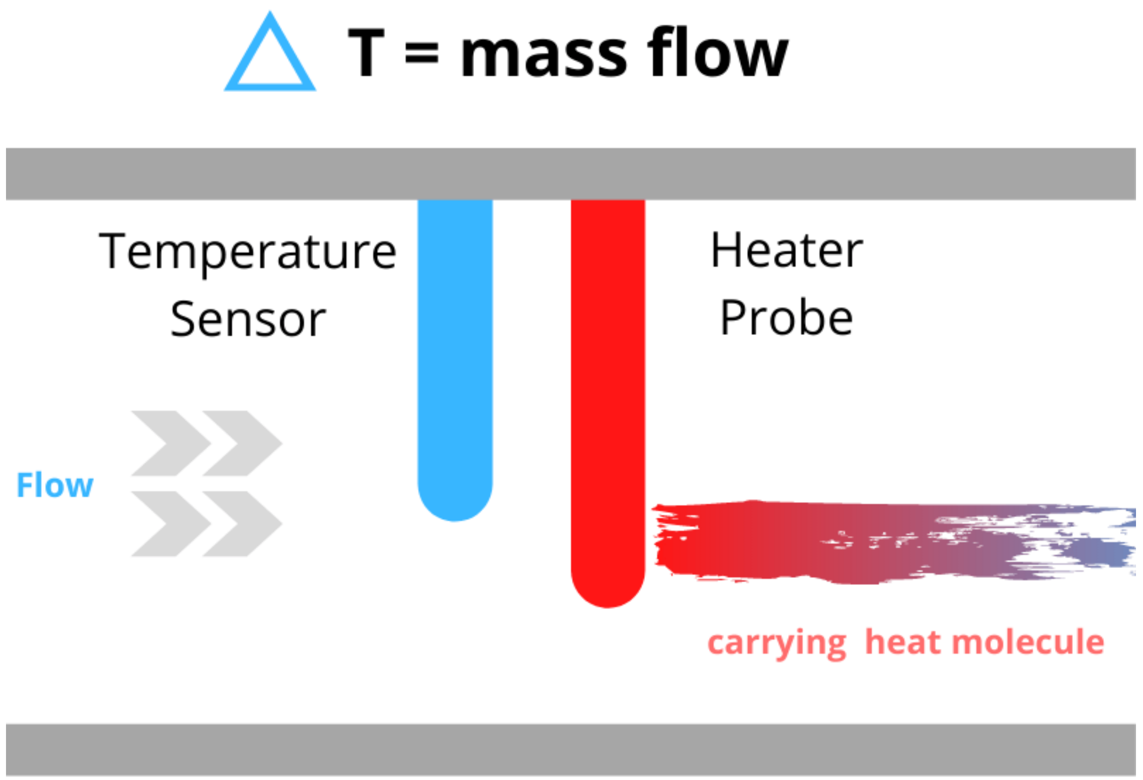
The Need to Make Measurements

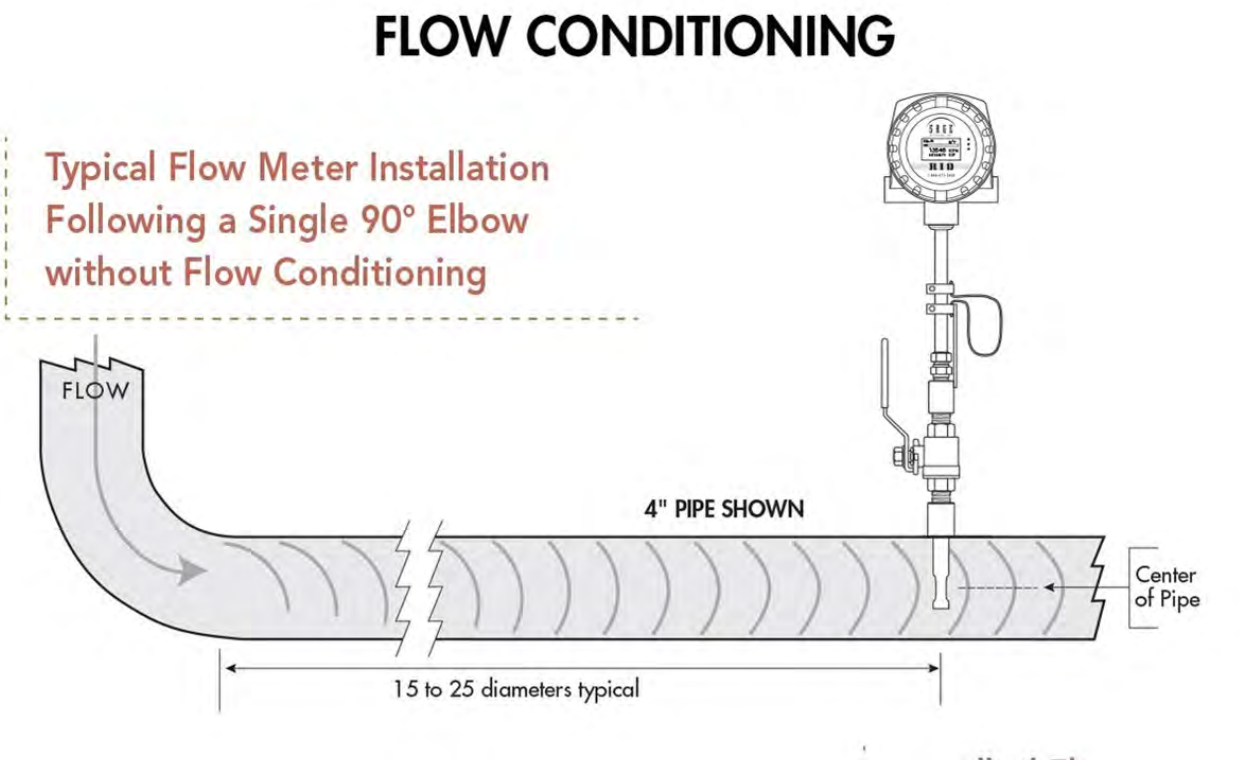
- Flow (cfm)
- Pressure (psi)
- Power (kW)
- Energy (kWh)
- Dollars ($)

