Better Plants
U.S. DEPARTMENT OF ENERGY

In-Plant Trainings

Virtual Platform

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 to conduct the trainings virtually requiring eight (8) 2-hour online training sessions.
- 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 manageme
  - 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

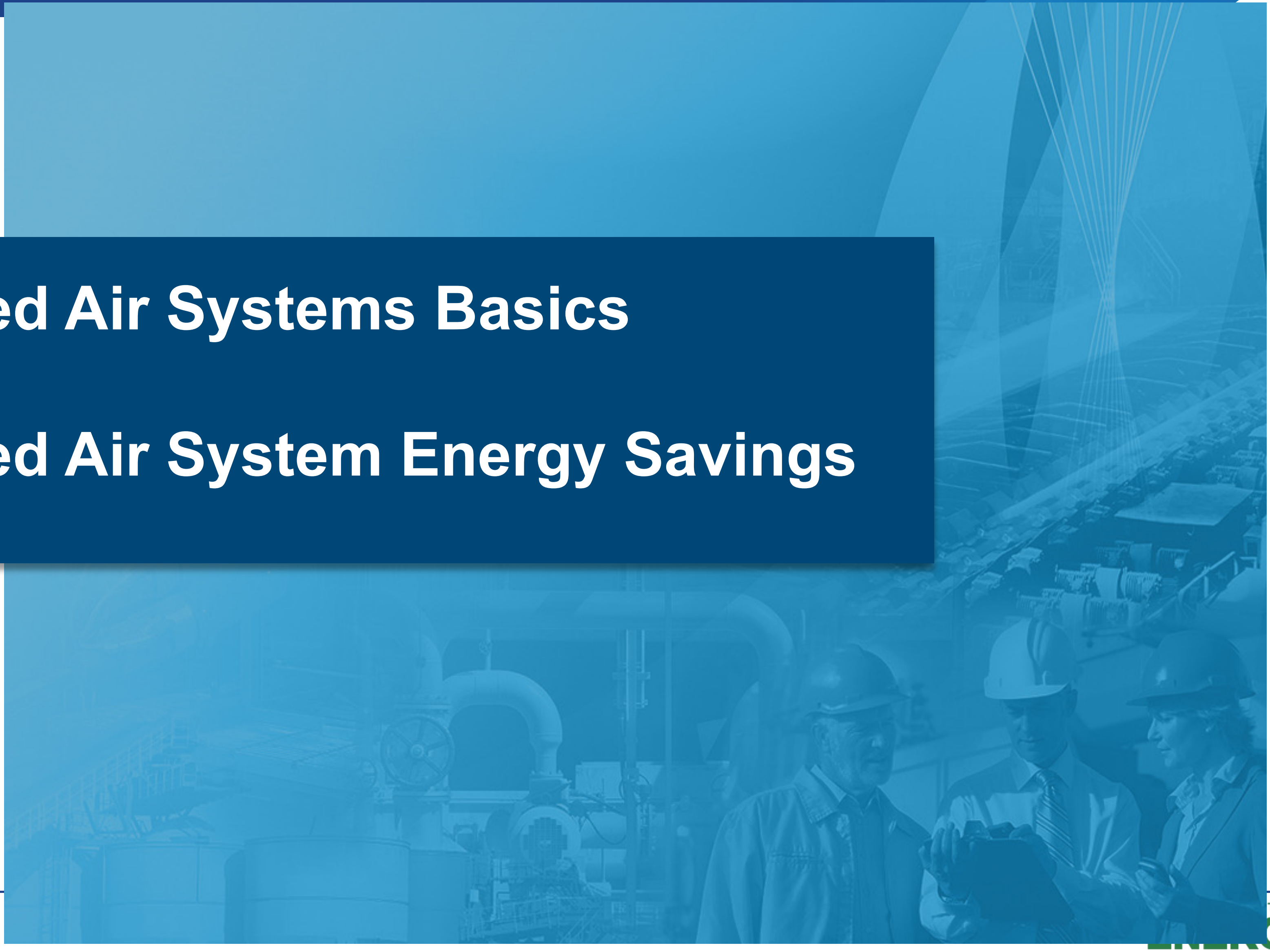
Assessment Process

- **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 Ventilaton
- Week 3 – Compressor Controls
- Week 4 - Air Treatment
- Week 5 – Distribution System
- Week 6 – System Volume vs Storage
- Week 7 – Demand Side and Inappropriate Uses
- Week 8 – Wrap Up Presentations

Week 1

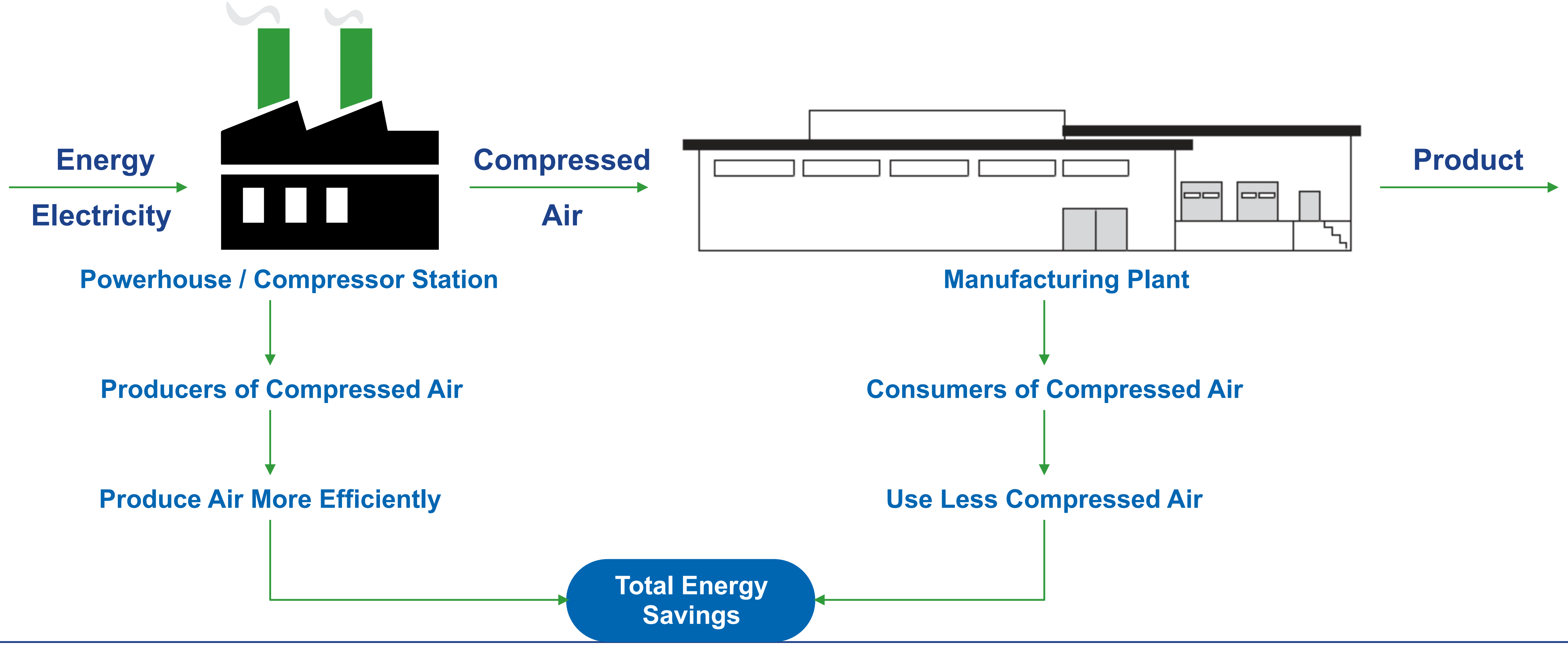


Compressed Air Systems Basics

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

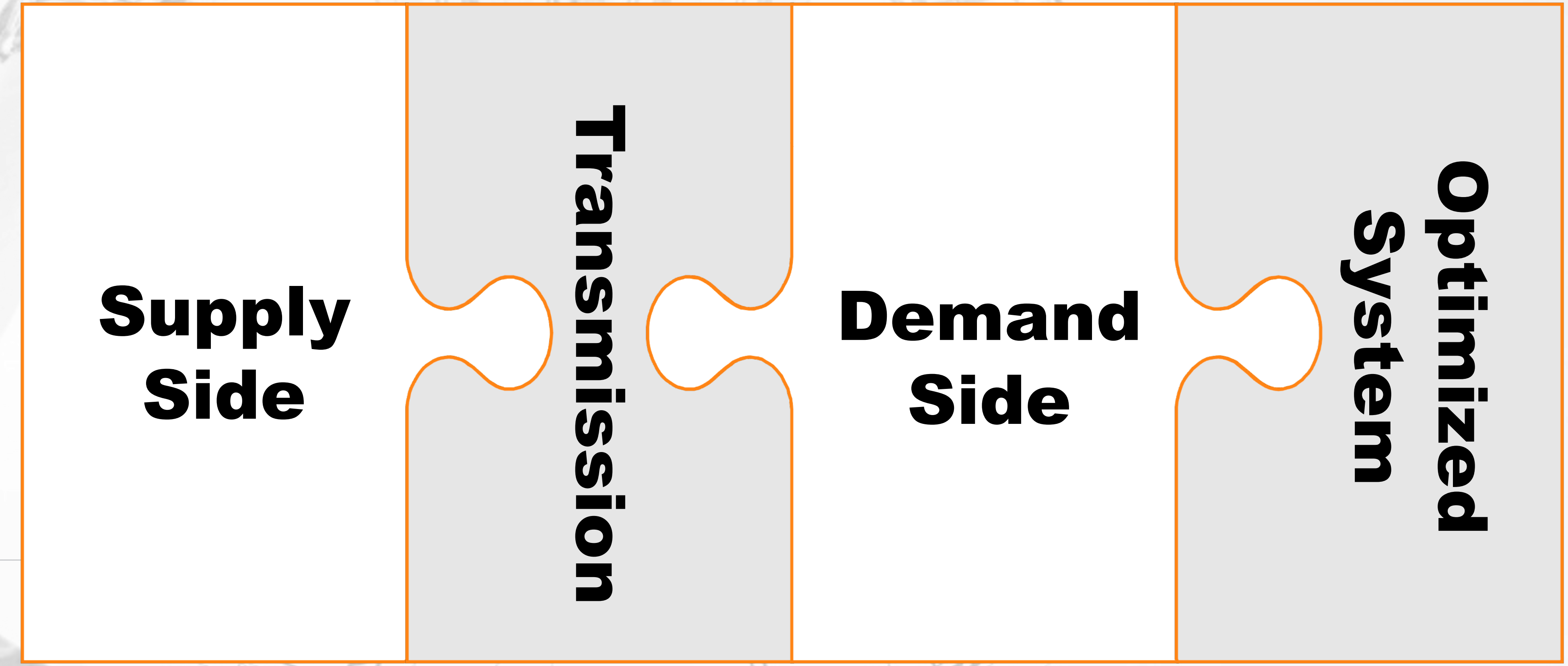
What am I looking for?

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.

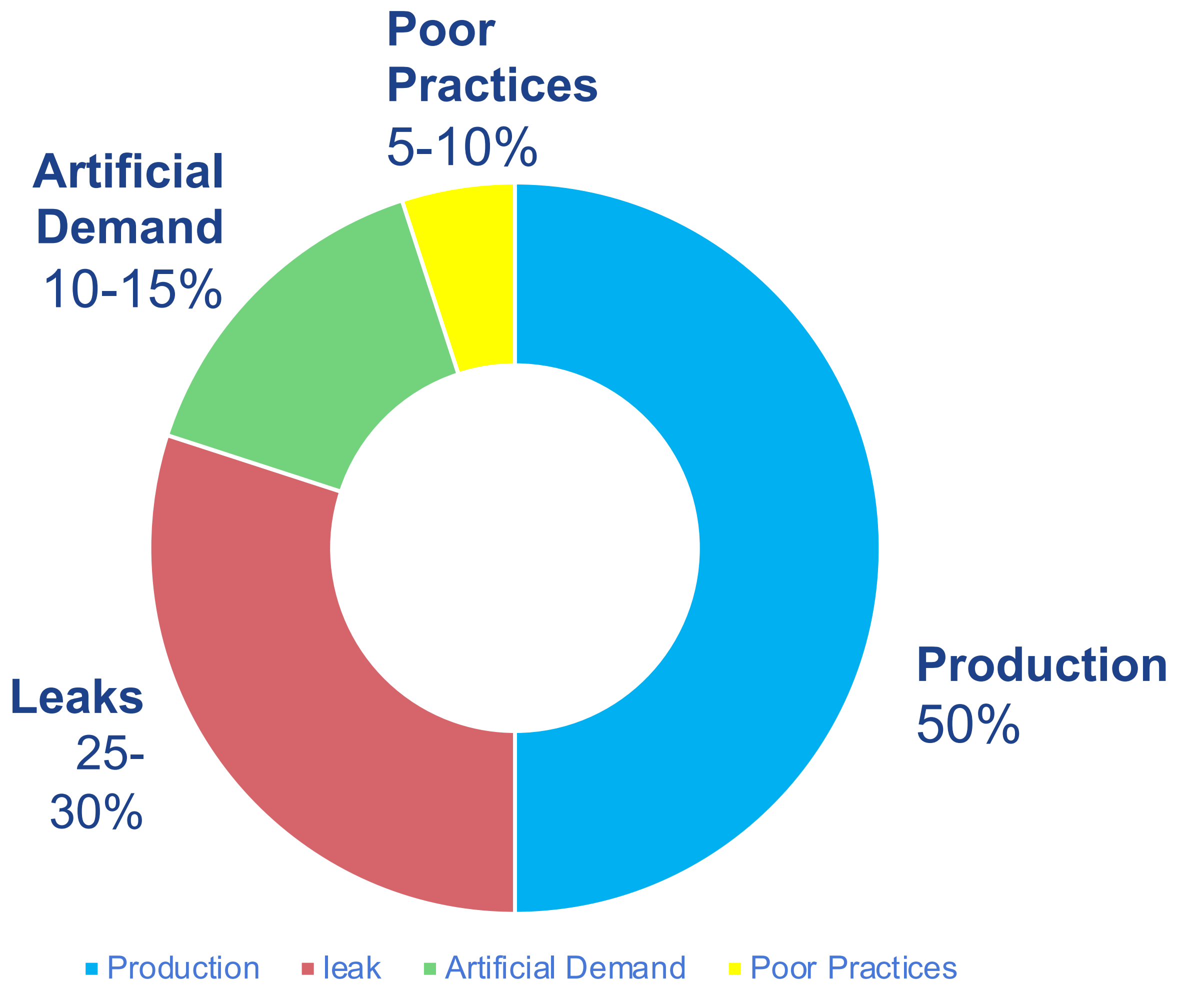
Compressed Air Versus Other Energy Sources

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

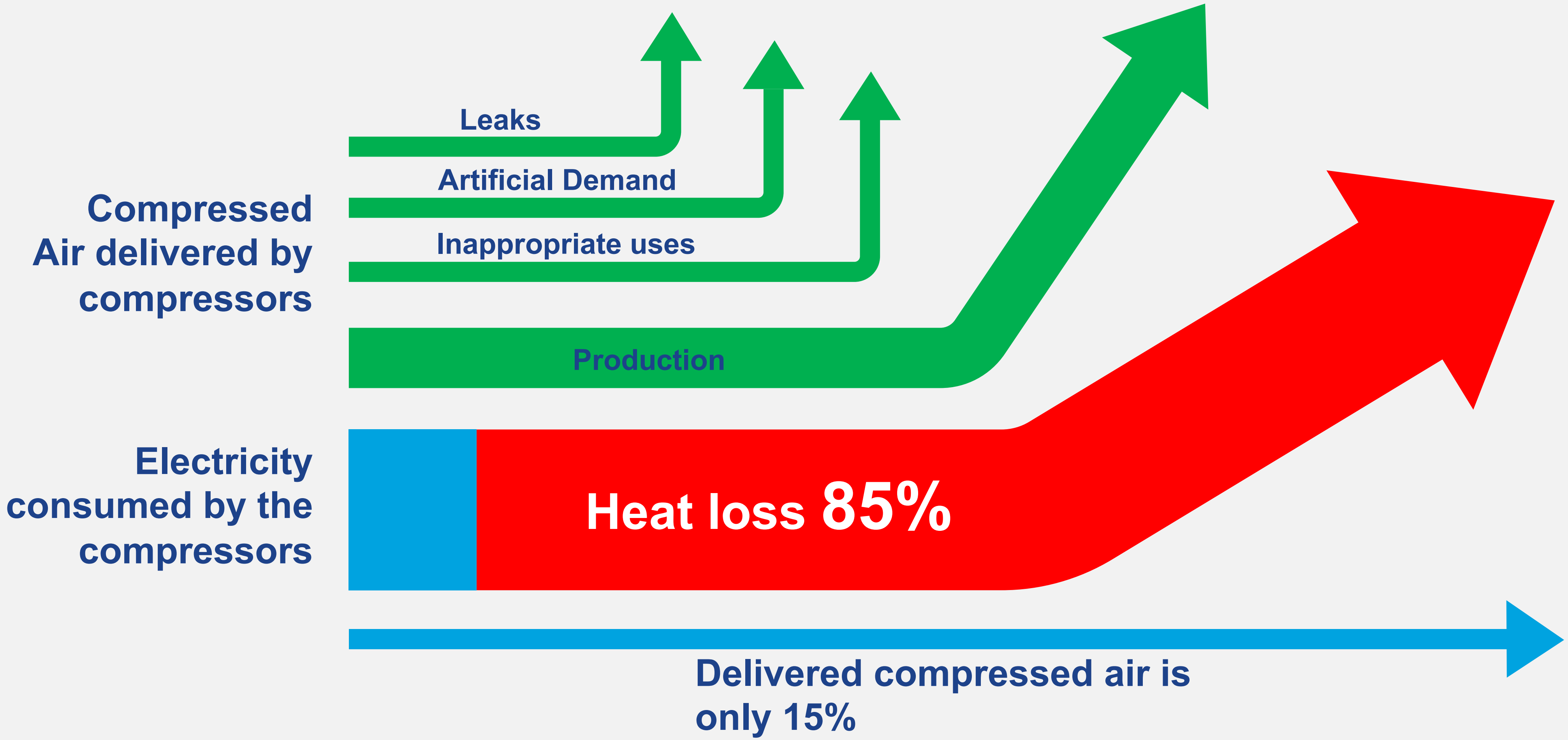
- You may be surprised, in most industrial plants, only 50% of the compressed air generated supplies productive air use.
- The other 50% is consumed by various losses.
- The losses are

