McKinstry commissioning guides renaissance in energy

Application Note

Each owner who has spent millions of dollars on a new or refurbished building has every right to expect that the mechanical systems will keep tenants comfortable, while delivering every BTU and saving every kilowatt hour possible.

Commissiong agents make sure it really does happen that way. From fixing glitches and tuning existing HVAC systems to providing new systems that deliver the promised results, building commissiong agents are focused on performance.

Geremy Wolff and his team of HVAC experts know what's at stake. Wolff manages the commissioning team for McKinstry, a Seattle design-build and service firm that specializes in mechanical systems and green building technology.

It's their job to prove that the state-of-the-art mechanical systems McKinstry has designed are delivering the energy-efficient performance owners and tenants expect. In existing facilities, they do retro-commissioning or building optimization to diagnose and fix problems in system operations and performance.

Commissioning verifies performance

"Our commissioning group was born as a support mechanism for our design-build construction group," Wolff said. "We want to ensure that what we intended when we sold it to the customer is what they got at the end of the project. We're responsible for bringing the equipment online and testing it to make sure it meets the performance standards that we set forth."

Based in Seattle, Wolff's 20-member commissioning team brings together a wide range of skills in engineering and multiple trades. Plus, the team can draw on the experience of the entire 1,600-person McKinstry organization, where collaboration is the standard. "We interface with all the different groups within the company to get all the right people in the room and make sure we're making good decisions," Wolff said. The commissioning group serves in-house customers—design-build, energy services or maintenance—and provides third-party commissioning and building tune-up services to outside customers.

"We do a lot of work directly for customers, or partnering with utilities," Wolff said. "Sometimes their system performance has degraded over time, and they just want someone to push the 'reset' button for them. Their energy spend has been going up and they don't know why. HVAC is a significant chunk of your energy spend in a building—typically 30 percent of total utility costs—so there's a good return in having someone come in and do a multi-part project to determine where's the energy going and come out with some modifications." The goal for such improvements is typically a two-year payback.

McKinstry commissioning engineer Bryan Morris checks a chiller circuit.

Retro-commissioning/ tune-up process (scope, investigate and verify)

Retro-commissioning follows the scope, investigate and verify process. First comes the Scoping Phase—the team spends several days reviewing design drawings and utility usage, walking the facility with the building engineer, learning the ins-and-outs of its operation and sampling such performance factors as temperature, CO_2 level and air flow. "We'll do lots of spot measurements, sensor calibration verification and data logging," Wolff said.

Additional advances in building automation systems allow many buildings to be monitored remotely over the Internet. "We'll look at temperature, look at scheduling and set up a trend log to record, say, the temperature coming out of an air handler every ten minutes," he said. "We're able to download that information, plot it on a chart and compare it to outside air, looking at the damper positions, looking at the heating and cooling load in the building and try to figure if it is performing optimally."

The Investigation Phase comes next. "The investigation phase will reveal lots of things they need to do to the building," said Wolff. The team studies building operations in detail and calculates the payback period for a laundry list of changes. Many are simple: adjusting dampers and returning thermostat and timer settings (which are frequently reset by tenants) to their most economical settings. Other improvements, like replacing an aging chiller unit, are capital improvements with a longer payback. By comparing the performance improvements possible in both cost savings and comfort, the building owner can decide which changes make the most sense.

In the Implementation Phase, the team carries out the measures the building owner has selected. "We'll go through the list and have them decide which of these projects they want to implement," Wolf said. "A lot of times we'll have them set aside a certain amount of money at the start of the project, and we'll help them figure out what is the best use of that money."

Performance Verification is the final commissioning step. "For anything we've identified as an issue and had somebody fix, we want to have our team go back in and verify that the issue was resolved and our goals were met," Wolff said. "We could do anything from a simple test to a long-term measurement and verification process, where we'll actually monitor the utility data for them over a period of time."

The process involves a wide variety of checks and tests. Was the right equipment installed according to specs, manufacturer requirements and best practices? Does it perform correctly on start-up, in terms of current draw, voltage, temperature, pressure and flow? Are controls and sensors calibrated accurately? Does the equipment work well both as a stand-alone and in working with other parts of the system? And finally, do emergency backup systems, such as power supplies and generators, perform as expected?

