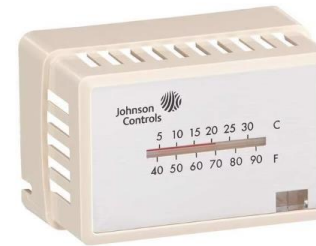# Non-Invasive retrofit from pneumatic to DDC

for BMA Smart Healthcare Conference, Nov 19-21, Miami, FL

Harry Sim, CEO of Cypress Envirosystems

Healthcare Users of WPT Technology – select examples

- Sutter Health
- LifePoint Health
- Orlando Health
- AdventHealth
- Prime Healthcare
- CommonSpirit
- Aurora
- Advocate
- HCA
- VA Medical Centers
- NYC Health and Human Services
- Yale Medical Center
- Catholic Health

The Challenge with Pneumatic Thermostats

Recognize these thermostats?

- Have been working for the past 100 years…

- Waiting to replace them with DDC

- Some converted already

- Still waiting for budget

- Still waiting for project window

Pneumatics are Still Widely Used

Estimated 70% of hospitals still use pneumatic thermostats

**Use Pneumatic Stats 70%**

Use Electronic Stats 30%
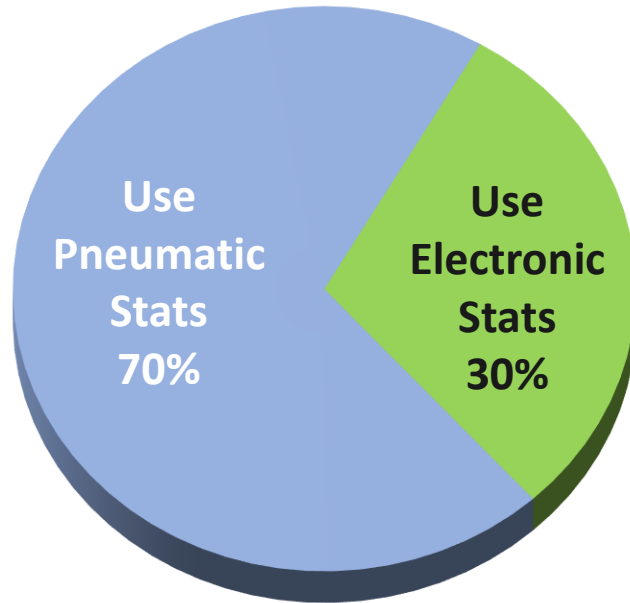
Why so many pneumatics still?

