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Photo courtesy of Pete Ewart, Pritchett Controls.

The Southeast Federal Center has 14,000 points of measurement and control. The U.S. DOT insisted on BACnet because of its scalability.

BACnet[®]: A Capital Idea

By Robert Rodenhiser

After an ambitious construction program that began as the largest BACnet project awarded in 2004, the JBG Southeast Federal Center, owned by JBG and leased to the U.S. Department of Transportation (DOT), opened its doors in April 2007. The first cabinet-level headquarters designed and constructed in the U.S. capital in more than three decades, the DOT complex consists of a shared underground parking garage and two similar towers of eight and nine stories that accommodate more than 5,000 federal employees.

The DOT's new administrative hub has been instrumental in transforming Washington's Southeast Federal Center into a lively waterfront of offices, restaurants,

shops and marinas. Two miles from the U.S. Capitol, the DOT complex anchors a larger neighborhood revitalization project, which will include more than 6,000 residential

housing units and a new baseball stadium for the Washington Nationals. Revitalization efforts began with the demolition of 11 buildings and the renovation of eight buildings of historic significance.

In designing the DOT complex, world-renowned architect, Michael Graves, found guidance in Pierre L'Enfant's 1791 street plan for the federal capital city, later to become the District of Columbia. The design team split the DOT complex's 2 million ft² (185 806 m²) of office and public space into two separate nine- and eight-story towers on opposite sides of Third Street. The western tower is one story taller to emphasize the public entrance along New Jersey Avenue (a

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boulevard within view of the U.S. Capitol). By converting Third Street into a pedestrian promenade between the two towers, and reopening New Jersey Avenue and Fourth Street south of M Street to traffic, L'Enfant's design was restored.

Unusual, lengthy encounters and obstacles underscored the evolution of the two towers. The government's acquisition strategy and underground infrastructure issues added delays to the project. The excavation program alone required an archaeological search for artifacts from the Old Washington Canal, which connected the Anacostia and Potomac rivers in the 18th century. More than 100,000 yd³ (76 460 m³) of contaminated soil had to be removed from the site, which in its former life was a factory for fabricating battleship gun barrels. In constructing the two towers, more than 150,000 yd³ (114 690 m³) of concrete and 14 tons (25 396 Mg) of rebar were used.

To condition the 2 million ft² (185 806 m²) of the DOT complex, two large central plants serve 94 air-handling units, 90 fan coil units and more than 2,000 variable air volume terminal (VAV) units. In the event of an opposite-building failure, each central plant is sized to serve mission critical equipment in both wings. Each tower has its own central plant located in a penthouse mechanical room that houses boilers, cooling towers and chillers. The central plant is augmented by pump skids that operate in a variable primary configuration. The penthouse mechanical equipment room (MER) in each tower also contains four large air-handling units (AHUs) that deliver tempered outside air (OA) to HVAC equipment throughout the building. Each OA AHU provides fresh air to a duct riser serving a mechanical room AHU on each floor. Four AHUs on each floor serve variable air volume boxes.

The entire facility uses the BACnet protocol to integrate the mechanical and electrical systems together. The building automation system (BAS) enables/disables the operation of the central plant, commands various modes of operation, such as power failure mode and mission critical mode, and displays all of the plant data on the BAS operator workstation.

Each VAV-AHU has a variable frequency drive (VFD) on the BACnet MS/TP network and is integrated fully into the BAS. AHUs are controlled by BACnet advanced application controllers (B-AACs). VAV terminals (cooling only shut-off type for the interior and fan-powered with hydronic reheat for the perimeter) provide final conditioning for each floor. Each VAV box is modulated by a dedicated BACnet application specific (B-ASC) VAV controller.

Each floor also contains telecom and electrical rooms served by dedicated fan coil units (mission critical equipment) controlled by B-ASC unitary controllers. The chillers, AHUs and fan coil units are made by one manufacturer; the VAV terminals are manufactured by another.

The ground floors and parking garage P-1 levels of each building are served by a combination of B-ASC VAV boxes and constant volume AHUs controlled by B-AAC controllers.

Computer room air-conditioning (CRAC) units serve the P-1 level. The BAS provides monitoring of the CRAC devices for temperature, status and alarm notifications. Garage fans and dampers located throughout the parking garage P-1 and P-2 levels also are controlled and monitored by the BAS.

The control specification for the project called for installation of an open protocol, but before ground was broken, the U.S. Department of Transportation insisted that a BACnet system be installed because of its scalability. The system features a BACnet/IP LAN and several MS/TP networks. All of the network wiring is specific to the BAS, and operates as a solitary network outside of the building's IT network. A high-speed Ethernet switch is located at the P-1 level of each tower connected by a 1 GB fiber Ethernet network. The high-speed fiber network extends to the penthouse control room where the operator workstation is located. A 100 MB Ethernet over Cat-5 cable is run to the mechanical room on each floor of the towers from the high-speed Ethernet switch.

There are four mechanical rooms per floor, with one housing a single riser in each tower. In these mechanical rooms, two BACnet building controllers (B-BCs) are used to route the network from BACnet/IP to MS/TP. Each mechanical room B-BC connects to B-ASC VAV and system controllers serving half of the floor.

Given the DOT complex's mission critical nature and its massive scope, with more than 100 sequences of operations, Dave Harman, chief engineer for JBG at the DOT complex, finds the BACnet system installed at the DOT complex to be faster than most dedicated, proprietary systems. Changes are almost instantaneous in the system, resulting in a time savings in hours per day for Harman and his staff. Time savings allow the DOT complex's building operators to devote more labor hours to fine-tuning the system's parameters, such as water pressure, and allow the engineer to plan for future system expansion.

Lighting and power management are also important parts of the BAS. Lighting panels are located on every floor and are attached to the BACnet/IP network. A power monitoring and control system (PMCS) controls generators, switchgear, auto transfer switches, electric meters and transient voltage surge suppression. The integration with this equipment is particularly important regarding power failures and mission critical mode. When the PMCS senses a power failure, it cycles the auto transfer switches, energizes the generators and informs the BAS of all of these conditions. The BAS mechanically initiates mission critical mode by restarting a central plant and energizing select pieces of HVAC equipment.

An estimated 14,000 points of measurement and control are on the system that are viewed, trended and archived by the controls software. Other BACnet equipment and hardware installed at the DOT complex include one generator, two pump skids, four chillers, 42 portals, 72 AHU speed drives, 91 unitary controllers, 144 system controllers and 2,055 variable air volume controllers. ●