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

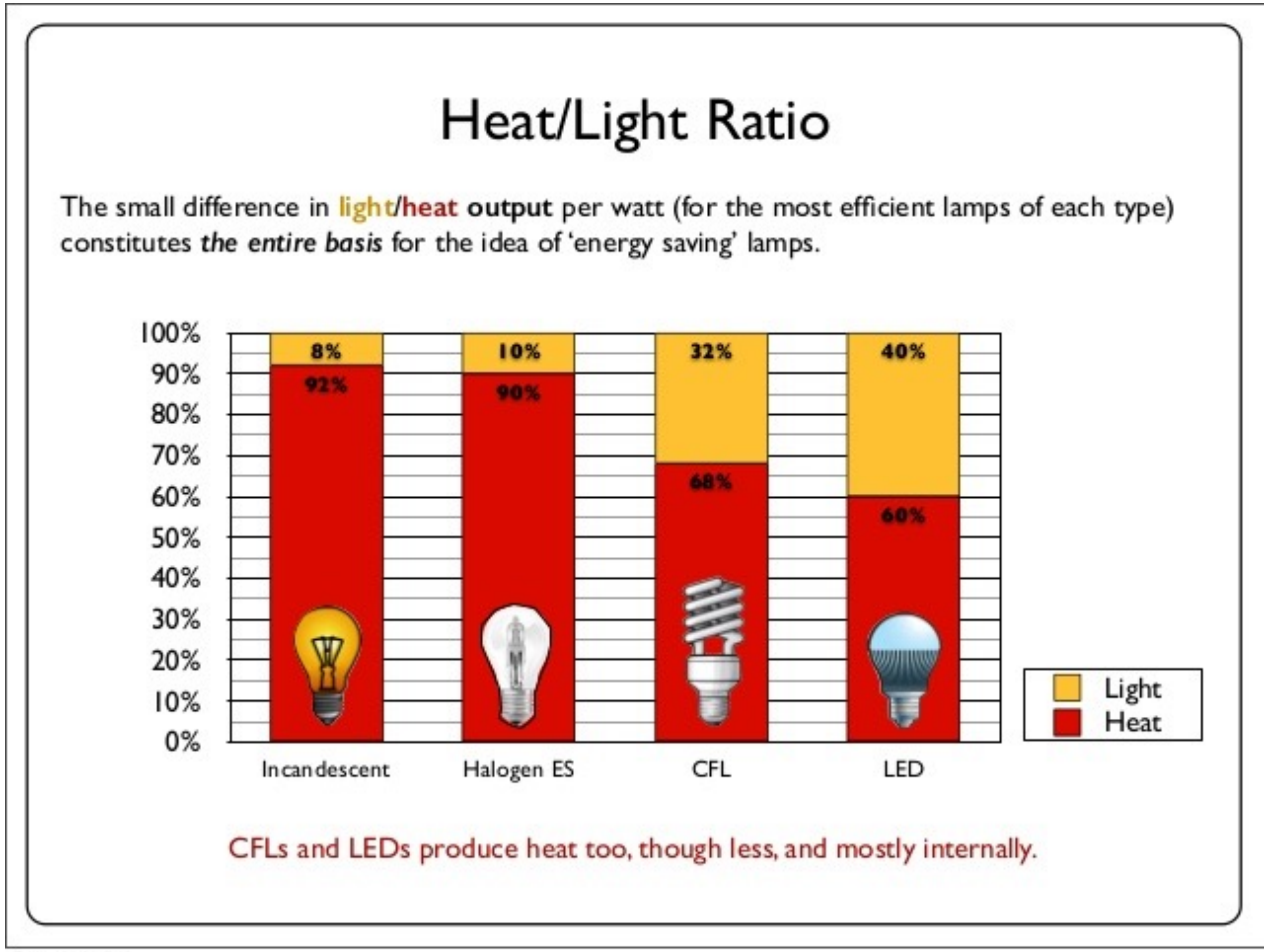
Where does the air go?



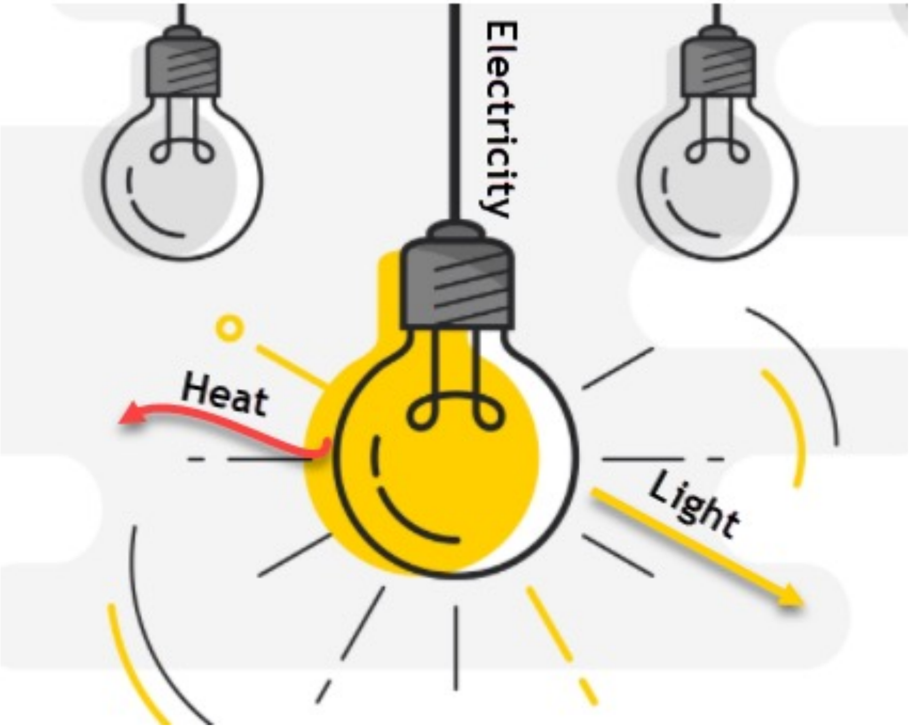
Not very efficient!



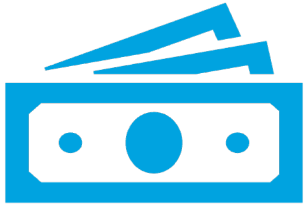
Not very efficient!



Friday 24 April 15

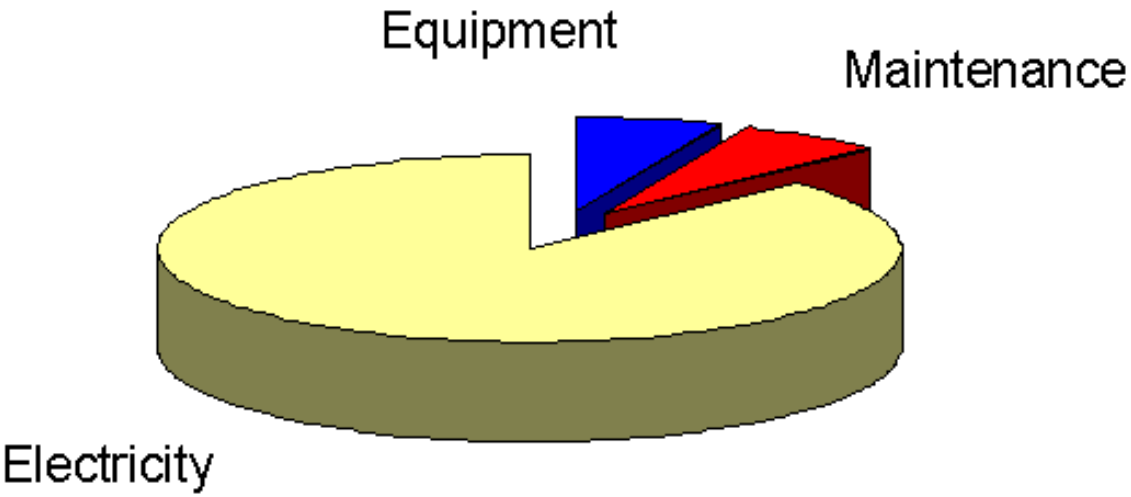


Compressed Air Systems
Total Cost of Ownership



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

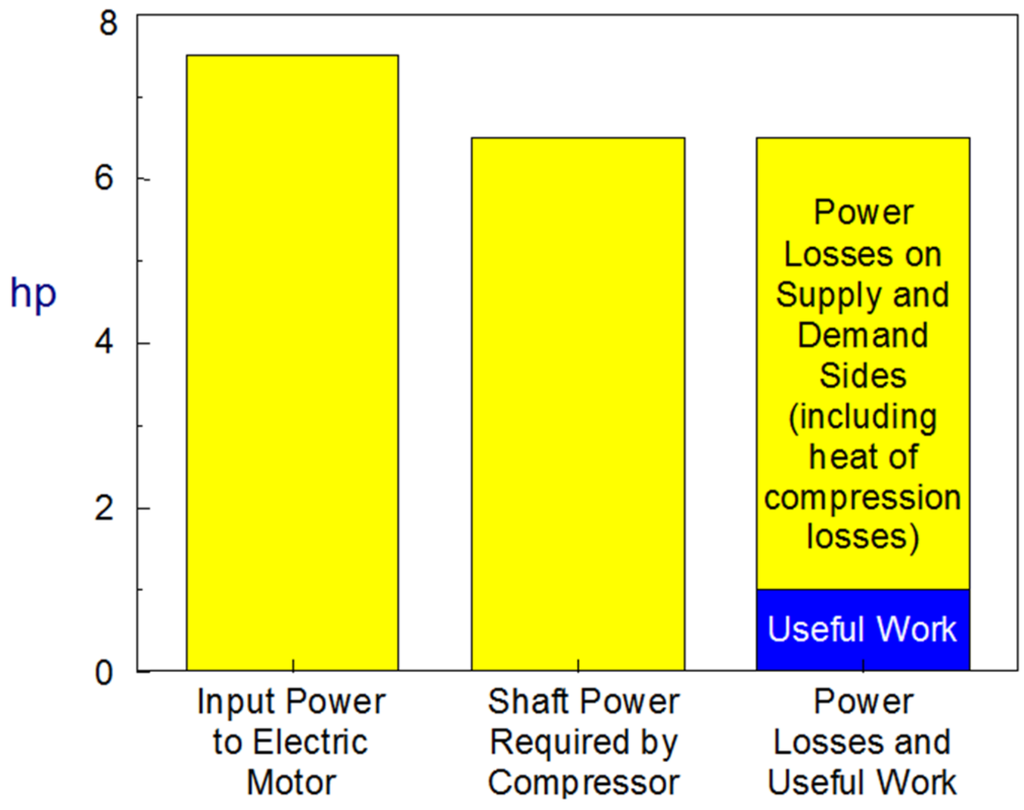
Electrical cost usually exceeds 75% of the total operating expense.



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

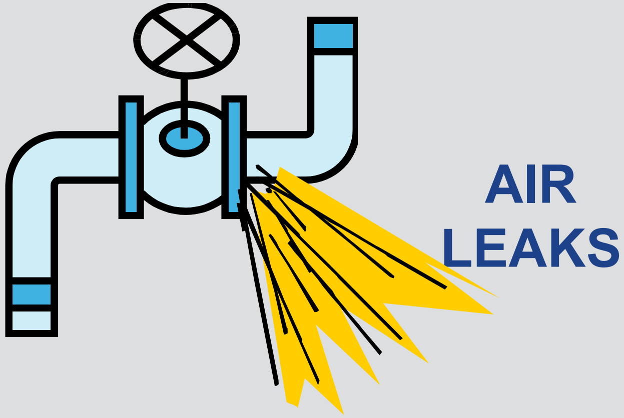
Reduce Pressure at Source

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

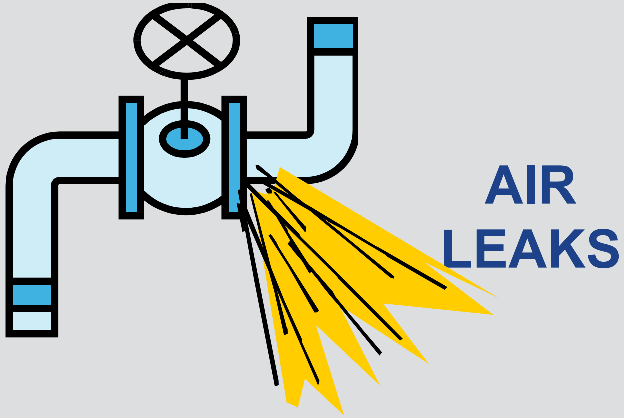
At 120PSIG



7.62 scfm FLOW

A 1/16 inch equivalent diameter leak

At 80PSIG



5.36 scfm FLOW

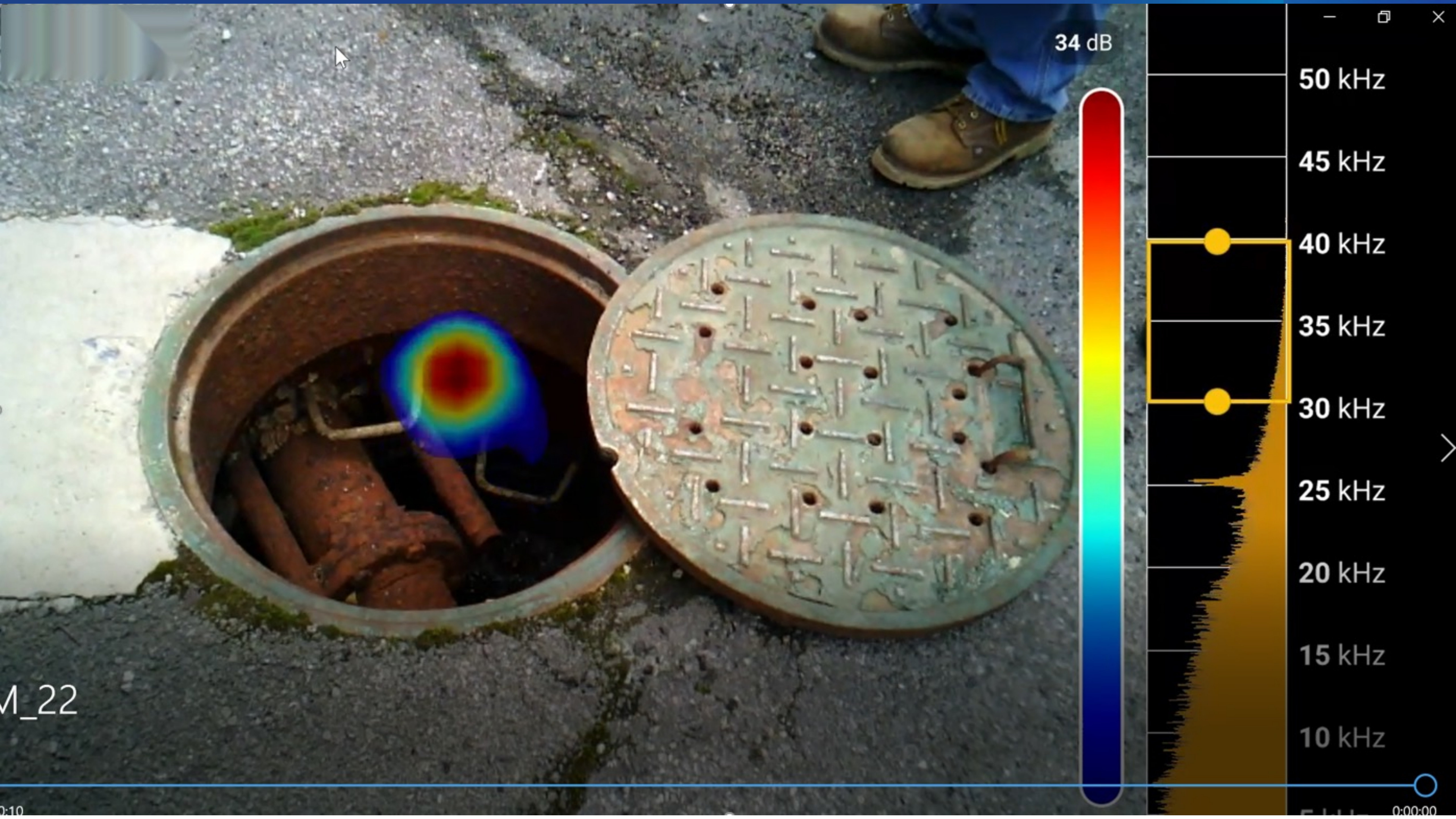
A leak consumes 42% more air at 120 psig than at 80 psig adding to the artificial demand on the system..