- Buildings constructed before 1999

- Conventional DDC retrofit too disruptive to occupants

- Requires opening up walls & ceilings, replacing actuators, running wires

- Very expensive, >$3000 per terminal unit

- Long payback period, typically 10 years or more

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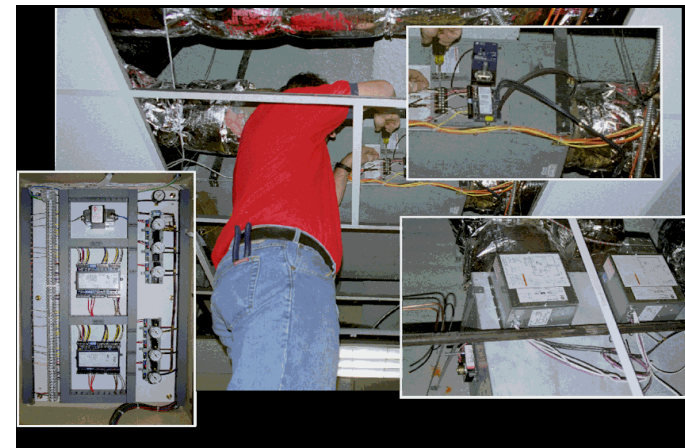
Pneumatic Shortcomings – No Visibility
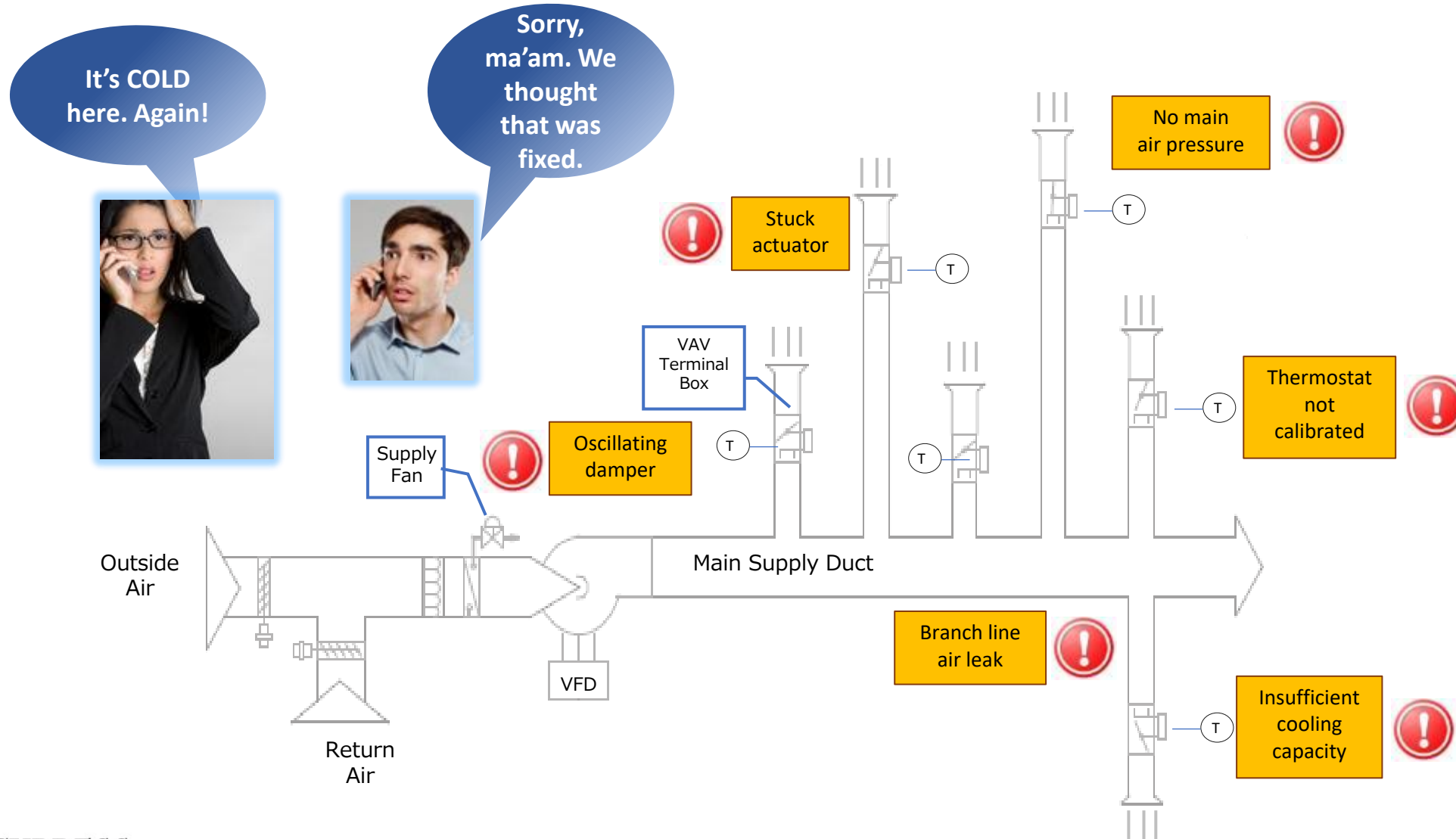
Pneumatic Shortcomings – Uses 20-30% More Energy

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

Pneumatic Controlled Buildings Uses 20-30% More Energy Than DDC Controlled
Energy Savings Strategies We Take For Granted in New Buildings are NOT POSSIBLE

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Non-Invasive, 10 minute Pneumatic to DDC Retrofit

