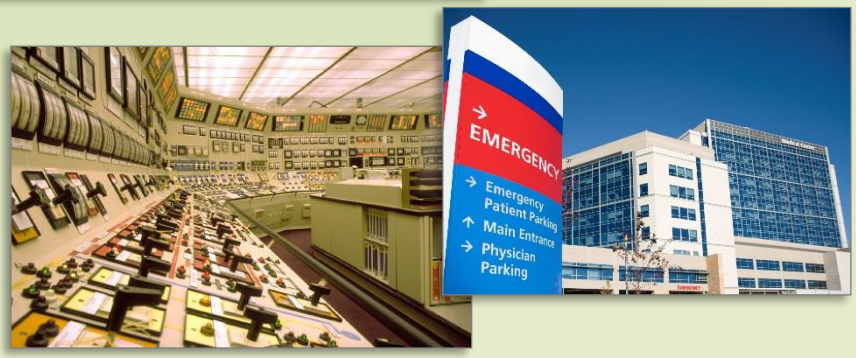
Deploying IoT in Existing Facilities



CYPRESS ENVIROSYSTEMS

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San Jose, CA, USA

References – Partial List

- Duke Energy
- Exelon
- Xcel Energy
- Ontario Power Generation, Pickering Nuclear Station, ON
- Eli Lilly
- Elanco (Lilly)
- Merck
- Johnson and Johnson
- Maple Leaf Foods
- Western Digital
- Applied Materials
- Sutter Health
- Kaiser Permanente
- Ascension Health
- Advocate Health
- New York City HHC
- VA Medical Centers

IoT – Connect EVERYTHING

IMAGE SOURCE: JOHNSON CONTROLS.

- Save Energy
- Reduce Labor
- Detect Faults
- Optimize Process
- Improve Comfort
- Enhance Safety
- Comply with Regulations

Nearly two-thirds (77%) of all businesses plan to increase their IoT investments over the next 12 months - BSquare

the impact of the Internet of Things on the global economy might be as high as $6.2 trillion by 2025. – McKinsey

CYPRESS ENVIROSYSTEMS

Sources:
http://reports.weforum.org/digital-transformation/electricity-an-industry-ready-for-digitization/
https://industrial-iot.com/2017/12/data-state-iiot-adoption-maturity/
https://www.mckinsey.com/industries/semiconductors/our-insights/the-internet-of-things-sizing-up-the-opportunity

Reality of IoT in Many Existing Facilities

Pneumatic Thermostats

Dial Gauges

Mechanical & Analog Instrumentation

Steam Traps

Standalone Transducers, LED/LCD Displays

Specialized Equipment: -80C Freezers

Manual Instrumentation, Not Programmable, No Diagnostics…
Equals: Wasted Energy, Higher Downtime, More Labor Required

Non-Invasive Retrofit Technologies

WIRELESS PNEUMATIC THERMOSTAT

"Go from Pneumatic to DDC in minutes"

WIRELESS GAUGE READER

"Remotely Read Gauges in minutes"

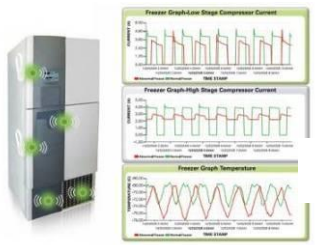
WIRELESS STEAM TRAP MONITOR

"Avoid Expensive Steam Leaks"

NETWORK CONTROLLER

WIRELESS TRANSDUCER READER

"Remotely Read Transducers – No Wires"



WIRELESS FREEZER MONITOR

"Predicts and Avoids Costly Freezer Failure"

Install in Minutes, no Disruption to Operations, Low-Cost

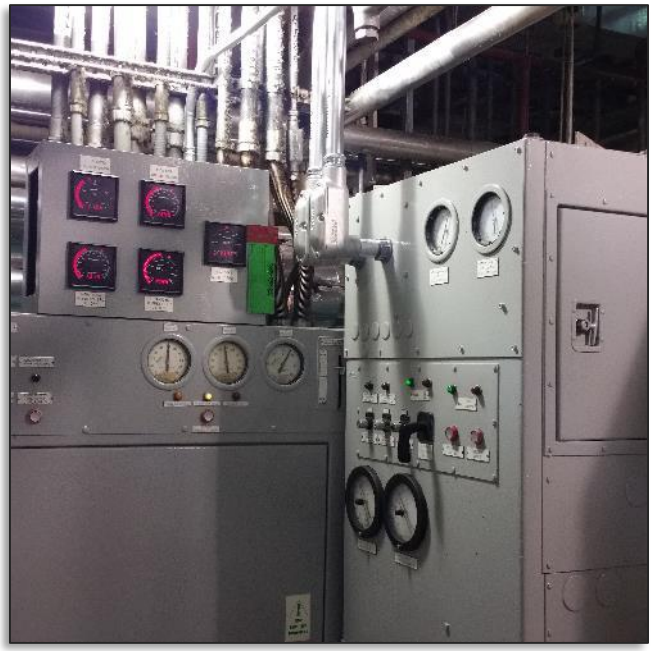
Wireless Gauge Reader & Wireless Transducer Reader

- “Electronic Eyeball” reads gauges and transmits readings wirelessly
- Non-invasive, clamp-on to existing gauges in minutes
- No downtime, no leak check, no wiring, no drawings
- Battery life of 3+ years at typical sample rates
- IP66/NEMA 4 rated for outdoor use

- Enables wireless remote monitoring of virtually any analog transducer or instrument with the following outputs: 4-20mA, 0-5V, or 0-10V, RS-232, RS-485, thermocouple, thermistor
- Compatible with most existing flow meters, current meters, particle counters, thermocouples, weigh scales, etc.
- Enables data logging to enable trend analysis, notification, or statistical process control

Non-Invasive Devices Enables Alarming, Trending, Historization for Process/Asset Monitoring and Troubleshooting of Legacy Equipment and Instrumentation