The importance of accuracy

Whether they're squeezing energy consumption out of an existing HVAC system or fine-tuning a brand new McKinstry-designed setup, Wolff's team bases its credibility on accurate test tools that produce dependable test results.

"For us, accuracy is really important," he said. "We're typically verifying somebody else's work. Our devices have to be more accurate than what we're measuring. Every one of my guys carries in their tool bag a Fluke 87V Digital Multimeter, a clamp meter for measuring current and a Fluke 50 Series II thermometer—those are troubleshooting and testing tools that we always have. We're always measuring voltage and amperage.

"We have the Fluke 975 AirMeter™ testers that we use for measuring CO and CO_2. If we're doing demand ventilation control in a building we can use the 975 to measure CO_2 levels, or for our parking garage we can measure CO levels. When our sustainability group is certifying a building as ENERGY STAR®, the walkthrough involves verifying what temperature and ventilation rate is maintained and so on. We use the 975 to take CO_2 and temperature measurements on the fly during the walkthrough."

They use the Fluke 922 Airflow Meter/Micromanometer to supplement larger and more cumbersome testers to measure air flow and pressure. And when utilities want verification as to how much energy a project has saved, the Fluke 43B Power Quality Meter handles the job.

Building a high-tech renaissance

A building renovation now under way near near Seattle, Washington, shows the key role commissioning plays in a major project. There construction crews are retrofitting an empty factory where workers in "bunny suits" once worked in clean rooms making semiconductors. The old factory opened in 1983 and passed through a series of owners.

A new chapter began in 2007, when Northwest real estate developer Benaroya Companies committed to a major investment on the 92-acre property and its 700,000 square feet of buildings that had sat empty for 10 years. Today what's called the South Hill Business + Technology Park is crowded with construction vehicles as workers ready the old factory for use as a data center to house the servers that hold corporate data and drive the Internet.

Commissioning engineer Jeff Flogel uses a multimeter and clamp accessory to verify chilled water valve operation.

Energy usage: "make or break a deal"

McKinstry was assigned to design and build mechanical systems capable of turning the old semiconductor factory into a world class data center. It's a major transformation, and provable energy efficiency is the key to success.

"Data center energy usage is a huge factor" for tenants or buyers, said Mark Johnson, head of construction for

Benaroya. "It can make or break a deal. It's measured by PUE (power usage effectiveness)—total usage divided by server usage. The savings can be in the millions."

The sound building structure, good network access and ample power supply gave McKinstry a solid starting point. But when it comes to HVAC system design, clean rooms and data centers share little in common. Out went the clean room's HEPA filters, replaced by an HVAC system engineered to cool banks of data servers at the lowest possible cost.

The finished data center space is bright, spotless and vast. The room stretches 180 feet by 130 feet, unobstructed by walls or columns. McKinstry's design uses the latest approach to data center cooling: separate hot and cold aisles for the data equipment, together with total reliance on outside air for cooling (see sidebar).

The innovative cooling systems in this facility represent the "Next Generation Data Center." The extremely low PUE and power rates will provide very low operating costs compared to a typical data center. With these innovations South Hill will be awarded LEED certification.

But first, Wolff's team must demonstrate that the HVAC system can handle the heat load of a data center (as measured in watts per square foot) before the data center is in place. Wolff's team may temporarily install electric heaters in the data center space to duplicate the heat that banks of computer equipment will create.

That's on top of their usual commissioning task load: installation verification; equipment startup operational test; confirm equipment controls sensors for temperature, pressure and flow; and an integrated system test.

An expert on everything

"One of the challenges with commissioning is they expect you to be an expert on everything," Wolff said. "One of the advantages we bring is the depth and breadth of resources we have at McKinstry. If we have a problem with a boiler I can go to my speed dial and talk to an engineer who designs these systems, talk to a pipefitter who pipes them, an electrician or a service tech who's been out fixing these things for the last 20 years. We leverage all the different resources we have to make sure we're providing the customer the best input and feedback.

"We're not the type of company that's trying to sell just one solution set to somebody," Wolff said. "It's really trying to understand what are your needs, and what do we have that can help you with your needs.

