CIM Properties

1333 Broadway, Oakland, CA

Wireless Pneumatic Thermostat Project

BUILDING PROFILE

Located in downtown Oakland across from Frank Ogawa Plaza, 1333 Broadway was the first HVAC energy efficiency project to be completed under the Oakland Shines program. Originally built in 1973, this 10-story building has 238,000 sq. ft. of rentable space, primarily for commercial office use. 1333 Broadway is an energy efficient building with an Energy Star and LEED Silver rating. However, like many office buildings built in the '70s, this building uses pneumatic thermostats to control the air conditioning systems. This outdated technology provides no information to the building engineers about how efficiently the systems are operating, leaving them with little more than the daily hot and cold calls they may receive from the building's occupants.

HVAC System

The HVAC system at 1333 Broadway utilizes a Variable Air Volume (VAV) dual-duct system with mixing boxes at the zone level. Each mixing box has an associated pneumatic thermostat in the zone to control space conditioning. The mixing boxes receive cold air from one of ten cooling-only Air Handling Units (AHUs) located on each floor. The cooling-only AHUs are 100% return air and have 40HP fans. The mixing boxes receive hot air from one of two heating-only AHUs on the roof. The heating-only AHUs are 100% outside air and have 25HP fans. Each AHU is equipped with new high efficiency motors being controlled by variable frequency drives (VFDs) to maintain a duct static pressure set point. The system is designed so that the building receives a constant 15% outside air fraction and therefore cannot utilize air-side economizers. The cooling units receive chilled water from a new variable speed 300-ton McQuay TurboCor chiller. The heating units receive hot water from two 3800 MBH output boilers on the roof. The building pressure is kept in balance with exhaust fans on the roof that exhaust about the same amount of air as the heating units provide.

The Technology

The Wireless Pneumatic Thermostat (WPT) by Cypress Envirosystems is a relatively inexpensive retrofit which allows a pneumatically controlled HVAC system to have all the same functionality as a Direct Digital Control (DDC) system. A full DDC retrofit would require removing all of the pneumatic tubes and controllers and re-wiring the entire system with electrical and digital controllers. The WPTs can be installed in a matter of minutes by removing the old pneumatic thermostat in the zone, and connecting the branch and lines to the

WPT—Installs in minutes

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WPT. Each WPT has a pressure transducer that converts a pneumatic pressure signal (both branch and line pressures) to a digital signal. The digital signals can then be wirelessly relayed back to the building's Energy Management and Control System (EMCS) where it is analyzed. The Cypress system utilizes a hybrid mesh wireless network that consists of a backbone of wireless repeaters running up the core of the building. The backbone receives the signals from each of the new thermostats and transmits the data to a "Green Box", a Cypress product that can be used as a control system for the thermostats. Management at 1333 Broadway elected to have the data from the Green Box relayed directly to its own EMCS (Automated Logic Control) using BACnet standard protocols.

PROJECT OVERVIEW

1333 Broadway had approximately 287 pneumatic thermostats controlling space temperature throughout the building. These thermostats are stand-alone systems so there is no way for a building operator to know what each thermostat is doing at any given time. All of these thermostats were replaced with Cypress WPTs. The backbone of the wireless network was set up to run through the center of the building in data closets that had existing conduit running from the top floor to the basement. 3in1 Controls from Sacramento, CA was contracted to perform the installation of the thermostats and to facilitate the mapping of the thermostat data into the existing ALC EMCS. The ALC front end now has detailed graphics of every zone temperature in real time. Additionally, every thermostat has several monitoring points trended in the EMCS. These points include branch pressure, zone temperature, zone set point, and battery level.

Energy Savings

The advantage of a DDC system is the feedback and zone control the thermostats can provide to the building's EMCS. Having feedback signals allows programming of energy saving control strategies into the EMCS. By replacing every thermostat in the building with Cypress WPTs, the building operator is able to see how each floor is being controlled, and gains the same control options provided by a full DDC system. 1333 Broadway was able to implement the following energy efficiency measures:

1. Temperature set-point policy – The building now has a global temperature set-point policy. This measure takes temperature control from the occupants and puts it in the hands of the building engineer. Invariably, occupant-controlled thermostats lead to energy management challenges, for example, leaving thermostats in extreme temperature positions over night, or having adjacent offices calling for cooling and heating at the same time. Creating a set-point policy allows engineers to set all zones at a constant temperature (100% of the time), which eliminates behavioral inefficiencies. This measure was verified by trending temperatures in a representative sample of zones, and confirming that temperature was constant.

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2. Optimum Start for HVAC equipment– Optimum Start varies the startup time of the HVAC equipment based on previous performance, zone temperature and outside air temperature. The programmed algorithm records when the equipment started the previous day and how long it took for the zone to reach the set point. If the zone reached the set-point before the set occupancy time on the previous day, the equipment will start a few minutes later. This strategy allows the EMCS to "learn" when equipment needs to start on any given day, in any given zone. This measure was verified as having reduced the equipment run time by over one hour per day.

3. Duct-Static Pressure Reset based on zone satisfaction– This is a typical measure in buildings with DDC. This measure employs a trim-and-respond algorithm which looks at zone set point and zone temperature. If the zone is satisfied, then the Duct Static Pressure (DSP) set point is reduced until the zone calls for either heating or cooling. A lower DSP results in the fans using less energy. This measure was verified as having allowed the DSP to drop two tenths of an inch of water (from 1" to .8" WC).

4. Occupancy Override– This measure takes advantage of the individual control the building engineer has over each thermostat. At the start of the project, 1333 Broadway demonstrated approximately 15% vacancy. With the old pneumatic thermostats, there was no way of shutting off air to the vacant zones. The WPTs can be put into an "override" mode which tells the thermostat not to call for cooling or heating, putting the VAV box into minimum position at all times regardless of zone temperature.

The verified annual aggregate savings resulting from all of these measures was:

139 KW	249,271 kWh	10,045 Therms

PROJECT FINANCIALS

Total Project Cost:	$ 221,695
Cost to Customer:	$ 25,200
Simple Payback:	5 months
Net Present Value*: (over 10 years @ 3% discount rate)	$ 462,402

* Based on energy savings only; maintenance benefits are not included in calculations.

PROJECT BENEFITS

- The building operator now has detailed information on hot and cold spots throughout the building. This reduces maintenance costs, as engineering efforts can be immediately focused on problem areas.
- Increase in occupant comfort due to targeted/quick response maintenance efforts.
- Reduction in environmental impact / carbon footprint of the building.

"The wireless thermostat project has given 1333 Broadway the ability to look several layers deep into the performance of the building and make adjustments for tenant comfort, all the while greatly lowering utility costs."

–Bob Woltz, Chief Engineer