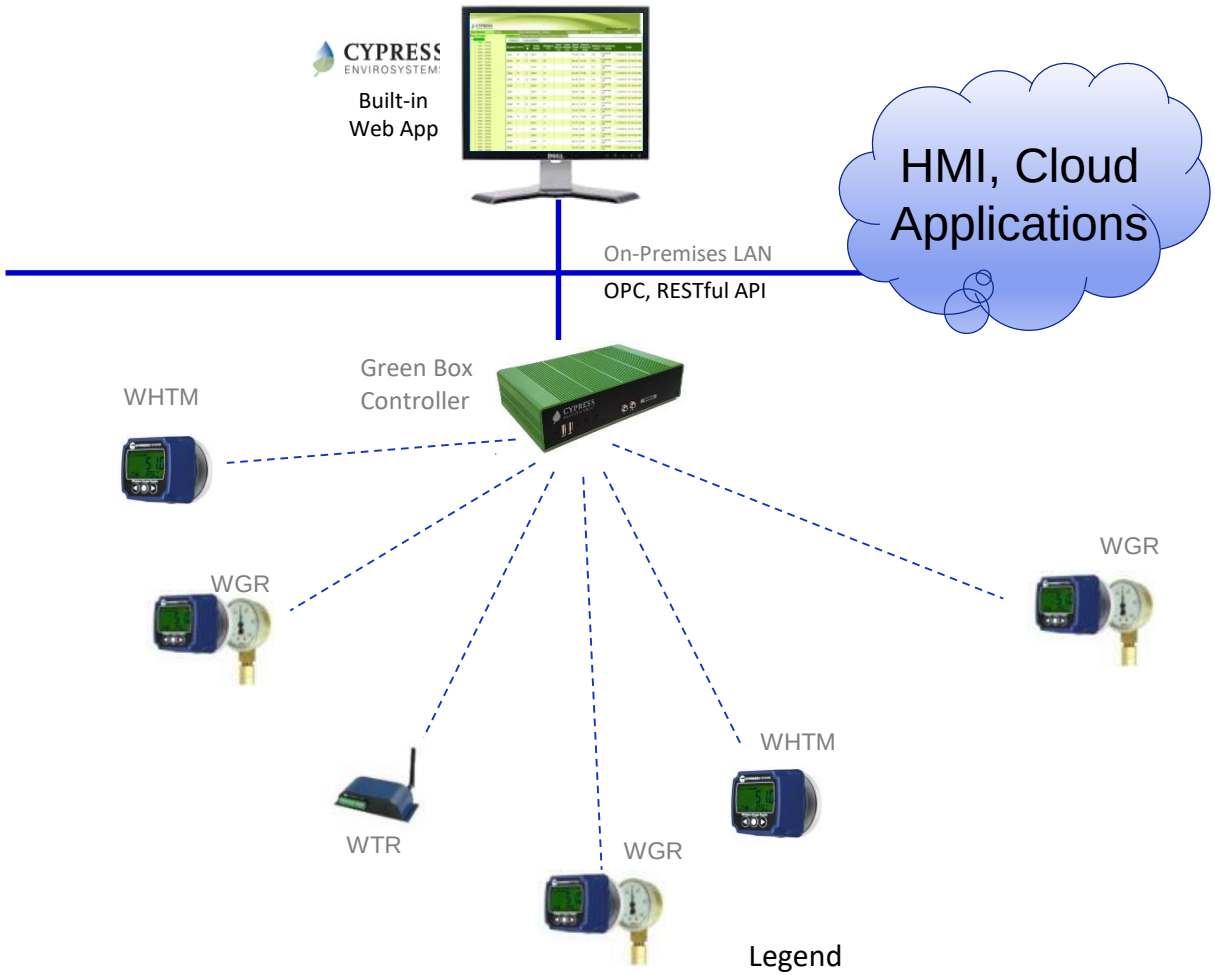
Most Plant Data is NOT Digitalized



Legacy mechanical, manual instrumentation for flow, temperature, pressure, pneumatic actuators

Wireless Communication Architecture

- 900 MHz LoRA open protocol
- LoRA encrypted communications
- Star network configuration, 300 ft range
- Industry standard OPC and RESTful API interfaces



Equipment Monitoring

Condition Based Monitoring
& Fault Diagnostics

Pump Head Pressure vs. Flow Rate – Failure Diagnostics

Customer Challenge:

Detect pending failure for pumps and compressors, and proactively repair or replace before production is impacted.

WGR Solution:

Use WGR and/or WTR to non-invasively monitor pump head pressure and flow rate, current consumption and compare with manufacturer's spec.

Early detection of faults when performance deviates from spec.

WGR installation takes minutes and cost 70% less than transmitters...
and may be removed and reused at other locations

CYPRESS ENVIROSYSTEMS

Improve Asset Health and Uptime

Customer Challenge:

Older equipment such as packaged heat exchangers, boilers, chillers, air dryers, hydraulic conveyors, water filters, HEPA filters, etc. often have little or no electronic monitoring outputs.

Adding new transducers require modifying the equipment package and may impact existing service/ warranty agreements.

WGR Solution:

Typically manual gauges are already installed on older packaged equipment.

The WGR can monitor, trend and alarm parameters for early fault detection and corrective action.

Case Studies Available:
"Facilities Monitoring"

"Tri-State Power Asset Health Monitoring"

"In the first two weeks of using the WGR, we were able to detect and develop corrective measures for a potentially costly issue that we never suspected" – Mike Long, Control System Supervisor, Tri-State Generation and Transmission

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HEPA Filters

Energy and Consumables Savings

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Monitoring of Legacy Air Handlers

Typical Air Handler Units

Wireless Magnehelic Reader
Monitors Filters and Airflow

- Most older Air Handler Units (AHU's) are not monitored/automated
- Labor intensive to detect problems, check filters
- Proper air flow is the critical parameter - but can only be seen via manual dial gauges (e.g. Magnehelics)
- Solution: Wireless Magnehelic Reader clamps on in minutes and transmits reading wirelessly to BMS/BAS
- No downtime, no wiring, no leak checks
- Alarm notification for filter changeout, low air flow
- Condition-based maintenance, not schedule-based

Wireless Readers
Mounts Over Existing Gauges

Enables Monitoring of Legacy Air Handlers for 70% Less Than Traditional Transducers

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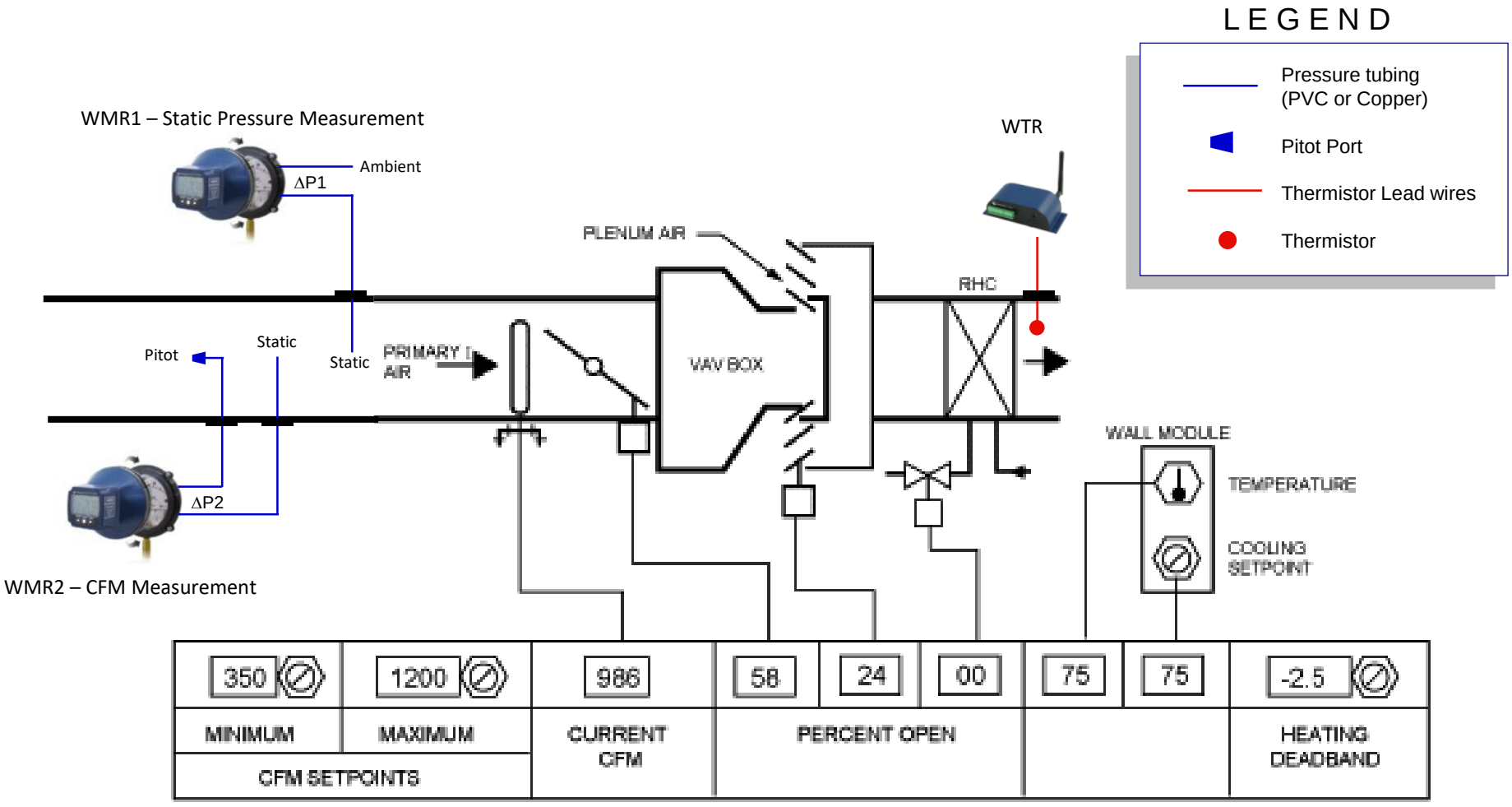
Duct/VAV Box Measurements



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Bag Houses

Compliance and Safety Improvement

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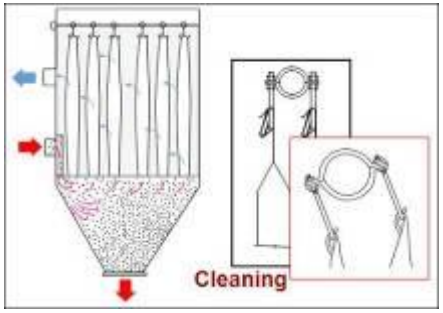
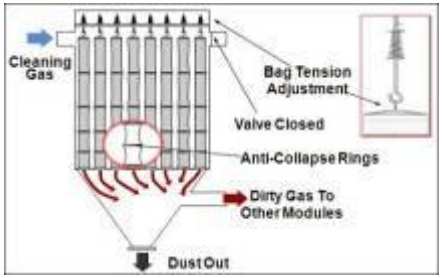
Application – Bag House and Filtration