Measurement Tools

Measurement Tools

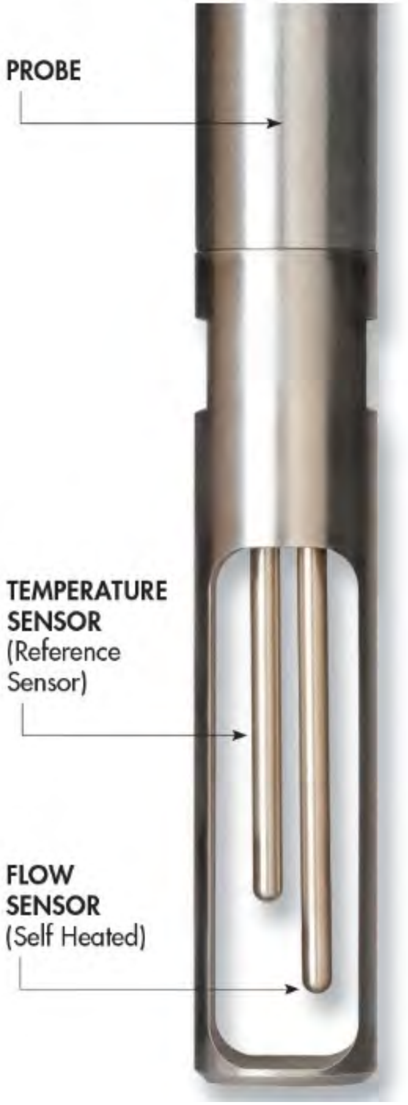
Measurement Tools





Thermal mass measurement versus other technologies

- Understanding the difference between a thermal mass flowmeter and other measurement technologies is the first step in deciding if the TMFM is the correct device for an application.
- The primary difference between a TMFM and other technologies is that it directly measures mass flow versus volumetric flow based on heat transfer.
- Gas is compressible. The gas volume changes under pressure and temperature fluctuations.
- For this reason, orifice plates, venturi meters and other Delta-P (differential pressure) devices, as well as turbine meters, rotary gas meters and vortex meters, require additional instruments to measure the temperature and pressure and then mathematically convert the volume to mass.
- A TMFM does not need separate temperature or pressure transmitters as it directly measures mass flow.



How to Hot Tap


10673


LB
"Apollo"