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

How Acoustic Camera Leak Detection Works

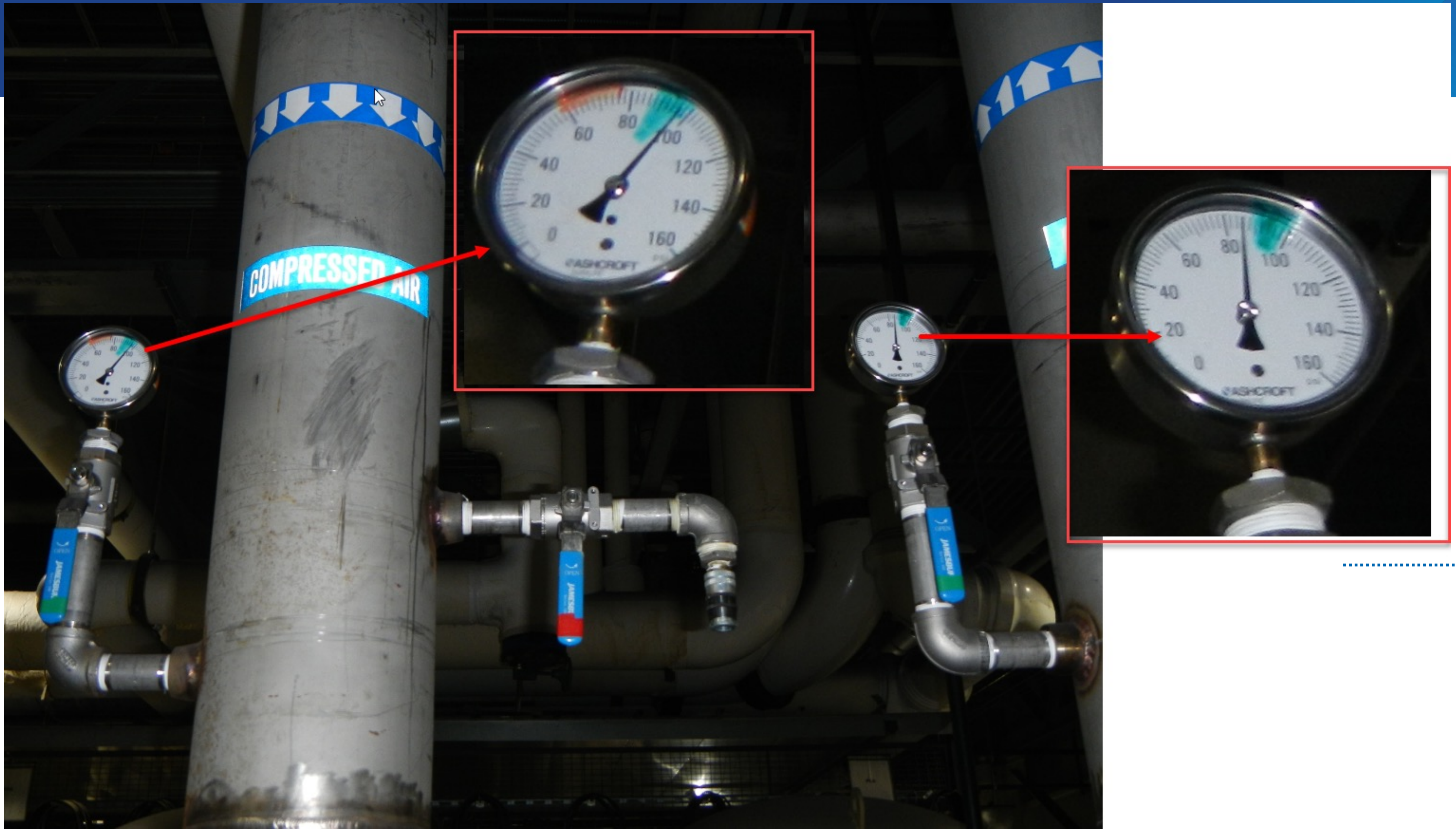
- An example of the graphical user interface of the Acoustic Camera is shown here.
- The measured sound value (in dB) is displayed top left of the screen.
- The Acoustic Camera converts this sound value to a leak flow sound value to a leak flow estimation (in scfm or l/min), using the distance to the leak.
- This distance can be selected using the distance slider to the right of the display.
- Some meters calculate their own distance from the leak source.



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

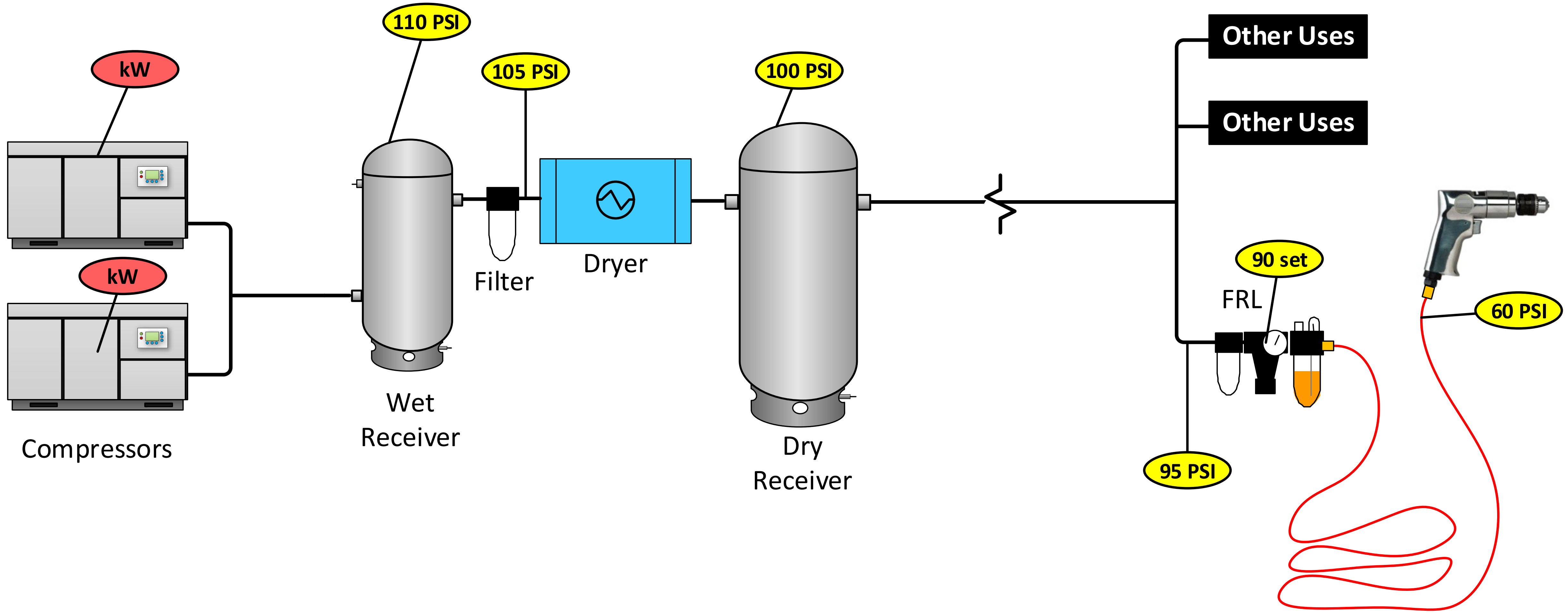

51 dB
50 kHz
45 kHz
40 kHz
35 kHz
30 kHz
25 kHz
20 kHz
15 kHz
10 kHz
5 kHz
0:00:01
0:00:09
10
30

Reduce Pressure at Source (Cont'd)

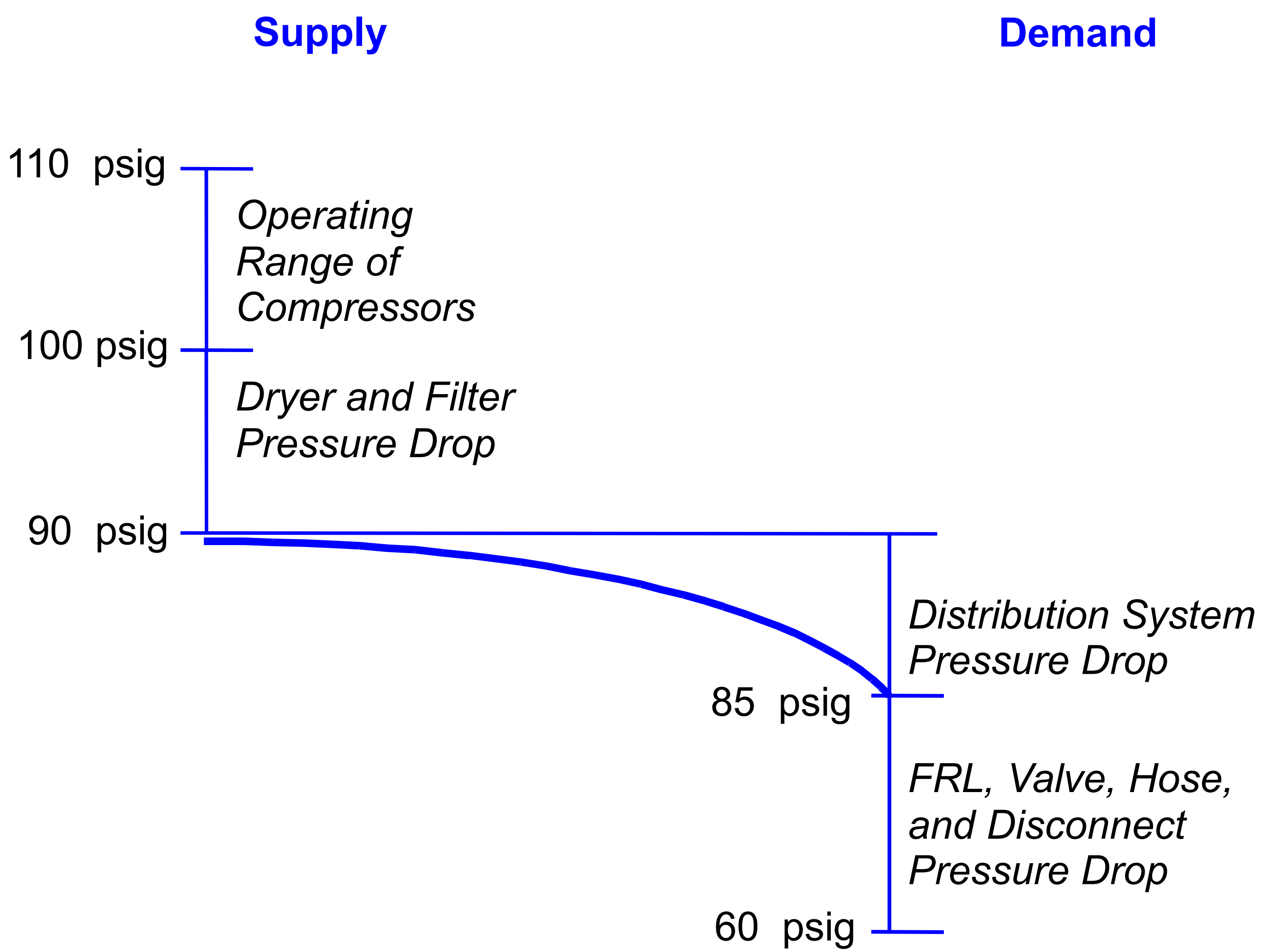

COMPRESSED AIR
0
20
40
60
80
100
120
140
160
ASHCROFT

Reduce Pressure at Source (Cont'd)

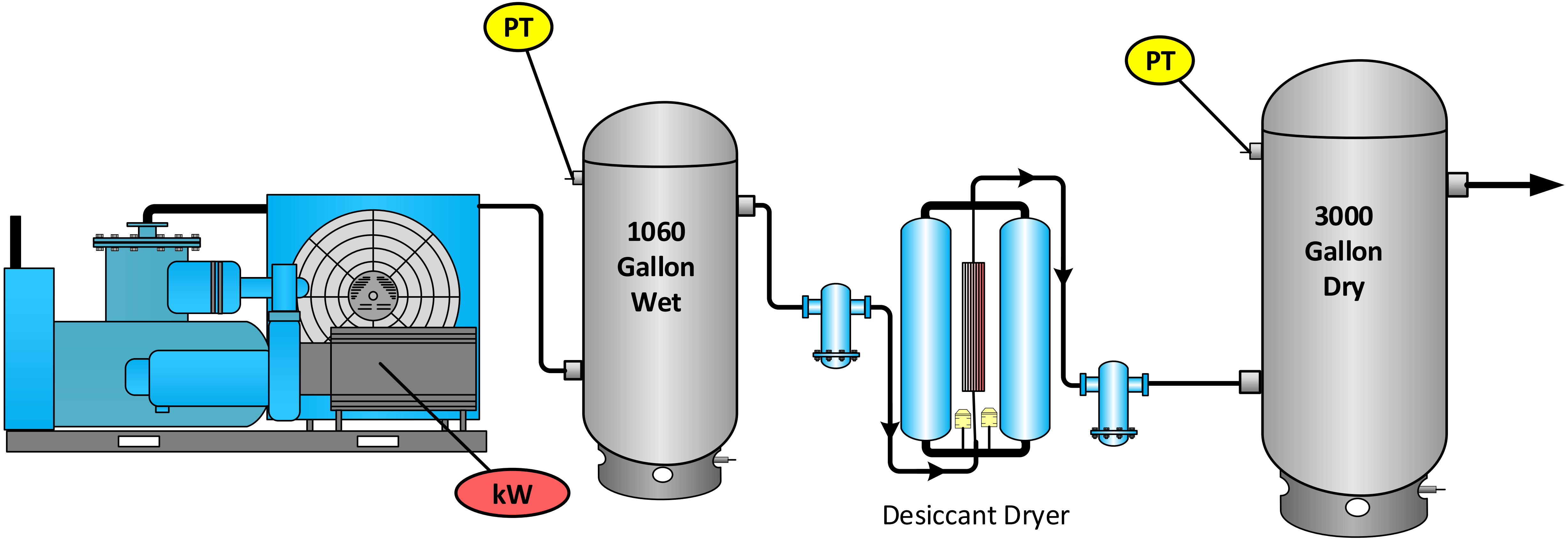
What Measurements Should I Record?



System Pressure Profile



What Measurements Should I Record?



