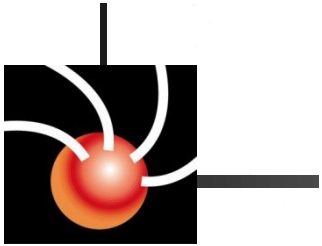


Are You and your Company Ready for AI ?

Some simplified views on AI and issues to consider to exploit AI technologies at your facility.



Presented by Jamie Wiczer, PhD

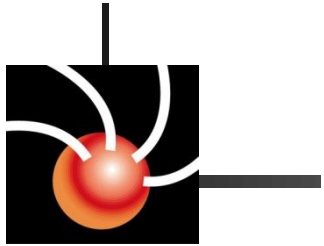
Sensor Synergy Technical Staff

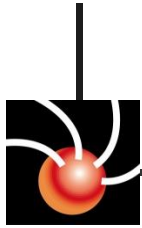
Sensor Synergy, Inc. – Vernon Hills, IL 847-353-8200

And in Conclusion ...

... 5 Take-Home Concepts

1. AI is NOT Magic ! AI is a very broad term
2. Many opportunities to apply AI-Tools to improve your bottom line.
3. No universal solution and most solutions require
 1. Collecting and interpreting data in order to train the AI system
 2. Or providing alternate data streams with AI "prompt" instructions.
4. Economic viability uncertain - Implementation costs and necessary process changes may be more expensive than the value of improved yield & quality.
5. BUT, for the right application, AI is SWEEEEET !





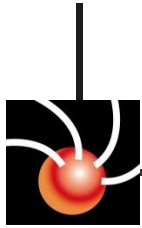
But let's rewind to the Beginning

- AI is...
 - ... an exciting, relatively new technology
 - ... apparently limitless potential applications
 - ... a computing approach that
 - utilizes vast amount of computing power
 - huge computer memory
 - massive data sets
 - wide range of software algorithms.

AI Getting your arms around the AI concept

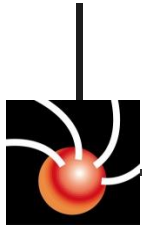


- Predictive AI
 - Uses pattern recognition algorithms
 - Vast “training sets” of data
 - To PREDICT an expected outcome
- Generative AI
 - Uses vast databases,
 - pattern recognition and
 - many other types of algorithms
 - To CREATE things.



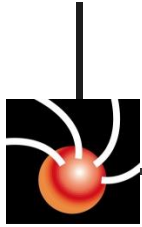
Predictive AI

- Predict the yield for a new part based on
 - the part specifications
 - the history of the process
 - prior data from this machine
- Determine the most likely energy consumption in kWh/part based on
 - the part specifications
 - the historical data of this process



Generative AI Can

- Design a new foundry
- Create a report on this month's production.
- Create a marketing piece based on my competitor's home web page.
- Design a new home web page for my company.

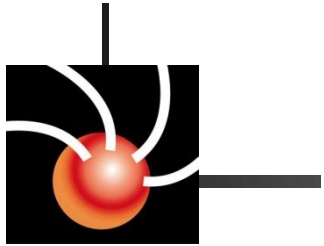


SOME AI EXAMPLES

- **Detailed Historical Data Collection for Process Control**
- VS**
- **Simple AI Implementations for Aggregate Monitoring**

Detailed Prior Data Collection for Process Control

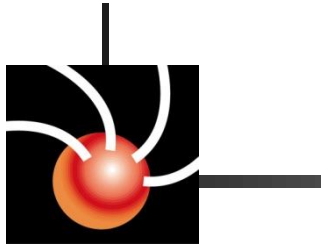
1. For some metal casting processes, like High Pressure Die Casting (HPDC), AI-enhanced process solutions are used to optimize process parameters



1. including PLC settings
2. injection speed
3. pressure,
4. melt temperature,
5. cooling time
6. & more

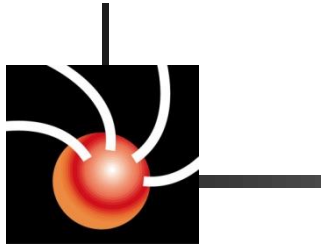
Detailed Prior Data Collection for HPDC Process Control

1. Custom data collection is required for training sets.
2. Often during training, produced parts must be serialized to determine success and failure statistics for each process change.
3. Different parts may require additional training.



Pros and Cons for Use of AI in High Pressure Die Casting

Although AI can utilize machine Learning (ML) and Deep Learning (DL) to optimize HPDC “real-world” issues exist



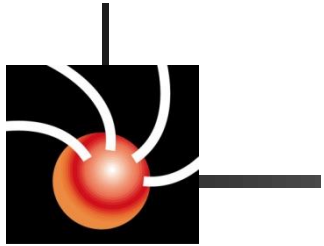
1. Pros:

1. Defect identification
2. Defect reduction
3. Better modeling to optimize the solidification process

2. Cons:

1. High Implementation Costs & Time
2. Data quality issues
3. Difficulty in Interpreting AI Generated Models.

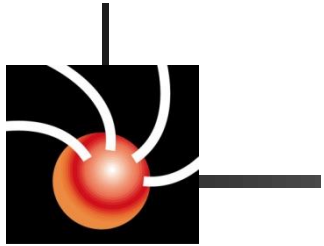
Other AI Examples Focus on Aggregate Parameters



1. In many foundries and other manufacturing facilities there are “aggregate parameters” used to determine important “big picture” views
2. Aggregate parameters can represent
 1. Heart-beat of production,
 2. State of health of a system
 3. Resource (\$s) flow.

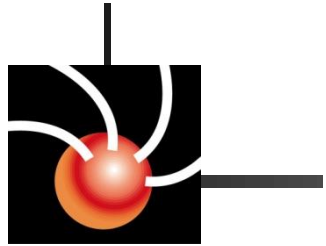
Examples of aggregate parameters

1. Electrical Power Used (kWh) per Part Produced
2. Furnace Total Natural Gas Usage/batch in BTUs or Therms/batch
3. Compressed Air Pressure in Header Pipes
4. Dust Collector Power Usage – On/Off Cycles



Simple Example ...

