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The Premier Energy Training Workshop
and Trade Show for Federal Agencies

A River of Energy Solutions

Making "Dumb" Buildings "Smart"

Retrofitting Existing Buildings for Demand Response & Energy Efficiency

Harry Sim

Agenda

- What are challenges with legacy buildings?

- Non-Invasive, Fast Payback Solutions:
  - Pneumatic HVAC Controls Retrofit, Retro and Automated Commissioning
  - Wireless Steam Trap Monitoring
  - Energy Baselining, Condition Based Maintenance

Existing Facilities: Largest Energy Use and Waste

Industrial Plants

- Steam, Thermal – 40%
  (solution: WSTM)
- Compressed Air – 25%
  (solution: WGR, WTR)
- Rotating Equipment, pumps, HVAC – remainder
  (solution: WGR, WTR, WFM, WBM)

Commercial Buildings

- HVAC – 40%
  (solution: WPT)
- Lighting – 20%
  (solution: Adura ALPS partnership)
- Plug loads, data centers – remainder
  (solution: WTR, WBM)

Source: US Energy Information Administration, 2007

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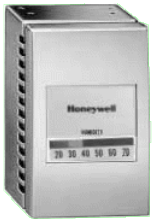
Typical Legacy Facilities



Pneumatic Thermostats

Dial Gauges

Need to save energy & improve uptime, but hindered by outdated facility?

Steam Traps

Standalone Transducers, LED/LCD Displays

-80C Freezers

Legacy Fluorescent Lighting

Uninterruptible Power Supplies

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

Lots of New Technology to Improve…BUT

- Retrofits are very disruptive to occupants, operations, production
- Retrofits are typically very costly with long payback periods

Non-Invasive, Fast Payback 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"

BLUE BOX HUB/RECEIVER

WIRELESS TRANSDUCER READER

"Remotely Read Transducers – No Wires"

WIRELESS FREEZER MONITOR

"Predicts and Avoids Costly Freezer Failure"

WIRELESS LIGHT CONTROLLER

"Reduce Electricity Use"

WIRELESS BATTERY MONITOR

"Automates UPS Health Check"

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70% of Commercial Buildings Still Pneumatic

- Waste energy, more maintenance, unhappy tenants…
  - No Night Setback, No Zone Control, No Optimal Start/Stop, No Occupancy Override, No Demand Response…
- High Cost to Retrofit
  - Market rate of $2500 - $3000 per zone for traditional DDC retrofit
- Disruptive to Tenants
  - Open Walls, Ceiling, Exposure to Asbestos

Retrofitting Existing Buildings is a PAIN IN THE NECK!!

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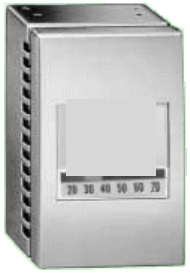
Wireless Pneumatic Thermostat (WPT)

EXISTING LEGACY STAT



DDC in 20 Minutes!

WIRELESS PNEUMATIC THERMOSTAT

Air Conditioning | Heating | Refrigeration
the NEWS
THE HVACR CONTRACTOR'S WEEKLY NEWSMAGAZINE SINCE 1926

Gold Award 2010

- **Manual Setpoint Control**
- **No Remote Readings**
- **No Diagnostics**
- **Manual Calibration Required**
- **Cannot support Demand Response strategies**

- **Remote Wireless Setpoint Control**
- **Remote Monitoring of Temperature & Pressure**
- **Pager/Cell Notification of Excursions**
- **Automatic Self-calibration**
- **Programmable Temperature Setbacks**
- **Occupancy Override**
- **Enables Demand Response strategies**
- **BACnet Interface to BMS**
- **Compatible With Existing Johnson, Honeywell, Siemens, Robertshaw**
- **Minimum 2yr battery life**