Apollo

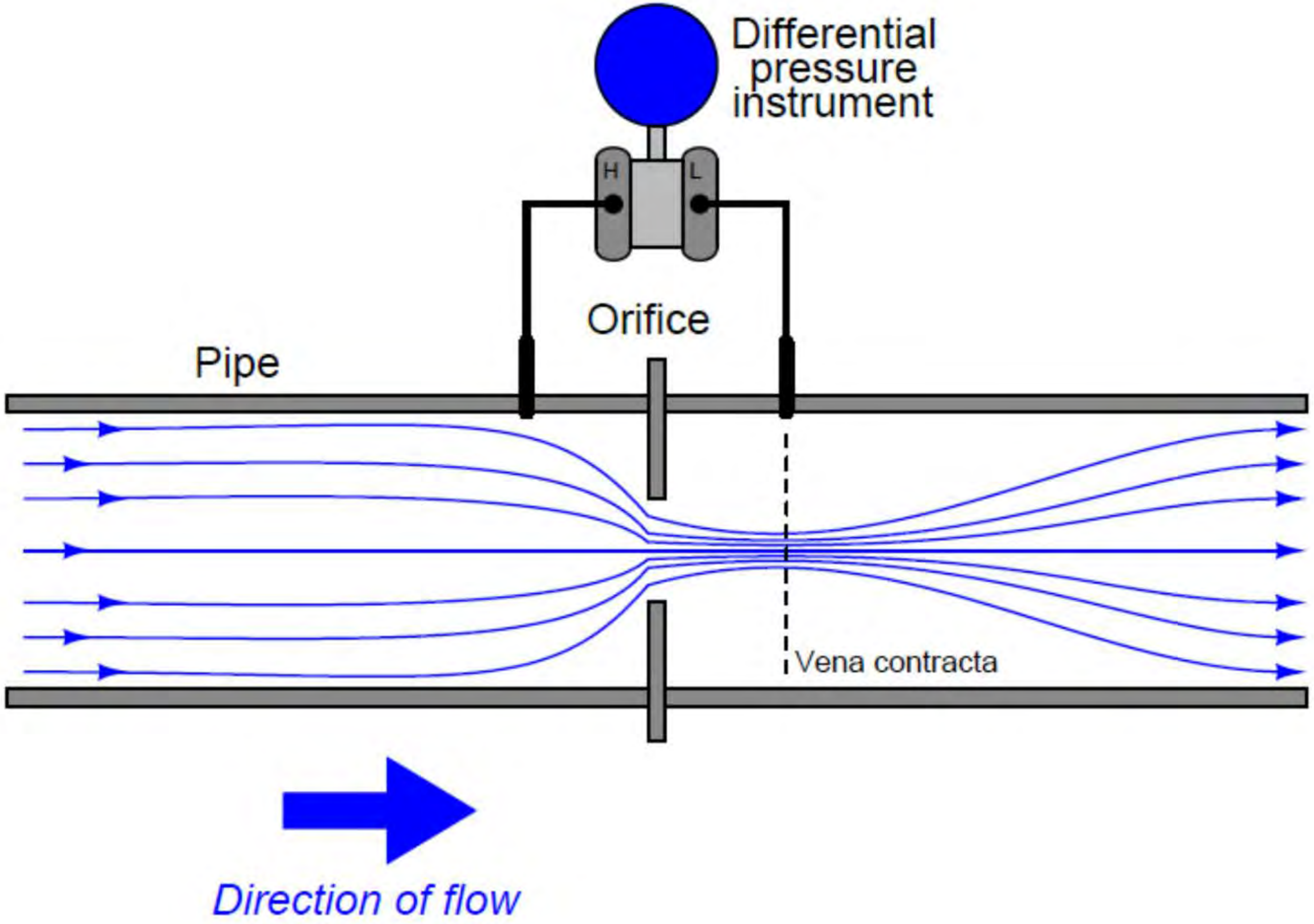

44

Orifice Plate Flow Meters

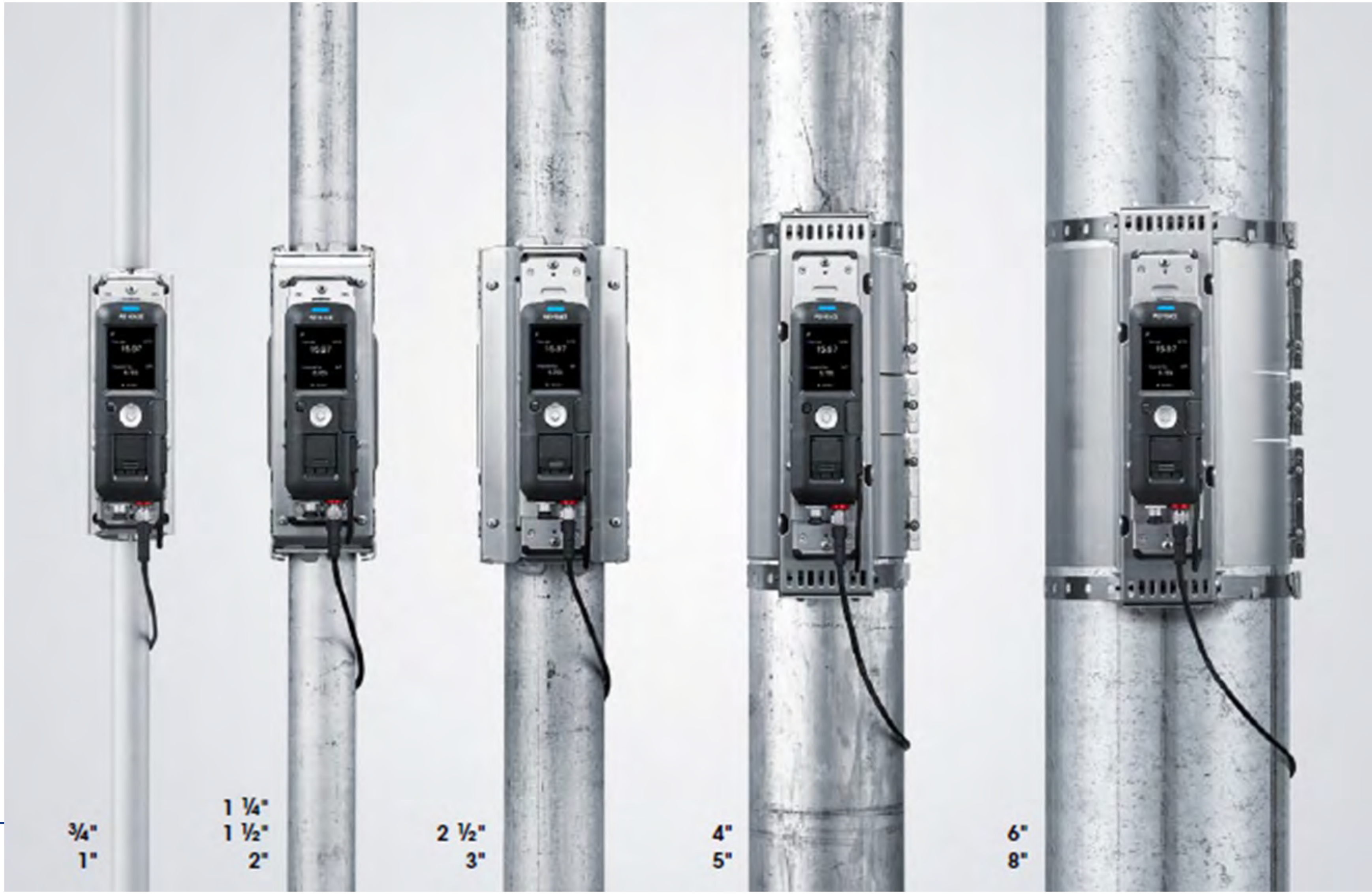
These meters are another carry over from fluid engineering.

They operate on the physics of a pressure drop being created as a medium flows through an orifice.

The problem with these meters is just that; they, themselves are a pressure drop.



Ultrasonic Flow Meters



Taking Measurements

- Money spent on energy is calculated by converting kWh to dollars.
- Dollars can be estimated using average $/kWh rates, or more complicated calculations can be made using actual electricity rates.
- You need to understand your electricity rate structure, your electricity bill, and how the compressed air system is impacting the bill.
- Calculations on how much is spent on compressed air should always be tied back into production by calculating dollars spent on compressed air per unit of production