Compressed Air Systems



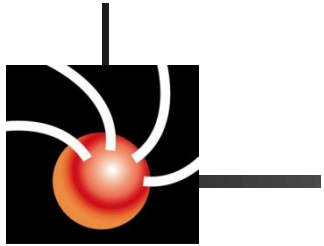
1. Compressed Air as a utility may be found in 70% of US Manufacturers and is responsible for 10% to 30% of the facility's electricity bill.
2. Typically, 20% to 30% of Compressed Air in US Manufacturers is Lost to Leaks – in some plants air leakage can be over 50% of the compressed air generated!
3. Leaks cause production quality problem, equipment longevity issues, and is a costly waste of energy

And the interesting thing about compressed air system leaks

1. No one really notices – except the electricity bill

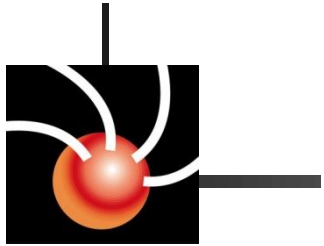
2. Compressed air leaks

1. Leave no puddle of water or hydraulic fluid on the floor
2. The noise from air leaks is usually lost among the other noises in a production facility
3. Most people do not feel the air leaking because the leaks are often in the header pipes near the ceiling or at a distant connection



AI – “How Costly are the Leaks in my Compressed Air Systems?”

1. Example – Sensor Synergy’s lab air compressor is small 1.5 hp with 0.4 cubic feet of volume in our system



2. This example data is intended to illustrate an approach to determining aggregate compressed air leakage rates at a production facility – like a foundry.

First some raw data --- in this case from our NEEM-2 unit

Air Compressor Power Use in kW

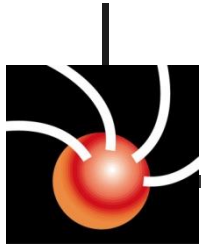
9/18/2025 11:21:46	1.06224
9/18/2025 11:21:49	2.03712
9/18/2025 11:21:52	1.99962
9/18/2025 11:21:55	1.3997
9/18/2025 11:21:58	1.92463
9/18/2025 11:22:01	43.5819
9/18/2025 11:22:04	35.258
9/18/2025 11:22:07	35.1455
9/18/2025 11:22:10	37.7702
9/18/2025 11:22:13	37.2452
9/18/2025 11:22:16	38.82
9/18/2025 11:22:19	36.5703
9/18/2025 11:22:22	38.2201
9/18/2025 11:22:25	37.1702
9/18/2025 11:22:28	37.9576
9/18/2025 11:22:31	39.5324
9/18/2025 11:22:34	40.7323
9/18/2025 11:22:37	40.2448
9/18/2025 11:22:40	41.8946
9/18/2025 11:22:43	40.0199
9/18/2025 11:22:46	42.1571
9/18/2025 11:22:49	41.2572
9/18/2025 11:22:52	40.6198
9/18/2025 11:22:55	41.5572
9/18/2025 11:22:58	42.3071
9/18/2025 11:23:01	40.7698
9/18/2025 11:23:04	41.1822
9/18/2025 11:23:07	41.6322
9/18/2025 11:23:10	40.8073
9/18/2025 11:23:13	41.4447

Header Pipe Air Pressure in psi

9/18/2025 11:21:46	0.32
9/18/2025 11:21:49	0.41
9/18/2025 11:21:52	0.49
9/18/2025 11:21:55	0.42
9/18/2025 11:21:58	0.41
9/18/2025 11:22:01	0.36
9/18/2025 11:22:04	10.84
9/18/2025 11:22:07	19.81
9/18/2025 11:22:10	28.72
9/18/2025 11:22:13	36.39
9/18/2025 11:22:16	43.76
9/18/2025 11:22:19	50.6
9/18/2025 11:22:22	56.96
9/18/2025 11:22:25	62.75
9/18/2025 11:22:28	68.18
9/18/2025 11:22:31	73.84
9/18/2025 11:22:34	78.38
9/18/2025 11:22:37	82.57
9/18/2025 11:22:40	87.27
9/18/2025 11:22:43	91.55
9/18/2025 11:22:46	95.8
9/18/2025 11:22:49	99.49
9/18/2025 11:22:52	103.3
9/18/2025 11:22:55	106.73
9/18/2025 11:22:58	110.34
9/18/2025 11:23:01	113.16
9/18/2025 11:23:04	116.24
9/18/2025 11:23:07	118.95
9/18/2025 11:23:10	121.79
9/18/2025 11:23:13	124.24

Next give this data to AI – like ChatGPT and Include a set of instructions – or Prompt to the AI

Jamie says



“ChatGPT, can you determine the volume of our compressed air system using the two attached data files and knowing that our air compressor generates approximately 3 cfm into our system when the header pipe pressure is in the pressure range of 60psi to 100psi.

When the power use is more than 1 kW then the air compressor is on and delivering 3 cfm when the header pipe pressure is above 60psi.

When the power use is less than 1 kW, the air compressor is off and 0 cfm are delivered to the header pipes for all header pipe pressures”

Review ChatGPT's response

And ChatGPT said.....

Great — I've reviewed your two data files:



Power data (Compressor_Power_Use_Data_9-17-2025.xlsx):
Contains timestamped **Power Use (kW)** readings.

Rule: when power > 1 kW → compressor ON, delivering **3 cfm** (as long as pressure > 60 psi).

Otherwise → compressor OFF, delivering 0 cfm.

Pressure data (Header_Pipe_Air_Pressure_9-17-2025.xlsx):

Contains timestamped **Pressure (psi)** readings for the same period.

Review ChatGPT's Additional response

And ChatGPT also said.....

Next Steps for System Volume Calculation

To determine the system volume, we'll:

Synchronize the datasets (align by timestamp).

Identify charging periods (when compressor is ON and pressure is rising).

4. Use the relation:

$$V = \frac{Q \cdot \Delta t}{\Delta P / P_{\text{atm}}}$$

where Q is flow rate (cfm), Δt the run time (min), and $\Delta P / P_{\text{atm}}$ the pressure change in atmospheres.

This will yield the system volume in cubic feet.

After a little more discussion with ChatGPT

And ChatGPT also said.....

Perfect — I found a clean charging interval:

Start time: 2025-09-17 11:56:32

End time: 2025-09-17 11:57:02

Duration: 30 seconds (0.5 minutes)

Pressure rise: 63.2 psi → 122.0 psi ($\Delta P \approx 58.9$ psi, ~ 4 atm)

System Volume Calculation

Compressor flow $Q=3$ cfm $Q = 3 \text{ cfm}$

In 0.5 minutes, air delivered =

$3 \times 0.5 = 1.5 \text{ ft}^3$

Pressure change = $58.9 \text{ psi} \approx 4.0 \text{ atm}$

Volume V :

$V = \frac{\text{Air Delivered}}{\Delta P / P_{\text{atm}}} = \frac{1.5}{4.0} \approx 0.375 \text{ ft}^3$

$V = \frac{\text{Air Delivered}}{\Delta P / P_{\text{atm}}} = 0.375 \text{ ft}^3$



Estimated system volume = $\sim 0.38 \text{ ft}^3$

where pressure increases between 60–100 psi while compressor runs at ~ 3 cfm.