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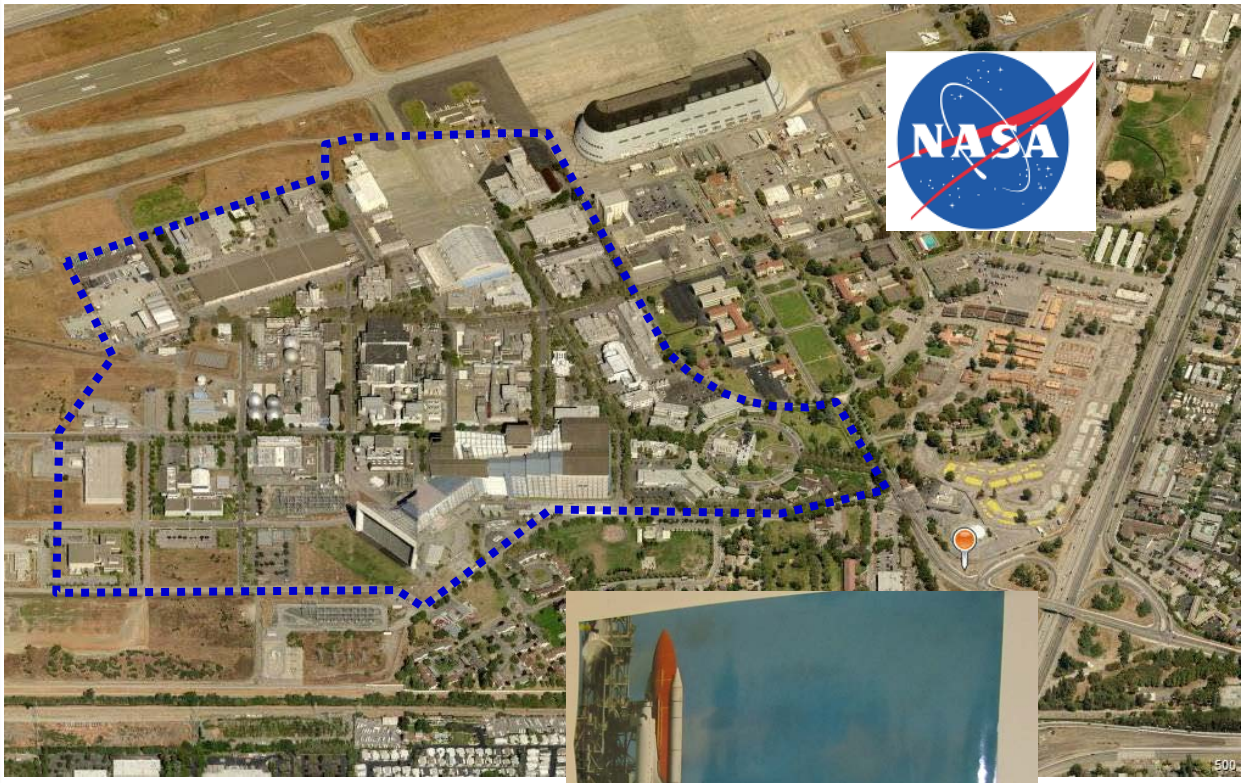
Get the benefits of Direct Digital Control (DDC) in less than 20 minutes, 80% Lower Cost

NASA Ames Research Center: 14 bldgs, 1m sq-ft



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Ford House, Capitol Hill, Architect of the Capitol

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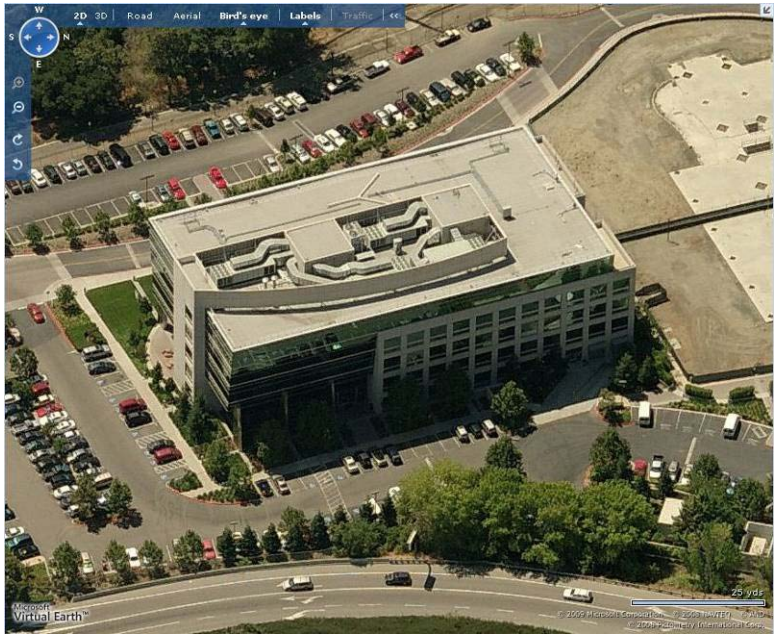
Case Study: Santa Clara County Gov't



