



The following article was published in ASHRAE Journal, November 2007. ©Copyright 2007 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. It is presented for educational purposes only. This article may not be copied and/or distributed electronically or in paper form without permission of ASHRAE.



*Aculight, a laser manufacturer in Washington, is using BACnet to provide precise temperature and humidity controls to its cleanrooms.*

# BACnet<sup>®</sup> for Cleanrooms

By Terry W. Hoffmann

**B**ACnet and open communications protocols have revolutionized building systems. Facilities no longer need to choose among single-vendor, proprietary packages that may or may not provide the desired functionality at an affordable price. They can select equipment from a variety of vendors to achieve the desired level of control. All this can be done at a reasonable cost without sacrificing interoperability.

Aculight is a 13-year-old company that develops and manufactures lasers for industrial, military/aerospace and medical applications. In 2006, Aculight consolidated two facilities into a

single Bothell, Wash., complex. The new building houses administrative offices, research laboratories and manufacturing space. Aculight renovated the facility, which provided the company with 20,000 ft<sup>2</sup>

(1858 m<sup>2</sup>) of additional space over its previous facilities.

In the larger Bothell facility, Aculight wanted to install new building systems. However, the state-of-the-art industrial complex posed unique challenges. Laboratories had to be enclosed to contain potentially hazardous high-powered lasers. Cleanrooms required continuous tuning to maintain pressure, temperature and humidity. Facility managers requested centralized, remote monitoring and control so they would not have to adjust controls in these areas.

Engineers designed a solution based on

---

## About the Author

**Terry W. Hoffmann** is director of marketing, Building Automation Systems at Johnson Controls in Milwaukee.



the BACnet protocol and BACnet Testing Laboratory (BTL) certified devices. The solution effectively integrated new and legacy systems from multiple vendors. It allowed a relatively small but rapidly expanding company to incorporate interoperable and expandable building systems without sacrificing advanced control technology.

### A Demanding Facility

Aculight, with 85 employees, is doing high profile work for the commercial and government sectors developing and manufacturing four categories of laser technology:

- Medical lasers;
- Infrared countermeasures for use in defense;
- High-powered lasers for industrial and military use; and
- Active imaging lasers for use in developing three-dimensional maps.

Aculight, originally focused on research and development, during the past four years transitioned its technology into products and begun manufacturing. The move meant investing in a new manufacturing space.

In 2006, Aculight began construction to expand its combined administrative and research facility with a manufacturing center. The expansion increased the facility's total square footage from 27,000 ft<sup>2</sup> (2508 m<sup>2</sup>) to 47,000 ft<sup>2</sup> (4366 m<sup>2</sup>). Contractors took the opportunity to update obsolete building controls and install systems that better supported the company's operational needs.

As project engineers began designing a solution for Aculight on a BACnet backbone, facility operators had a variety of non-standard requirements and concerns. For laser safety reasons, Aculight's research, development and manufacturing floor is not one open space. Rather, it contains a number of enclosed spaces including cleanrooms. Each space has separate climate control requirements. Aculight requested a building management system that could reliably monitor and control a variety of separate zones and enclosures simultaneously.

Previously, laboratory spaces had in-suite climate controls, requiring facility managers to "suit up" in lab coats, hairnets, booties and laser safety glasses prior to entering the laboratory; a time consuming practice. "Employees were always making their own adjustments to the controls," said Ken Bean, Aculight's director of manufacturing operations. "Just when we thought we had a handle on a room's environment, it would be out of whack again." To enable remote monitoring and control, Aculight asked for a centralized climate control system that allows adjustments to be made from a single all-encompassing user interface.

A number of other variables made maintaining internal environments challenging in the prerenovation facility. Metropolitan Seattle's climate is characterized by fluctuations in outside temperature and humidity. Meanwhile, inside the facility high-powered lasers produce large amounts of heat. To



*Ceiling-mounted HVAC equipment serving the production area.*

maintain comfortable and safe working conditions, Aculight had installed two rooftop chiller units in the original facility. In the renovation, these had to be integrated into the overall solution. Since Aculight works on dozens of different laser projects and the heat produced from each laser is highly variable, continuous adjustment is needed to keep temperatures within an acceptable range. Previously, this was a manual operation. Personnel adjusted in-room thermostat controls to maintain comfort. Aculight wanted a system featuring continuous adaptive control to maintain consistent indoor environments automatically.