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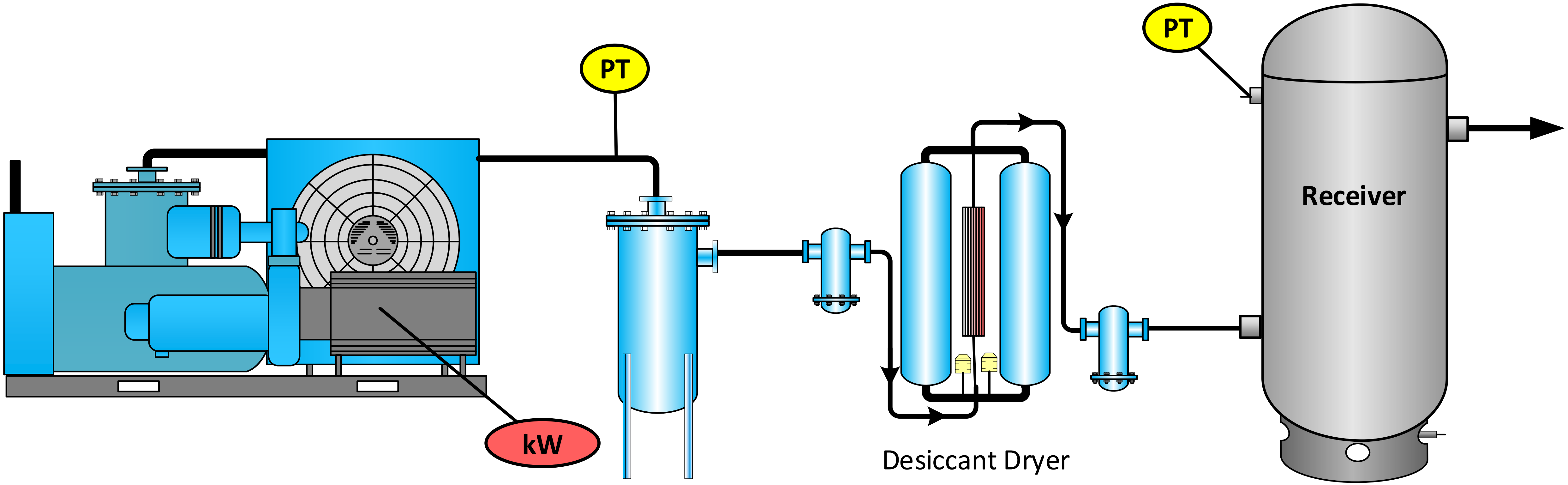
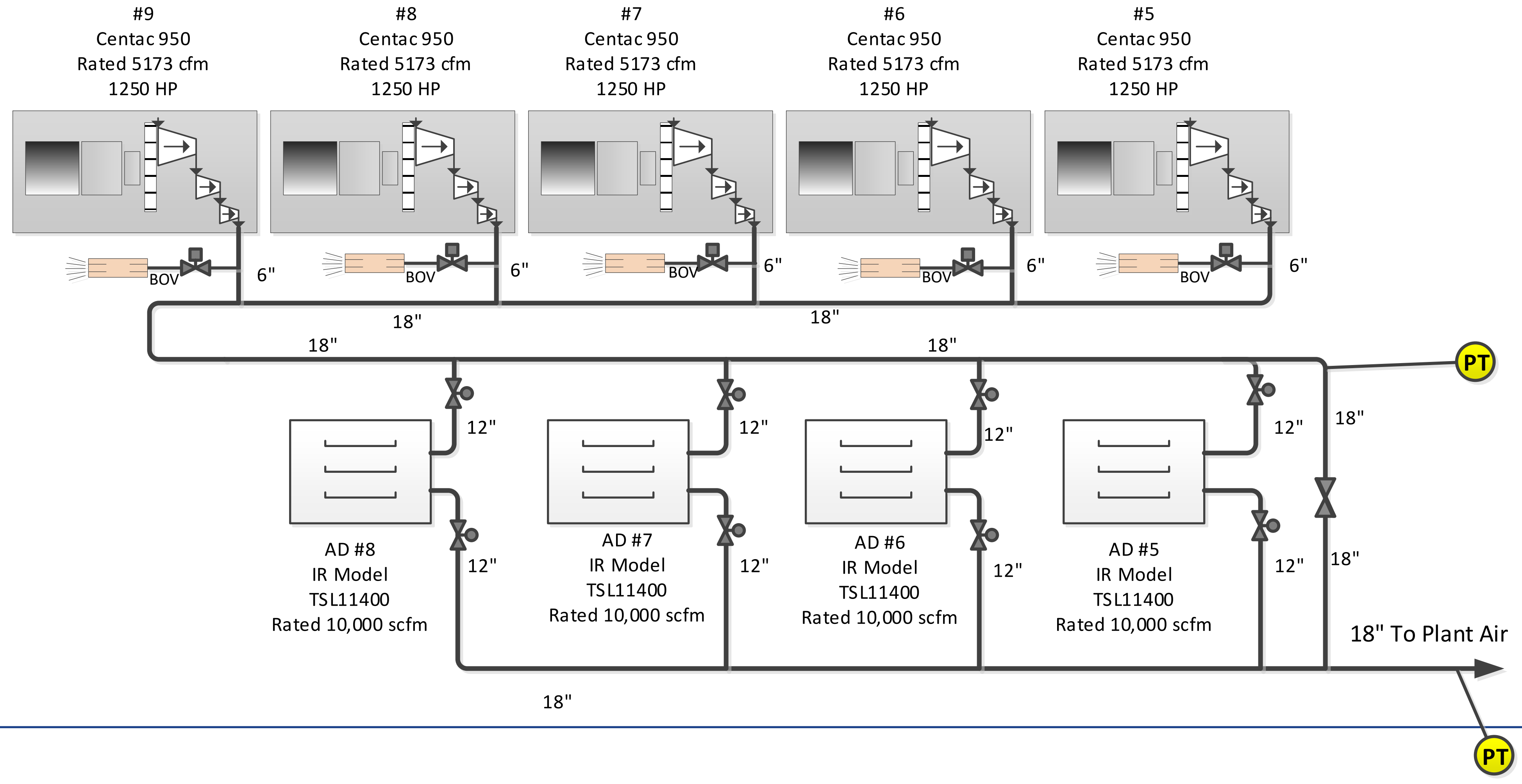
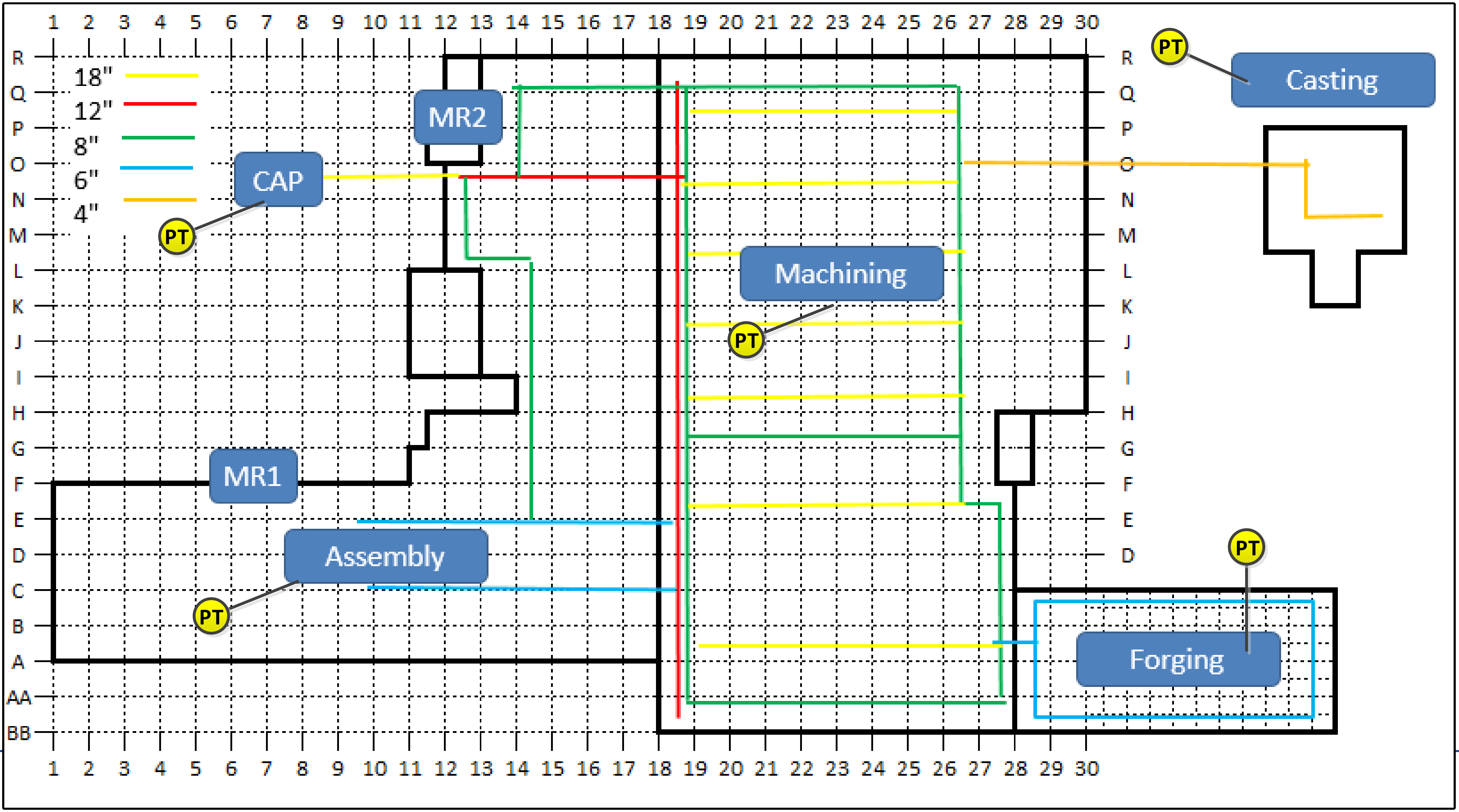


What Measurements Should I Record?

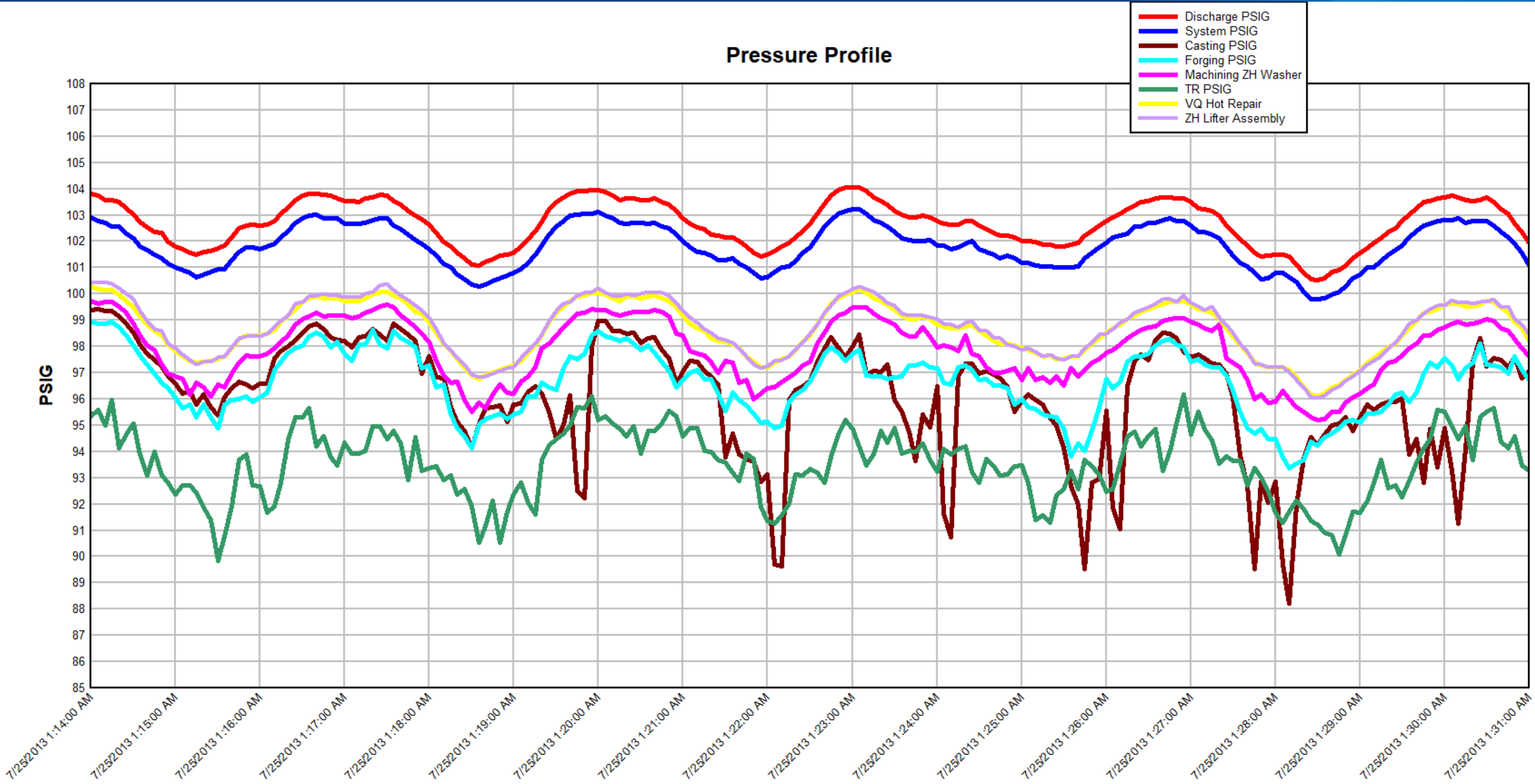
Compressed Air Plant



What Measurements Should I Record?



Data Collection Can Be Interpreted



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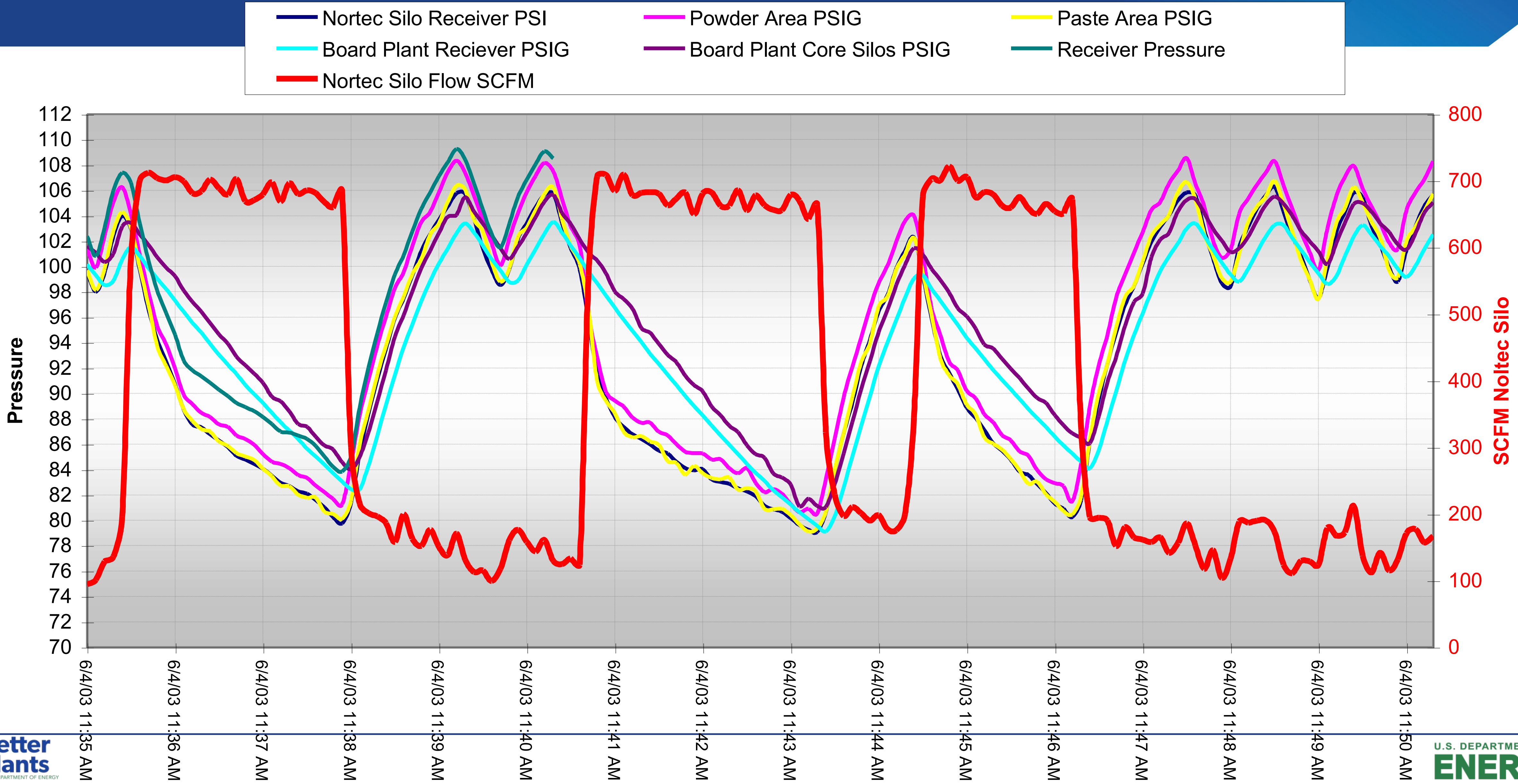
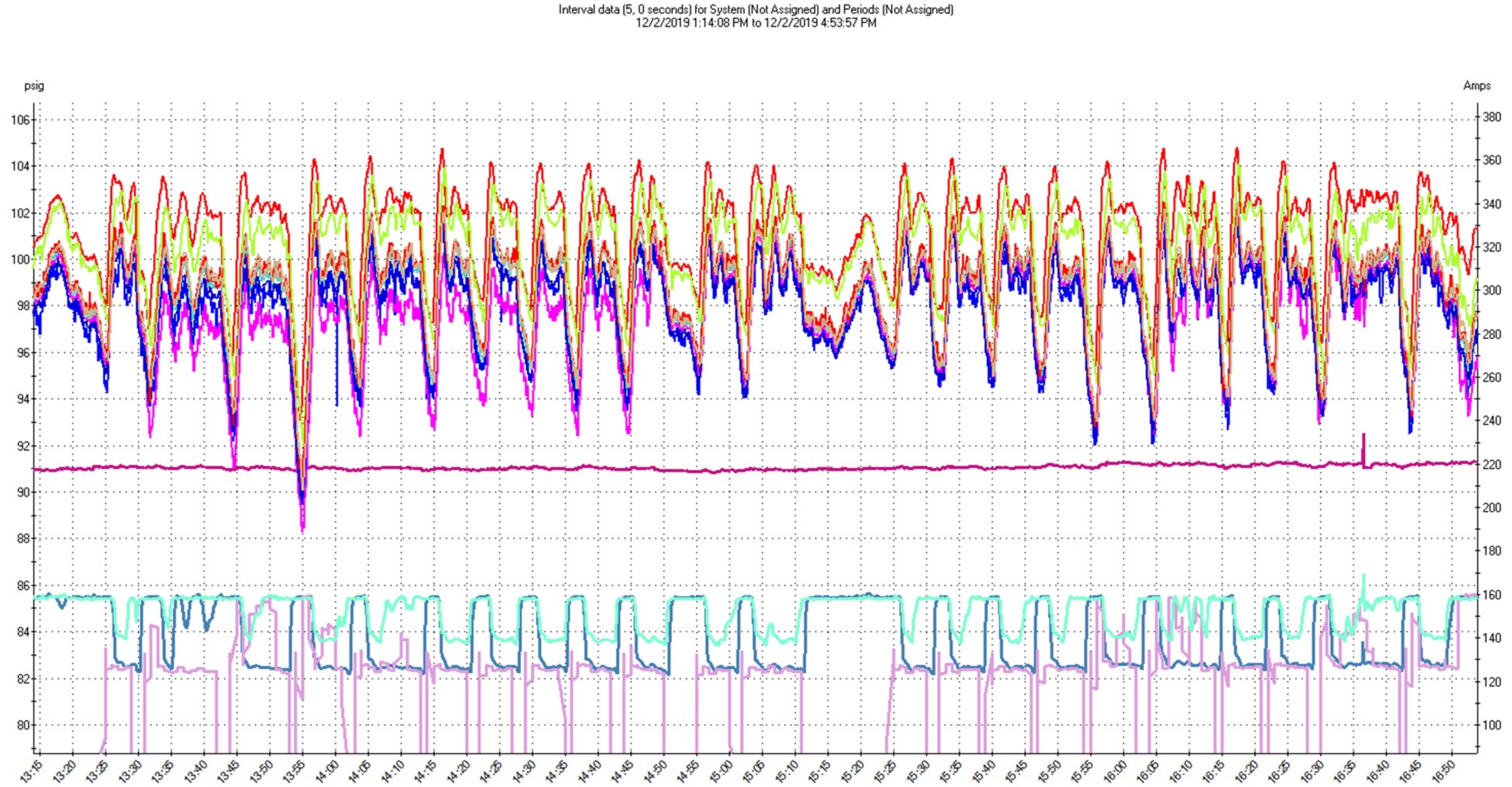
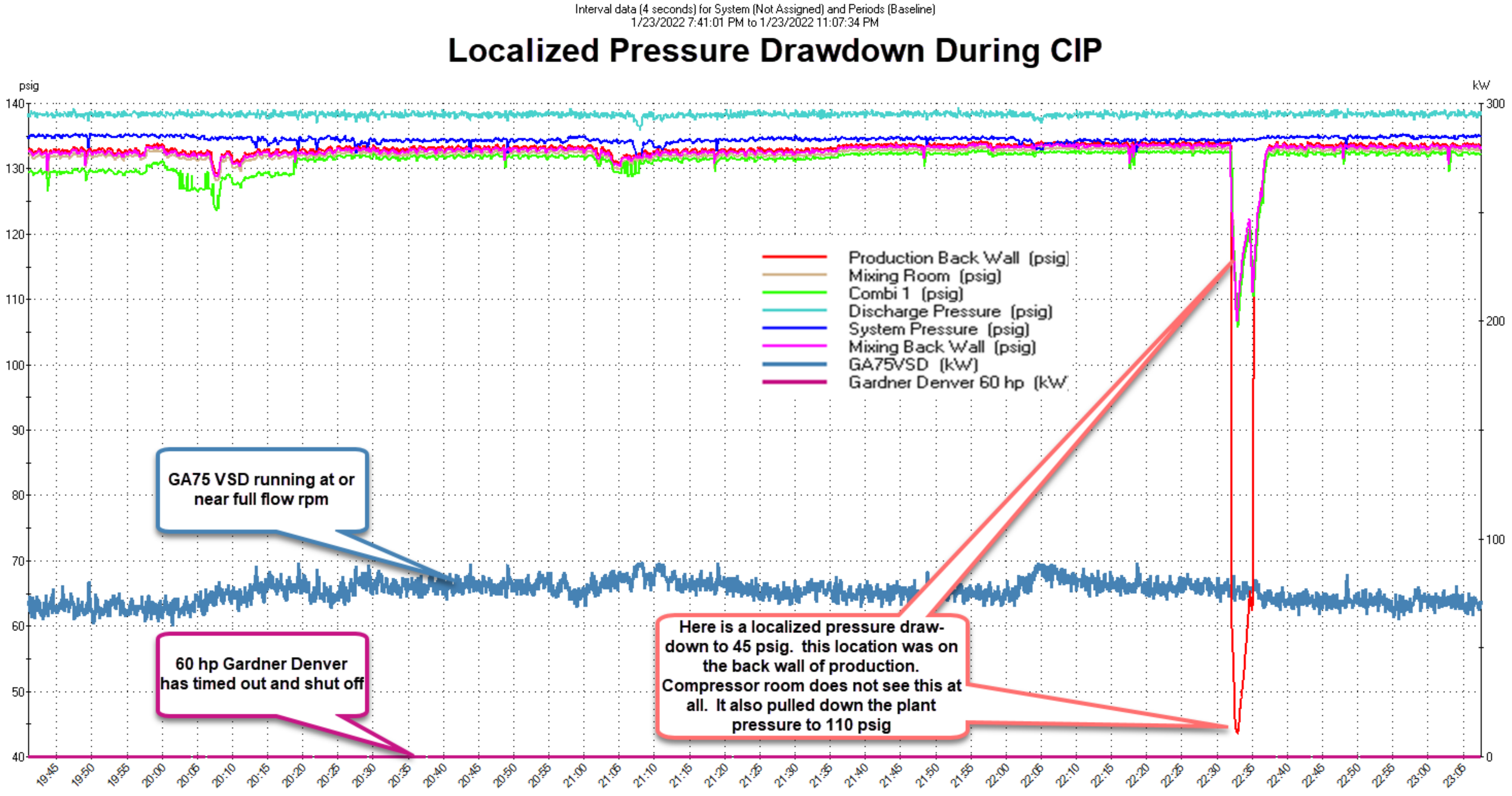