- County of Santa Clara, Social Services Administration
- 2 Buildings, each 5 story, built 2000
- Total 300,000 sq-ft
- 350 Pneumatic Thermostats, non-communicating
- Estimated Demand Response load shed: 200kW
- Would like to participate in PG&E Auto-DR program, but challenging with pneumatic thermostats

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80% Lower Cost, 5% of the Time vs. Conventional DDC

Santa Clara County Government Project

	Non-Invasive Retrofit	Conventional Direct Digital Control Retrofit
Installed Price	350 x $500 = $175,000	350 x $2,500 = $875,000
Time Required	8 days	6 months
Disruption to Operations	Minimal	Significant
Potential Exposure to Toxic Substances in Walls	None	Unknown
Paid for by PG&E Auto DR Incentive	100% covered	31% covered

"Installation took only eight days and was one of the easiest, fastest and most cost effective energy efficiency improvements we have ever made in our buildings"
- Jeff Draper, Manager of Building Operations

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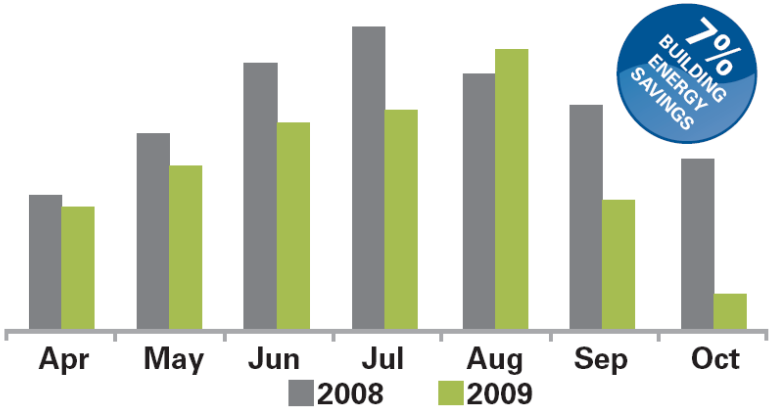
Quantified Savings for Santa Clara County

15% Energy Savings

Actual Year-Over-Year Energy Savings From WPT Retrofit[1]



[1] Graph is based on actual PG&E billing data and reflects average kWh/day. The range shown is 15,000 to 20,897 kWh/day.

- 300,000 sq-ft facility, $175,000 cost to retrofit (before utility incentives)
- Energy Savings: $42,000 per year
  - 350,000 kWh per year base load reduction, at $0.12 per kWh
  - Derived from enforcing Temperature Setpoint Policy and Retrocommissioning
- Demand Response Savings: $7,500 per ye
  - 10,700 kWh curtailed at peak rates $0.70 per k
  - Based on 12 events per year, 4 hours each, 0.6kW shed per thermostat
- Maintenance Cost Savings: $156,000 per year
  - Continuous commissioning data helped prioritize maintenance and reduced troubleshooting time
- Estimated Payback Period for Santa Clara County Project: 16 months *BEFORE* UTILITY INCENTIVES
  - Some savings kick in partially in first year, fully in subsequent years.