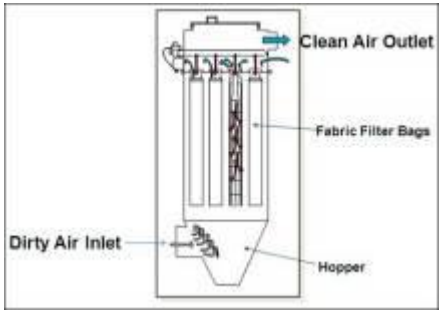
- Approximately 5 million baghouses installed worldwide remove pollutants and particulates from the exhaust air of industrial facilities
- Avoiding baghouse failure is critical to ensure safety and regulatory compliance
- Improperly maintained baghouses can have catastrophic fires and explosions
  - 130 deaths and 800 injuries since 1980
- Regulatory agencies oversee baghouses to ensure air quality
  - Over 500 administrative penalty cases
  - 100 judicial enforcement cases
  - Penalties often exceed $1 million per incident
- Industries that use baghouses:
  - Stone & Cement, Steel, Power, Mining, Chemical, Waste, Food, Pharmaceutical



Shaker



Reverse Air



Pulse Jet

Legacy Baghouses

Typical Baghouse

Baghouses Require Frequent Maintenance and Inspection

- Existing analog systems make maintaining baghouses challenging
- Regulatory audits can be cumbersome due to lack of historical data
- Failures can persist for weeks or months without notice, increasing potential fines and safety risks
- Manual inspection of analog systems is labor intensive
- Production line efficiency can be impacted
- Energy is wasted

Retrofit Magnehelic Gauges and Flow Meters

Analog Magnehelic Gauge

Wireless Magnehelic Reader

Airflow Meter

Wireless Transducer Reader

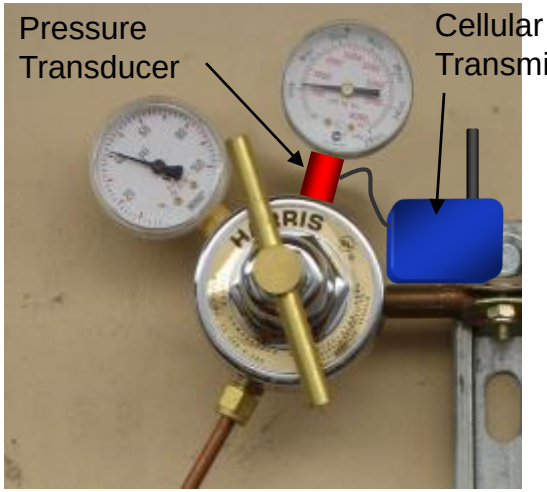
- The Wireless Magnehelic Reader (WMR) is a version of our Wireless Gauge Reader (WGR) for Magnehelic gauges
- The WMR combined with the Wireless Transducer Reader (WTR) access the data in existing Magnehelic gauges and flow meters
- The WMR and WTR provide data for central monitoring and alarming of baghouses
- Trend data helps maintenance teams identify issues before failures occur
- Alarms can be set to avoid catastrophic failure
- Historical data can be used to verify compliance making audits faster and easier
- Integration with existing systems can close control loops for more efficient operations

Gas Cylinders

Labor and Consumable Savings

Wireless Gauge Reader (WGR) vs. Conventional Solution

Conventional Pressure Transducer Solution



- Requires skilled technician to install – incurs cost of team, truck rolls
- Requires cylinder/process to be taken offline
- Risk of introducing leaks
- Risk of damaging regulators

Non-Invasive, Optical Wireless Gauge Reader Solution

- Easy installation, faster deployment
- No breaking seals, no leak checks
- No disruption to customer's operation
- Long battery life – up to 5 years

WGR Provides Faster Time to Market, Lower Cost and Risk to Deploy, Sustainable Differentiation

Received Top Industry Recognition and Award

Cover Story

Gases & Instrumentation INTERNATIONAL™
The Technology and Application of Industrial, Specialty and Medical Gases™

GOLDEN GAS AWARD 2010

Gases & Instrumentation International Announces the Winners of the 2010 Golden Gas Awards

Wellesley Hills, MA—February 17, 2010—*Gases & Instrumentation International*, a MetaWord, Inc. premiere publication covering the technology of industrial, specialty and medical gases, announces the winners of the 2010 Golden Gas Awards.

This year's competition attracted more than 43 entries in 8 categories. Each product was rated on 5 criteria based on the product's ability to solve an important challenge to the gas industry; technological innovativeness; environmental "green" attributes; superior specifications in terms of power requirements, speed, footprint, maintenance; cost effectiveness, and other quality considerations. Each criterion was awarded points from 0-10. If any product came within 3% of the winner, it was given the Silver Award.

Paul Nesdore, G&I's Publisher/Editor stated that, "This is the finest array of products we have ever seen. Our judges, representing decades of experience in all aspects of gases technologies, had a difficult time, as the products entered represented the cutting-edge of gases technology and implementation."

Proven Technology Deployed Since 2008

Current Versions of WGR Already Deployed

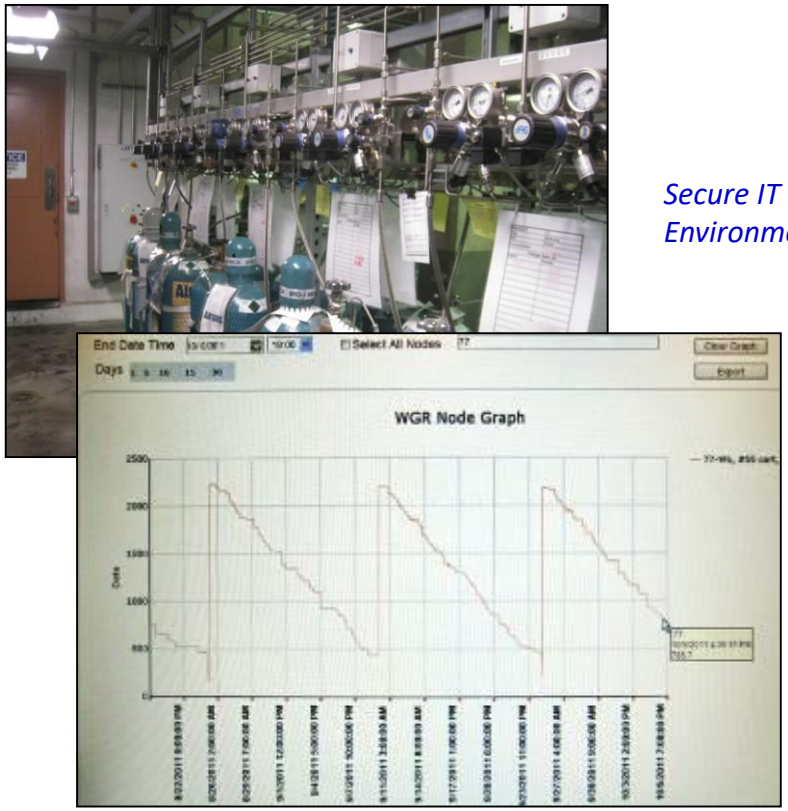
CATERPILLAR®

- Peoria, IL ~200 Cylinders
- Initial installation in 2011
- Large site, basement areas
- Demanding, data driven end-customer

Long Distances

Basement

Concrete and Metal walls



Secure IT Environment

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Vibration Monitoring

Condition Based Monitoring
& Fault Diagnostics

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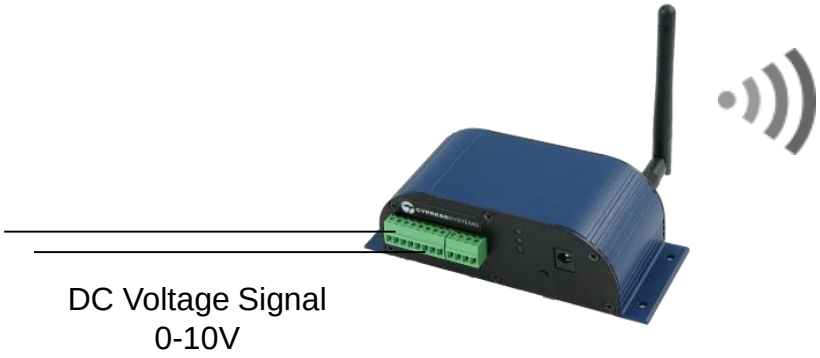
Wirelessly Capture Data from Vibration Sensors

Accelerometers
(DC-Response)



DC Voltage Signal
0-10V

Wireless
Transducer Reader
(Battery Operated)

Wireless
Transmission
to Blue Box

Monitor Vibration Changes Over a Period of Time
(e.g. misalignment, not for high frequency analysis)

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ENVIROSYSTEMS

Compressed Air System

Energy Savings

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Compressed Air Systems – Save Energy

Customer Challenge:

Compressed air systems are one of the largest energy users in a manufacturing facility which often run at settings beyond what is needed.

