GSA Public Buildings Service

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WIRELESS PNEUMATIC THERMOSTATS

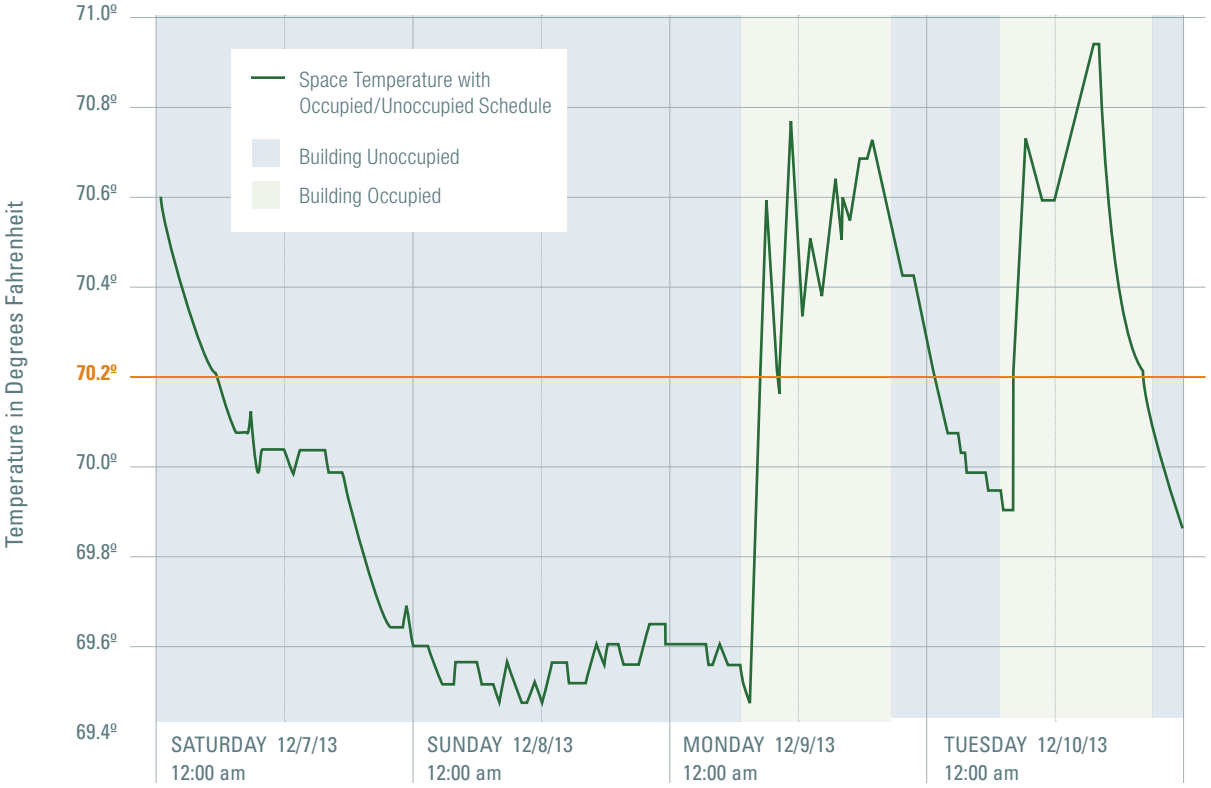
Wireless Pneumatic Thermostats Implement Energy Saving Control Strategies

Conventional pneumatic thermostats are typically found in larger multi-story buildings built before 1999. Such thermostats can gauge room temperature and adjust heating, ventilation, and air conditioning (HVAC) equipment. They cannot, however, communicate with a central control system, nor can they exercise more sophisticated energy-saving control strategies, such as automatically setting thermostats back when a building is unoccupied at night or on weekends. The wireless pneumatic thermostat (WPT) is a new technology that can be retrofitted to an existing pneumatic control system. WPTs give conventional pneumatic controls the energy-conserving functionality of more contemporary control systems, such as direct digital controls (DDC), but at a fraction of the cost. To put WPT to the test, GSA's Green Proving Ground (GPG) program commissioned the Department of Energy's (DOE) Oak Ridge National Laboratory (ORNL) to assess the technology's operational capabilities under real-world conditions at the Woodrow Wilson International Center for Scholars (Wilson Center), in Washington, DC. Researchers found that WPT had the ability to successfully implement energy-saving control strategies. Modeling demonstrated financial viability across a wide spectrum of facilities and climates, with simple payback as low as two years.