EXISTING LEGACY STAT

WIRELESS PNEUMATIC THERMOSTAT

Minimal Disruption 10 Minute Upgrade
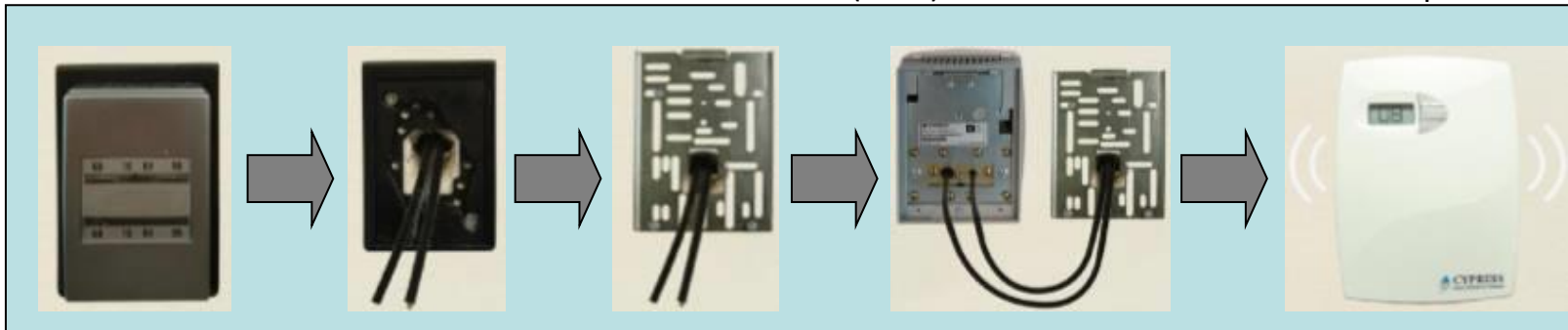
- Manual control, non-communicating
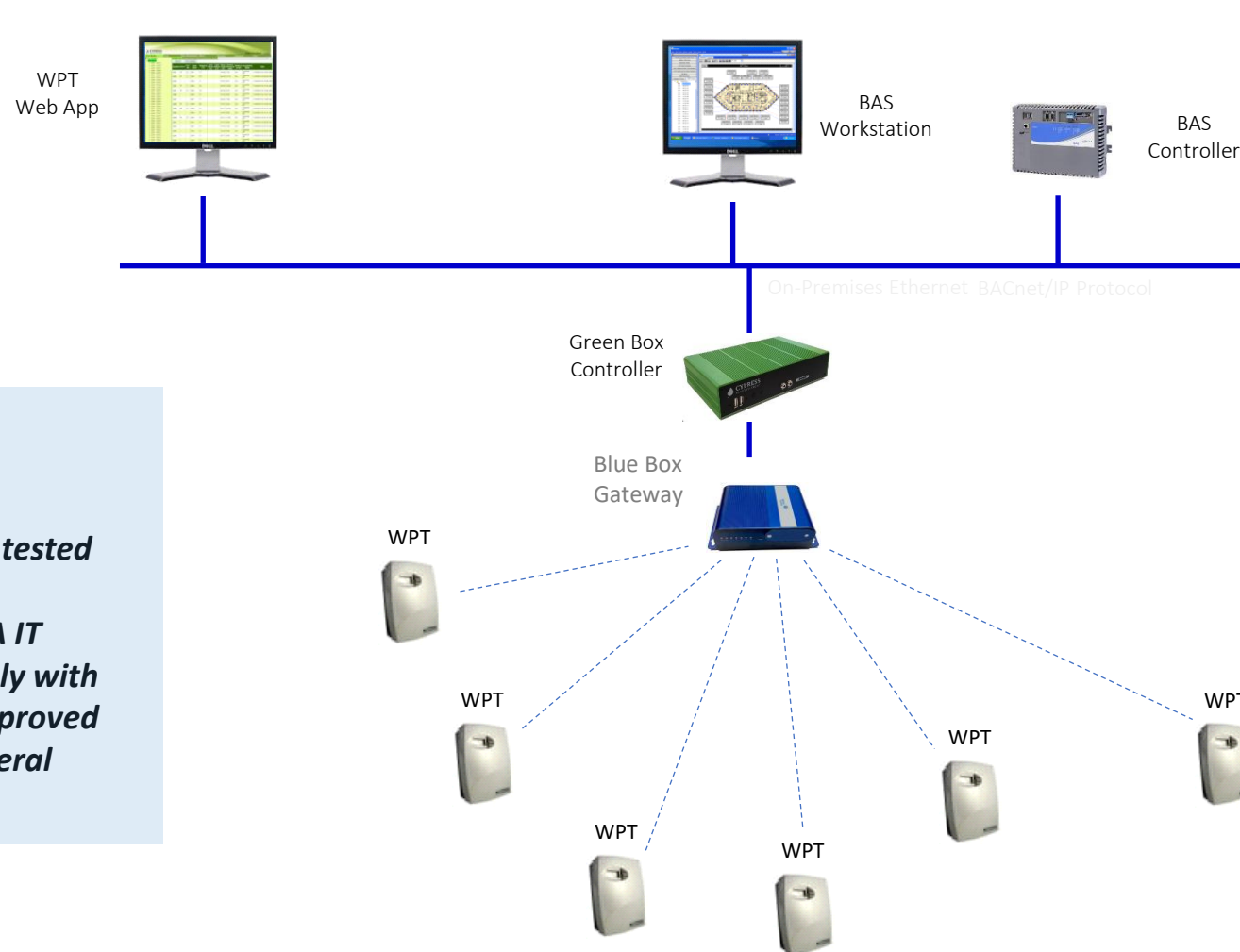- No fault detection, no energy savings strategies
- Manual Calibration Required

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

The Wireless Pneumatic Thermostat Provides (WPT) DDC Zone Control without Disruption
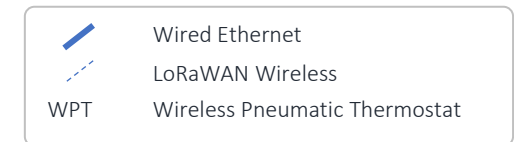

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WPT System Components and Architecture

WPT
Web App

BAS
Workstation

BAS
Controller

On-Premises Ethernet BACnet/IP Protocol

Green Box
Controller

Blue Box
Gateway

WPT

WPT

WPT

WPT

WPT

WPT

WPT

BACnet interface compatible with:

ALERTON®   Johnson Controls

AUTOMATEDLOGIC®   TRANE

Delta™   Schneider Electric
CONTROLS

Honeywell   SIEMENS

Cypress solution tested by US Federal Government GSA IT Security to comply with NIST 800-53. Approved for use in all Federal buildings.