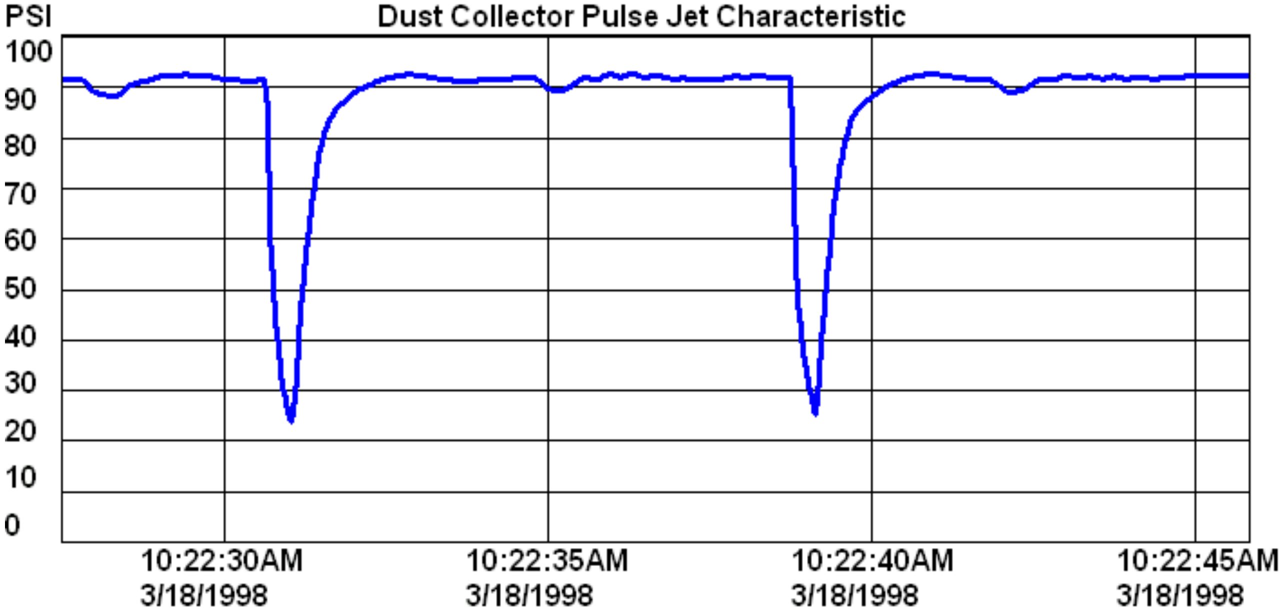
Comparing Pressure and Power

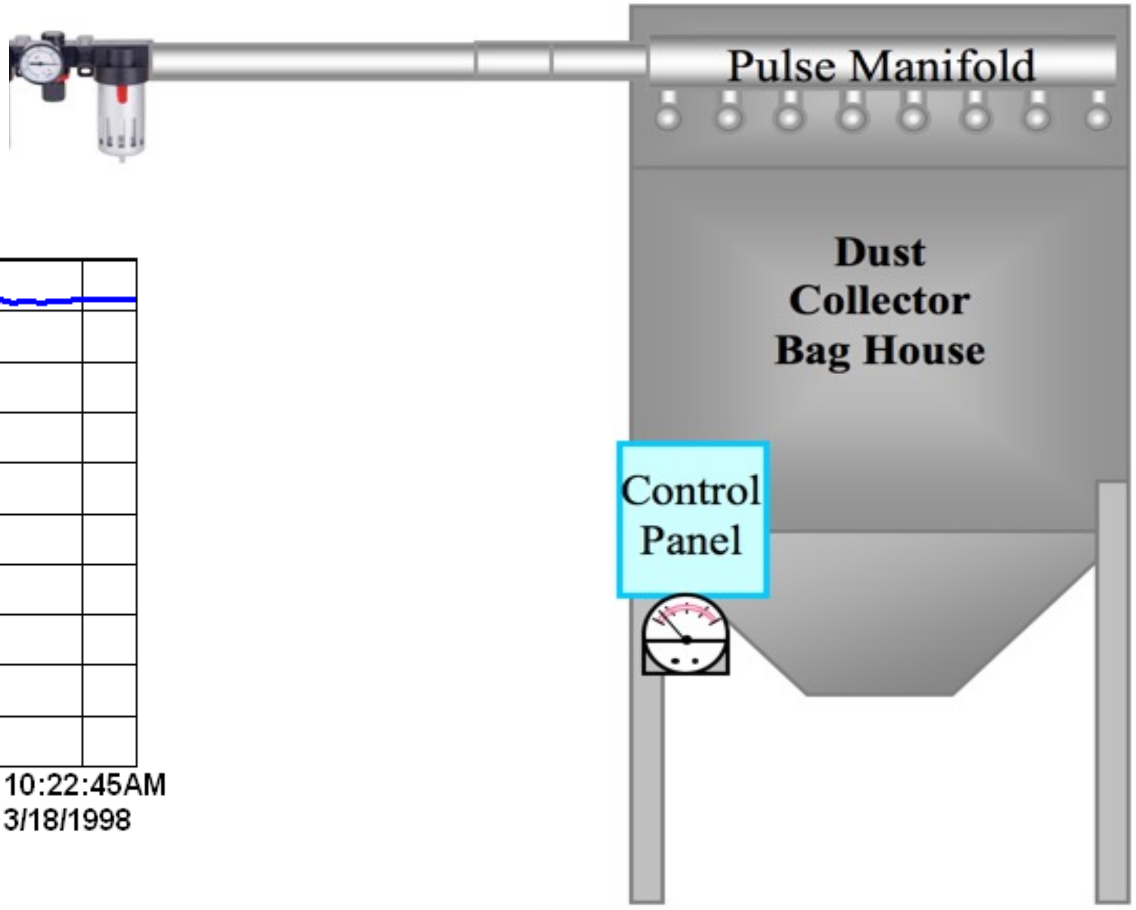


Localized Pressure Drawdown During CIP



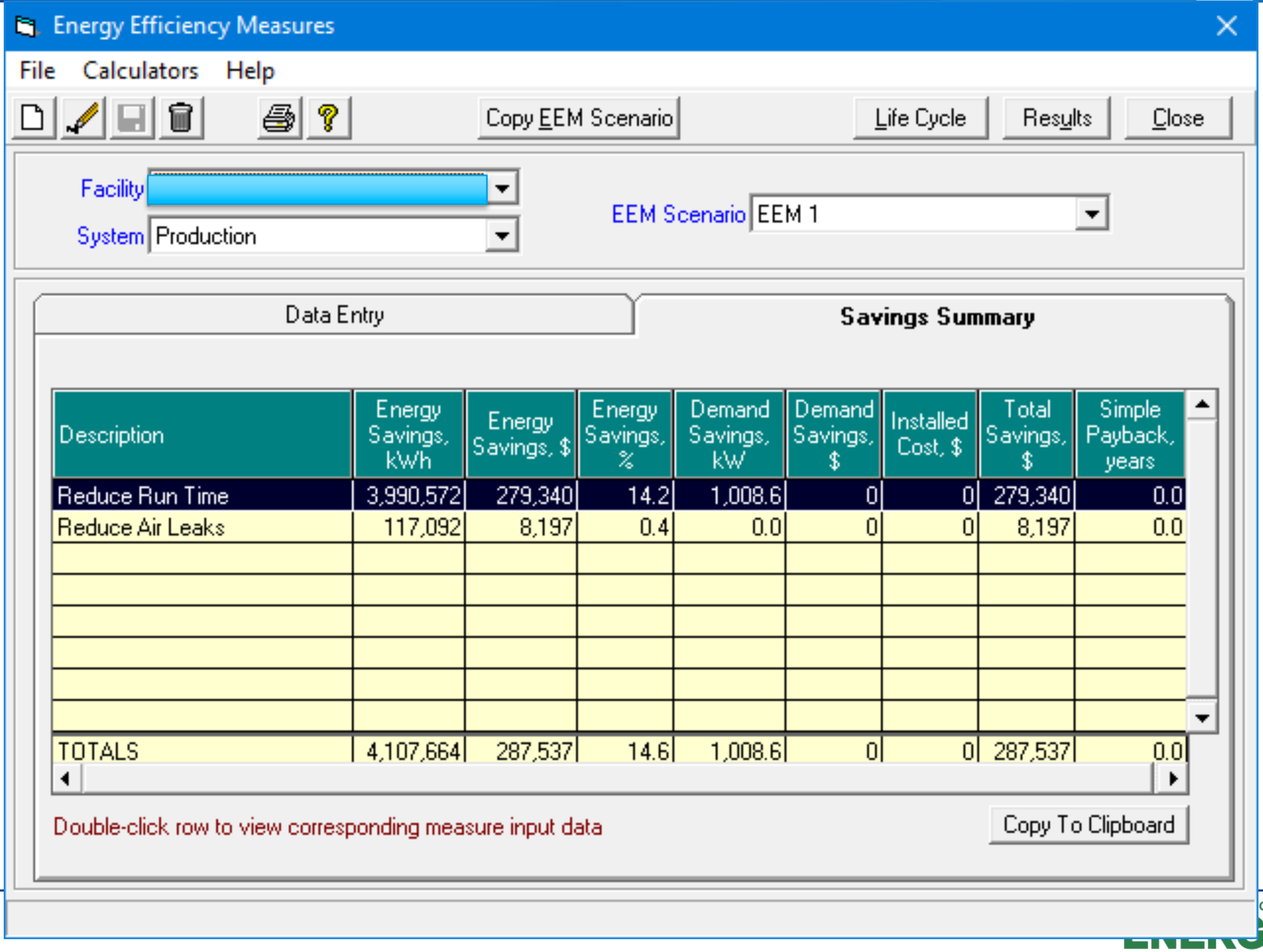
High Speed Data Collection





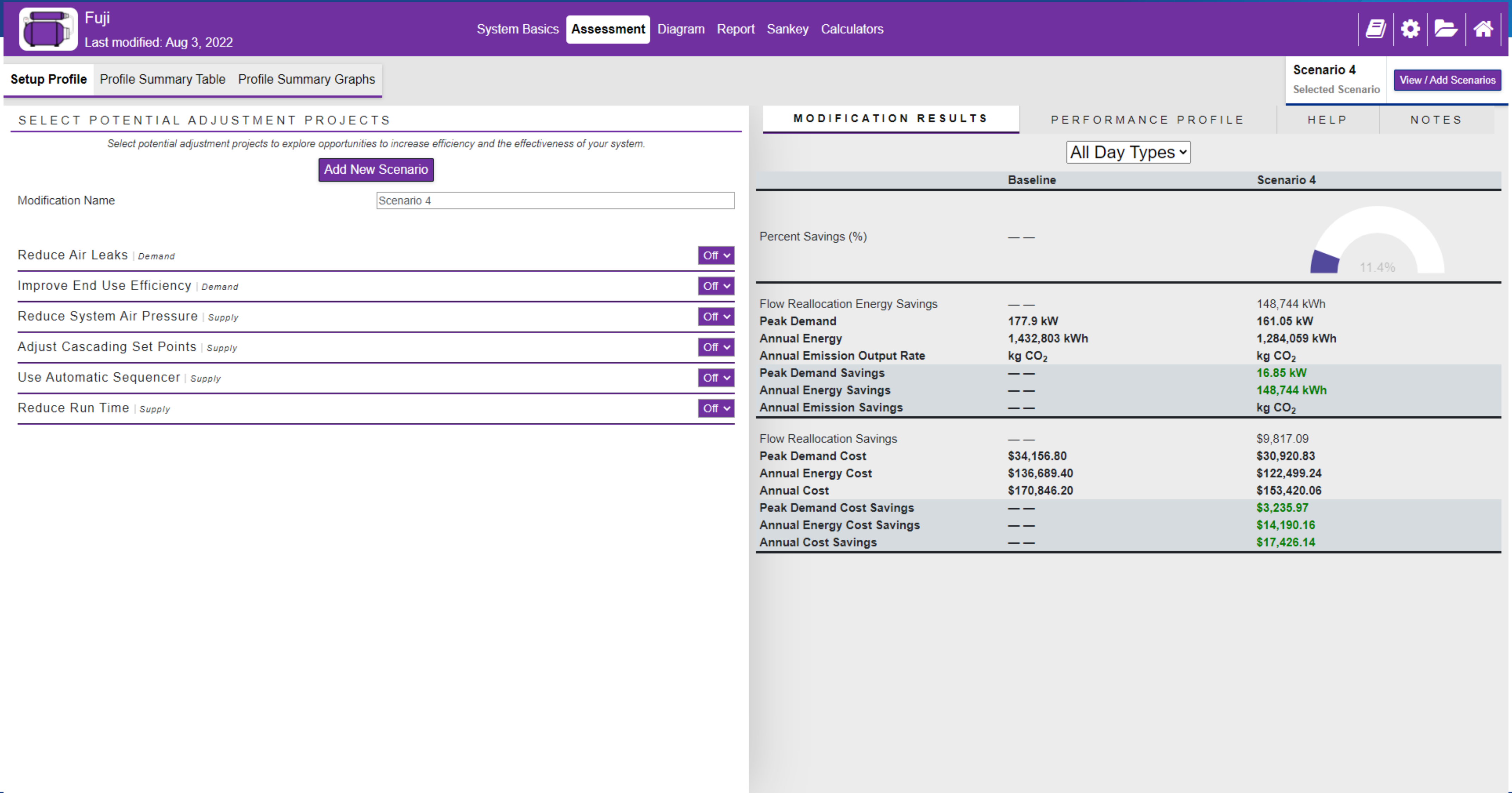
AIRMaster+ Energy Efficiency Measures

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

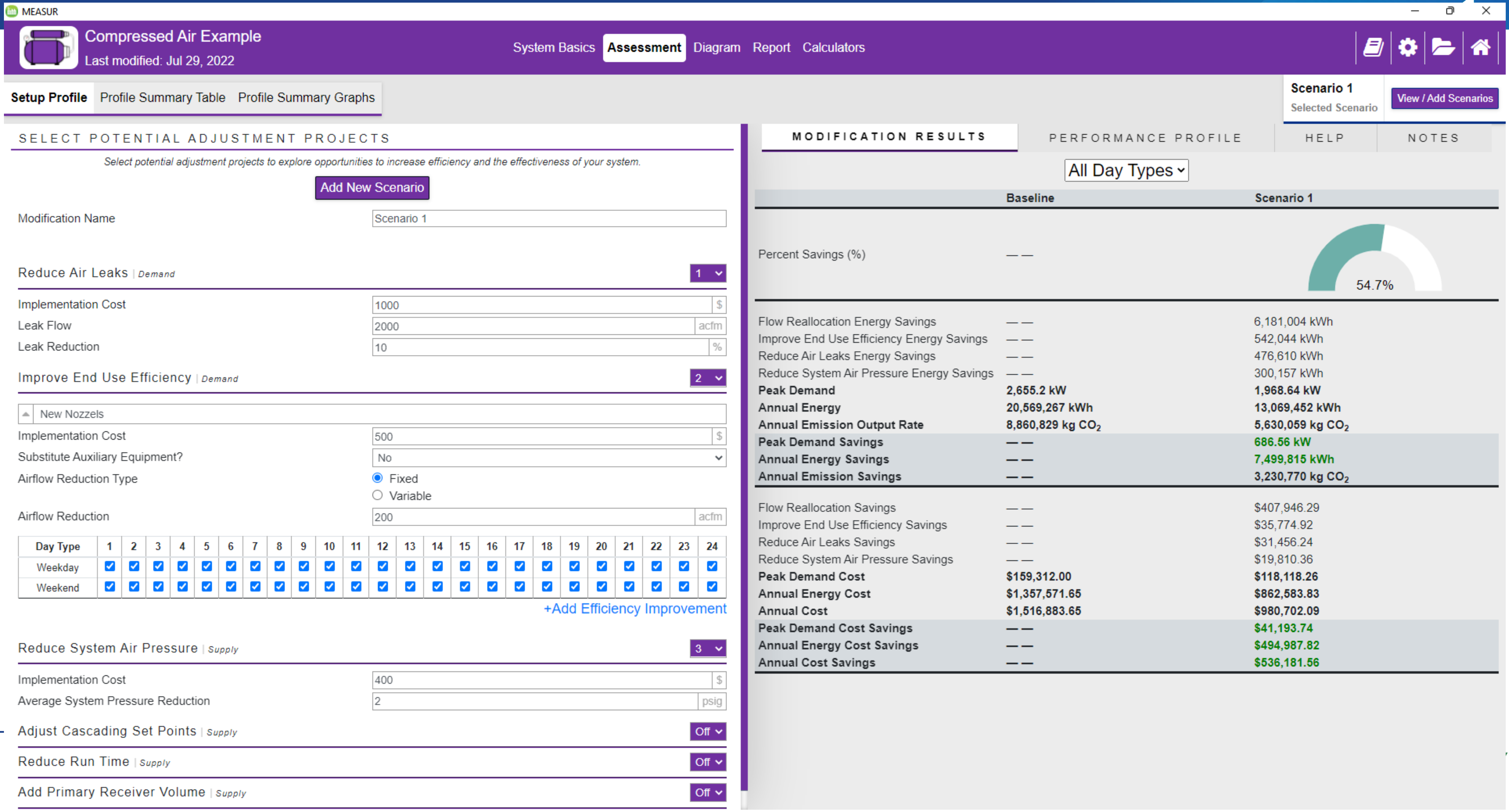


Description	Energy Savings, kWh	Energy Savings, $	Energy Savings, %	Demand Savings, kW	Demand Savings, $	Installed Cost, $	Total Savings, $	Simple Payback, years
Reduce Run Time	3,990,572	279,340	14.2	1,008.6	0	0	279,340	0.0
Reduce Air Leaks	117,092	8,197	0.4	0.0	0	0	8,197	0.0
TOTALS	4,107,664	287,537	14.6	1,008.6	0	0	287,537	0.0

MEASUR Tool Energy Efficiency Measures



MEASUR Tool



Better Plants
U.S. DEPARTMENT OF ENERGY

Virtual Session 1 – The Basics

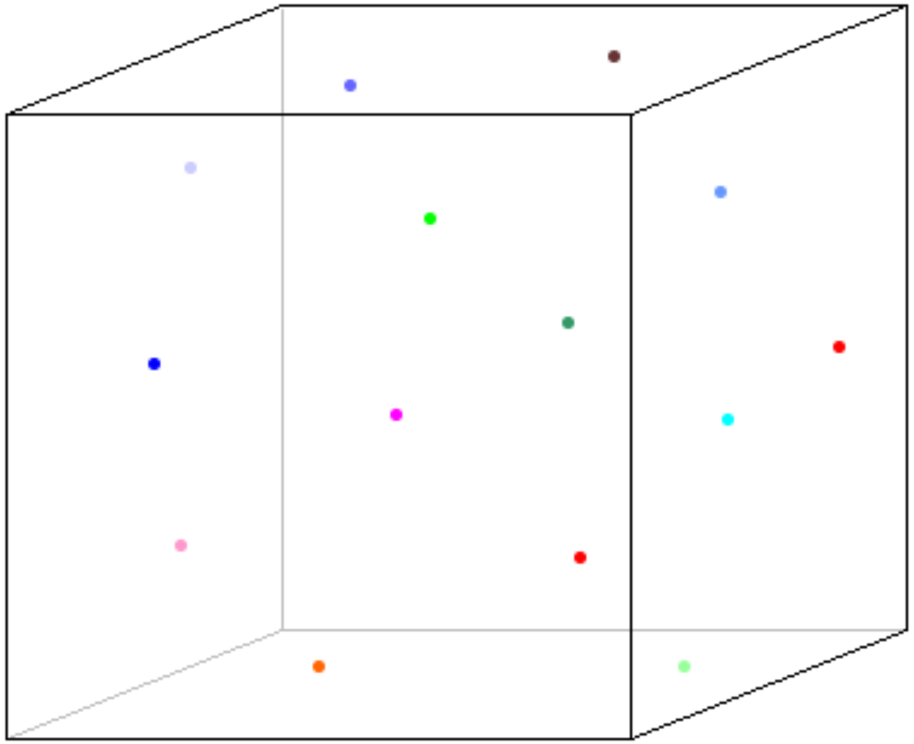
Let's leave the compressor room and have a look out in the demand……

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

Week 1

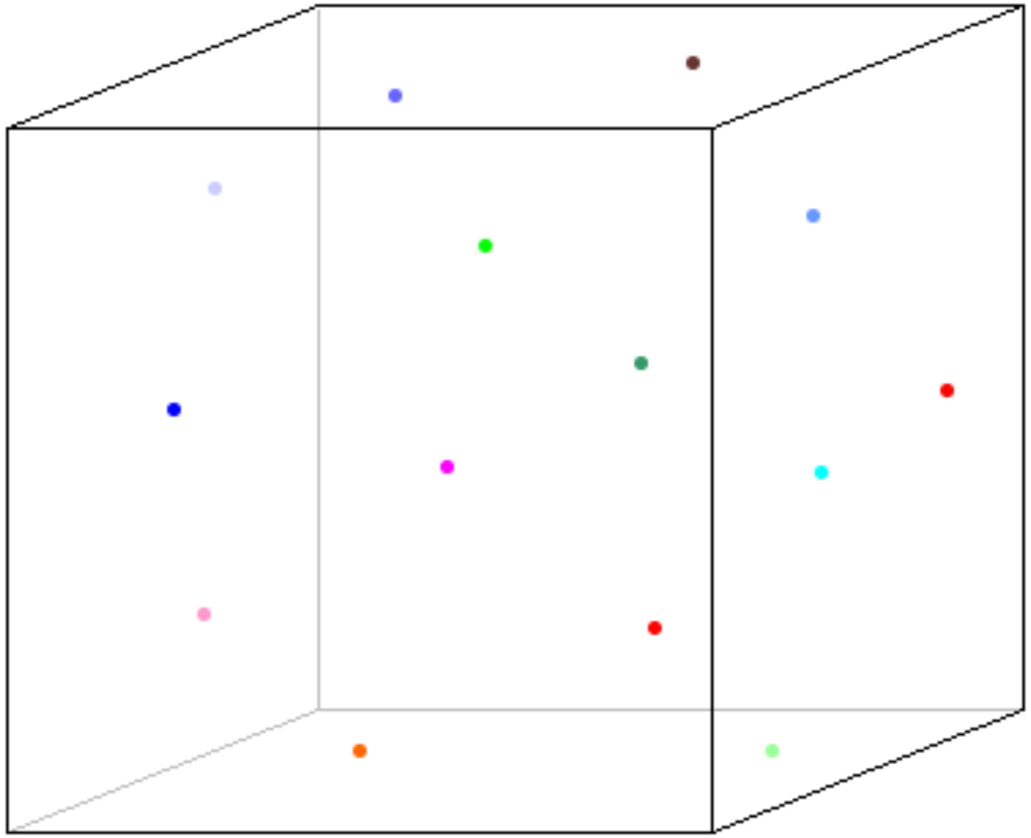