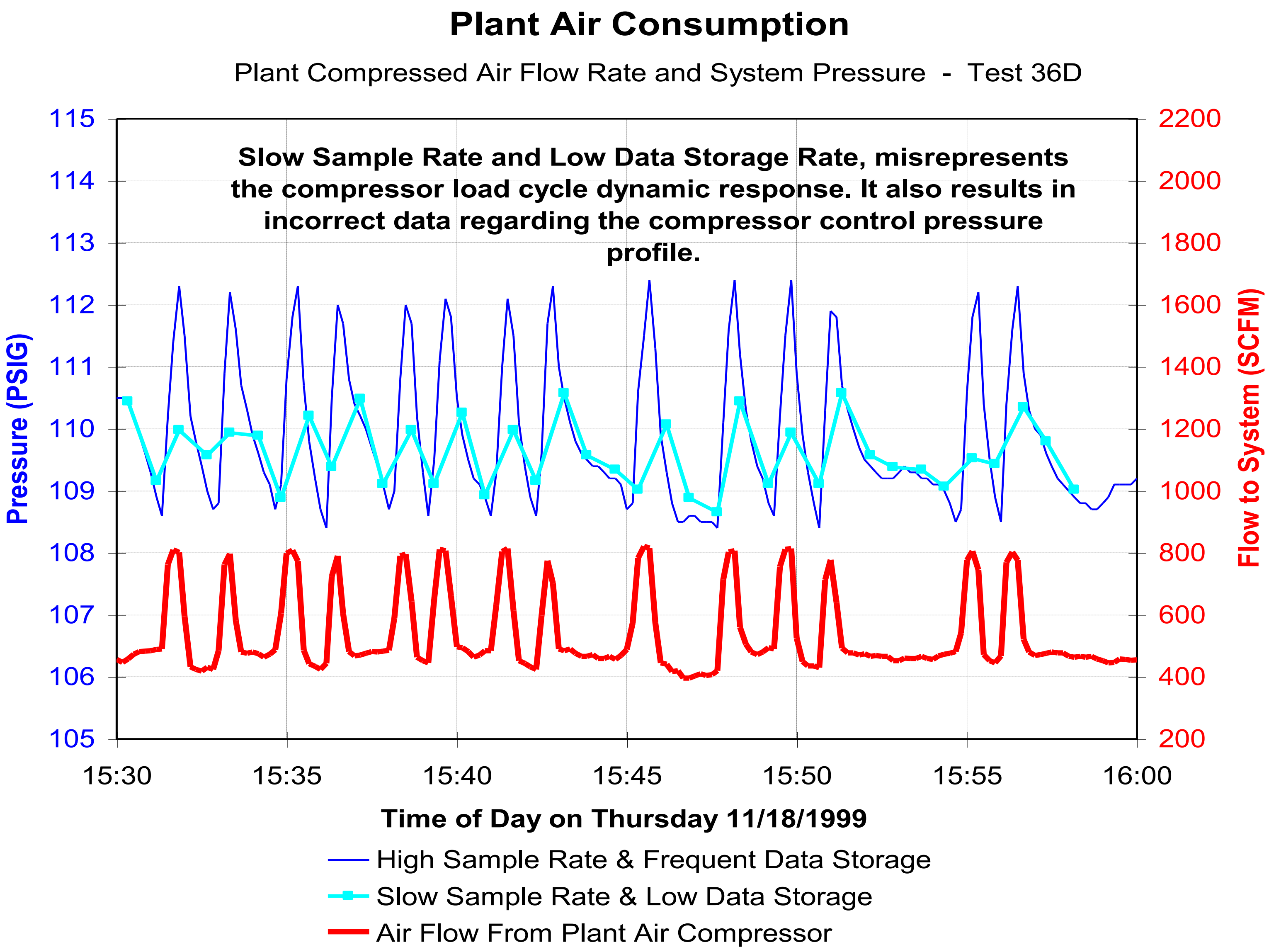
Measurements – A Snapshot Versus a Movie

- Taking data at a single point, or even during various shifts can provide some answers, but not the complete picture.
- The use of data logs is important in determining how a system operates over time.
- When data logging system performance sample rate (reading transducer signals), and data storage interval are critical.
- Sample rate, data reduction averaging methods, and data storage interval must be consistent with system dynamics.

Measurements – A Snapshot Versus a Movie

- This data chart shows a comparison of different sampling rates and data intervals.
- The inappropriate data collection leads to a misrepresentation of compressor load cycles.

	High Rate	Slow Rate
Sample Rate	1 sample per 1 second	1 sample per 3 seconds
Data Averaging	10 samples	15 samples
Data Interval	10 seconds	45 seconds