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Wireless Pneumatic Thermostat Savings

Estimated Savings Potential

$635/year (per 1000 sq-ft)
Upfront Retrofit Cost: $600 (per 1000 sq-ft)
Payback Period: 11 months

Energy Savings

18-30% reduction in HVAC use
2500 kWh per year / 1000 sq-ft
$235/year @ $0.10/kWh

- Temp Setpoint Policy
- Retro Commis-sioning

10-15%
1200 kWh/yr
$115/yr

Source: Case Study

- Night/ Weekend Setback & Occupancy Override

5-10%
600 kWh
$60/yr

Source: DOE2 eQUEST Modeling

- Duct Static Pressure & Supply Air Temp Reset

2-4%
300 kWh
$30/yr

Source: Trane Application Note

- Deadband Temp Policy

3-5%
400 kWh
$30/yr

Source: Cypress Modeling

Maintenance Savings

3-6 hours/year per 1000 sq-ft
$400/year @ $80/hour

- Automatic Calibration
- Faster Trouble-Shooting/ On-going Commissioning
- Reduced Tenant Complaints/ Calls

5 hours/yr
$400/yr

Source: Case Study

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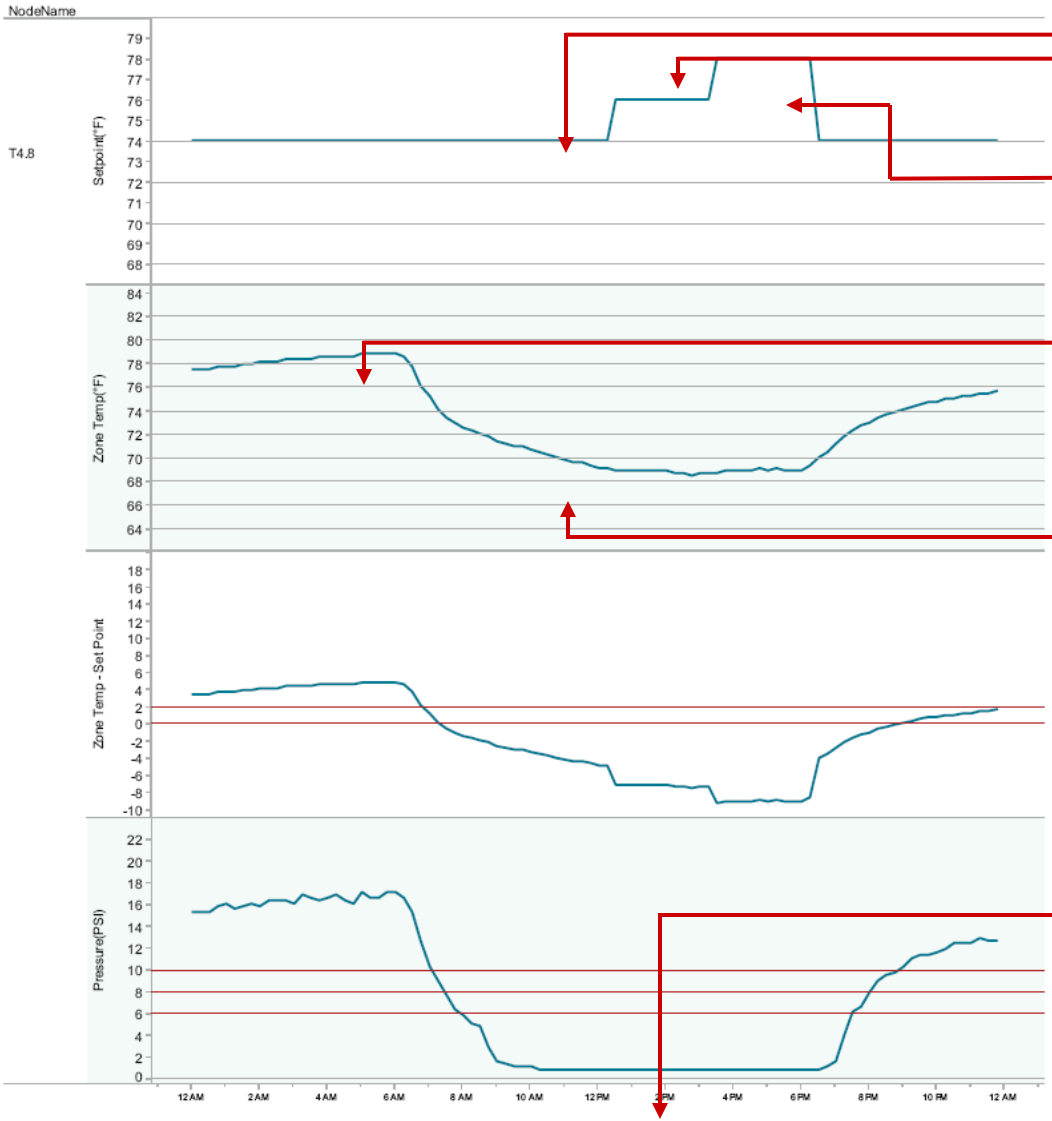
Zone Behavior – Too Much Cooling (example)



