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Application Note

Testing Functions
Case Study

Tools: Temperature humidity meter, mini infrared thermometer, industrial multimeter

Operator: ENTEC Services

Applications: Temperature and environmental control system implementation and monitoring

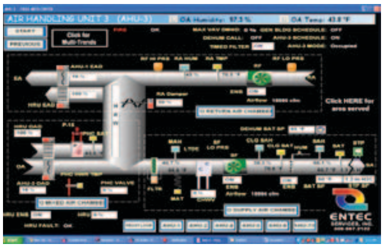
When the new Figge Art Museum opened its doors in Davenport, Iowa in August 2005, it was a work of art in itself. The 114,000-square-foot (10,591-square-meter) building offers space for regional and international art exhibits and community-oriented educational activities.

The Figge Art Museum is a civic landmark that meets high standards of temperature and humidity control.

Designed by British architect David Chipperfield, the Figge combines aesthetic beauty with world-class mechanical systems that meet stringent Smithsonian Museum environmental guidelines for temperature and humidity control. These guidelines, governing relative humidity (RH) and temperature in exhibits and exhibit storage spaces, were established to prevent the degradation of paint, paper, wood, and other media used in displayed artwork and to prevent damage caused by excessive heat, cold, or moisture that promotes the growth of mold.

Environmental control criteria meet energy efficiency

Meeting the Smithsonian's environmental control criteria was particularly important because it meant that the Figge would be able to display some of the world's most impressive art collections. However, energy efficiency was just as important from both a cost and environmental standpoint. The museum's new mechanical systems promised to reduce energy consumption, which would earn the Figge approximately $400,000 in energy efficiency incentives and save a significant amount on annual energy costs.



All air handlers in the Figge Museum's HVAC system are monitored through Delta Controls Building Automation system.

The HVAC system for the Figge consists of:

- Eight air handling units (AHUs) that provide conditioned air to various spaces using a variable air volume (VAV) system.
- More than 40 VAV boxes that control temperature and humidity to individual zones.
- Two chillers and cooling towers that provide mechanical cooling to the air handling units.
- Three boilers that provide hot water for perimeter finned tube and VAV reheat coils.
- A dedicated hot water loop that serves the frost prevention coils upstream of the energy recovery wheels in the AHUs.
- A garage fan ventilation system that provides fresh air in the parking deck
- A light shade control that provides the proper amount of natural sunlight in the gallery areas.

Balancing temperatures for energy efficiency

The museum's HVAC system includes an economizer that mixes outdoor air for ventilation with return air to minimize cooling and heating costs. The incoming air needs mechanical cooling when it's above 55 °F (12.7 °C) outside and heating if it's below 25 °F (-3.8 °C) to keep the museum exhibit space around 70 °F (21 °C). The system also includes an energy recovery wheel, positioned between incoming air and exhaust air. As the wheel rotates, it transfers energy between those two airstreams, recovering energy from the exhaust air and using it to temper the outdoor air that's coming into the air handler.

When the air is warmer than 55 °F (12.7 °C) the chilled water system is enabled, so when the indoor/outdoor air mixture flows over the cooling coil its temperature is lowered to the proper supply air temperature. If the outside air is less than 25 °F (-3.8 °C), ice would likely form on the energy recovery wheel, reducing the air flow. To prevent that, frost prevention coils are located at the outdoor air inlet to keep the air temperature entering the energy recovery wheel above 25 °F (-3.8 °C).

Those measures, along with some lighting measures, were estimated to reduce energy use enough to earn the museum $400,000 in incentives and to reduce heating and cooling bills while still meeting the Smithsonian environmental requirements.

At least that was the plan.