Monitoring of the compressed air system is intrusive and expensive

Installing additional compressed air capacity to accommodate system needs due to excessive leakage and compressor duty cycling.

WGR Solution:

Typically manual gauges are already installed throughout CDA systems or coolant loop systems.

WGR's can monitor and alarm pressure/flow to ensure process integrity and reduce energy use.

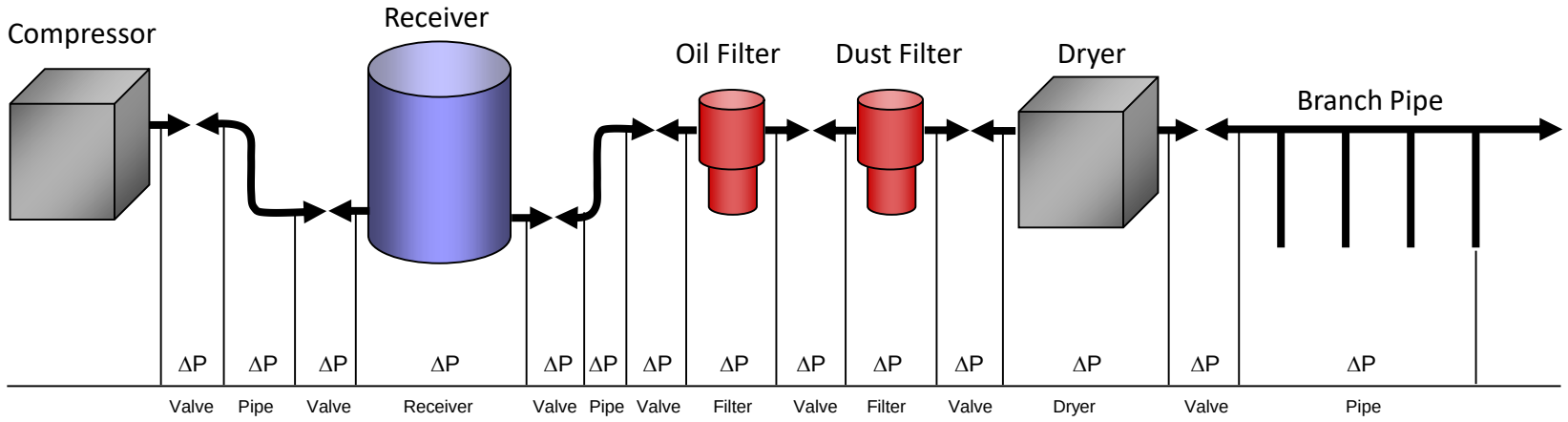
App note available:
"Compressed Dry Air System Energy Savings"

Savings on 500hp Compressed Air System can be up to $100K per year, with a 8 month payback.

Compressed Air – Design vs. Typical Case

Design Case

Compressor Working Pressure		End User Pressure
105 psi	15 psi loss	90 psi



Typical Case

Compressor Working Pressure		End User Pressure
125 psi	Unknown Loss	Must keep at least 90 psi

Clogged Filters, Leaks, Peak Usage

Typical Plant Operator Overpressures to Compensate for Potential Losses

Non-Invasive Retrofit Technologies

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"Avoid Expensive Steam Leaks"

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WIRELESS FREEZER MONITOR

"Predicts and Avoids Costly Freezer Failure"

Install in Minutes, no Disruption to Operations, Low-Cost

Wireless Steam Trap Monitor (WSTM)

Leaking Traps Waste Energy

Typical Steam Trap

- Traps are a necessary part of the steam distribution system, usually hundreds of units per site
- 15-20% average failure rate; leaks steam
- Failed traps lose $5,000 per year (1/8” orifice)
- Manual inspection typically done annually – labor intensive, do not catch problems in timely manner
- Solution: Wireless steam trap monitor detects faults and alarms on error, avoiding expensive leak loss
- Non-invasive installation: no breaking seals, wireless, integrates with BMS
- Battery life of 3+ years at typical sample rates
- IP65/NEMA 4 rated for outdoor use
- One year payback on investment

Save Energy and Time Locating Faulty Steam Traps

WSTM Distribution System Applications

Thermocouples Allow Remote Mounting of Transmitter

Inaccessible "Hot Vault" traps

Standard NEMA 4 Enclosure

25 foot deep cement bunkers

"Hard to Access" Remote Monitoring = $$$ Savings & Eliminates Safety Incidents

WSTM Executive Summary Report

CYPRESS ENVIROSYSTEMS

Readings | Graph | Table | Reports | Alarm History | Status | Configuration | Site Settings | Help

WSTM Executive Summary Report

Overview

Total Number of Traps: 12		
Health Status	**Count**	**% of Total**
Nodes with low battery	0	0.00
Nodes with poor RF signal strength	0	0.00

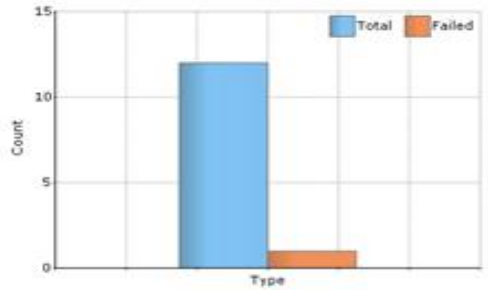
Energy Summary

Steam loss (lbs/hr)	35.70
Dollar loss ($/yr)	4,691.38

Condition Summary

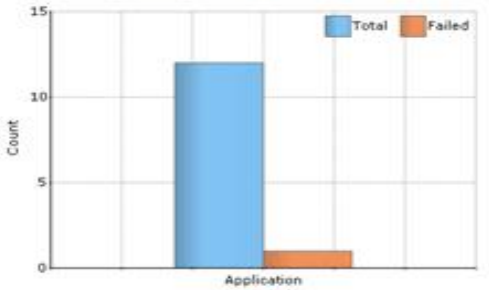
Condition	Count	% of Total
Good	8	66.67
Out of Service	3	25.00
Blowing	1	8.33
Error	0	0.00
Flooded	0	0.00
Leaking	0	0.00

Type Summary



Type	Total Count	% of Total	Failure Count	Out of Service Count	% of In Service Failure
Bucket	12	100.00	1	3	11.11
Totals:	**12**	**100.00**	**1**	**3**	**11.11**

Application Summary



Application	Total Count	% of Total	Failure Count	Out of Service Count	% of In Service Failure
Drip	12	100.00	1	3	11.11
Totals:	**12**	**100.00**	**1**	**3**	**11.11**

Comprehensive Reports with Energy Summary for Analysis and Auditing of All Traps

WSTM Payback Matrix

WSTM Payback Calculator[2] (years)

WSTM Installed Cost[3]:

$850 per unit

Your Steam Cost:

$20 per 1,000 lbs.