SETPOINT TEMPERATURE

- 1st DR Event bumped up setpoint 2 deg
- 2nd DR Event bumped up additional 2 deg
- Completion of Event – back to normal

ZONE TEMPERATURE

- Morning A/C comes on
- Temp keeps dropping, even below setpoint

DELTA SETPOINT MINUS ZONE TEMP

- Temperature way too cold, much below setpoint most of the day

BRANCH PRESSURE

- Thermostat is trying to compensate for over cooling all day long.

Causes/Remedy:

- Faulty Reset Velocity Controller
- VAV Box Fault
- Adjacent Zone Overcooling

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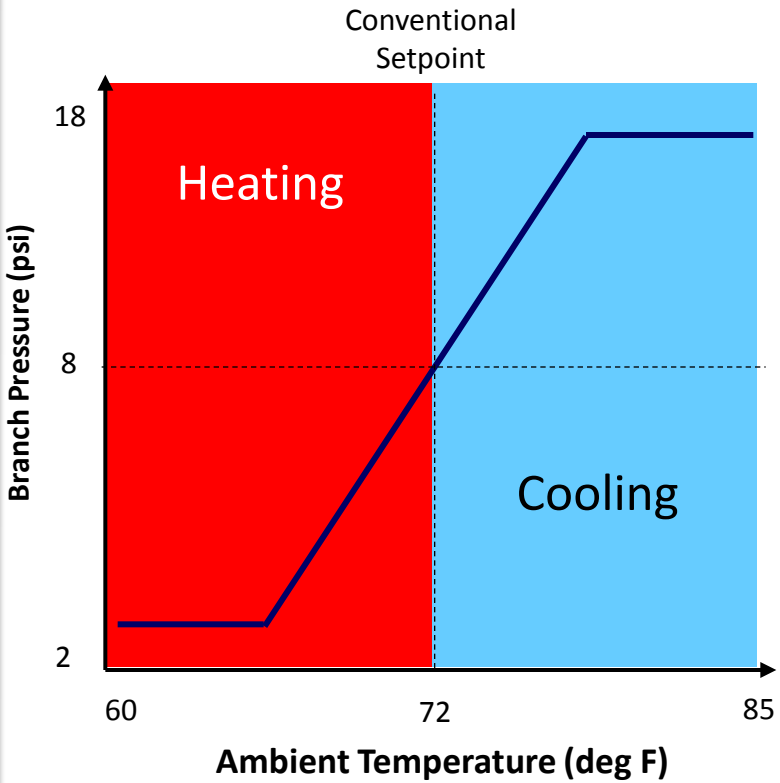
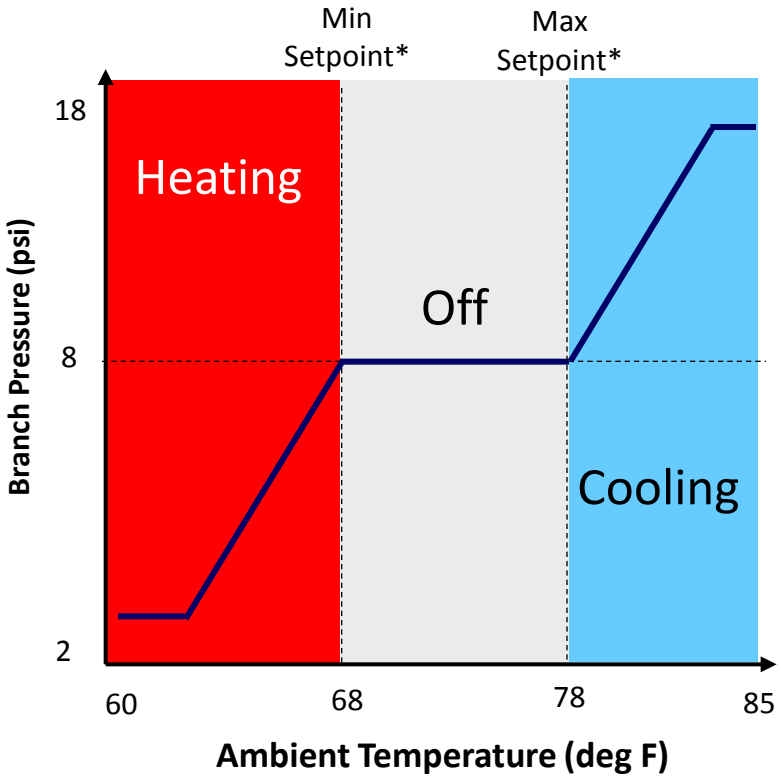
Comparison: Standard Pneumatic vs. Deadband Function