Legend

╱	Wired Ethernet
╱	LoRaWAN Wireless
WPT	Wireless Pneumatic Thermostat

WPT Wireless Network can also accommodate:
* Occupancy Sensors
* Discharge Air Temperature Sensors
* Airflow CFM Sensors

Non-invasive retrofit pneumatic to DDC

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8

Technology Vetted by U.S. DOE GSA Proving Ground

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

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

Finalist – 2016 Federal Energy Management Program JUMP Award

Link to GSA/DOE Report:
https://www.gsa.gov/governmentwide-initiatives/climate-action-and-sustainability/emerging-building-technologies/published-findings/energy-management/wireless-thermostats-for-pneumatic-systems

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Benefits of Retrofit

- **Improve Occupant Comfort:**
  Reduce Hot/Cold Calls

- **Reduce Maintenance Effort:**
  Improve Visibility and Fault Detection

- **Enhance Energy Efficiency:**
 Energy efficient control sequences

Visibility: Enables Trending of Key Pneumatic Parameters

- Monitor, Trend, Alarm, Notify on Zone Temperatures, Setpoint Temperature(s), Branch Pressure, and Relative Humidity.

- BACNet Integration – control and view via BAS, or directly via GBC Controller.

- Know who is uncomfortable before they complain.

Node 1014: Rm. 101
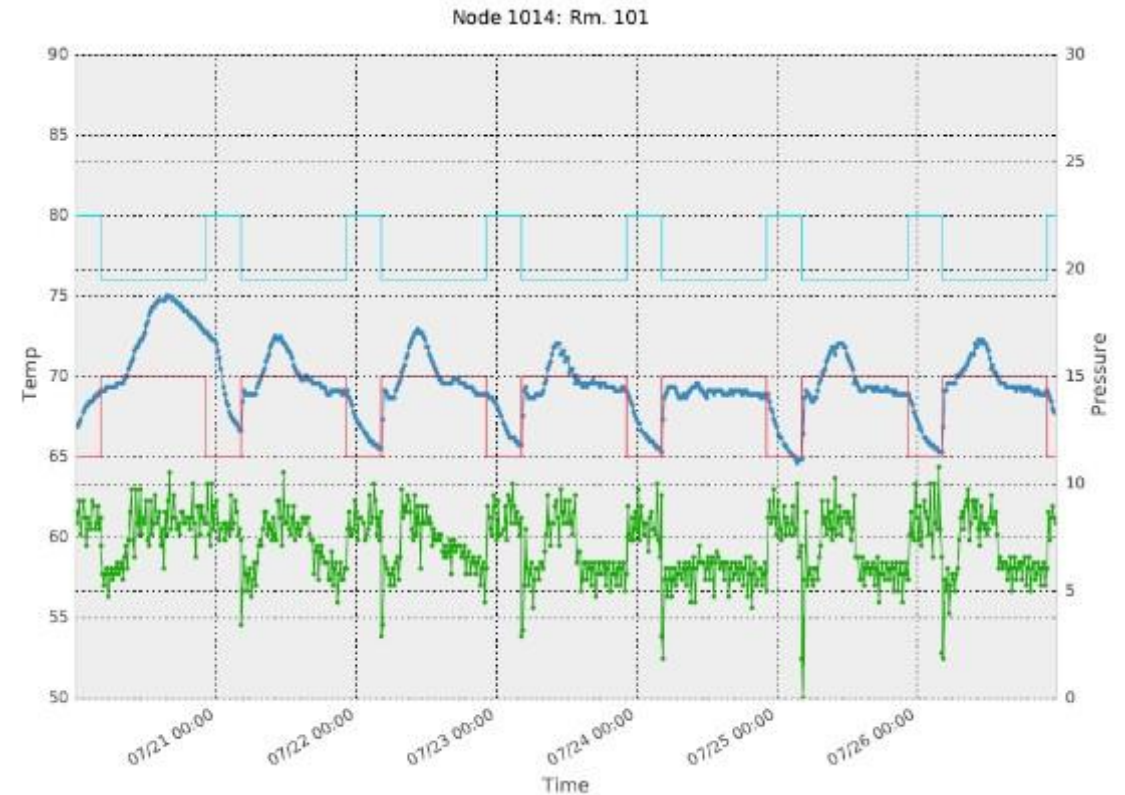
Green Line = Branch Pressure
Dark Blue Line = Room Temperature
Light Blue Line = Cooling Setpoint
Red Line = Heating Setpoint