GPG Green Proving Ground Program

The Green Proving Ground program leverages GSA's real estate portfolio to test innovative building technologies and provide recommendations on their deployment. The program helps GSA meet its sustainability goals with actionable data that informs investment decisions targeted at reducing energy- and water-use.

INTRODUCTION



Heating Season Unoccupied Setback

During unoccupied hours, the WPT allowed temperatures to drop below 70.2°F, the lower end of the occupied heating deadband.

"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 and International Trade Center
Washington, DC
National Capital Region
U.S. General Services Administration

What is This Technology?

OFFERS ENERGY-SAVING CONTROL STRATEGIES OF DDC

Wireless pneumatic thermostats replace the wall-mounted component of conventional pneumatic thermostats while taking advantage of existing pneumatic tubing to control HVAC systems. Like conventional thermostats, WPTs detect space temperature and send a pneumatic signal to the HVAC system. Unlike conventional thermostats, WPTs can be controlled through a wireless network by either a dedicated controller or a building automation system (BAS). Using centralized control, building managers can implement energy-saving control strategies typical of those available through DDC systems.

What We Did

PERFORMANCE AND ECONOMICS ASSESSED

GPG conducted both performance and economic assessments of the WPT technology. To evaluate performance, ORNL first charted temperatures in select Wilson Center spaces when HVAC was still responding to the legacy pneumatic control system. After establishing baseline temperatures, a WPT system was installed, an occupied/unoccupied schedule was set by the technology's central controller, and temperatures in the same spaces were logged and evaluated again. ORNL researchers then used DOE's energy modeling software, DOEII, to calculate the WPT's potential energy savings for small-, medium-, and large-office buildings in 16 different climate zones.

FINDINGS

ENERGY SAVINGS ACROSS WIDE VARIETY OF OFFICE TYPES Energy modeling indicates that WPT saves energy across a wide spectrum of facilities. It should be noted that this assessment looked at the energy savings potential of only the most basic occupied/unoccupied control strategy. If other strategies were implemented, the potential for energy savings and financial viability would be greater.

STRONG ECONOMIC VIABILITY ACROSS CLIMATE ZONES, FACILITY SIZES, AND INSTALLED COSTS Payback is determined largely by installation costs, which are driven primarily by the number of thermostats in a building. According to the technology's manufacturer, thermostat density ranges between one every 250 ft^2 and one every 1,000 ft^2, with the national average being about one thermostat every 900 ft^2. Offices with large open spaces tend to have lower thermostat density. Labor also affects cost. In some older buildings that have concrete walls instead of sheet rock, it takes longer to mount the thermostats and connect the pneumatic tubes while maintaining aesthetics.

ROBUST SYSTEM REQUIRES LITTLE MAINTENANCE WPT requires no more maintenance than a conventional pneumatic control system and has a useful life of 10+ years. Also, WPT helps with other maintenance issues, such as identifying air leaks, using built-in pressure sensors that report to the BAS.

CONSIDER FOR ANY FACILITY WITH CONVENTIONAL PNEUMATIC CONTROLS* This technology is well-suited to any facility with a conventional pneumatic control system that is already operating properly, i.e., no air leaks, no moisture in the system, and actuators that are functioning correctly. Deployment priority should be given to facilities with high energy costs. There is not a deployment priority associated with any of the 16 climate zones modeled.