Compressed Air Fundamentals

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:

$$\frac{P1 \times V1}{T1} = \frac{P2 \times V2}{T2}$$

Compressed Air Fundamentals

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

Compressed Air Fundamentals

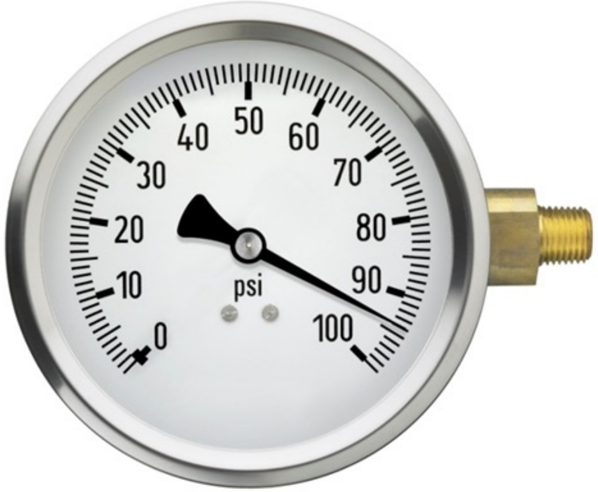
- In Death Valley, which is 500 feet below sea level, The air pressure is 14.94 psia

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

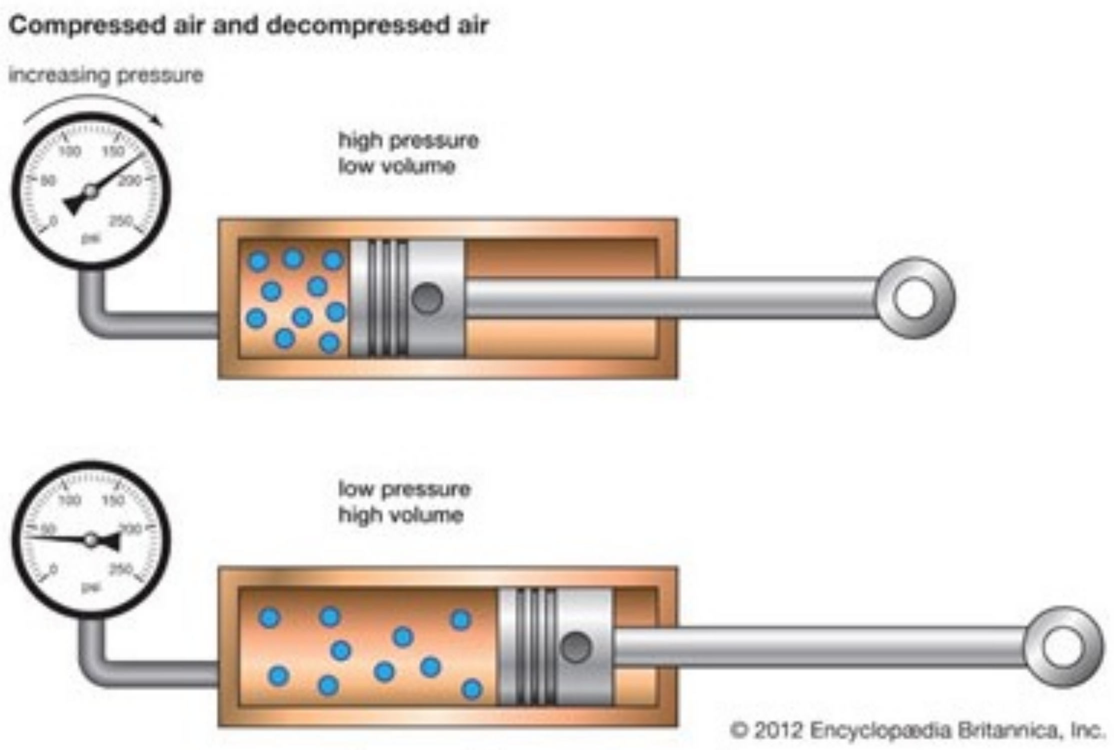
- psig is pounds per square inch gauge - the pressure on the gauge or digital readout of the compressor's controller.
- At zero gauge, the pressure is at atmospheric pressure. If the gauge reads 100 psig, then that means the pressure is 100 pounds above ambient atmospheric pressure.
- psia is pounds 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



(Source: Encyclopedia Britannica)

- 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.

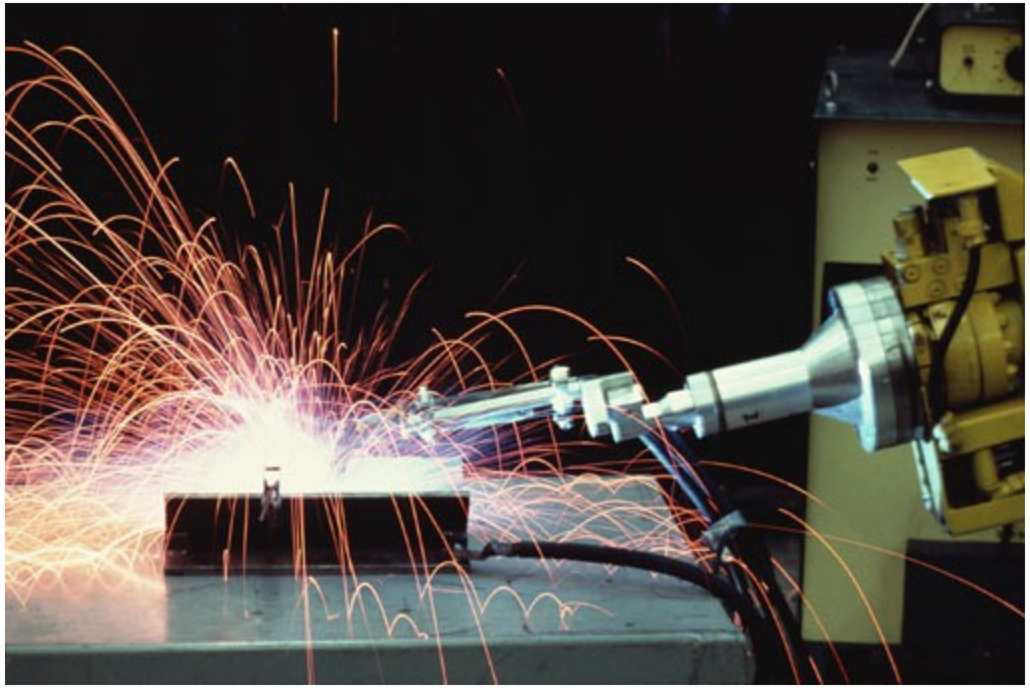
Compressed Air Fundamentals

- 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.