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Example of Fault Detection:
Zone Temperature Always Hotter than Setpoint

Node 1008: Room 124

LEGEND
Red line: setpoint temperature
Blue line: zone temperature
Green line: branch pressure
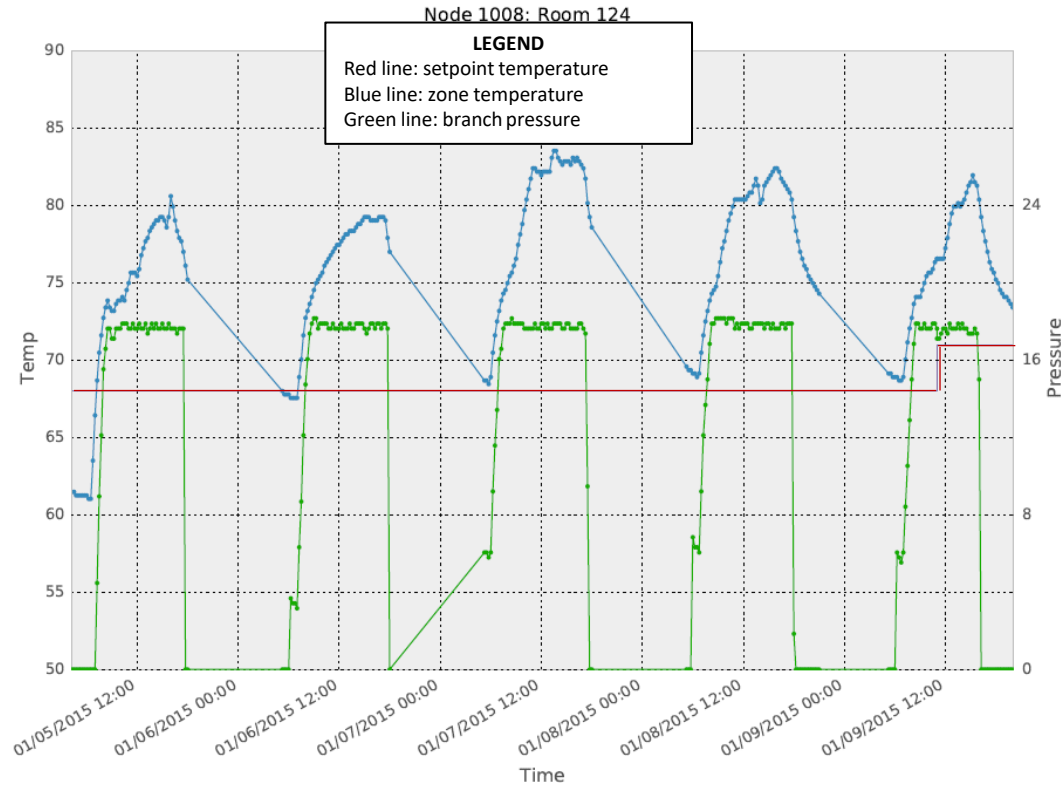
- Hot water valve for reheat was broken and stuck open.

- Terminal unit was always in maximum heat, even though thermostat commanded maximum cooling for that zone.

- Corrective Action: Repair/replace faulty valve actuator.

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AI Fault Detection for Pneumatics

1

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

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

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

2

See the big picture and drill down on problems

Zones not able
to maintain setpoint

Cooling setpoints
too low

Heating valve
may be stuck open

Worst performing
Zones sorted at top

Node	Type of WPT	WPT Action	Sample Rate (min)	Maintain Setpoint? (ABS DeltaT)	Heating Setpoint Suspect? (deg F)	Cooling Setpoint Suspect? (deg F)	WPT Calibrated? (psi error)	Main Pressure OK? (psi)	Oil in Line? (sticking psi)	Heating Actuator Stuck Open/Uncal?	Cooling Actuator Stuck Open/Uncal?	Insufficient Heating Capacity?	Insufficient Cooling Capacity?	Low Batt?	Wire-less Missed Comm?
0118	1.0	Direct	0.0	7.9	65	65	1.7	14.2	1.8	TRUE	FALSE	FALSE	FALSE	OK	1.9%
0119	1.0	Direct	0.0	6.9	63	63	2.5	14.0	0.0	FALSE	FALSE	FALSE	FALSE	OK	0.5%
0113	1.0	Direct	0.0	4.3	68	72	0.9	15.3	4.0	FALSE	FALSE	FALSE	FALSE	OK	5.1%
0117	1.0	Direct	0.1	4.1	68	70	1.2	15.3	0.5	TRUE	FALSE	FALSE	FALSE	OK	0.5%
0116	1.0	Direct	0.0	3.9	70	74	4.1	15.3	1.8	FALSE	FALSE	FALSE	FALSE	OK	0.7%
011A	1.0	Reverse	0.0	0.5	71	71	0.4	11.3	0.0	FALSE	FALSE	FALSE	FALSE	OK	1.1%