Inspection Frequency[4]:

1 times/year

Inspection Costs[5]:

$5 per trap

Facility Uptime:

365 days/year

Failure Rate[6]:

15% per year

Steam Trap Orifice Diameter[1]

Steam Pressure PSI (gauge)	1/32"	1/16"	3/32"	1/8"	5/32"	3/16"	7/32"	1/4"	9/32"	5/16"	11/32"	3/8"	13/32"	7/16"	15/32"	1/2"
5	76.4	28.9	14.2	8.3	5.4	3.8	2.8	2.2	1.7	1.4	1.2	1.0	0.9	0.8	0.7	0.6
10	67.1	23.8	11.5	6.7	4.4	3.1	2.3	1.8	1.4	1.1	1.0	0.8	0.7	0.6	0.5	0.5
15	59.7	20.3	9.7	5.6	3.7	2.6	1.9	1.5	1.2	1.0	0.8	0.7	0.6	0.5	0.5	0.4
25	49.0	15.7	7.4	4.2	2.8	1.9	1.4	1.1	0.9	0.7	0.6	0.5	0.5	0.4	0.4	0.3
50	33.9	10.0	4.6	2.6	1.7	1.2	0.9	0.7	0.6	0.5	0.4	0.3	0.3	0.3	0.2	0.2
75	25.9	7.3	3.4	1.9	1.3	0.9	0.7	0.5	0.4	0.4	0.3	0.3	0.2	0.2	0.2	0.2
100	20.9	5.8	2.7	1.5	1.0	0.7	0.5	0.4	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.1
125	17.6	4.8	2.2	1.3	0.8	0.6	0.4	0.4	0.3	0.2	0.2	0.2	0.2	0.1	0.1	0.1
150	15.2	4.1	1.9	1.1	0.7	0.5	0.4	0.3	0.3	0.2	0.2	0.2	0.1	0.1	0.1	0.1
175	13.3	3.6	1.6	0.9	0.6	0.4	0.3	0.3	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1
200	11.9	3.2	1.5	0.8	0.6	0.4	0.3	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1
225	10.7	2.9	1.3	0.8	0.5	0.4	0.3	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1
250	9.8	2.6	1.2	0.7	0.5	0.3	0.3	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1
275	9.0	2.4	1.1	0.6	0.4	0.3	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1
300	8.3	2.2	1.0	0.6	0.4	0.3	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1

Payback Period

0 - 2 Years | 2 - 8 Years | 8+ Years

1. Orifice diameter should not be confused with pipe diameter. Consult the steam trap manufacturer if orifice size is not known.
2. Calculations are theoretical estimates and actual results will vary. Payback calculation includes avoided lost steam and inspection labor. Benefits from avoided damage resulting from blocked traps are not included in model. The formula used for steam loss in this model is: L=24.24*Pa*D2. Where L=pounds/hour, Pa=Pgauge + Patm , D=orifice diameter.
http://www.energy.rochester.edu/efficiency/steam.pdf
3. Actual WSTM installed cost will vary based on volume and integrator.
4. Refers to the manual inspections of steam traps that are currently being done at the facility. The frequency determines the potential avoided failure time when using the WSTM.
5. The frequency and cost of inspection determine the labor savings enabled by the WSTM.
6. The failure rate per year should be based on historical data from the facility. 15-20% failure rates per year are typical. In unmaintained facilities, the failure rate can be much higher:
http://www1.eere.energy.gov/femp/pdfs/om_combustion.pdf

Typical Payback Period of 2-3 Years

Non-Invasive Retrofit Technologies

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"Go from Pneumatic to DDC in minutes"

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WIRELESS FREEZER MONITOR
"Predicts and Avoids Costly Freezer Failure"

Install in Minutes, no Disruption to Operations, Low-Cost

Pneumatic Stats: 20% - 30% Energy Savings Opportunity

- Pneumatic thermostats?
- No monitoring, limited visibility?
- No remote control, hot/cold calls?
- No BACnet connection to thermostats?
- Cannot implement energy savings strategies?

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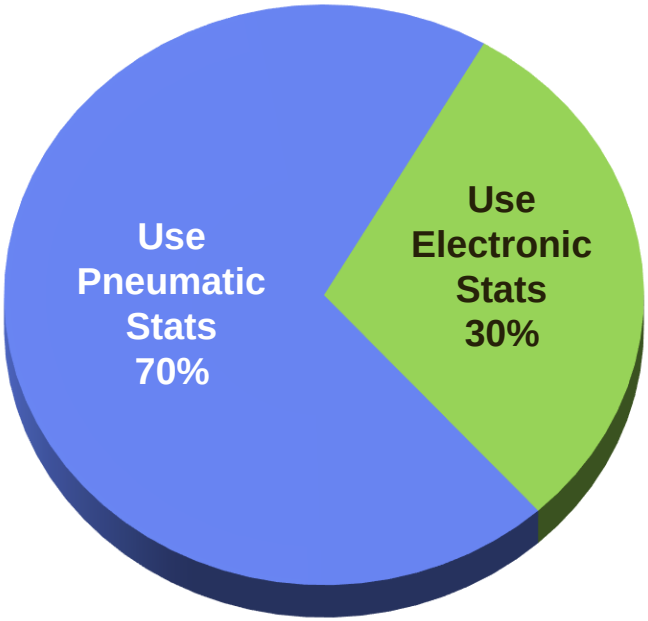
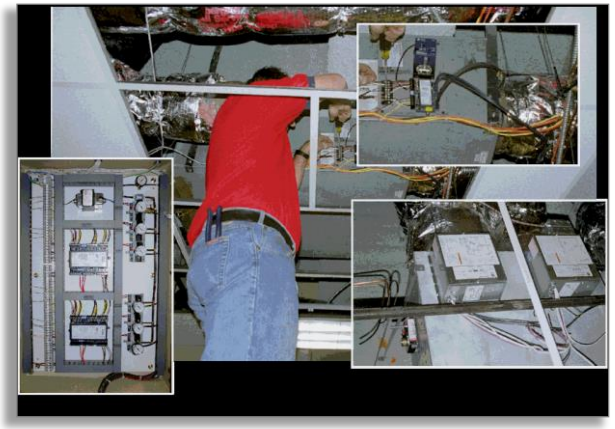
Most Non-Residential Buildings Still Employ Pneumatics

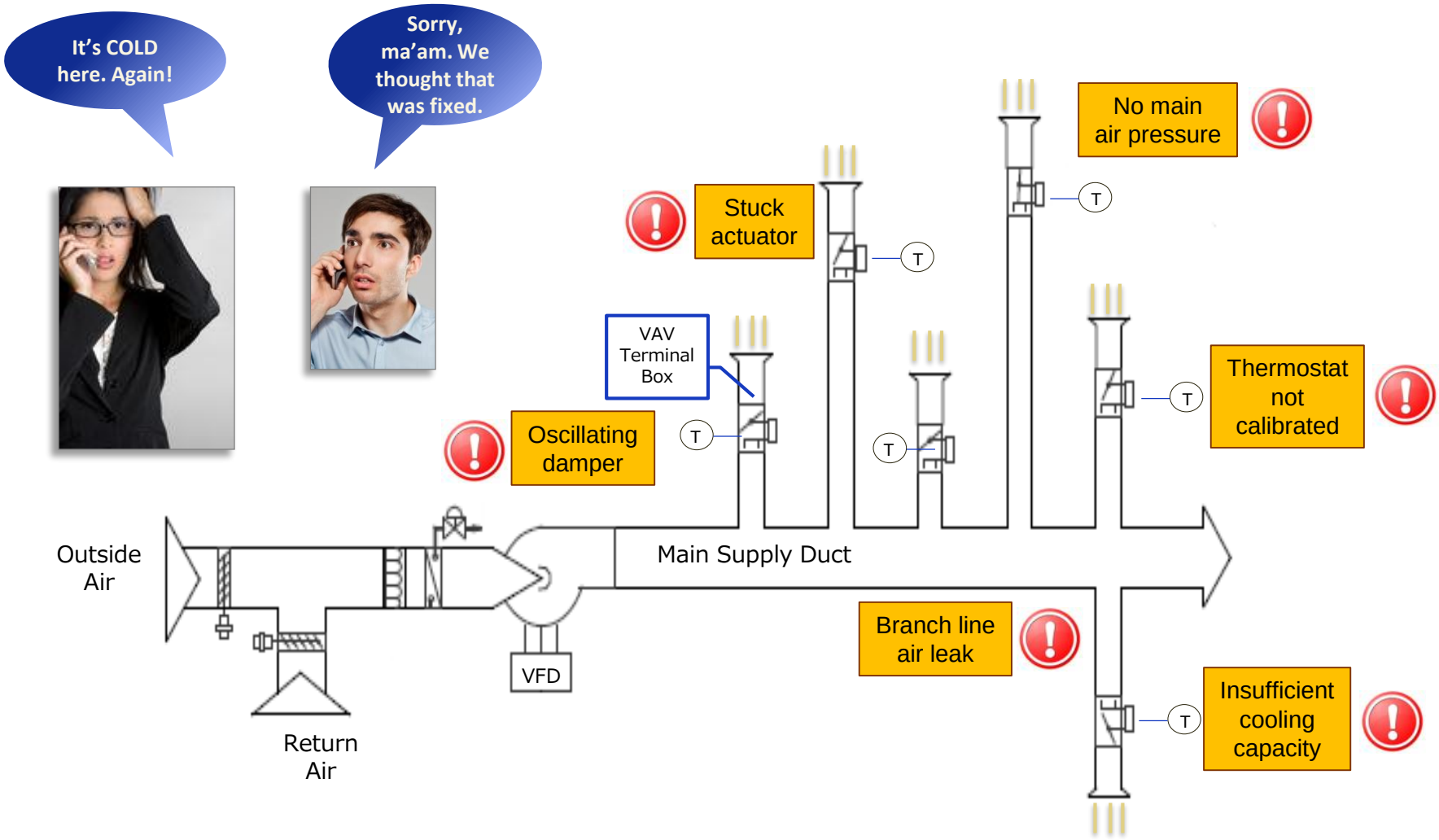


Why so many pneumatics still?