Compressed Air Fundamentals

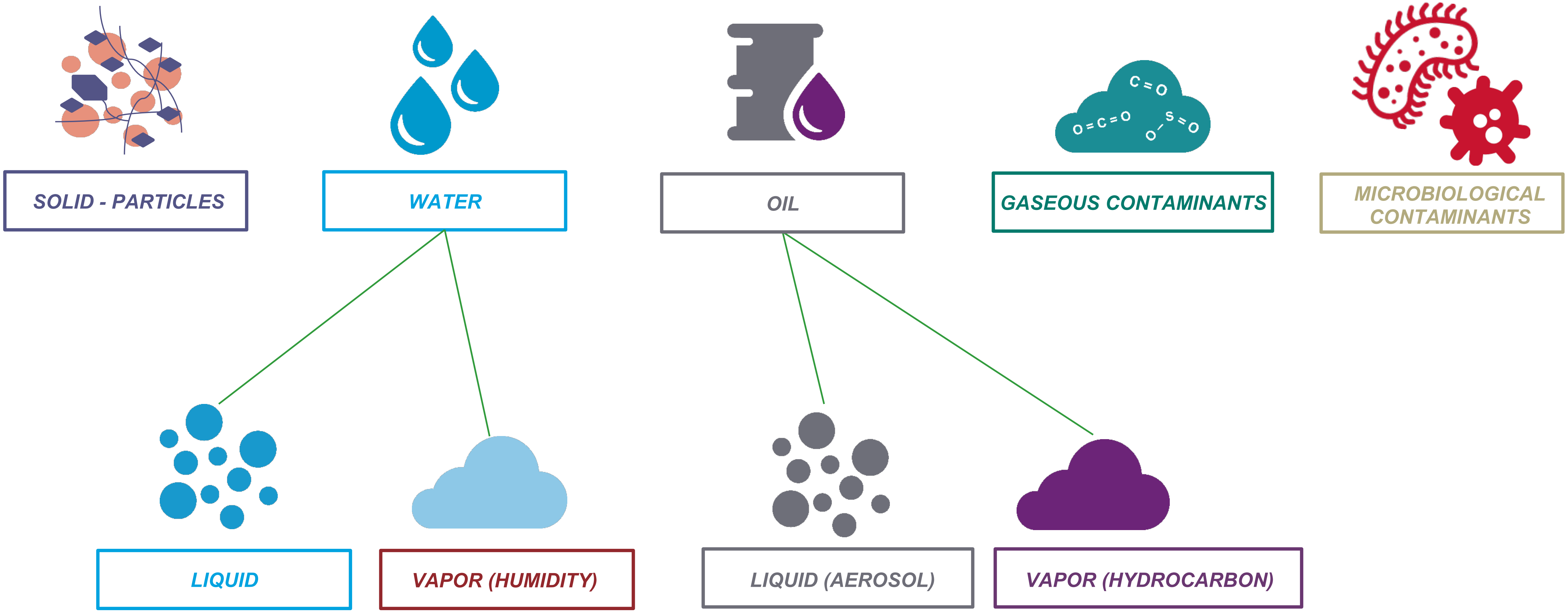


- Energy from compressed air is used to power pneumatic production equipment.
  - E.G.--air motors, actuators, instrumentation, tools, etc.
- To cool components or parts during fabrication
- To blow off waste material

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?



ISO 8573-1

International standard for compressed air purity classification

PURITY CLASS	Solid particles			Water		Total oil*
	Number of particles per m³			Pressure dewpoint		Concentration
	0,1 < d ≤ 0,5 µm**	0,5 < d ≤ 1,0 µm**	1,0 < d ≤ 5,0 µm**	°C	°F	mg/m³
0	As specified by the equipment user or supplier and more stringent than Class 1.					
1	≤ 20.000	≤ 400	≤ 10	≤ -70	≤ -94	≤ 0,01
2	≤ 400.000	≤ 6.000	≤ 100	≤ -40	≤ -40	≤ 0,1
3	-	≤ 90.000	≤ 1.000	≤ -20	≤-4	≤ 1
4	-	-	≤ 10.000	≤ 3	≤ 37,4	≤ 5
5	-	-	≤ 100.000	≤ 7	≤ 44,6	-
6	≤ 5 mg/m³			≤ 10	≤ 50	-

** Liquid, aerosol and vapor.*
*** d = diameter of the particle.*

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%

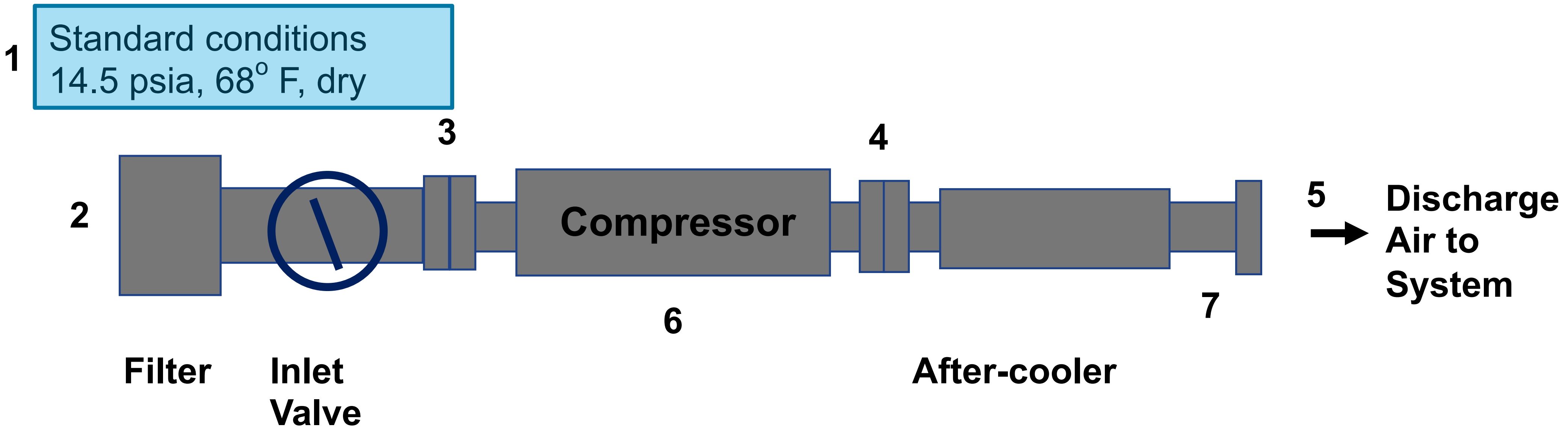
Ratings

- 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

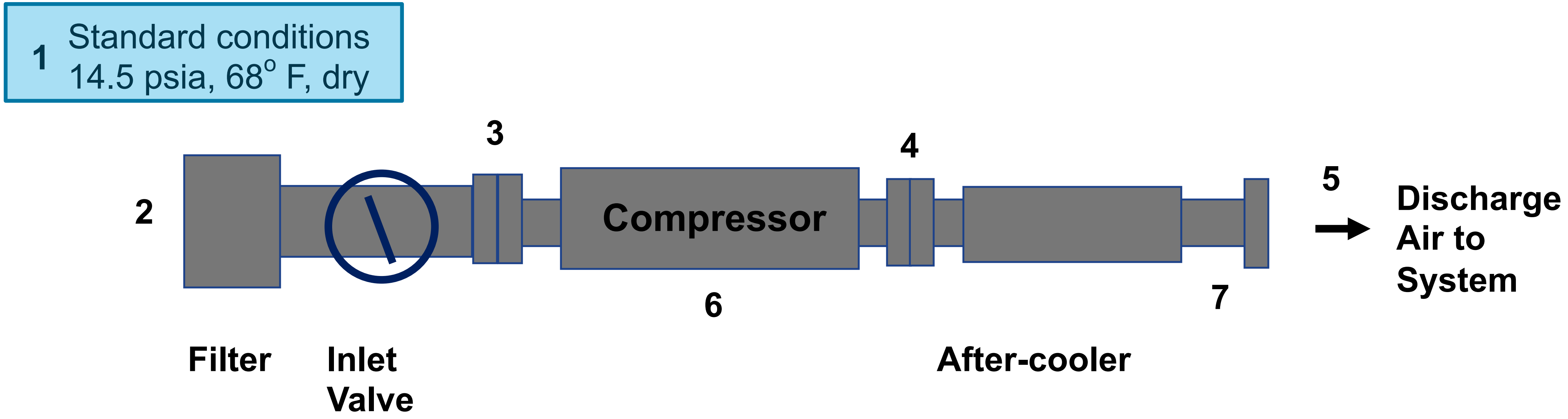
- Capacity calculations (Positive-Displacement)
  - **Golden rule**: FAD, ACFM, and ICFM are fixed volume flow rates which do not change with respect to atmospheric conditions.
  - In other words, a given compressor, when operating at rated speed and discharge pressure will essentially deliver the same 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° F, dry
2 = Ambient conditions, example 14.5 psia, 95° 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



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

SCFM ⇅ ACFM

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.

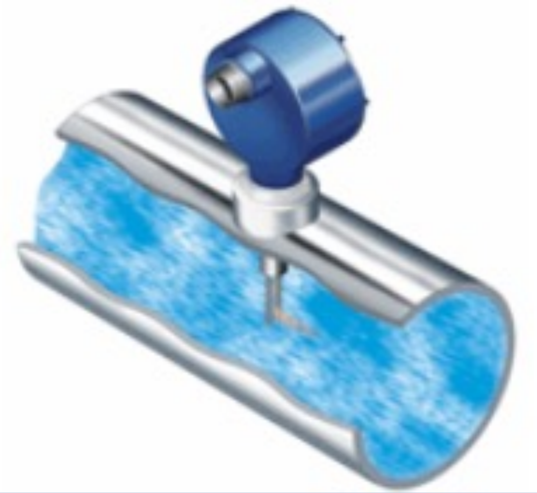
Week 1

Taking Measurements

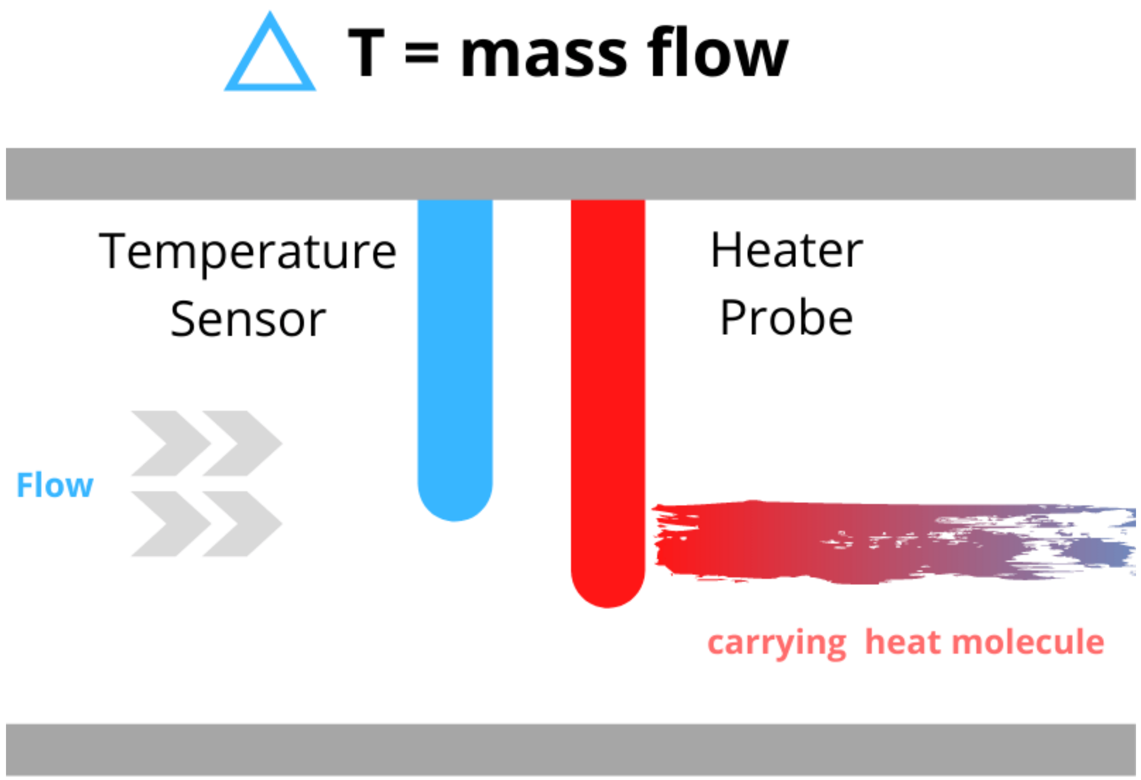
The Need to Make Measurements

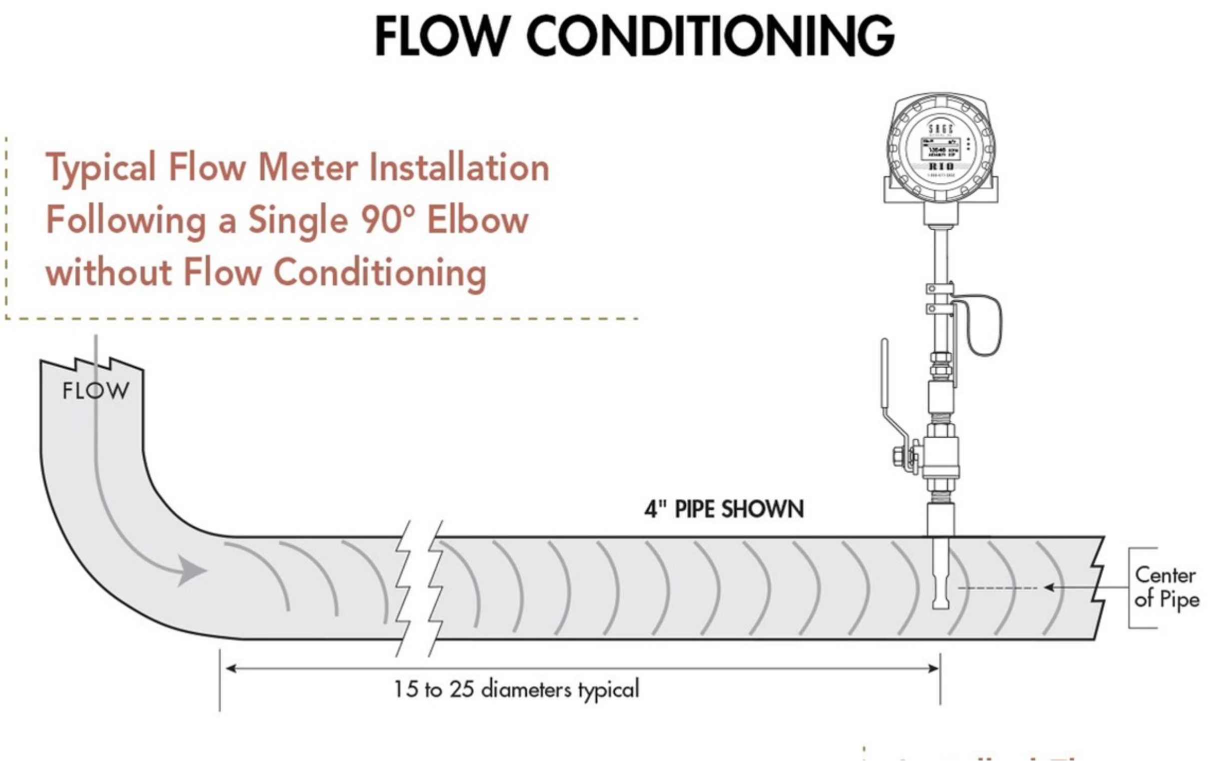
- Flow (cfm)
- Pressure (psi)
- Power (kW)
- Energy (kWh)
- Dollars ($)