Standard Pneumatic Thermostat Behavior (Typical, Direct Acting)



Deadband Pneumatic Thermostat Behavior (Typical, Direct Acting)



*Minimum and Maximum Setpoints are selectable by user or building manager

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LEED Credits

LEED for Existing Buildings: Operations & Maintenance
Registered Project Checklist

			Energy & Atmosphere, continued			
			Existing Building Commissioning			
			Credit 2.1	**Investigation and Analysis**	✓	2
			Credit 2.2	**Implementation**	✓	2
			Credit 2.3	**Ongoing Commissioning**	✓	2
			Performance Measurement			
			Credit 3.1	**Building Automation System**	✓	1
			Credit 3.2-3.3	**System Level Metering**		1 to 2
				Credit 3.2 40% Metered		1
				Credit 3.3 80% Metered		2

Tenant Comfort and Satisfaction, Ability to Attract Top Tier Tenants, and Lower Lease Churn Rates Are Incremental to Energy Savings Benefits

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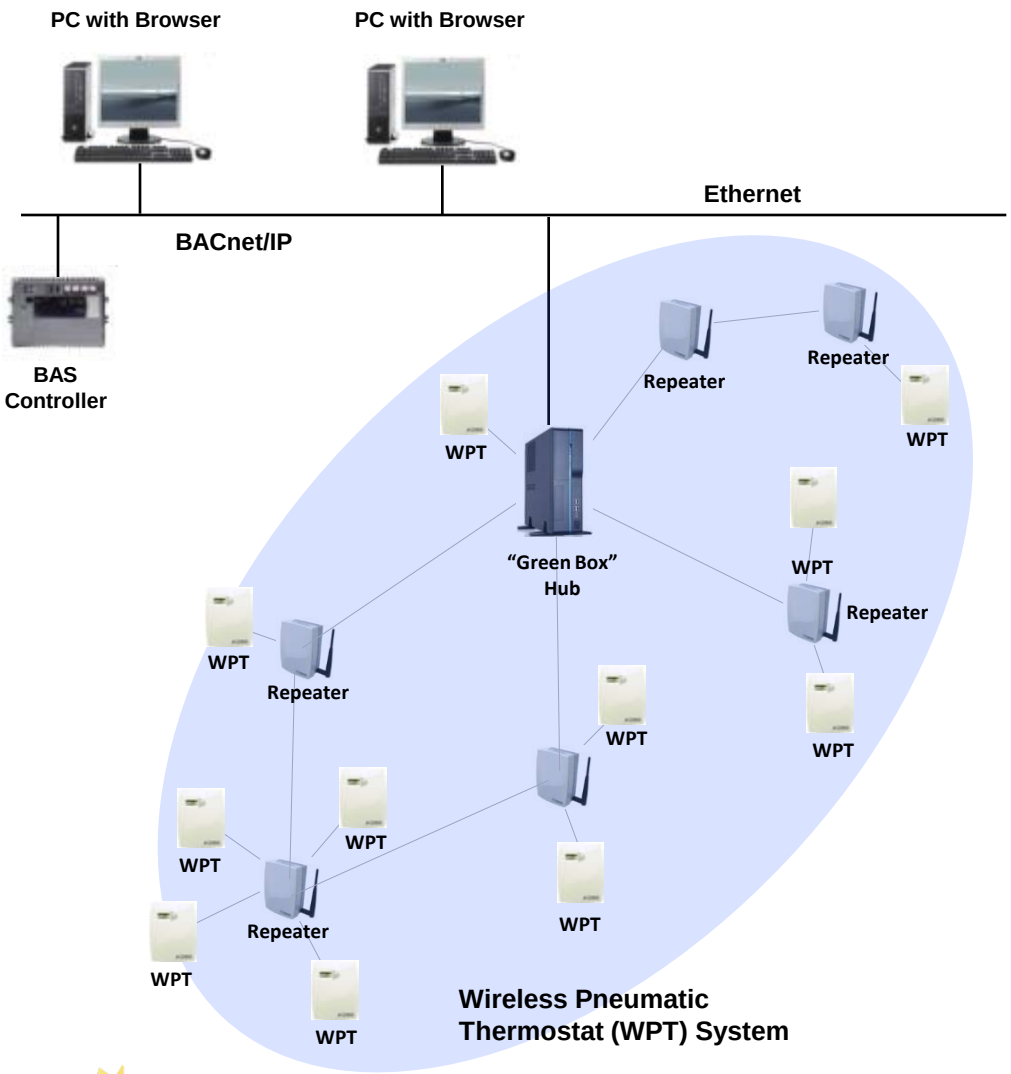
Wireless Pneumatic Thermostat (WPT) Architecture



BACnet Interface with:

VENDOR	BAS
ALERTON	BACtalk
AUTOMATEDLOGIC CORPORATION	ALC
Honeywell	Excel, Tridium
Johnson Controls	Metasys
SIEMENS	Apogee
t.a.c by Schneider Electric	Andover Continuum
TRANE	Trane Tracer Summit BCU
Delta CONTROLS	ORCA