- Buildings constructed before 1999
- Conventional DDC retrofit too disruptive to occupants
- Requires opening up walls & ceilings, replacing actuators, running wires
- Very expensive, >$2,500 per stat
- Payback period >10 years . Typically not economical.



Cannot see lurking issues…



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Cannot Implement Energy Savings Strategies

Compared to Fully Digital Buildings, pneumatically controlled buildings use 20-30% more energy

No remote control
No programmability

- ✘ Temperature Setpoint Enforcement
- ✘ Separate Heating and Cooling Setpoints
- ✘ Programmable Occupancy Schedules
- ✘ Auto Demand Response (zone level)

No/Limited zone sensor data

- ? Duct Static Pressure Control
- ? Supply Air Temperature Resets
- ? Optimal Start/Stop

CYPRESS ENVIROSYSTEMS

Non-Invasive Pneumatic to DDC Retrofit

EXISTING LEGACY STAT

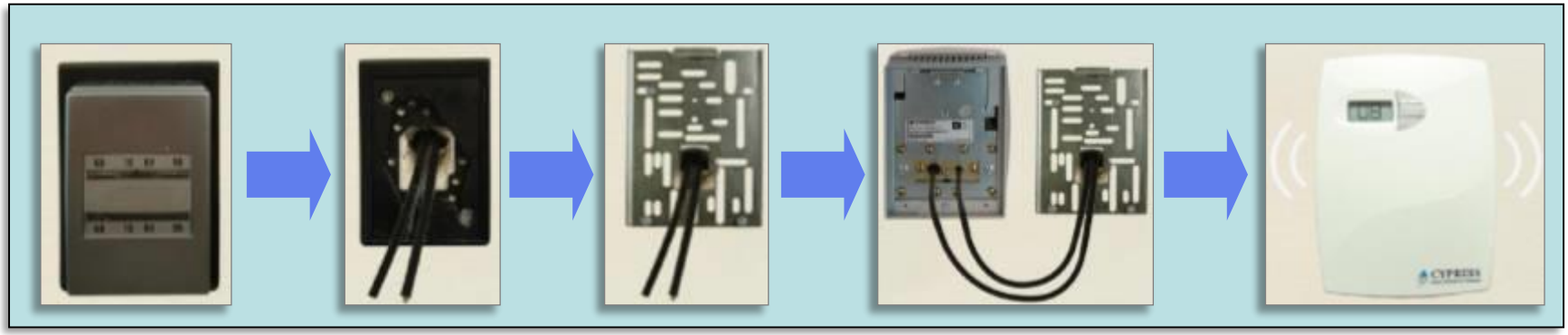
- Manual control, non-communicating
- No fault detection, no energy savings strategies
- Manual Calibration Required

DDC in 20 Minutes!

WIRELESS PNEUMATIC THERMOSTAT

- Remote Monitoring, Alarming, Control
- BACnet Integration with 3rd party BAS
- Automatic Self-calibration
- Programmable energy savings, demand response

Simply remove existing thermostat from wall, connect WPT, activate wireless interface



SMARTPneumatics Analytics

1

Wireless Pneumatic Thermostat collects extensive sensor and operational data on zone temperatures, setpoints, occupancy modes, air pressure etc.

Time	NodeID	Node Nan	Type	Setpoint (	Zone Tem	Branch Pn	Battery Le	Occupanc	Hop-1	Hop-2	Hop-3	Hop-4	Hop-5	Hop-6	RSSI-1	RSSI-2	RSSI-3	RSSI-4	RSSI-5	RSSI-6
11/27/2015 0:04	101	Barnes Co	Conv	62	69.8	18.95	OK	Occupied	15	14	13	12	11	1	5.38	5.21	3	2.5	3	4
11/27/2015 0:19	101	Barnes Co	Conv	62	69.8	18.68	OK	Occupied	15	14	13	12	11	1	5.42	5.21	3	1.86	3.33	3.67
11/27/2015 0:34	101	Barnes Co	Conv	62	69.8	18.42	OK	Occupied	15	14	13	12	11	1	5.42	5.21	3	2.5	3	4
11/27/2015 0:49	101	Barnes Co	Conv	62	69.8	18.68	OK	Occupied	15	14	13	12	11	1	5.42	5.25	3	2.5	3.33	3.67
11/27/2015 1:04	101	Barnes Co	Conv	62	69.8	18.68	OK	Occupied	15	14	13	12	11	1	5.42	5.21	3	2	3.33	3.67
11/27/2015 1:19	101	Barnes Co	Conv	62	69.58	18.68	OK	Occupied	15	14	13	12	11	1	5.42	5.21	3	2.5	3.33	3.67
11/27/2015 1:34	101	Barnes Co	Conv	62	69.58	18.68	OK	Occupied	15	14	13	12	11	1	5.42	5.21	3	2.5	3.33	4
11/27/2015 1:49	101	Barnes Co	Conv	62	69.58	18.68	OK	Occupied	15	14	13	12	11	1	5.42	5.21	3	2	3	3.67
11/27/2015 2:04	101	Barnes Co	Conv	62	69.58	18.68	OK	Occupied	15	14	13	12	11	1	5.42	5.21	2	1.86	3	3.67
11/27/2015 2:19	101	Barnes Co	Conv	62	69.58	18.68	OK	Occupied	15	14	13	12	11	1	5.42	5.25	2.5	2	3	4
11/27/2015 2:34	101	Barnes Co	Conv	62	69.58	18.68	OK	Occupied	15	14	13	12	11	1	5.42	5.21	2	2.5	3	3.67
11/27/2015 2:49	101	Barnes Co	Conv	62	69.58	18.68	OK	Occupied	15	14	13	12	11	1	5.38	5.21	2.5	2	3.33	4
11/27/2015 3:04	101	Barnes Co	Conv	62	69.58	18.16	OK	Occupied	15	14	13	12	11	1	5.42	5.21	2.5	2.5	3.33	3.67
11/27/2015 3:19	101	Barnes Co	Conv	62	69.58	18.68	OK	Occupied	15	14	13	12	11	1	5.42	5.21	3	2.5	3	3.67
11/27/2015 3:34	101	Barnes Co	Conv	62	69.58	18.68	OK	Occupied	15	14	13	12	11	1	5.42	5.21	3	2	3	3.67
11/27/2015 3:49	101	Barnes Co	Conv	62	69.58	18.68	OK	Occupied	15	14	13	12	11	1	5.42	5.21	3.33	2.5	3	3.67
11/27/2015 4:04	101	Barnes Co	Conv	62	69.58	18.42	OK	Occupied	15	14	13	12	11	1	5.42	5.21	3.67	2.5	3.33	4
11/27/2015 4:19	101	Barnes Co	Conv	70	69.8	4.21	OK	Occupied	15	14	13	12	11	1	5.42	5.21	2.5	2	3	3.67
11/27/2015 4:34	101	Barnes Co	Conv	70	70.03	3.95	OK	Occupied	15	14	13	12	11	1	5.42	5.25	3	1.86	3	3.67
11/27/2015 4:49	101	Barnes Co	Conv	70	70.7	5	OK	Occupied	15	14	13	12	11	1	5.42	5.21	2.5	2	3.33	3.67
11/27/2015 5:04	101	Barnes Co	Conv	70	70.7	5.53	OK	Occupied	15	14	13	12	11	1	5.42	5.21	3	2	3	4
11/27/2015 5:19	101	Barnes Co	Conv	70	70.93	5.79	OK	Occupied	15	14	13	12	11	1	5.42	5.21	2.5	2	2.5	3.67
11/27/2015 5:34	101	Barnes Co	Conv	70	71.15	6.32	OK	Occupied	15	14	13	12	11	1	5.42	5.25	2.5	1.86	3	4
11/27/2015 5:49	101	Barnes Co	Conv	70	71.15	6.58	OK	Occupied	15	14	13	12	11	1	5.42	5.21	3	2	3	4
11/27/2015 6:04	101	Barnes Co	Conv	70	71.38	6.58	OK	Occupied	15	14	13	12	11	1	5.42	5.21	2.5	2	3	4
11/27/2015 6:19	101	Barnes Co	Conv	70	71.38	6.84	OK	Occupied	15	14	13	12	11	1	5.42	5.21	3	2.5	3	3.67
11/27/2015 6:34	101	Barnes Co	Conv	70	71.6	6.84	OK	Occupied	15	14	13	12	11	1	5.42	5.21	2.5	2	3	3.67
11/27/2015 6:49	101	Barnes Co	Conv	70	71.6	7.11	OK	Occupied	15	14	13	12	11	1	5.42	5.21	3	2	3.33	3.67
11/27/2015 7:04	101	Barnes Co	Conv	70	71.6	7.11	OK	Occupied	15	14	13	12	11	1	5.42	5.21	2.5	2	3	3.67
11/27/2015 7:19	101	Barnes Co	Conv	70	71.6	7.11	OK	Occupied	15	14	13	12	11	1	5.42	5.21	2.5	2	3	4
11/27/2015 7:34	101	Barnes Co	Conv	70	71.83	7.37	OK	Occupied	15	14	13	12	11	1	5.42	5.21	2.5	2	3.33	3.67
11/27/2015 7:49	101	Barnes Co	Conv	70	71.83	7.37	OK	Occupied	15	14	13	12	11	1	5.42	5.21	2.5	1.71	2.5	4
11/27/2015 8:04	101	Barnes Co	Conv	70	72.05	7.63	OK	Occupied	15	14	13	12	11	1	5.42	5.21	2.5	2.5	3.33	3.67
11/27/2015 8:19	101	Barnes Co	Conv	70	72.05	7.89	OK	Occupied	15	14	13	12	11	1	5.42	5.21	2.5	2	3	3.67
11/27/2015 8:34	101	Barnes Co	Conv	70	72.05	7.89	OK	Occupied	15	14	13	12	11	1	5.38	5.21	3	2	3.33	3.67
11/27/2015 8:49	101	Barnes Co	Conv	70	71.83	8.42	OK	Occupied	15	14	13	12	11	1	5.42	5.21	3	2	3.33	3.67
11/27/2015 9:04	101	Barnes Co	Conv	70	71.6	8.68	OK	Occupied	15	14	13	12	11	1	5.42	5.21	3	2	3	3.67

