FLUKE®

Energy savings make the case for an HVAC upgrade

Application Note

Field Applications **Case Study**

Tools: Fluke 1735 Three-Phase Power Logger and Fluke 975 AirMeter™ test tool

Profile: Mike Klingler, Service Mgr., Farber Corporation

Measurements: Energy consumption, air quality

Business needs: An older six-story building requires cooling even in winter. To condition the air, a 200-ton refrigeration unit operates year round, consuming major amounts of energy. The client wants to reduce HVAC energy usage without increasing the temperature.

Solution: Service contractor Farber Corp. measures energy usage and air quality. Tests show that installing a heat exchanger and shutting down a 200-ton chiller during winter months will save the building owner $9,954 in annual energy costs.

Tools used: The Fluke 1735 Power Logger measures energy consumed by the chiller. The Fluke 975 AirMeter tester measures indoor air quality before and after the installation to verify system performance.

Cool it: There must be a better way

It was a familiar challenge for Mike Klingler, service manager for Farber Corporation, an HVAC/R contractor in Columbus, Ohio: Prove to a customer that investment in a major HVAC system upgrade would pay for itself in energy savings, without compromising occupant comfort or indoor air quality (IAQ).

"I work in all kinds of buildings," says Klingler, "and I am often asked to reduce the energy costs of the HVAC systems." The subject this time was an older six-story building that once housed an insurance company, but now serves students at a Columbus-area law school.

Working on a project to replace two outdoor cooling towers and install variable-frequency drives in the building's HVAC system, Klingler noticed that one of the facility's two big 200-ton capacity chillers was kept running to supply cold water for the system, even in winter.

"A lot of buildings we can cool with outside air," Klingler says. "When we get down to 50-52 °F and below, we can just draw that outside air in and use it for free cooling. But because of the setup of the law school building, they had to run one of the chillers even when it was 20-25 °F outside. Because of the duct distribution system we couldn't rely on outside air in certain areas of the building."

As a result, one chiller kept running to supply water chilled to 45 °F to the air handling units and keep the building's occupied spaces comfortable. The big motors powering the device were consuming a lot of energy and money—power and cost the school could save if Klingler could find a better way to cool. Of course the solution would have to deliver acceptable indoor air quality.

Klingler had a plan in mind, but didn't want to guess how much energy the big chiller was consuming. The return on investment (ROI) for his system optimization program would hinge on energy savings.

The law building uses hot water heating and chilled water cooling, with a dual-duct system for air distribution. Hot and cold air travel to terminal units (also called mixing boxes) which mix flows to the required supply temperature. Water chilled to 45 °F is pumped to the air handler, where it cools supply air. In the process, excess building heat is transferred to the water, warming it to about 55 °F. That warmer water then returns to the chiller, where it is cooled back down to 45 °F and pumped back through the loop. In the original configuration, the chiller used the refrigeration cycle to transfer the waste heat to another water loop on the condenser side. Condenser water at about 85 °F was then pumped through rooftop cooling towers that rejected the heat into the outside air.

Taking the guesswork out

"What if I figure another way to cool the system?" Klingler asked himself. There was plenty of cold air available outside during the Columbus winter, where temperatures average 33.5 °F in December, 28.3 °F in January, 32 °F in February and 42 °F in March. Klingler figured he could bypass the chiller entirely.

We can use the water from the cooling towers on the roof, he reasoned, to cool the chilled water. Instead of running the chiller, why not use the cooling towers to cool the condenser side water down to 45 °F, and simply pump it through a plate and frame heat exchanger to extract waste heat from the chilled water loop? Instead of the chiller's powerful compressor motors, the system would run with just a small pump. The cost of the upgrade would be significant, but Klingler felt he could prove it financially with accurate data on the potential energy savings. (see illustration)

Finding the ideal balance between building energy consumption and indoor air quality requires a careful balance of multiple factors. "One of the areas we look to are ventilation rates for the building," Klingler said. "Decreasing ventilation rates may reduce overall energy consumption and reduce operating costs, but at the same time we have to maintain good indoor air quality standards too. There's usually a very tight ventilation standard that the service provider has to control in order to reduce energy costs and maintain quality indoor air conditions. Considering the dynamic changes in a building and a functioning HVAC system, in many cases, it's not real easy."