The inclusion of Class 1000 cleanrooms in the renovated facility imposes special demands on building controls. Common in manufacturing and scientific research, cleanrooms have a controlled level of environmental pollutants. Special filters remove dust and other particulate matter from outside air entering the room. Inside air circulates through high-efficiency particulate air (HEPA) and ultra-low penetration air (ULPA) filters to remove contaminants. Cleanroom HVAC systems usually also control humidity to low levels. "Class 1000" refers to U.S. Federal Standard 209E, and denotes the number of particles of size 0.5  $\mu\text{m}$  or larger permitted per cubic foot of air.

The rooms stay "clean" by maintaining higher atmospheric pressure inside than out. When a door opens, it creates a vacuum that sucks particulate matter out of the cleanroom rather than allowing it to enter. Maintaining constant atmospheric pressure also requires continuous adaptive tuning. Pre-renovation, the facility did not have control systems capable of continuous monitoring and adaptive tuning. The addition of Class 1000 cleanrooms made installing advanced control technology in the facility imperative.

### Affordable, Customized Solution

Project engineers recognized that the manufacturing and research performed at Aculight made advanced control tech-

---

nology compulsory. As a small company, Aculight did not have the financial resources for a building project on the scale of larger industrial facilities or large-scale projects in the commercial, health-care or education sectors. It would be difficult to find a proprietary, single-vendor solution that fit Aculight's demands for advanced control and interoperability at an affordable cost.

BACnet gave Aculight the freedom to customize a solution using equipment from a variety of vendors. They were able to select the right amount of control technology to suit their unique requirements and did not have to sacrifice interoperability for robust monitoring and control.

Previously, building automation controls communicated with building systems and equipment using a proprietary protocol. The new solution made data available as BACnet information. As a result, Aculight was able to ensure seamless integration between third-party, multivendor equipment including:

- New and legacy rooftop units;
- A new air-handling system; and
- Equipment for cleanrooms including split-system air conditioning, duct furnaces and supply fans.

The solution devised for Aculight was also a building management system that is capable of monitoring and controlling a large number of unique climate zones. "If I get a call from an employee saying his workspace is a little chilly, I can call up a floor plan, get a precise temperature reading from the workspace and make adjustments without affecting any other zone within the facility," said Bean.

The system also delivers single-session monitoring and control for cleanrooms, overheated manufacturing spaces, laboratories and offices. The user interface is Web-based and can be accessed from any computer with an Internet connection. Aculight benefits by having single-session access to monitor and control all building systems and equipment.

The system monitors temperature, pressure, humidity and overall air quality. It

maintains optimal indoor environments with continuous adaptive tuning. If a laser begins to radiate large amounts of heat, sensors detect the temperature change and controls notify the chiller and air handling system to pump in chilled air. When a cleanroom door opens, releasing some of the pressure built up within, controls compensate to bring air pressure back to the desired psi. All of this is accomplished through intelligent data exchange between BACnet sensors, the building management system and field equipment controllers.

As an added benefit, interoperability means the building management system can collect trend data from sensors and controls throughout the facility. The data helps facility managers identify equipment that needs maintenance or replacement. It also enables regular recommissioning. Systems can be reprogrammed to take advantage of observed trends. For example, the rooftop chillers and other equipment may idle during times when manufacturing activities are typically on hold.

When systems share data via the BACnet protocol, they operate more intelligently and efficiently. Aculight estimates that it is saving 23% on energy costs thanks to intelligent, interoperable building systems. BACnet technology helps buildings contribute to business outcomes in three ways: by making buildings "smart," reducing energy and other operating costs, by enabling investments in the best and most cost-effective equipment regardless of vendor and by enhancing operations.

Aculight's new facility has been in operation since January 2007. Company leaders are pleased with how well BACnet systems and devices operate as an integrated whole. Open data protocols enabled a solution customized enough for the facility's unique demands and cost-effective enough for its budget. Aculight got the precise level of control technology it needed, at a reasonable cost, without sacrificing interoperability.●

*Advertisement formerly in this space.*