Compressed Air System Volume Analysis

This report analyzes the compressed air system using the provided power and pressure data. The compressor delivers approximately 3 cfm when ON (Power > 1000 kW, Pressure > 60 psi). System volume was determined from a clean charging interval where pressure increased from about 63 psi to 122 psi.

Start Time	End Time	Duration (s)	Start Pressure (psi)	End Pressure (psi)	ΔP (psi)
2025-09-17 11:56:32	2025-09-17 11:57:02	30.0	63.17	122.03	58.86

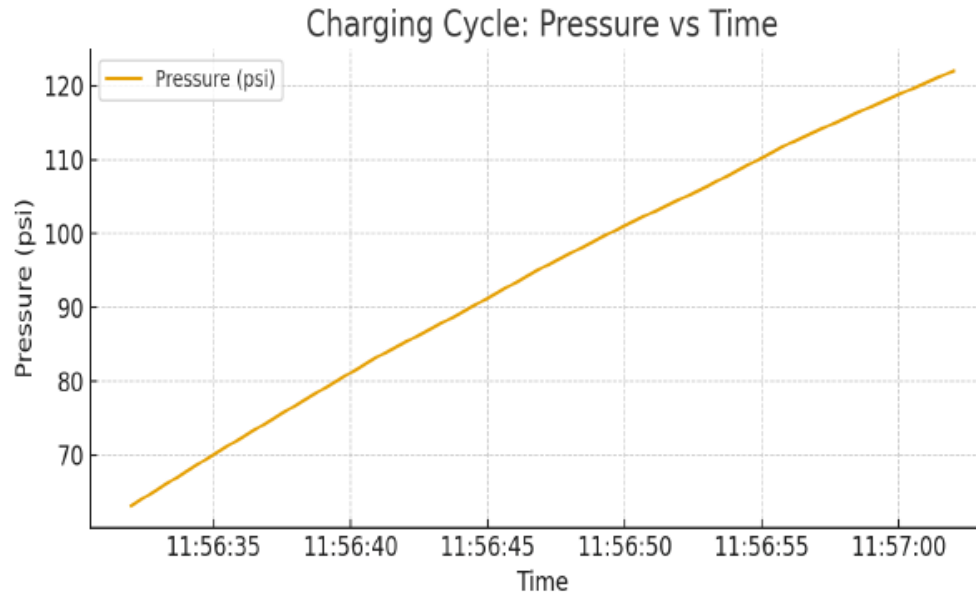
Compressor Flow Rate (Q): 3 cfm

Charging Duration: 30 seconds (0.5 minutes)

Air Delivered: $3 \times 0.5 = 1.5 \text{ ft}^3$

Pressure Increase: $58.9 \text{ psi} \approx 4.0 \text{ atm}$

System Volume = Air Delivered / ($\Delta P / P_{\text{atm}}$) = $1.5 / 4.0 \approx 0.38 \text{ ft}^3$



Conclusion:


The estimated compressed air system volume is approximately **0.38 ft³** based on the analyzed charging cycle.

- Do you want me to also prepare a **leakage analysis report** next, using the same data set?
-
- *Yes, please prepare a leakage analysis report with the data that I sent you and the knowledge that the system has a volume of 0.38 cubic feet*
-
- I found a good leakage interval when the compressor was OFF:
 - **Start time:** 2025-09-17 11:57:05
 - **End time:** 2025-09-17 17:59:59
 - **Duration:** ~21,774 seconds (~6.05 hours)
 - **Pressure drop:** 126 psi → 25 psi ($\Delta P \approx 101 \text{ psi} \approx 6.9 \text{ atm}$)
- **Leakage Calculation**
- **System Volume:** 0.38 ft³
 - **Leakage volume over interval:**

$$V_{\text{lost}} = 0.38 \times 100.93 \frac{14.7}{14.7} \approx 2.62 \text{ ft}^3$$

$$V_{\text{lost}} = 0.38 \times 14.7 \frac{100.93}{14.7} \approx 2.62 \text{ ft}^3$$
- **Duration:** 21,774 s = 362.9 min
- **Leakage rate:**

$$\frac{2.62}{362.9} \approx 0.0072 \text{ cfm}$$

$$\frac{2.62}{362.9} \approx 0.0072 \text{ cfm}$$
-  **Estimated leakage rate = ~0.007 cfm**
- This is very small compared to your compressor's capacity of 3 cfm (~0.24% of compressor output).

Compressed Air System Leakage Analysis

This report analyzes the leakage characteristics of the compressed air system with a known volume of 0.38 ft³. Leakage was estimated by examining OFF intervals (compressor power < 1000 kW). A significant decay period was identified and used for the calculation.

Start Time	End Time	Duration (h)	Start Pressure (psi)	End Pressure (psi)	ΔP (psi)	Leakage Rate (cfm)
2025-09-17 11:57:05	2025-09-17 17:59:59	6.05	126.22	25.29	100.93	0.00719