Adjust Setpoint(s) to More "Reasonable" Temperature

NodeID	Description	Recommended Action
118	O'Brien Rm 25	Cool Above Setpoint is too low (63F). Try adjusting.
119	O'Brien Rm 27	Cool Above Setpoint is too low (63F). Try adjusting.

Check for Oil in Pneumatic Lines

NodeID	Description	Recommended Action
113	O'Brien Rm23	May need to clean system, install new filter/dryers, replace WPT.

Actuators May be Stuck

NodeID	Description	Recommended Action
118	O'Brien Rm 25	Check Heating Actuator - may be stuck open
117	O'Brien Rm 30	Check Heating Actuator - may be stuck open

Check Thermostat Calibration

NodeID	Description	Recommended Action
116	O'Brien Rm 28	Check thermostat calibration - 4.1 deg F offset

2

Advanced patent pending analytics software perform fault detection diagnostics and produces easy to read actionable report.

CYPRESS ENVIROSYSTEMS

WPT Technology Recommended by DOE

Where does M&V recommend deploying Wireless Pneumatic Thermostats?

ANY FACILITY
WITH CONVENTIONAL PNEUMATIC CONTROLS

Deployment priority should be given to facilities with high energy costs

[1]Wireless Pneumatic Thermostat Evaluation, Ronald Reagan Building and International Trade Center, Washington, DC, Dan Howett, P.E., Mahabir Bhandari, PhD ORNL, March 2015, p. 2 [2]Ibid, p.3 [3]Ibid, p.4 [4]Ibid, p.4

GSA GPG Green Proving Ground Program

The Green Proving Ground program leverages GSA's real estate portfolio to evaluate innovative sustainable building technologies.
www.gsa.gov/gpg | gpg@gsa.gov

"Our wireless pneumatic thermostats are easy to use and cost-effective, and they provide access to energy-saving control strategies that weren't available through our old pneumatic system."

—Greg Dix
Building Manager, Ronald Reagan Building
Washington, D.C.
National Capital Region
U.S. General Services Administration

GSA

OAK RIDGE National Laboratory

U.S. DEPARTMENT OF ENERGY

CYPRESS ENVIROSYSTEMS

311 S. Wacker Drive Chicago - ComEd Case Study

- Built in 1990
- Owned and operated by Zeller Realty
- 65 Story Tower Chicago Loop
- Premium Class A Office
- 1.4 million sq-ft
- Upgraded Andover BAS in 2000

smart ideas

311 SOUTH WACKER DRIVE
CASE STUDY

PROJECT SNAPSHOT	
Customer	311 South Wacker
Measures implemented	Wireless pneumatic thermostats connected to an energy management system; Lighting
Total project cost	$870,197
Estimated annual energy savings	4,384,242 kWh
Estimated annual cost savings	$329,000*
Smart Ideas incentive received	$402,318
Estimated payback period without incentive	2.7 years
Estimated payback period with incentive	1.4 years

*Estimated annual cost savings are based on an electricity rate of 7.5 cents per kWh.

PROJECT SUMMARY

The illuminated crown at the top of 311 South Wacker is prominently featured in the Chicago night skyline. The 1.3 million square-foot Class A commercial office building was built in 1990 and acquired by Zeller Realty Group in 2014. The new owner significantly upgraded the infrastructure and amenities to provide an upscale tenant experience. Zeller Realty Group committed to projects that aligned with their environmental sustainability goals.

THE SOLUTION

With incentives from the ComEd Smart Ideas® Energy Efficiency Program, Zeller Realty Group upgraded 311 South Wacker's energy management system and common area lighting. They installed and connected 944 wireless pneumatic thermostats to an Internet-enabled energy management system that tracks and controls electricity use through a computerized network of monitors and sensors. As part of the building retrofit, 296 inefficient T12 fluorescent lamps were replaced with T8 fluorescent lighting and 95 high-wattage PAR lamps were replaced with LED lights. The new lighting offers a decrease in electricity use as well as improved light quality, uniformity, output, color and appearance. Additionally, the new lights have a much longer life, which creates operational maintenance savings.

PROJECT BENEFITS

Zeller Realty Group received a total of $402,318 in ComEd Smart Ideas® incentives when they implemented the energy management system enhancement and lighting retrofit projects. The annual cost savings from 311 South Wacker's reduced electricity use is an estimated $329,000. Facility management gained the ability to use real-time data to make operational energy savings decisions. The new LED lighting is visually appealing and saves energy. Additionally, state-of-the-art technology investments are appealing to potential tenants. "311 South Wacker is the first major office tower in Chicago to install wireless pneumatic thermostats connected to a cloud-based intelligent building system. A total of 944 thermostats were installed by our engineering team in record time," said Consolato Gattuso, Vice President of Technical Operations, Zeller Realty Group. "The system allows sophisticated algorithms to utilize real time data to make operational energy saving decisions."

FOR MORE INFORMATION

For more information about ComEd Smart Ideas, visit **ComEd.com/BizIncentives**, call **855-433-2700** during normal business hours or email us at **SmartIdeasBiz@ComEd.com**.

ComEd. powering lives
An Exelon Company

CYPRESS ENVIROSYSTEMS

M&V Validated 20% Savings at NYC School

CYPRESS ENVIROSYSTEMS, INC.

IDEA | **TECHNOLOGY DEMONSTRATION OVERVIEW**

COMPANY
Cypress Envirosystems, Inc.