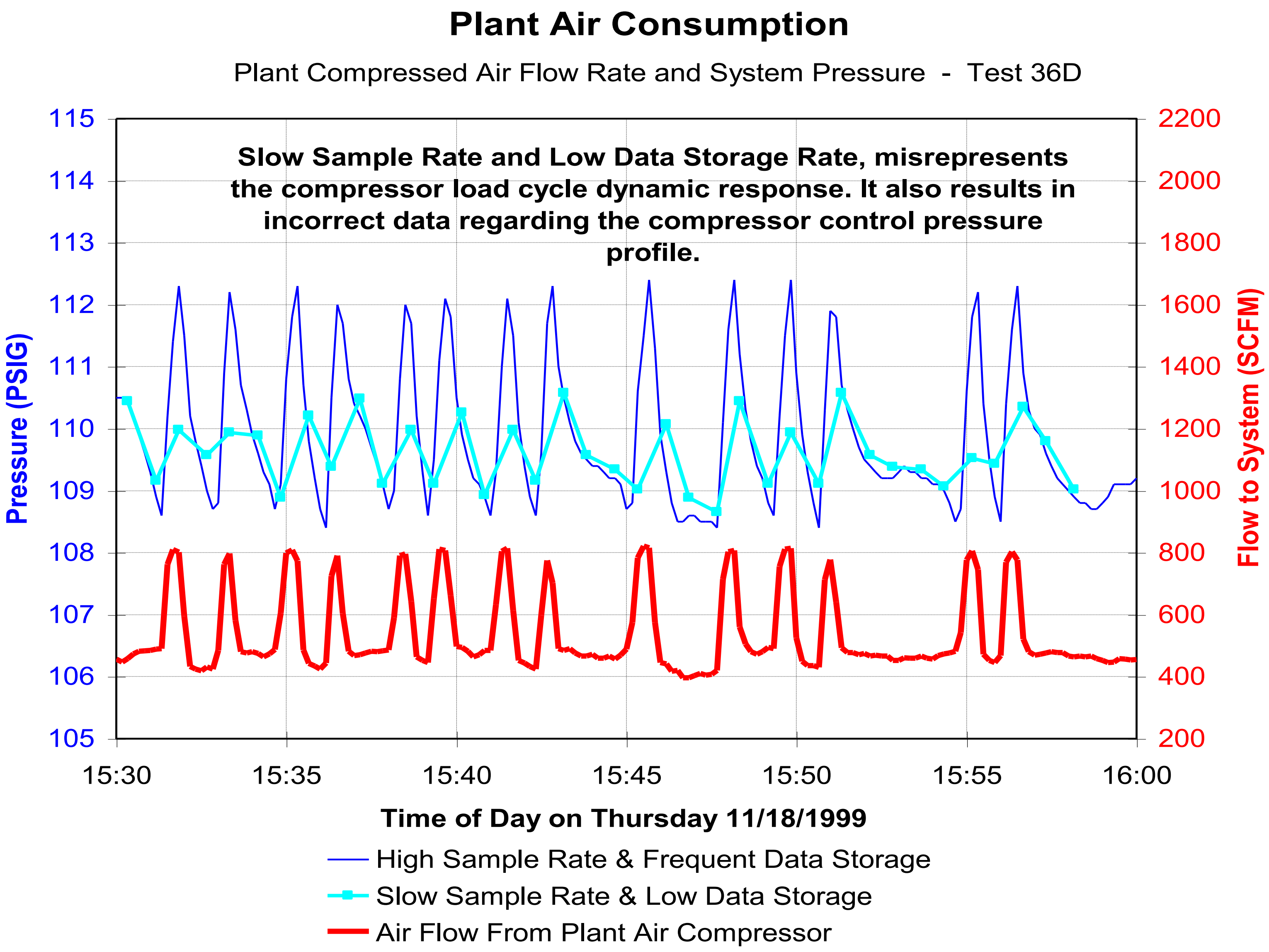


Better Plants
U.S. DEPARTMENT OF ENERGY

Measurements – A Snapshot Versus a Movie

- Signal aliasing in the data tracing above could easily lead to misinterpretation of the recorded system dynamics.
- The 350 scfm swing in flow to the system is NOT a demand event.
- The true wave forms, collected at the high sample rate, clearly show a direct correlation of increasing flow with increasing pressure.

	High Rate	Slow Rate
Sample Rate	1 sample per 1 second	1 sample per 3 seconds
Data Averaging	10 samples	15 samples
Data Interval	10 seconds	45 seconds