Check thermostat
calibration

Check for oil or
water in pneumatic line

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

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 CONFRM.	COLD		T'STAT SET TO 65-69, RESET TO 70-73	ARTURO	13
155597	5-Aug-09		31	NORTH CONFRM	COLD	68	TEMP. WAS 68 RESET TO 70-73	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
159854	13-Nov-09		31	N CONFRM.	COLD	69	INCREASED SPT TO 71-74, FROM 69-73	ARTURO	28
159854	17-Nov-09		31	N CONFRM.	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 WIIL 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

CUSHMAN & WAKEFIELD®

Enable Energy Savings Strategies – 20-30% reduction

Savings

Energy

Maintenance

| Temp Setpoint Policy | Night/ Weekend Setback & Occupancy Override | Retro Commis- sioning/ Diag- nostics | Deadband Temp Policy | Auto- Demand Respond Peak Load Shedding | Duct Static Pressure & Supply Air Temp Reset | Optimal Start/ Stop |

Standalone Capability (typically 75% of savings)

Requires BAS Connectivity

| Auto Calibration | Reduced Occupant Complaints | Faster Trouble Shooting, Fault Detection |

Standalone Capability

Same Benefits as Direct Digital Control –
but at a Fraction of the Price and Disruption

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Case Study:

Conemaugh Memorial Medical Center

Duke LifePoint Healthcare System
April 2025

Conemaugh Memorial Medical Center - Overview

Facility Type	540 bed hospital, Level 1 trauma center
Location:	Johnstown, PA
Building:	Multiple Connected Buildings Built From 1962-2021
Total Hospital Area:	855,000 Sq-ft
Project Areas:	93,200 Sq-ft (patient wings and vascular support)
New Wireless Thermostats	156 Total: Patient wing, P Building - 128 stats Vascular support, M Building - 28 stats
Terminal Unit Type:	Pneumatic Constant Air Volume w/hot water reheat
AHU's	7 AHU's with VFD Fans
Central Plant:	Electric Chiller, Gas Boiler
BAS:	JCI Metasys
Utility:	Penelac

Energy Source:	Consumption
Electricity HVAC:	25,455,000 kWh per year $0.085 Per kWh $2,189,000 Total per year
Gas HVAC:	185,300 MMBTU $5.175 Per MMBTU $ 960,000 Total per year
TOTAL HVAC Energy Use:	**$ 3,149,000** **$ 3.68 / Sq-ft**

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Multi-zone HVAC System - Before Upgrade

AHU's with VFD Fans

CAV Terminal Units with Hot Water Reheat

Pneumatic room thermostats

Air Handler Unit(s)

Pneumatic CAV Terminal Unit

Pneumatic CAV Terminal Unit

Pneumatic CAV Terminal Unit

Constant Air Volume At Max Flow (worst case)