TECHNOLOGY
Wireless Pneumatic Thermostat (WPT)

DEMONSTRATION SITE(S)
Q021 Edward Hart School
(147-36 26 Avenue, Queens NY)

DEMONSTRATION PERIOD
October 2014 – October 2015

SYSTEM(S) INVOLVED
HEATING AND COOLING

TYPE OF SAVINGS GENERATED
FUEL OIL

VENDOR'S POTENTIAL FOR SAVINGS
10%-25%
in HVAC energy consumption

SAVINGS ACHIEVED IN THIS DEMONSTRATION
20%

SAVINGS

Technology Description

The Cypress Envirosystems Wireless Pneumatic Thermostat (WPT) retrofits an existing pneumatic thermostat to provide Direct Digital Control (DDC)-like zone control functionality at a fraction of the time and cost compared to a conventional DDC upgrade, without disturbing occupants. The WPT enables remote monitoring of zone temperature and branch pressure, remote control set points, and programmable setback or setup of the pneumatic HVAC systems. This functionality gives operators the ability to detect and diagnose faults that may cause energy waste or discomfort to occupants. It also enables integration with utility Demand Response programs.

Optimum Facility Characteristics

- Central heating and cooling systems with or without BMS
- Uneven temperature distribution among spaces
- Existing pneumatic thermostats
- Stable internet connection

Demonstration Results

After retrofitting 69 of the school's thermostats and actively engaging with the technology, a savings of 20% in oil consumption was recorded. In 17 zones the WPT detected likely equipment faults, which were causing improper temperature control issues and energy waste. Building operators were then able to complete the repairs, which contributed to the recorded savings of 20%. Since oil is used in this facility for space heating, savings were calculated using only the months in the heating season. During the demonstration the boilers were repaired and the insulation was removed and not replaced until after the completion of the demonstration. As a consequence, oil consumption savings could have been higher and additional savings beyond the 20% could have been expected.

Recommendations for Implementation

- The WPT system can be integrated with existing Building Automation Systems through BACnet/IP
- Internet connection with the Cypress Greenbox needs to be verified for optimum operation of the trend logs and wireless communication with users and/or BMS.
- Fuel consumption data from utility bills, or monthly tank dipping in the case of oil, can be analyzed to determine baseline energy usage.

energy NYC

CYPRESS ENVIROSYSTEMS™

- Edward Hart Middle school Queens, NYC
- Uses Oil Fired Boilers, hot water radiators
- Fault detection, example:
  - Radiator hot water valve stuck open
  - Undetected probably many years
  - Occupants open window to compensate
  - Maintenance staff stretched thin, no data, not aware of situation

CYPRESS ENVIROSYSTEMS

Reduced Hot/Cold Calls – 345 California St, San Francisco

- 17,000 sq-ft Class A Office Space, 31st Floor
- 48 Story Hi-Rise, managed by Cushman & Wakefield
- San Francisco Financial District
- Tenant: Private Equity Firm

CUSHMAN & WAKEFIELD

Pre-WPT Installation
Mar - Nov

W.O #	DATE	TENANT	FLOOR	OFFICE #	REQUEST	TEMP.	WORK PERFORMED	BY	#
148516	9-Mar-09		31	3115	COLD		FOUND STAT PUTTING OUT 1#	JIM	1
150125	6-Apr-09		31	LARGE CONF.	PRE COOL		PUT STAT INTO COOLING FOR MTNG.	TIM	2
150195	8-Apr-09		31	CONF ROOM	COLD		CAL. T-STAT AND SET TO 70-74	PAUL	3
150500	15-Apr-09		31	3146	COLD	70	OFFICE TEMP. WAS 70	PAUL	4
151016	27-Apr-09		31	3155	COLD	71	TEMP. WAS 71	FRAZER	5
153307	15-Jun-09		31	CONF ROOM	HOT	73	AMBIENT 73 LOWERED STAT TO 65/70	PAUL	6
153976	26-Jun-09		31	EAST CORNER	COLD	73	RM TEMP 73 RAISED STAT TO 74	JIM	7
153991	26-Jun-09		31	PINE SIDE	COLD	73	AREA TEMP. 73, RAISED STAT TO 74	JIM	8
N/A	6-Jul-09		31	3156	COLD	71	OFFICE TEMP. WAS 71	PAUL	9
154347	7-Jul-09		31	S. ADMIN	COLD	72	AREA TEMP WAS 72	C.W/ PF	10
155020	22-Jul-09		31	3115	COLD	71	AREA TEMP AT 71 F, T'STAT AT 75 F	ART	11
155582	5-Aug-09		31	3134-A	COLD	73	AREA TEMP WAS 73.	CRAIG	12
155597	5-Aug-09		31	N CONF RM.	COLD		T'STAT SET TO 65-69, RESET TO 70-73	ARTURO	13
155597	5-Aug-09		31	NORTH CONF RM	COLD	68	TEMP. WAS 68 RESET TO70-73	ART	14
155808	12-Aug-09		31	3104	HOT		RE-SET STAT TO 71-74, FROM 70-74	CRAIG	15
157113	8-Sep-09		31	3127	HOT		CAL. STAT AND SET TO 71-74	CRAIG	16
157849	30-Sep-09		31	CAL. ST. SIDE	COLD		CAL. AND SET STAT TO 75	CRAIG	17
158278	6-Oct-09		31	3134A	COLD		REDUCED CFM, REDIRECTED AIR FLOW	C.W./S.T.	18
158192	7-Oct-09		31	3134A	COLD	74	TEMP.IS 74 ADJUSTED TWO STATS IN AREA	ART	19
158563	16-Oct-09		31	EAST CORNER	HOT	73	SET STAT TO 73	GRAIG	20
159030	27-Oct-09		31	3152	HOT	71	OFFICE TEMP. WAS 71	PAUL	21
159095	29-Oct-09		31	EAST CORNER	COLD	72.5	AREA TEMP WAS 72.5	ARTURO	22
159113	29-Oct-09		31	3146	HOT		DECREASED STPT TO 71-74 FROM 71-75	ARTURO	23
159222	2-Nov-09		31	3146A	HOT		CHILLER STARTED AT 10:45	ARTURO	24
159222	2-Nov-09		31	3146A	WARM	73	AREA TEMP WAS 73. MADE NO ADJ.	ARTURO	25
159240	2-Nov-09		31	WEST ADMIN	WARM	71.5	AREA TEMP. WAS 71.5 MADE NO ADJ.	PAUL	26
159321	3-Nov-09		31	3143/3140	WARM	72.5	AREA TEMP. WAS 72.5 MADE NO ADJ.	PAUL	27
159759	13-Nov-09		31	N CONF RM.	COLD	69	INCREASED SPT TO 71-74, FROM 69-73	ARTURO	28
159854	17-Nov-09		31	N CONF RM.	COLD	69	CAL. AND SET STAT TO 71-74	CRAIG	29

Post-WPT Installation
Mar – Nov

W.O #	DATE	TENANT	FLOOR	OFFICE #	REQUEST	TEMP.	WORK PERFORMED	BY	#
164055	1-Mar-10		31	3155	COLD	69	NEW W.P.T. WAS SET AT 71, SET TO 74	PAUL	1
164473	5-Mar-10		31	3113	COLD	71	FOUND COAT HANGING OVER T-STAT	PHIL	2
164916	12-Mar-10		31	3134A	COLD	72	SUPPLY AIR AT 68F STAT SET @ 72, RAISED TO 73	ART	3
165486	25-Mar-10		31	3120A & B	COLD	72	RAISED SPT. TO 73	CRAIG	4
166825	27-Apr-10		31	3120A & B	COLD	72	WPT WAS SET TO 73, RAISED TO 74	PAUL	5
166853	27-Apr-10		31	3121	HOT	77	UNABLE TO CALIBRATE WPT WILL FOLLOW-UP	PHIL	6
166994	3-May-10		31	3121	HOT	76	FOLLOW-UP TO REPLACEMENT OF WPT BY	CRAIG	7
169919	28-Jun-10		31	3155	COLD	70	RESET STAT TO 72	CRAIG	8
174033	27-Sep-10		31	PINE SIDE	HOT	80	CALIBRATED (3X) STATS AND SET AT 70 F.	CRAIG	9
176108	17-Nov-10		31	3155	COLD	70	STAT WAS SET @ 71 RAISED TO 73	PAUL	10

- ✓66% reduction in hot/cold calls
- ✓25 avoided calls/year
- ✓7-10¢/sq-ft/year savings

CYPRESS ENVIROSYSTEMS™

Non-invasive retrofit is our mission.

Please come see us!