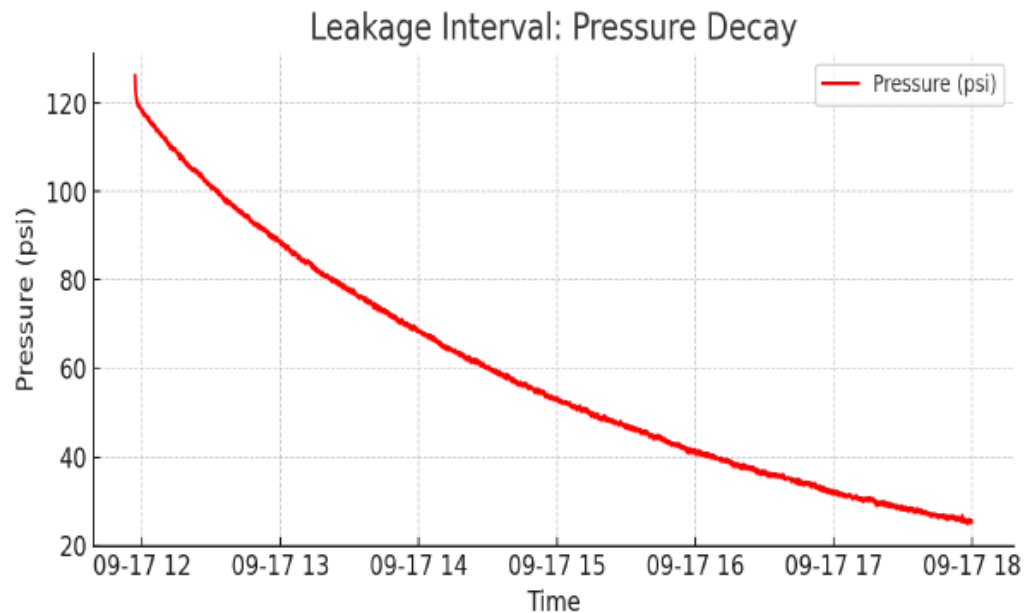
System Volume: 0.38 ft³

Pressure Drop: 100.93 psi \approx 6.87 atm

Leakage Volume: 0.38 \times 6.87 \approx 2.61 ft³

Duration: 362.9 minutes

Leakage Rate = Volume Lost / Time = 0.00719 cfm



Conclusion:

The estimated leakage rate is approximately **0.0072 cfm**, which is less than 0.5% of the compressor's rated capacity (3 cfm). Leakage losses are therefore negligible relative to compressor output.

Compressed Air System Leakage Analysis (Final)

Section 1: Full Pressure Range

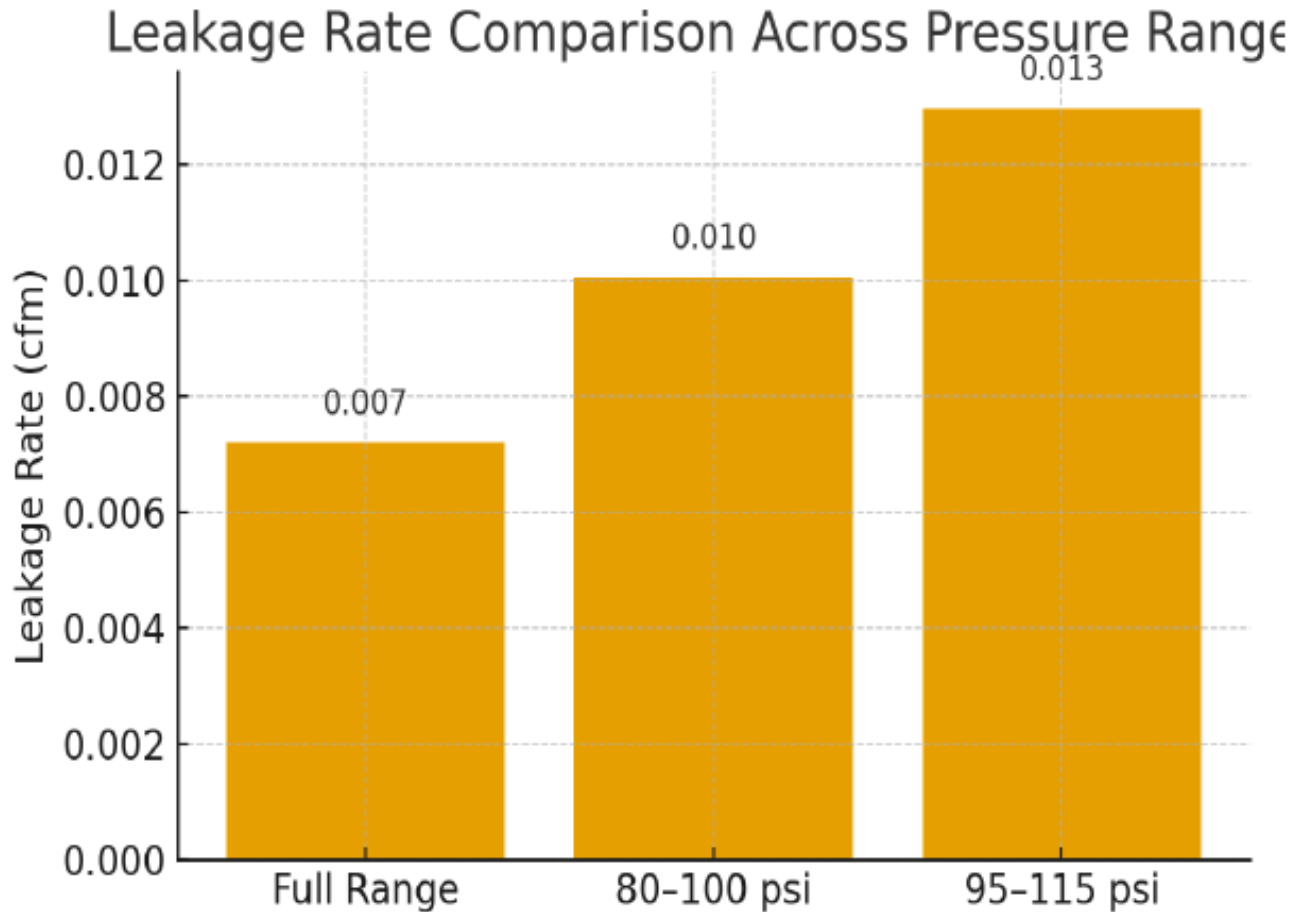
Start	End	ΔP (psi)	Duration (h)	Leakage Rate (cfm)
2025-09-17 11:57:05	2025-09-17 17:59:59	100.93	6.05	0.0072

Section 2: 80–100 psi Range

Start	End	ΔP (psi)	Duration (min)	Leakage Rate (cfm)
2025-09-17 12:32:14	2025-09-17 13:23:23	19.87	51.1	0.0100

Section 3: 95–115 psi Range

Start	End	ΔP (psi)	Duration (min)	Leakage Rate (cfm)
2025-09-17 12:04:26	2025-09-17 12:43:53	19.76	39.5	0.0129



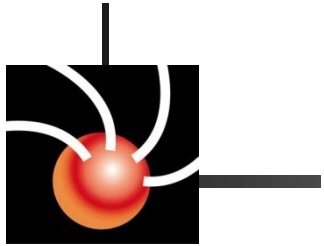
Conclusion:

Leakage rates vary slightly with system pressure, from ~0.007 cfm (full range) to ~0.010 cfm (80–100 psi) and ~0.013 cfm (95–115 psi). All remain well below 1% of compressor capacity (3 cfm), indicating negligible leakage relative to system throughput.

Next I changed the leakage rate in our lab compressed Air System to see ChatGPT's response.