Today's data center cools it—economically

The latest approach to data center cooling uses separate hot and cold aisles for the data equipment. Equipment runs at higher temperatures than in the past. The cool, low-humidity Northwest climate allows total reliance on outside air for cooling.

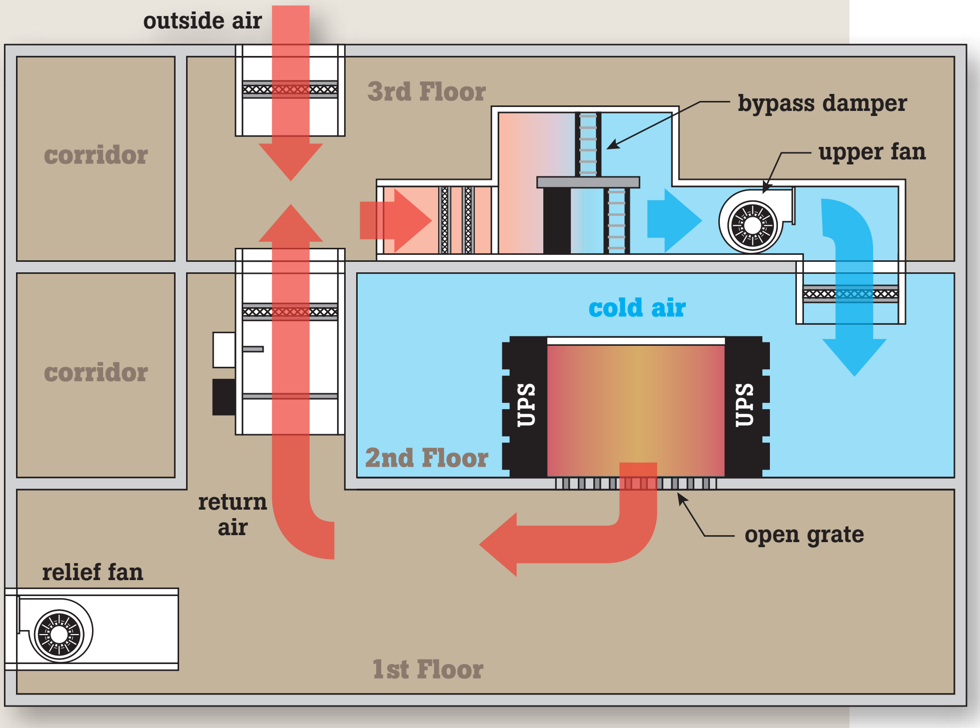
A robust high-density power and cooling infrastructure is designed to deal with a heating load of 150 w/sf scalable to 230 w/sf, with 100 % free cooling.

The cold aisle is to be maintained at 78 °F (max) between 20 % and 80 % RH (the relative humidity limits are intended to prevent static discharge and condensation). The hot aisle is designed for a 20 °F rise across the servers. This hot-aisle/cold-aisle segregation optimizes the outdoor-air economizing potential. Direct evaporative cooling and humidification can support all of the cooling needs of the raised floor area. This design differs from the conventional method of delivering 50 °F to 55 °F supply air that mixes with the heat rejected from the server racks. The design will provide up to 75 % energy savings compared to traditional chilled water system cooling.

The tile floor is divided at regular intervals by return air grids. Racks of computer servers in the data center are set up on each side of these grids, and air warmed by the data equipment (the hot side) is drawn into the space below. The data center occupies the building's second story, while the first story serves as a return air plenum. Exhaust fans in the first story space serve to balance the air pressure inside.

From the first-story space the heated air is moved to the third story, where it is mixed with outside air as needed to cool the computer servers. In addition to air handlers, this space contains new evaporative cooling equipment that can be used to bring the air temperature down on the warmest days. On very cold days (15 °F) heat from data servers will warm the building. The evaporative system will also run during the winter to maintain the minimum relative humidity in the space. But that, according to McKinstry engineer Michael Frank, will be rare.

"We will be in economizer operation, mixing return air with outdoor air with no mechanical cooling or evaporative cooling required, for approximately 8,500 hours out of the year, with only 260 hours where we will be using evaporative cooling," Frank said. "Mechanical cooling is not required for the data center space at all." The existing chilled water system will serve some support spaces and equipment rooms that were left unchanged during the retrofit.



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