Measurement Tools



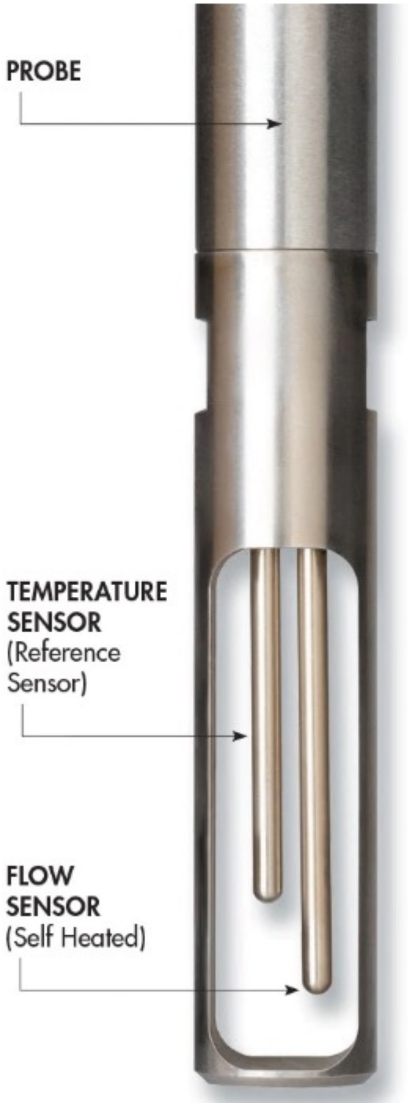
Measurement Tools





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


LB
Apollo


Apollo

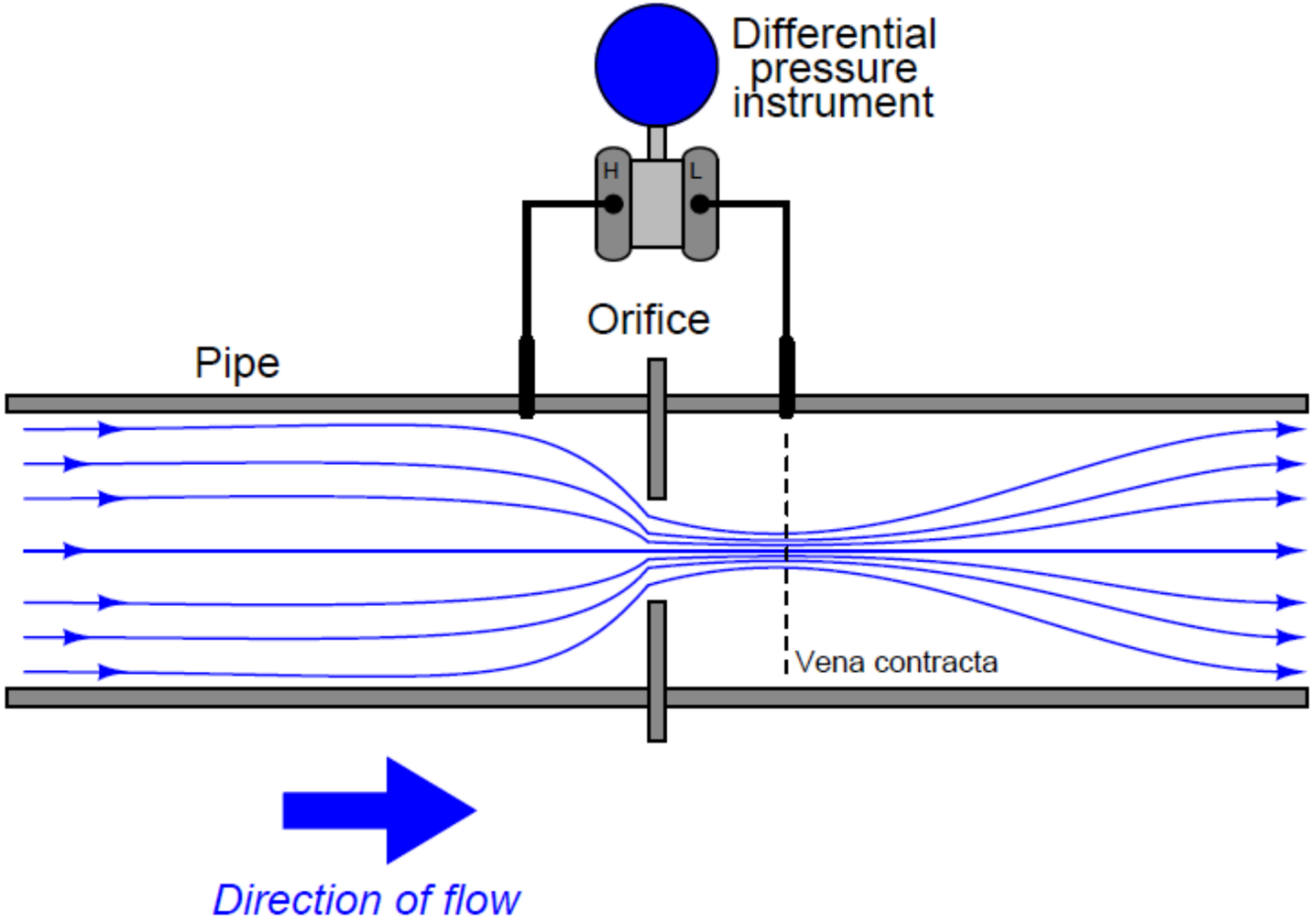

44

Orifice Plate Flow Meters

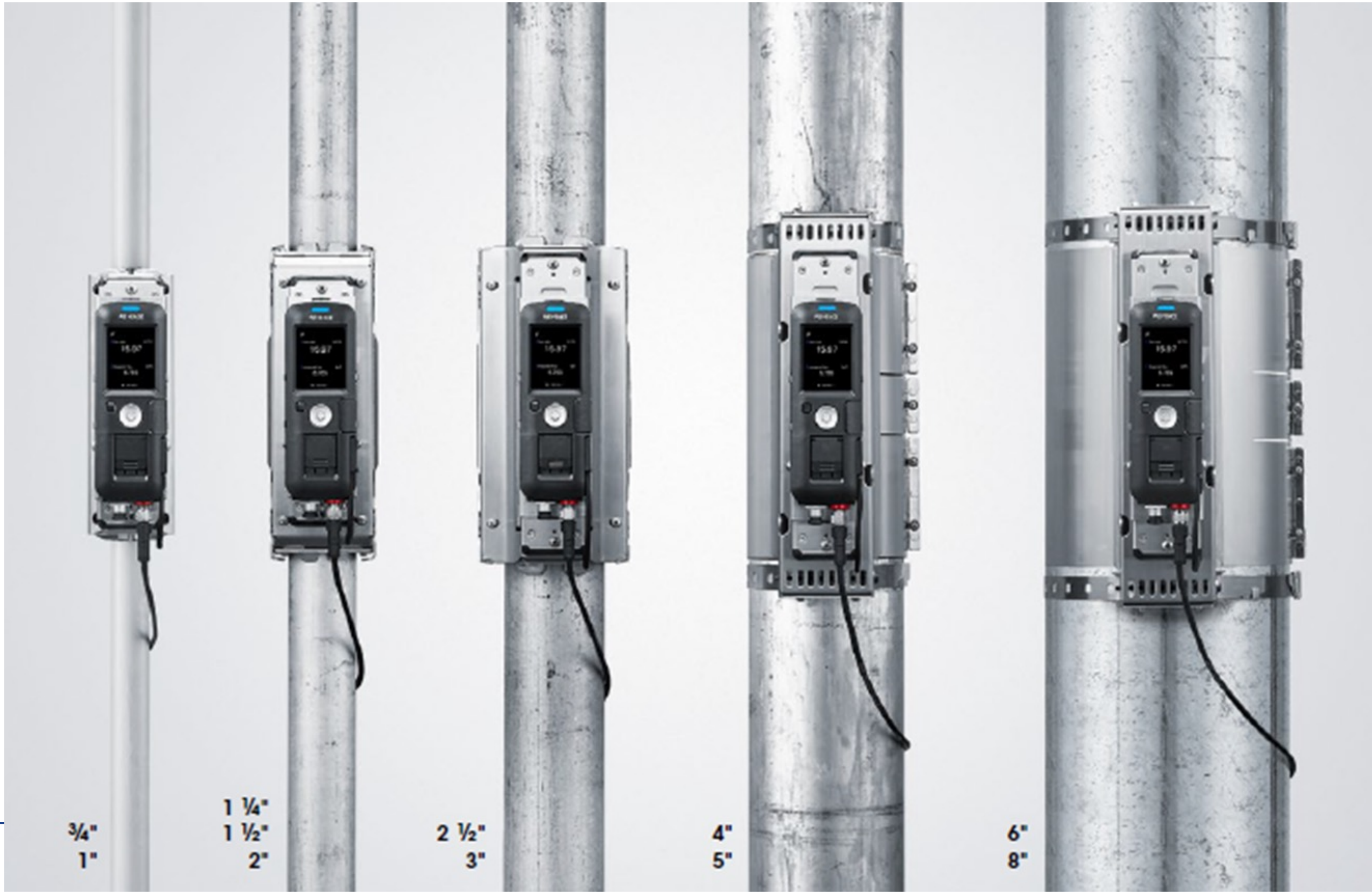
These meters are another carry over from fluid engineering.

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



Measurement Tools

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

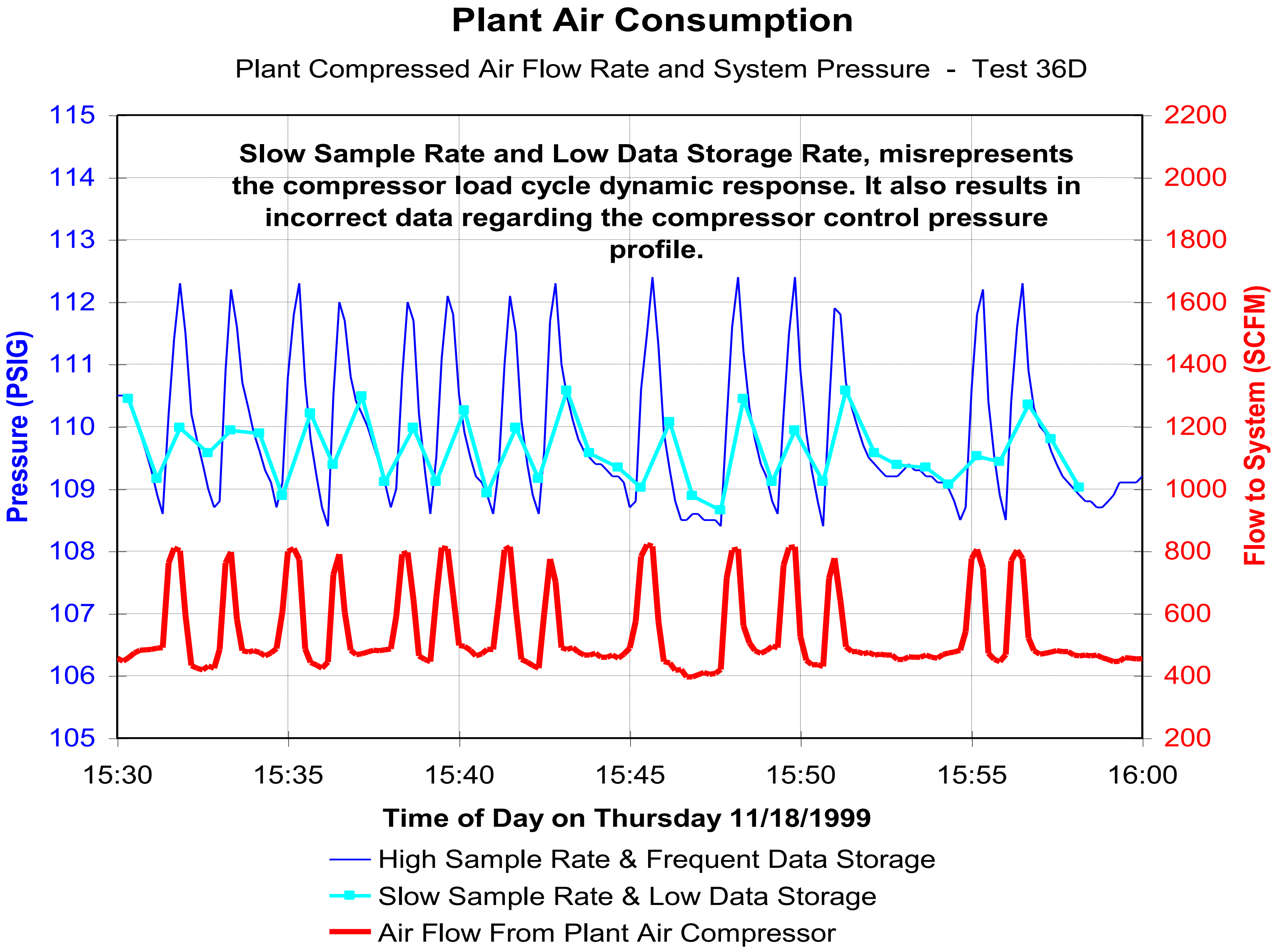
Measurements – A Snapshot Versus a Movie

- 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



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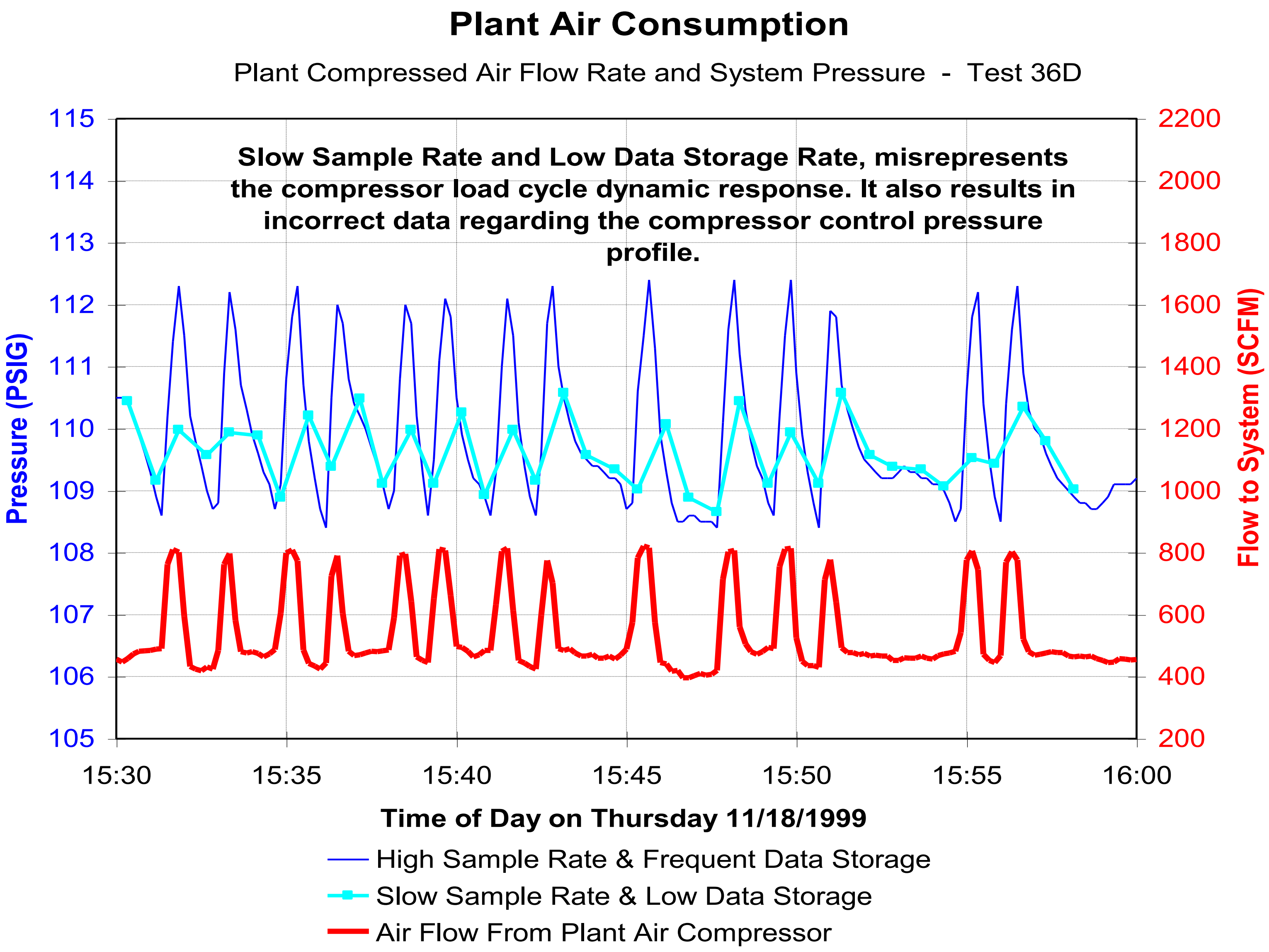
Measurements – A Snapshot Versus a Movie

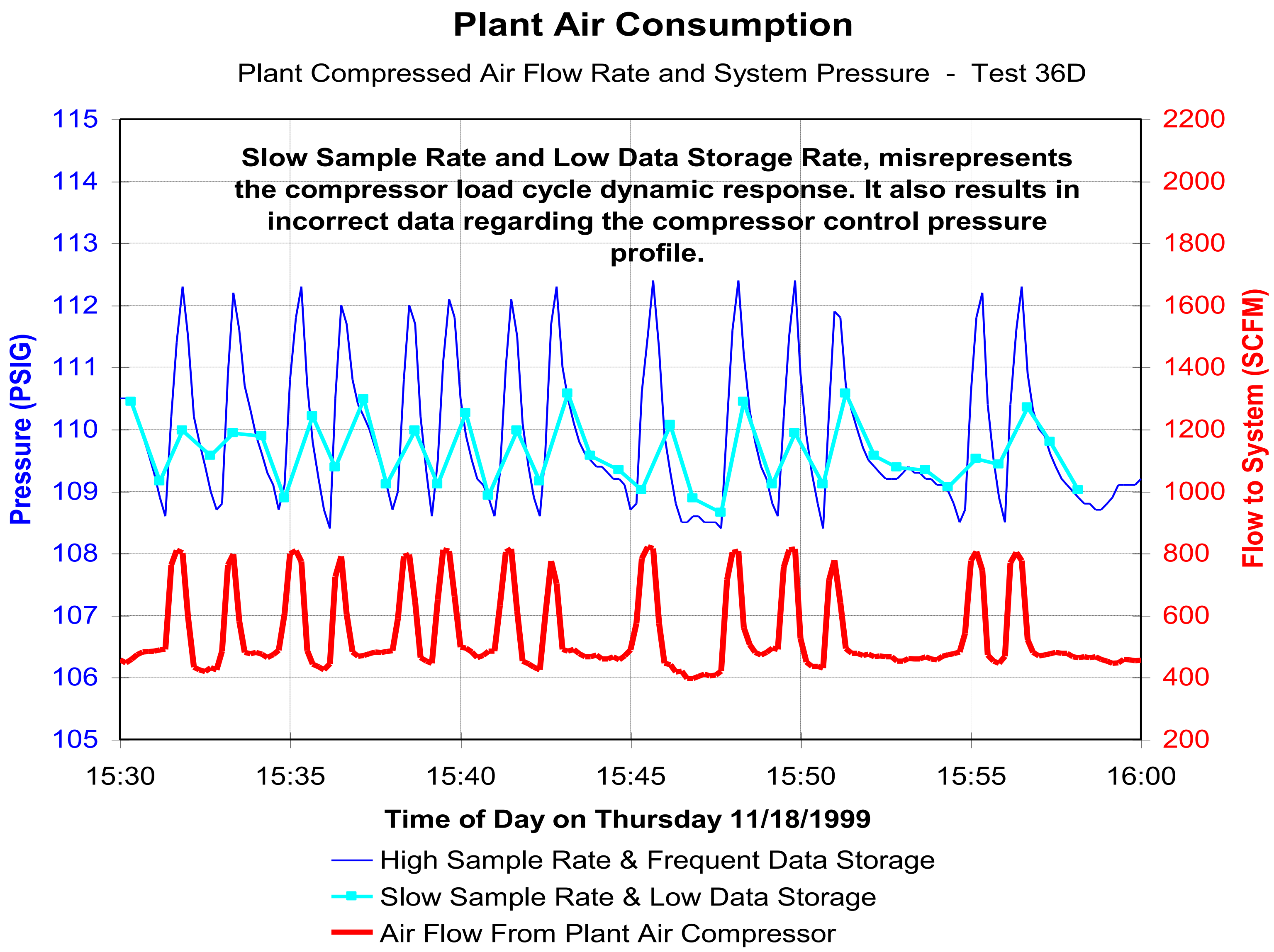
- Signal aliasing in the data tracing above could easily lead to misinterpretation of the recorded system dynamics.
- The 350 scfm swing in flow to the system is NOT a demand event.
- The true wave forms, collected at the high sample rate, clearly show a direct correlation of increasing flow with increasing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



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.**



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