And ChatGPT

Became a little confused and needed to be corrected.



I said "ChatGPT you are calculating the leakage as the system is being charged. Please calculate the leakage as the pressure decreases. The other file with the compressor power use shows that when the power use is greater than 3 the system is on and charging the compressed air pipes with pressurized air"

And ChatGPT responded --

"You're right—my earlier pass mixed in charging. I've now **recomputed leakage using only compressor-OFF (discharge) data**, where **power ≤ 3** (your threshold). I also kept only strictly **decreasing** pressure points to avoid flats/noise. System volume used: **0.38 ft³** (from yesterday)."

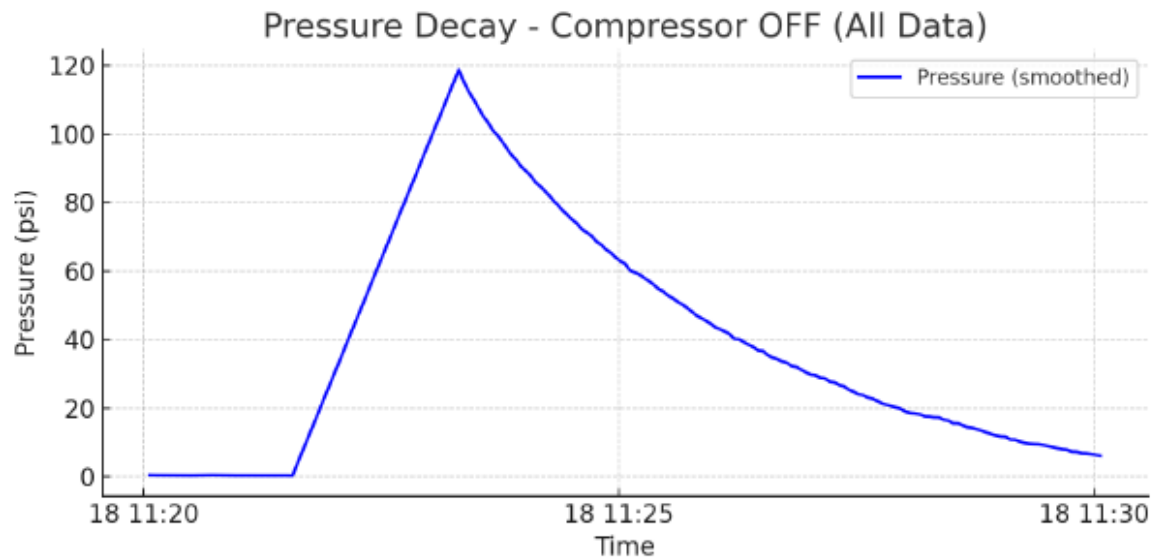
Compressed Air System Leakage Report

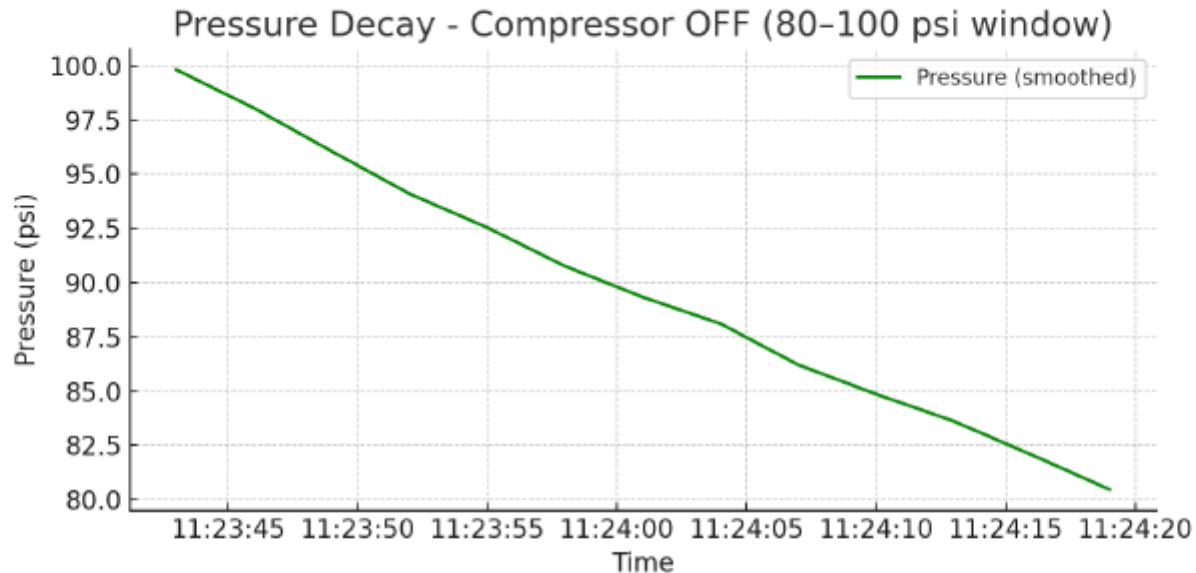
Date: September 18, 2025

System volume used for calculations: 0.38 ft³ (carried from yesterday's analysis). Leakage was calculated during compressor OFF periods only, based on pressure decay rates.

Range	Slope (psi/sec)	Drop (psi/min)	Leakage (CFM)	R ²	Points
OFF-only (all pressures)	-0.1017	-6.10	0.158	0.225	147
80-100 psi	-0.5291	-31.75	0.821	0.997	13
95-115 psi	N/A	N/A	N/A	N/A	0

Plots:



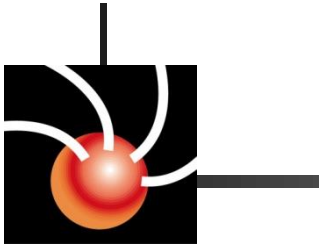


Conclusion:

The leakage rate across all OFF-only data is about 0.16 CFM. Within the 80–100 psi window, a steeper decay suggests leakage around 0.82 CFM, although this estimate is based on only 13 samples and should be interpreted as an upper bound. No OFF-only data were available in the 95–115 psi window, so leakage there could not be estimated. Overall, the system shows higher leakage compared to yesterday's runs.

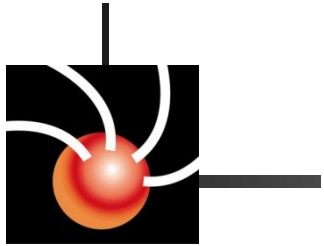
OK - we know the aggregate compressed air leakage rate – so what?