But Klingler was well equipped to find the balance point. He could measure multiple IAQ factors before the upgrade, then check afterward to ensure air quality was not compromised, using the Fluke 975 AirMeter™ test tool. And he didn't have to estimate energy consumption, or guess. He logged actual kWh consumption at the chiller over multiple 12-hour cycles, using a beta test version of the new Fluke 1735 Power Logger.

"I'm saying okay, I have to run that 100-horsepower motor in the winter time," Klingler said. "What's the real kWh? Then I can go back to the owner and say, here's how much is it costing us to run that chiller. The Fluke 1735 will measure and monitor over time and tell me the real power consumption of that equipment. It takes the guesswork out of it. Before having the power analyzer, you would have to say well, it's probably consuming about this much power. But you can set this tool up and walk away, then come back and get the information. You can see what your real power consumption is for any equipment in your building, and then equate that to real dollars."

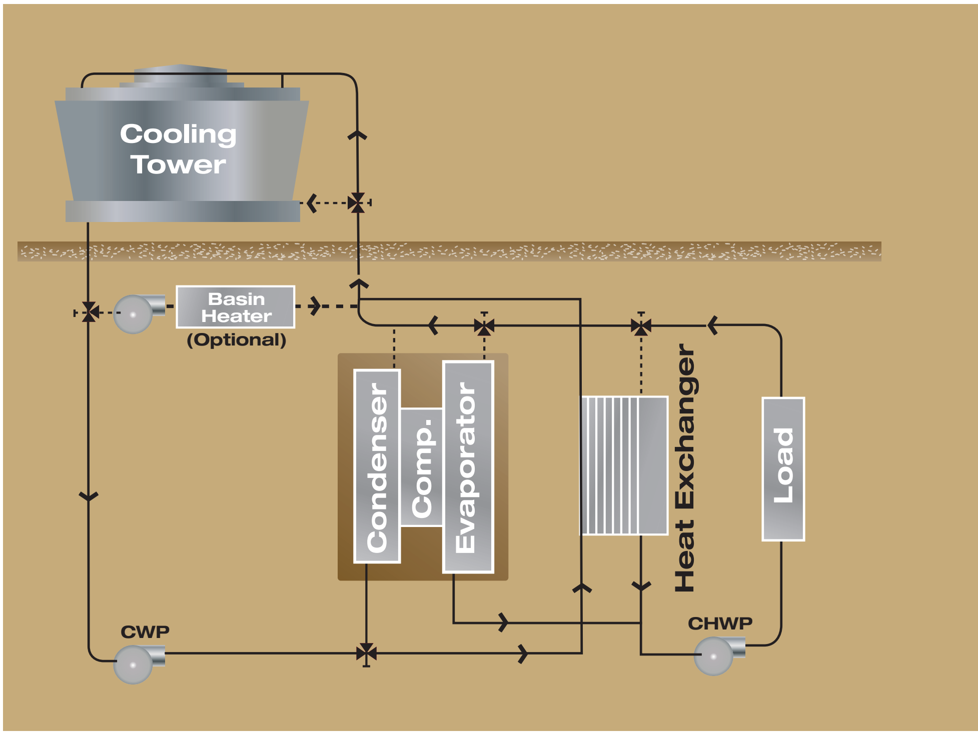

Figure 1. Proposed new system with heat exchanger.

Proving in the payback

Klingler's measurements with the Fluke 1735 showed that the big chiller averaged 790 kWh of power consumption over a 12-hour period. He computed a total power consumption over the four cold-weather months of 189,600 kWh. At a cost of six cents per kWh, running that chiller was costing the law school $11,376 every winter. Klingler figured his alternate approach would cut that bill by 87.5 percent, for an annual energy saving of $9,954.