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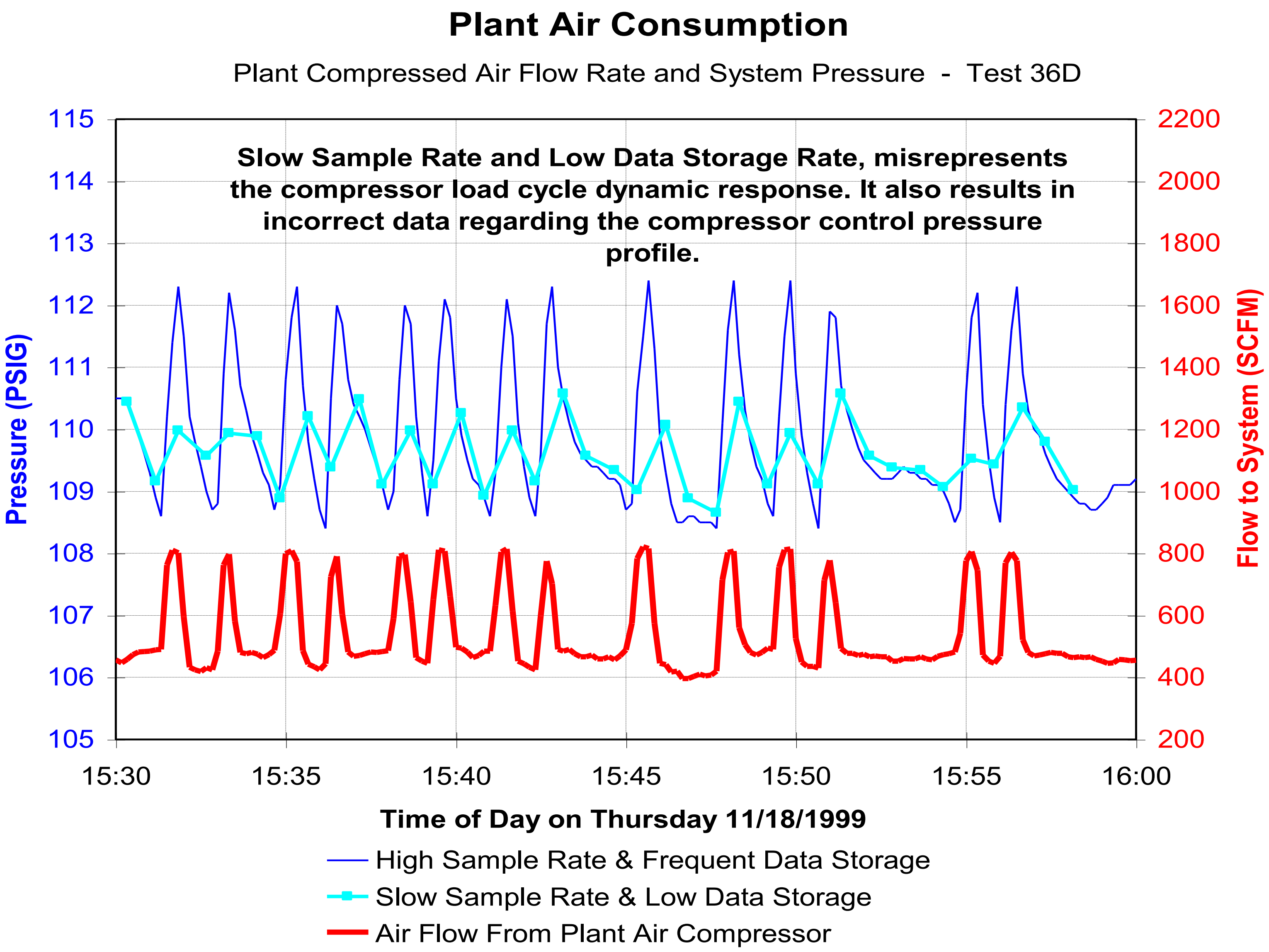
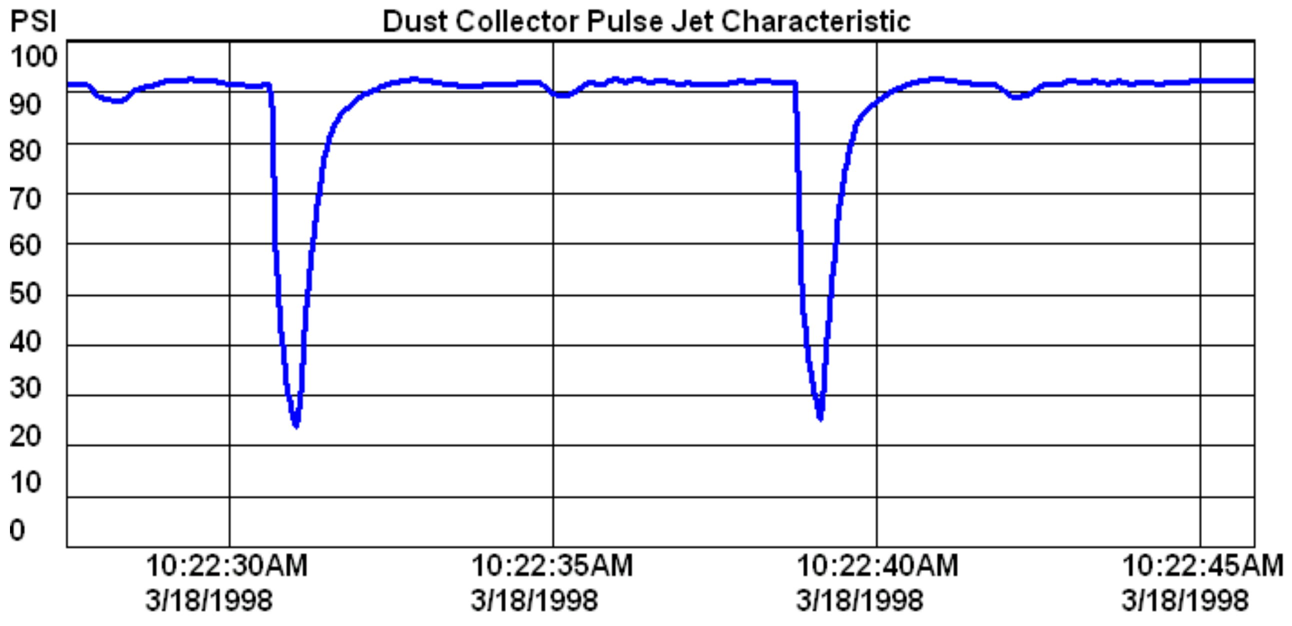
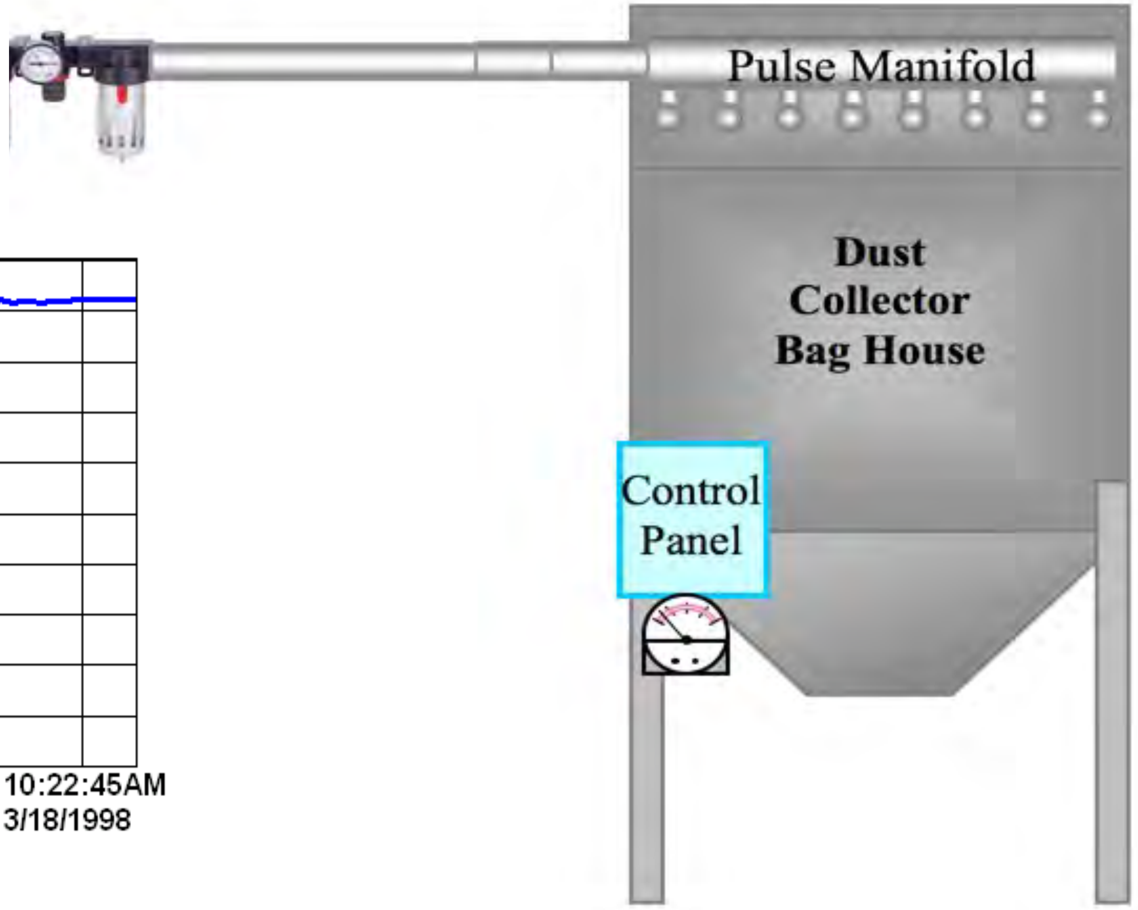
Measurements – A Snapshot Versus a Movie

- The aliased pressure tracing between 15:30 hours and 15:35 hours might be interpreted to show increasing flow with decreasing pressure, or no change in pressure.
- The slow sample rate and alias pressure tracing could lead to the conclusion that the flow increase is a demand event.
- **Increasing flow with decreasing, or no pressure change, is due to a demand event.**



High Speed Data Collection





Using Measurements

- Measurements take the "vital signs" of a compressed air system to see how it is operating and how efficient the system is
- Once the system baseline is established, it can be tracked over time to monitor improvements or degradation in the system’s performance.
- This information is then converted into dollars and communicated to management.

Summary

- Measurements need to be taken to understand how a compressed air system is operating
- Measurements can help you adjust and optimize your system
- Data logging can help you better understand and optimize the system, although sometimes substantial improvements can be made without them
- Care needs to be taken to ensure that you have the right tools for the job, know how to use them, know their limitations, and know how to interpret the data being produced
- Understanding the difference between accuracy and repeatability is important when taking measurements
- Measurements will help you understand how much you are spending on compressed air on a per unit of production basis

Next Week

- Positive Displacement – Typically Rotary Screw
- Dynamic Compressors – Typically Centrifugal
- Compressor Room Ventilation