No visibility nor feedback from occupant zones

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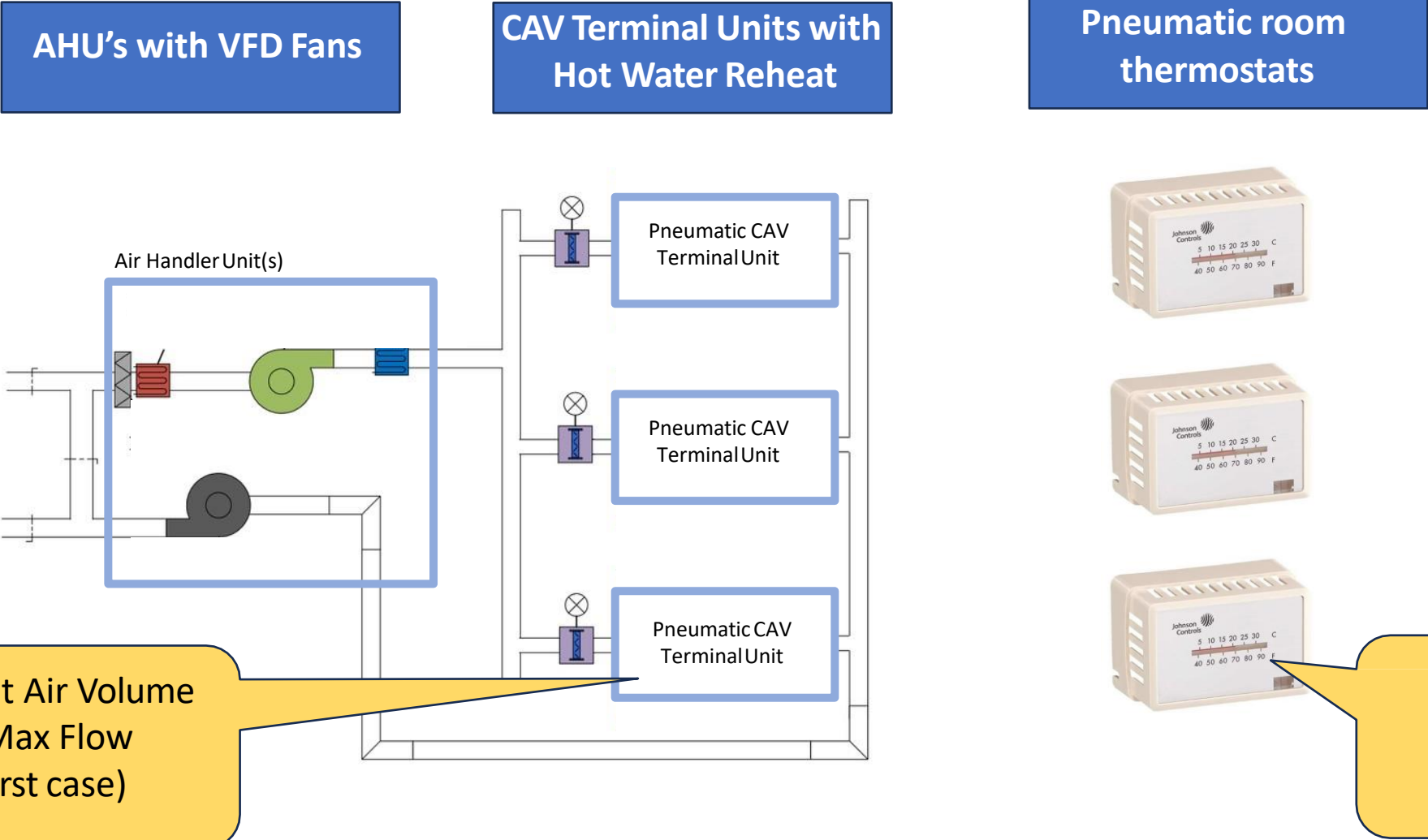
Multi-zone HVAC System - After Upgrade

AHU's with VFD Fans

CAV Terminal Units with Hot Water Reheat

Pneumatic room thermostats

Air Handler Unit(s)

Pneumatic CAV Terminal Unit

Pneumatic CAV Terminal Unit

Pneumatic CAV Terminal Unit

Adjust VFD fans to maintain comfort and code

Feedback from Zones Temperature, Comfort
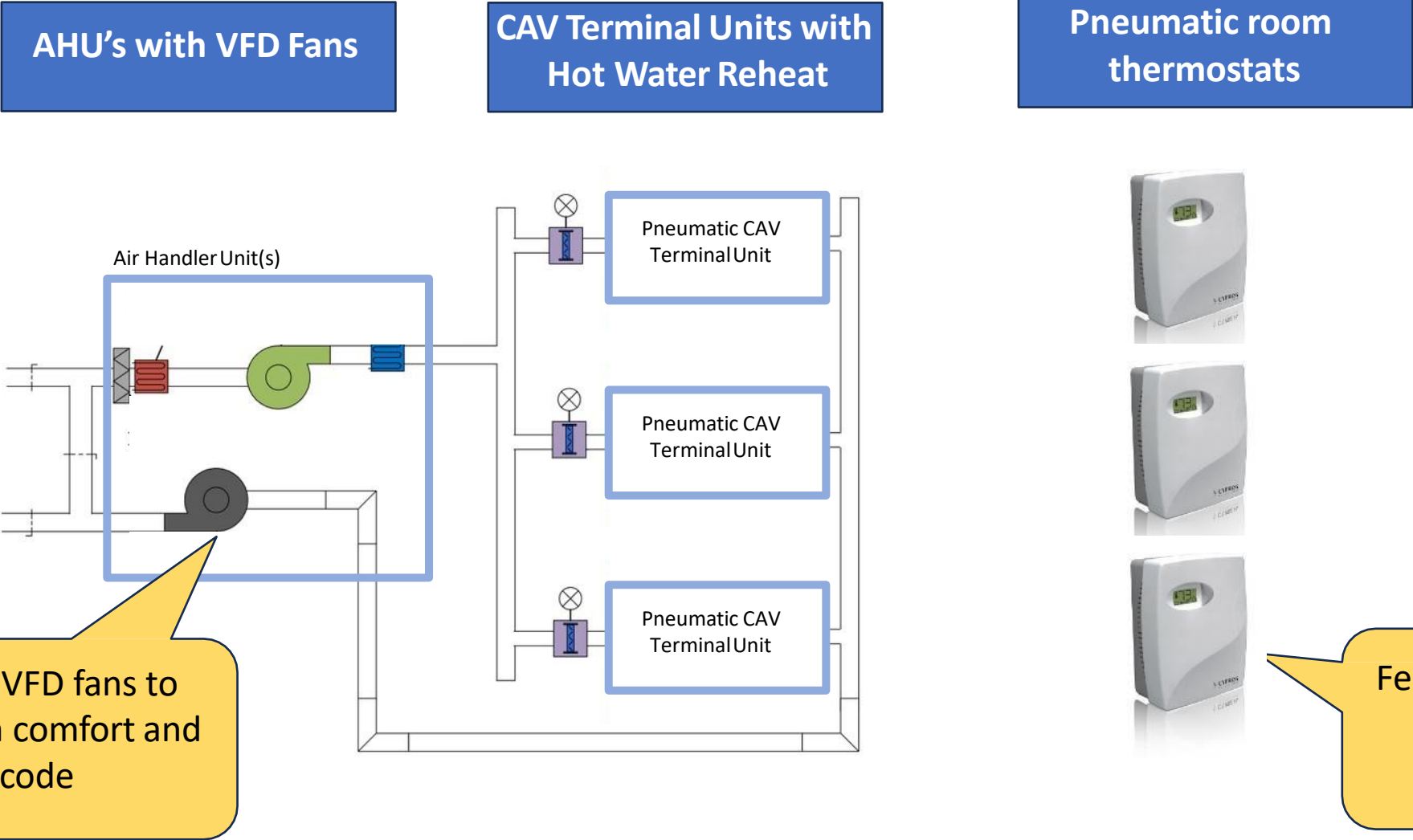
Resulting Energy Savings - P Building (128 Rooms)