He estimated that installing the heat exchanger, piping, valves and controls would cost $46,000. That meant the payback period for the project would be just 4.62 years. And that estimate did not include possible savings due to reduced wear and tear on the chiller unit.

While he's waiting for a response on his proposal for a system upgrade, Klingler has found lots of other uses for the Fluke 1735 and the 975 AirMeter. Beyond simply measuring power consumption, the Fluke Power Logger collects all kinds of power quality information that Klingler figures will help him do his job. And the AirMeter makes it a snap to calculate percentage of outside air required to meet standards.

Working on a one-floor remodel in a ten-story office building, Klingler had to calculate the percentage of outside air delivered to a newly laid out conference room. "We go to ASHRAE 62 and the local building code, and they say 15 percent of the air delivered to the space needs to be outside air," he said. "How do you know that 15 percent is really outside air? You have to go back to the big air handler, take a reading and say, how's this air handler set up right now? What's the percentage of outside air we're providing to the entire building?

"With the 975 AirMeter, the service company can go right into the air handler and take those readings and it will tell us, based on temperature or carbon dioxide. It's a very quick, easy, labor-saving tool."

On the power quality side, the Power Logger measures voltage on three phases and current on three phases and neutral. It records multiple parameters that can help determine system load, including voltage, current, frequency, real power (kW), apparent power (kVA), reactive power (kVAR), power factor, and energy (kWh). It can also perform power quality measurements. And the Fluke 1735 downloads to a PC and comes with software for creating reports.

A more savvy contractor

"The power logger makes it real easy for the contractor or engineering group to come in and measure power consumption on individual components in a building, a plant or an industrial facility," Klingler said. "When you start to look at the individual components, it allows you to think in terms of control strategies: how can I control this piece of equipment to reduce energy consumption? How much is it costing me and what can I do for savings?"

Beyond such applications, Klingler sees the Fluke 1735 as a tool that can help him move his business to a higher level.

"For a mechanical contractor such as myself, you're adding service offerings through the use of this product," he said. "It allows you to be a more savvy contractor. It allows you to be more advanced and offer the additional services that I think we should be providing to our customers. You can export the data to spreadsheets, which you can use for presentations to the building owners. That's a big feature when I sit down at the table."

In addition to measuring power consumption, as Klingler did at the law school, the Fluke 1735 measures and logs voltage, amps, frequencies, waveforms, harmonics and power anomalies. "For maintenance and servicing, it's a troubleshooting tool," Klingler said. "You can see if you're having a problem with power, or when you're not sure what's happening and you can't see it with a snapshot from your meter. You can measure it, record it and view it with this device.

"As a contractor, I would use it as a diagnostic tool, and it would be just as valuable to me in that regard as it is as a power consumption tool. I can use it both ways."

ASHRAE 55 and 61

Guidelines for creating comfortable, affordable, indoor environments

ASHRAE Standard 55, "Thermal Environmental Conditions for Human Occupancy", explains how to create an indoor environment that satisfies 80 percent of a building's occupants. You do it with a combination six factors: air temperature, radiant temperature, air speed, humidity, metabolic rate, and clothing insulation.

Similarly, ASHRAE Standard 62, "Ventilation for Acceptable Indoor Air Quality", lists the minimum ventilation rates and air quality parameters that are acceptable to occupants. It also explains how to use ventilation to control air contaminants.

Combined, the two standards provide a set of thresholds for you to compare customer systems against. Optimize toward ASHRAE and you'll probably improve both air comfort and energy usage.

Tips for optimizing your HVAC system

1. **Measure airflow**
   Use duct traverses to measure air pressure, velocity and flow. If pressure is too high and/or airflow too low, check dirty coils, fans and filters that could be blocking the system.
2. **Check ventilation**
   Many buildings are either under-ventilated (bad IAQ) or over-ventilated (expensive). Readjust to ASHRAE standards.
3. **Add VFDs**
   Variable air volume systems use variable frequency drives (VFDs) to more efficiently regulate motors and pumps. An upfront installation cost in exchange for long term energy savings.

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

Printed in U.S.A. 5/2007 3034723 A-EN-N Rev A