Surprising developments

ENTEC Services, of Peoria, Illinois, executed the temperature and environmental control systems for the new museum and continued to monitor those systems after the facility opened. Within the first few months after the museum opened, ENTEC could tell that, although the environmental conditions met the Smithsonian guidelines, the museum was achieving those requirements at a steep cost. "We were working with the measurement and verification company, The Weidt Group, and learned that, based on its energy usage, the Figge Art Museum was going to be short $100,000 on the energy incentive money and more than $60,000 short in annual energy savings," says Tom Weed, CEO of ENTEC Services.

The problems started with the frost prevention coils, which relied exclusively on the velocity of water flow to prevent

Mark Janco, System Specialist for ENTEC, uses a Fluke 971 to confirm that the temperature and humidity are at the optimum levels for a high-end art display.

freezing. Unfortunately the water flow wasn't adequate, so the coils froze and burst when temperatures fell below 25 °F (-3.8 °C) for an extended period of time. After repairing the coils, the museum tried to solve the problem by raising the temperature of the water running through the frost prevention coils and increasing the flow velocity. This kept the coils from freezing and prevented ice from forming on the energy recovery wheel but increased energy consumption, cancelling out some of the energy savings that the Figge was expecting.

Improving system performance and energy efficiency

Although ENTEC didn't design the HVAC system for the Figge Art Museum, they suggested some system improvements that would allow the mechanical and control systems to perform as originally intended. "The most logical idea was to get the air in the mixing box to mix better, but that would have required adding mechanical equipment to the air handling unit," says Mark Janco, System Specialist for ENTEC. "There wasn't enough room in the museum's mechanical room so that option wasn't going to work."

Since there was not adequate physical space to overcome the outdoor air stratification problem in the mixing box that prevented the proper economizer operation, anitifreeze solution was added to the chilled water distribution system, eliminating the risk of freezing the chilled water coils while allowing the economizer to provide "free cooling." To address the proper operation of the frost prevention coils, ENTEC built a separate frost-prevention coil loop that is still heated by the normal boiler hot water loop but has antifreeze added. That allowed them to drop the temperature of the incoming air to the energy recovery wheel to 25 °F (-3.8 °C), optimizing the wheel's energy-saving properties.

Janco worked closely with the Figge Museum staff to resolve the problem. Once the fix was made, The Weidt Group agreed to conduct another energy evaluation of the Figge's systems. It turned out the improvements not only recovered the remaining $100,000 of the original incentive—they also gained the museum an additional $30,000 of energy efficiency incentives. That meant the museum received a total energy incentive of $430K rather than $400K, and saved approximately $63,000 in annual energy costs.

"When we moved into our new facility we faced a number of unresolved mechanical system issues. Not only did ENTEC solve these problems, but their solution paid back immediately in lower energy costs and energy efficiency incentives," says Bob DeBlaey, Facilities Manager, Figge Art Museum.

Maintaining ideal conditions

Now, six years later, ENTEC's Janco continues to perform regular onsite inspections of all control systems—particularly those for temperature and humidity—using a range of Fluke tools. He uses the Fluke 62 Mini Infrared Thermometer to measure the air temperature coming out of the ducts and to verify that the temperatures coming off the coils in the AHUs are adequate to keep them from freezing. He uses the Fluke 971 Temperature Humidity Meter to verify the humidity of the overall exhibit space. If those measurements show that the temperature and/or RH values are off, Janco uses the Fluke 971 to calibrate the controls to bring them back within the Smithsonian guidelines.

Janco notes that the Fluke 87V Industrial Multimeter probably gets the most use of all his tools. He uses it for everything from checking the supply voltage in variable speed drives to checking fuses. "The Fluke 87V allows us to make sure that everything is working properly in the control aspect of the devices," Janco concludes. It's probably one of the most valuable tools we have besides our computers."

Mark Janco, System Specialist for ENTEC, uses his laptop with the Fluke 87V to tap into the Figge's building automation system to run routing checks of various low-voltage HVAC system control centers.

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Web access: http://www.fluke.com

Printed in U.S.A. 2/2012 4141170A AW-EN-N