CFM Airflow Control Sequence:

- Reduce airflow when max cooling/heating not needed

- Maintain FGI minimum four air exchanges/hour

- Average 200 CFM reduction per room

Equipment	Savings per room per year		
Fan & Cooling	Elec.	2,530 kWh	$202
Reheat	Gas	17.00 MMBTU	$87
Total			**$289**

Number of Rooms	128
Total Annual Savings for Building P	$36,992

Project Payback Period: 2.9 yr with Utility Rebates

Project Cost and Payback (P Building)

Est. cost per installed thermostat	**$1,100**
Number of thermostats	**128**
Utility Rebate (for Electricity)	**$32,385**
TOTAL COST WITH REBATE	**$108,415**

Energy Savings (Gas and Electric)	**$36,990**
Payback Period without Rebate	**3.8 Yrs**
Payback Period with Rebate	**2.9 Yrs**

WPT Retrofit: 1/3 Cost of DDC, 3x Faster Payback

Comparison WPT vs. Conventional DDC Retrofit per Room

Est. cost per installed thermostat	$1,100	$3,200
Number of thermostats	128	128
TOTAL COST WITHOUT REBATE	$140,800	$409,600

Energy Savings (Gas and Electric)	$36,990	$36,990
Payback Period without Rebate	3.8 Yrs	11.1 Yrs

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LifePoint Health - WPT Installations

- Sovah Danville Regional Medical Center, Danville VA — 80 WPT's – Completed

- Lake Cumberland Regional Medical Center, Somerset KY — 90 WPT's - Completed

- Clinch Valley Medical Center, Richlands VA — 83 WPT's - In Progress

- Southern Tennessee Winchester, Winchester, TN — 40 WPT's – In Progress

- Starr Athens Regional Medical Center, Athens, TN — 60 WPT's – In Progress

- Sumner Regional Medical Center, Gallatin, TN — 50 WPT's – In Progress

- Additional Locations Planned — Later 2025 and 2026

Summary – Non-Invasive Pneumatic Upgrade

Less cost and effort

- Upgrade from pneumatic to DDC thermostats in less than 15 minutes

- Less than 50% of the cost of conventional DDC

- No disruption to patients/occupants

Quantifiable Benefits

- Occupant comfort

- Reduced Maintenance

- Energy Savings

- Typically under 3 year payback

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Additional Non-Invasive Retrofit Solutions

Wireless Steam Trap Monitor

Leaking Traps Waste Energy

Typical Steam Trap

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WIRELESS STEAM TRAP MONITOR

- 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

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Wireless Gauge 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 15 minute sample rate

- IP56/NEMA 4 rated for outdoor use

- Various size and types of mounting adapters to fit most existing gauges

- Reads dial gauges, hour meters, LED/LCD displays

Thank you!
Q&A

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