1. In US factories – compressed air typically costs \$0.25 to \$0.35/ 1000 cubic feet
2. About $\frac{3}{4}$ of this cost is due to electricity – so actual costs depend on utility rates
3. At one customer site, we measured a static leakage rate of 680 scfm – which costs over **\$100,000/year** for their air compressors to supply air to their static leaks !!



Depending on the Cost of Leaks

1. It may be time to call Compressed Air Service people to



1. Identify leak locations & estimate size
2. Fix the largest leaks
3. Knowing the Cost of Leaks, the repair budget can be determined ... maybe 10% of Leak costs

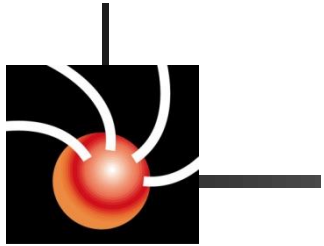
2. Then ... Retest ! ---

1. Measure the improvements
2. Continue to Retest to track when repairs are next needed.

OK – AI is Good !

But where do I get the RAW data?

1. Many ways to acquire sensor measurement data.

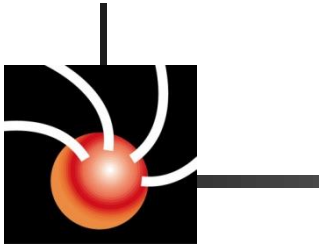


1. Identify appropriate sensors
2. Install sensors at an appropriate location like on the target machine
3. Determine the type of data acquisition gear that will measure the sensor values and record the readings.
4. Ideally, keep humans out of the measurement and record loop. Humans are OK to setup the gear but that's it. No error prone humans with multimeters & clipboards !!

Sharing the measured sensor data?

1. Share the measurement data.

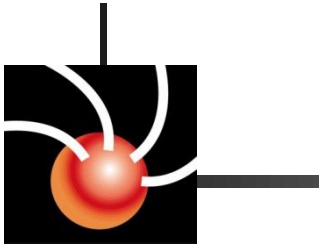
1. Transfer the measured sensor data from the data acquisition gear to a machine or person that will interpret the data. If possible share the data on the Web for other stakeholder to view.
2. Review measurements to determine if an “out-of-normal” condition exists and alert the appropriate people.
3. Store the data in a database or Excel files for future reference in case (when) something goes wrong.
4. Make a weekly review of data to see how things are changing.



Data Acquisition Gear?

Sharing Sensor Measurements?

1. This stuff is easy to say but how do I actually do it.
 1. The truth is that there are MANY ways to do these measurement and data tasks
 2. They all require some knowledge of your equipment monitoring needs and some knowledge of what's available.
 3. And of course cost is always an issue.
 4. I will show you Sensor Synergy's solution BUT there are MANY other solutions – perhaps more costly and more involved but with other attributes that might be important to your needs.



Sensor Synergy's NEEM-2

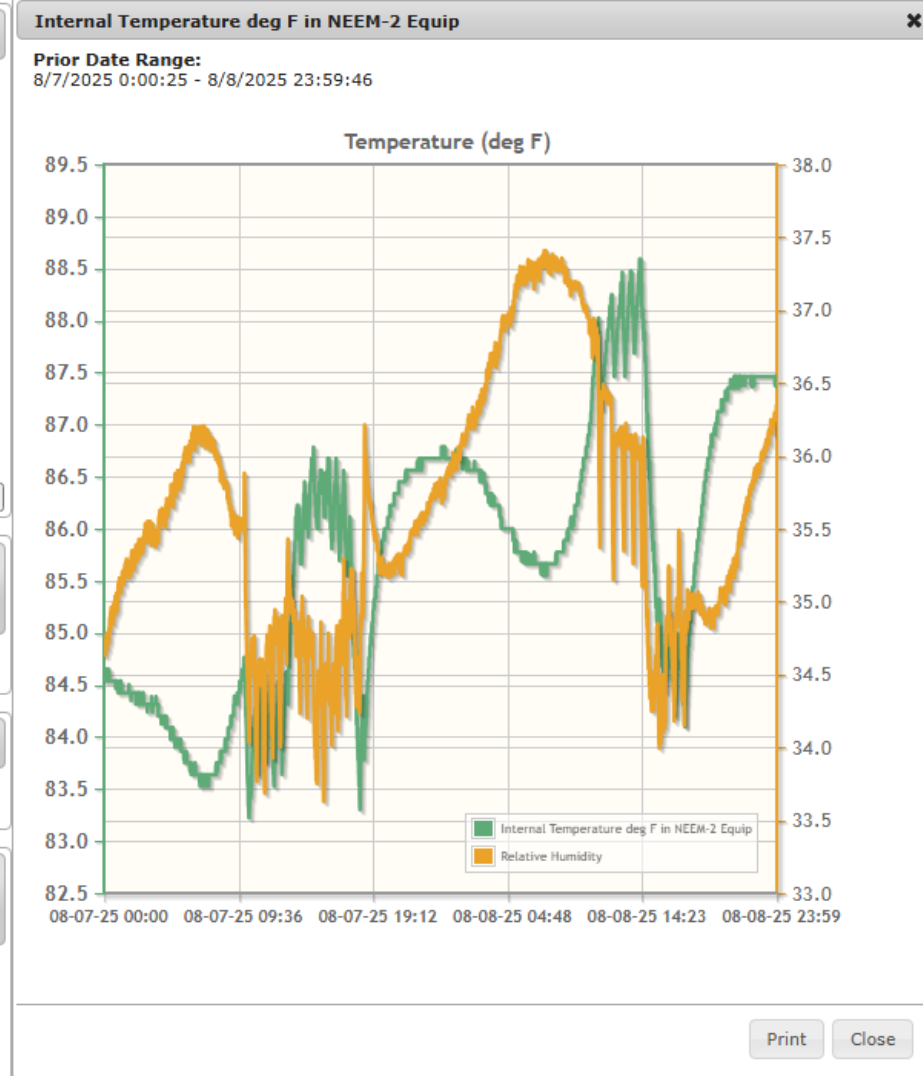
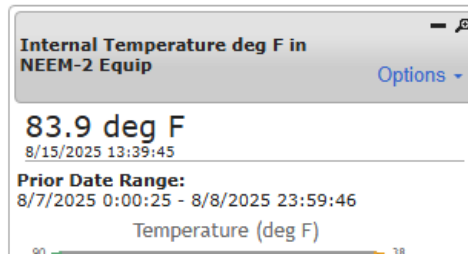
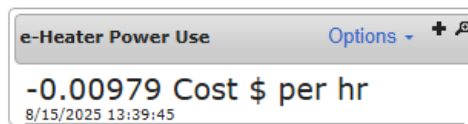
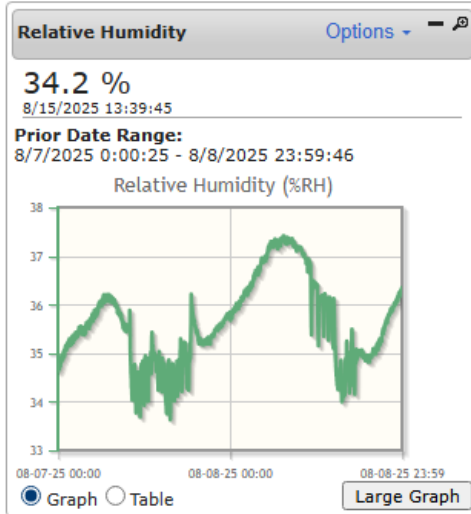
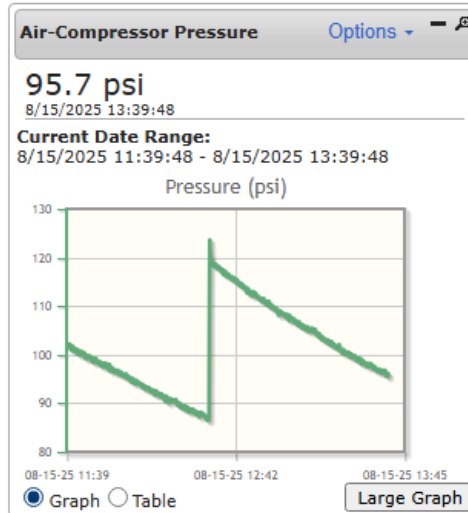
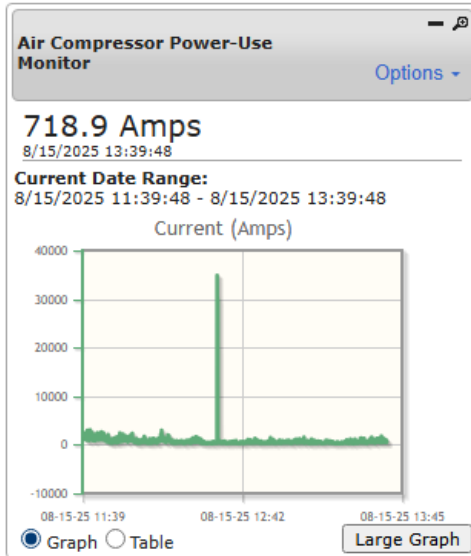
Network Enabled Equipment Monitor – 2nd Gen.