Modeled Payback for Unoccupied/Occupied Control Strategy

Payback assumes an unoccupied setback of 83° for cooling and 62° for heating

Location		Large Office - 498,500 ft^2 Payback (years)		Medium Office - 53,630 ft^2 Payback (years)		Small Office - 5,500 ft^2 Payback (years)	
CLIMATE ZONE	CITY	LOW[1]	HIGH[2]	LOW[3]	HIGH[4]	LOW[5]	HIGH[6]
1A	Miami, FL	3.6	6.5	3.7	6.8	1.9	3.3
2A	Houston, TX	3.7	6.7	4.5	8.2	2.9	5.0
2B	Phoenix, AZ	4.6	8.2	4.0	7.3	2.5	4.3
3A	Atlanta, GA	3.0	5.4	3.5	6.4	2.6	4.5
3B-coast	Los Angeles, CA	2.8	5.1	3.7	6.8	3.7	6.3
3B	Las Vegas, NV	5.3	9.5	5.0	9.2	3.1	5.4
3C	San Francisco, CA	3.0	5.5	3.8	7.0	3.2	5.5
4A	Baltimore, MD	2.8	5.0	3.3	6.0	2.7	4.7
4B	Albuquerque, NM	5.4	9.7	6.0	10.9	3.5	5.9
4C	Seattle, WA	3.6	6.5	4.5	8.2	4.3	7.4
5A	Chicago, IL	3.1	5.6	3.8	7.0	2.8	4.8
5B	Boulder, CO	5.0	8.9	5.7	10.5	3.7	6.4
6A	Minneapolis, MN	4.6	8.3	5.7	10.5	3.7	6.3
6B	Helena, MT	3.9	7.1	4.6	8.4	3.3	5.7
7	Duluth, MN	4.3	7.8	5.3	9.7	3.7	6.3
8	Fairbanks, AK	4.2	7.6	5.2	9.5	3.1	5.3

Installation Costs: [1] $0.50/$ft^2$ [2] $0.90/$ft^2$ [3] $0.60/$ft^2$ [4] $1.10/$ft^2$ [5] $0.70/$ft^2$ [6] $1.20/$ft^2$

CONCLUSIONS

These Findings are based on the report, "Wireless Pneumatic Thermostat Evaluation, Ronald Reagan Building and International Trade Center, Washington, DC," which is available from the GPG program website, www.gsa.gov/gpg

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What We Concluded

ENERGY SAVING HVAC CONTROL TECHNOLOGY DESERVES BROAD DEPLOYMENT

The wireless pneumatic thermostat proved its ability to implement energy-saving controls strategies at the Wilson Center. Payback was as low as two years, using only the most basic occupied/unoccupied control strategy. If other strategies were implemented, the potential for energy savings and financial viability would be greater. WPT represents an economically viable technology that can reduce HVAC energy consumption, resulting in lower energy costs and greenhouse gas emissions across a wide variety of office types and climate zones. It should be considered for any facility that currently uses conventional pneumatic controls with their HVAC system.

Best Practices

Test Wireless Signals It is advisable to perform pre-installation tests to determine how well wireless signals can be transmitted within a building where a WPT retrofit is being considered. Certain construction types may interfere with wireless signal transmission.

Train Facility Operators Training is required for facilities operators to learn how to manage the technology. WPT training can be accomplished in one day.

Consider Effects of Thermal Mass Planning for a WPT occupied/unoccupied control strategy should take into account the possibility of reduced energy savings in areas where high thermal mass stabilizes temperature over longer periods of time. During the WPT assessment, some interior areas within the concrete-and-steel Wilson Center did not demonstrate temperature changes normally associated with an occupied/unoccupied schedule, though other indicators suggested that such a schedule was in effect. After exploration of the issue, it was determined that the high thermal mass of the interior spaces was slowing temperature changes that were occurring more rapidly in the building's exterior spaces.

Notes

*Subject to evaluation and approval by GSA-IT and Security.