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Steam Trap Challenges

Leaking Traps Waste Energy

Typical Steam Trap

Wireless Monitoring of Steam Traps

- 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

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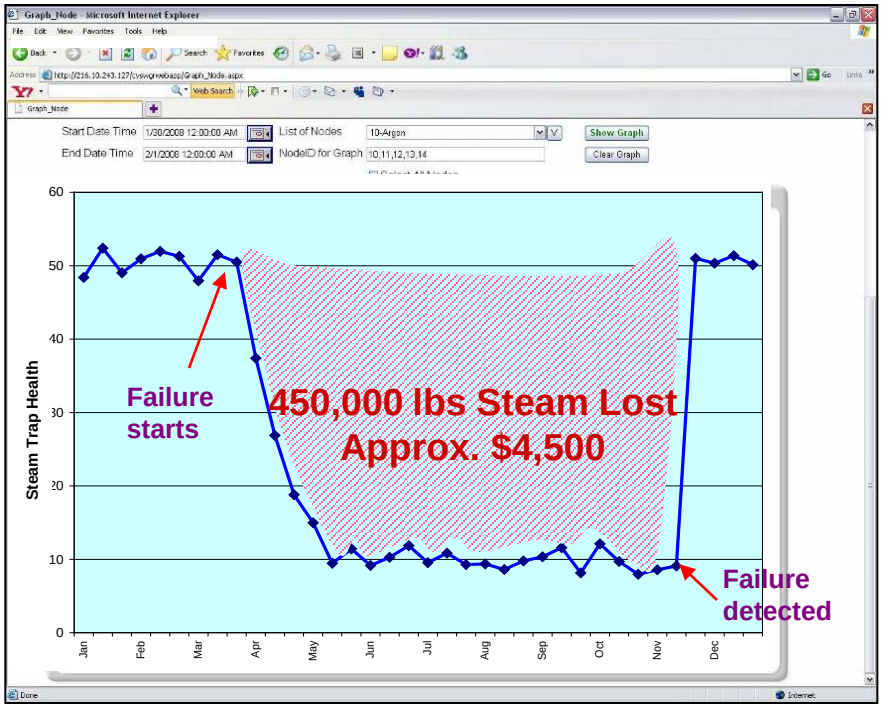
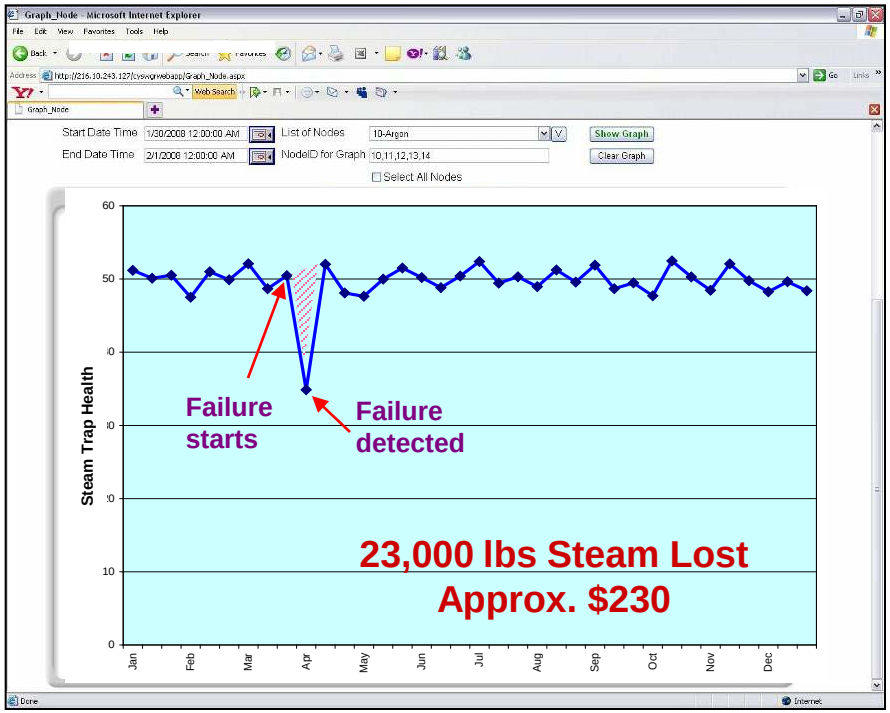
Under 18 month payback

How Steam Trap Monitoring Saves Energy

Without Steam Trap Monitoring



With Steam Trap Monitoring



Typical savings for 1/8” orifice steam trap

Timely Detection and Correction of Trap Failures Avoids Prolonged Costly Steam Leaks

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Lilly Indianapolis, IN – Deploying 2,400 WSTM's

BBS WRE WSTM

Energy Audits, Continuous Commissioning

Typical Air Handler Units

Wireless Magnehelic Reader
Monitors Filters and Airflow

- Chilled Water, Steam, Airflow are tough to measure in legacy buildings
- Most older Air Handler Units, Chillers, Boilers etc. are not monitored/automated
- Labor intensive to detect problems, check filters
- Manual gauges often the main means to check pressure, temperature, flow
- Solution: Wireless Gauge Reader clamps on in minutes and transmits reading wirelessly to BMS/BAS
- No downtime, no wiring, no leak checks
- Alarm notification and condition-based maintenance

Wireless Readers
Mounts Over Existing Gauges

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

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Summary

- Retrofit for Commercial and Industrial Plants for Energy Efficiency and Auto-Demand Response

- Key Principles:

  - Non-Invasive, Clamp-on Devices Which Install in Minutes
  - Compatible with Existing Infrastructure
    - DDC Integration
    - No new training of staff
    - No new systems software

- Typical Payback of 18 Months or Less

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Harry Sim
www.CypressEnvirosystems.com
Email: harry.sim@cypress.com
Phone: (408) 307-0922

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