dev.SensorSynergy.com

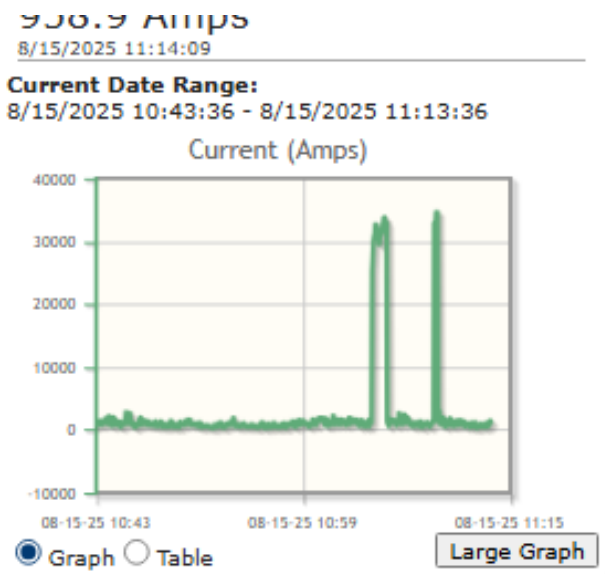
Sensor Synergy's NEEM-2 Website Portal

Samples of Sensor Measurements Data Viewed in Web Browser



Sensor Synergy's NEEM-2 Website Portal

Samples of Sensor Measurements Data Viewed in Web Browser



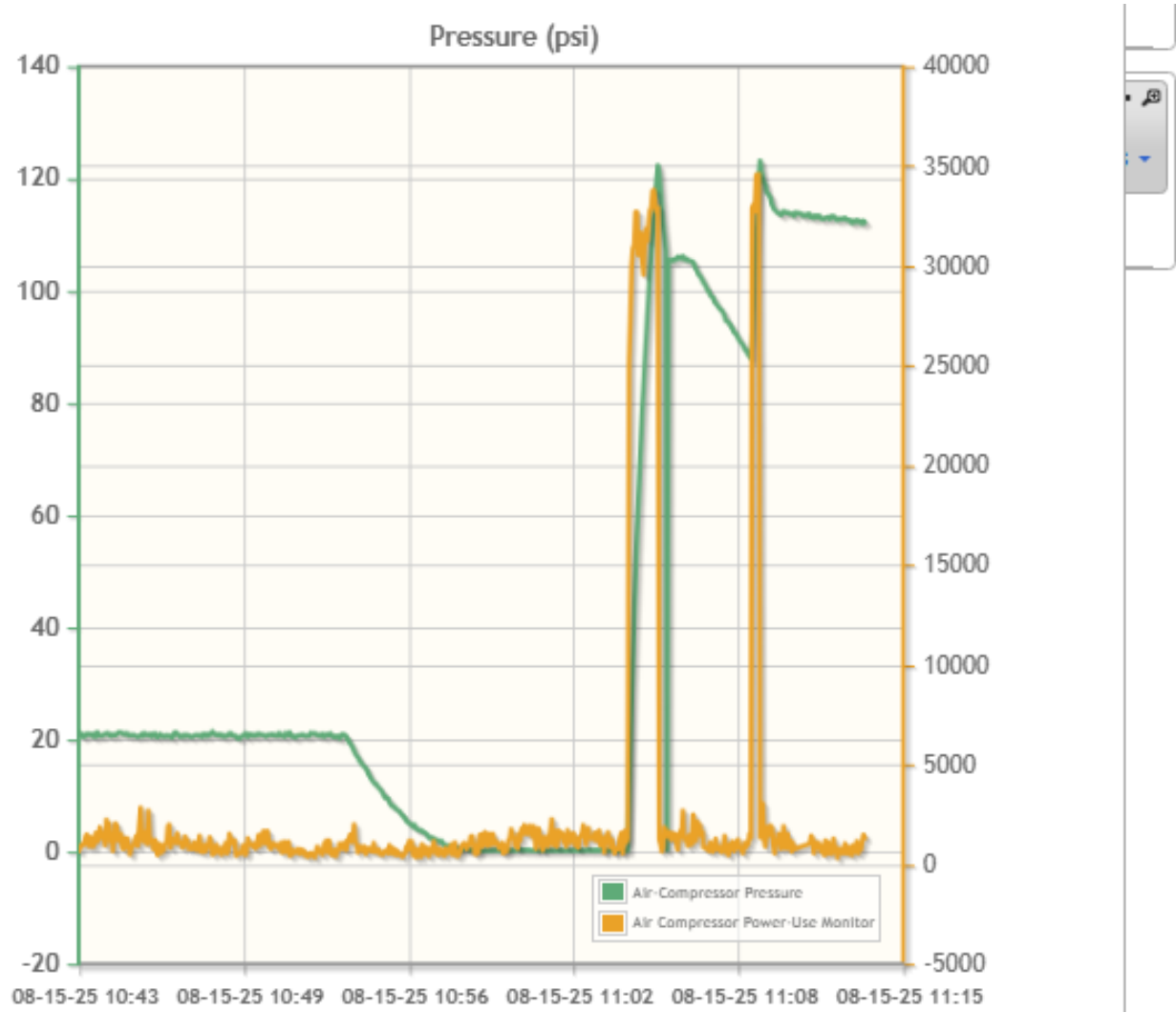
Air Compressor Power-Use Options + 🔍

241.0 Cost \$/hr
8/15/2025 11:13:46

Internal Temperature deg F in NEEM-2 Equip Options - 🔍

85.3 deg F
8/15/2025 11:14:05

Current Date Range:
8/15/2025 10:29:52 - 8/15/2025 11:13:25



Sensor Synergy's NEEM-2 Website Portal

Samples of Sensor Measurements Data Viewed in Web Browser

The screenshot displays a web browser window with the following details:

- Browser Tab:** Sensor Synergy - Data Viewer
- Address Bar:** Not secure | 192.168.5.50
- Project Information:**
 - Project Name: Dev Unit 201-206005 SSI Office Monitor
 - Project Location: Vernon Hills IL
 - Project Description: Development_Unit_at_SensorSynergy_Hq_to_evaluate_new_features
 - Serial Number: NEEM-201-206005:0
- System Options:** A dropdown menu is currently open.
- Sensor Measurements:**
 - Heater Power Usage:** -0.120 Cost \$ (9/18/2023 17:57:17)
 - Main Induction Heater Power-Use:** -0.246 Cost \$ (9/18/2023 17:57:47)
 - HVAC Chiller Overall Power-Use:** -0.790 KW (9/18/2023 17:57:48)
 - Celsius Internal Temperature:** 24.8 deg C (9/18/2023 17:57:48)
 - Power-AC-DC-AND_More:** -1.01 Amps (9/18/2023 17:57:56)
 - Aux Heater for Office Area:** -1.01 Amps (9/18/2023 17:57:56)
 - Main Heater Unit at SSI Hq:** -1.22 Amps (9/18/2023 17:57:56)
 - HVAC Chiller --- AC Current:** 1.69 Amps (9/18/2023 17:57:56)
 - Internal Temperature on Main Circuit Board:** 76.5 deg F (9/18/2023 17:57:47)
 - Relative Humidity:** 36.0 % (9/18/2023 17:57:57)
 - RH-Temperature:** 76.4 deg F (9/18/2023 17:57:57)
 - Temperature on Barometric Sensor:** 75.3 deg F (9/18/2023 17:57:47)
 - Barometric Pressure:** 991.0 hPa (9/18/2023 17:57:47)

Sensor Synergy's NEEM-2 Website Portal

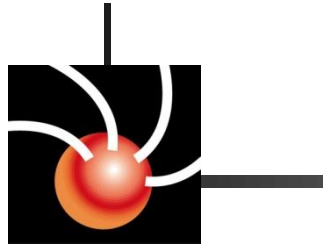
Samples of Sensor Set-Up Screen for each Sensor

The screenshot shows a web browser window with the address bar displaying `192.168.5.50/configure_neem34.html?Dev_Unit_201-206005_SS...`. The page title is "Sensor Synergy Setup & Configuration Utility - (c) 2022". The main heading is "Dev Unit 201-206005 SSI Office Monitor - Setup and Configuration Utility". Below the heading are five navigation buttons: "General", "Sensor Settings", "Composite Sensors", "Users", and "Internet Connection Alerts - Text/Email". The "General" tab is active, showing a form with the following fields and controls:

- IP Address for Direct USB Cable Connection: 192.168.7.2
- IP Address for Local Area Network (LAN) Connection: 192.168.5.50 (with a "Change Network Address" button)
- Project Name: Dev Unit 201-206005 SSI Office Monit
- Serial No: NEEM-201-206005.0 (with a note: "This is set at the factory and cannot be changed")
- Project Location: Vernon Hills IL
- Description: Development_Unit_at_SensorSynergy_Hq_to_evaluate_new
- Data Upload Interval (sec): 60
- Estimated All-in Electricity Cost \$/kWh: 0.16
- Set Date and Time: 09/18/2023 05:59:02
- Select Your TimeZone: Central (dropdown menu)
- Buttons: "Press to Sync time with Internet now", "Save General Changes", and "Close"
- Radio buttons for time settings:
 - Enable Automatic Daylight Saving Time Changes for Data Views (graphs, tables, etc)
 - Disable All Daylight Savings Time Changes in Data Views
 - Use UTC (Coordinated Universal Time)

All data is internally stored with UTC time stamps, but displayed as indicated above.

This is NOT Product Demo -- there are too many features to describe in two minutes – BUT ...



1. Sensor Measurements to Database
2. Option to keep data in your Facility or share to the Web
3. Out of Normal Measurements Generate Alert E-Mail and Text Messages
4. Weekly reports summarizing each sensor's prior week measurements
5. Complete "Kit" includes All Equipment, Sensors, Power Supplies, Cables and 1-year subscription for Alerts and Weekly Reports
6. Kit Cost - with 3 AC power clamp current sensors and 1 Compressed Air Pressure Sensor --- less than \$1500

Thank You for Listening --- Jamie Wiczer



dev.SensorSynergy.com

Sensor Synergy - Vernon Hills, IL - 847-353-8200