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Collaborative approach enables seamless integration of high-performing HVAC Systems into historic K-12 schools

Integrating modern, high-performing HVAC systems into historic K-12 buildings is a challenging task for today's owners and facilities maintenance team members. Aging facilities are often not designed to accommodate newer systems; system replacements are inherently invasive; and construction seasons are limited due to a lack of swing space.

This was the case when the Niagara Falls City School District asked CPL to help add air conditioning to four of their historic elementary schools as part of their $55 million Stewardship Project.

CPL'S COLLABORATIVE DESIGN PROCESS

DISCOVERY

The design process began as a discovery phase with meetings between CPL and owner stakeholders—including district leadership and maintenance staff to identify the following priorities:

- The system needed to be maintenance friendly for owner's facilities maintenance team.
- Systems with compressors, which require unique qualifications to maintain were flagged to be avoided.
- Duct and utility routing was expected to be difficult, requiring any adjustments to existing ceiling heights and disruption to the facilities to kept to a minimum.
- The system needed to be energy efficient and have quality thermal performance.

DREAM

Based on initial meetings and identified priorities, CPL worked with the ownership team to evaluate potential HVAC systems, assessing the pros and cons of each. Evaluated systems included packaged rooftop units with variable air volume terminal units, variable refrigerant volume systems, heat pumps, fan coils and chilled beam systems.

The team quickly gravitated toward a more unique approach to integrating chilled beam systems. However, since this modern system type was a far cry from the central ventilation fans and steam radiation that the owner was more familiar with in their existing facilities, CPL consulted closely with the owner to increase their familiarity and comfort level with the proposed system.

Part of this process included an educational trip to Clark County Public Schools in Winchester, Kentucky, where CPL accompanied Niagara Falls facilities and maintenance team members on site visits to multiple Clark County schools. The trip gave the team an opportunity to closely scrutinize Clark County's standardized chilled beam systems and talk one on one with the school's leadership and maintenance staff.

DEFINE

The owner, in conjunction with CPL, identified major benefits to the chilled beam approach and ultimately chose it as the best alternative for their application. The most attractive attributes of this system included:

- The owner's facilities maintenance staff was already familiar with any system components that were likely to require maintenance or repair (ie. zone components consisting of valve actuators, small cartridge pumps, etc.).
- Fan motors were not required in the school's zones, which would reduce potential noise and maintenance.
- The Dedicated Outdoor Air System (DOAS) allowed a reduction in duct size, which would minimize impact on existing ceiling heights and disruption to the existing facilities. Some existing ductwork would also be able to be reused.
- The system would offer excellent indoor air quality performance including increased ventilation, great air distribution and low sound levels.
- The system would provide superior energy efficiency.

DELIVER

Every part of the system was designed utilizing proven engineering principals and components innovatively applied with energy efficiency optimization and minimization of maintenance in mind. All system components were designed and selected to compliment both the other system components and the unique requirements of each building.

DOAS Ductwork
The DOAS utilizes smaller ductwork when compared to traditional VAV systems. Building components were carefully coordinated in the design process to minimize the impact on ceiling heights.

INNOVATIVE APPLICATION OF FAMILIAR SYSTEM COMPONENTS

Chilled Beams

The chilled beams were designed around FläktGroup SEMCO® IQHC beams with Neuton® pumping modules for zone control. This unique system utilizes a single pipe loop in place of traditional supply and return piping, which reduced installed cost and complexity. The pump modules also provide year-round heating and cooling capability as well as condensation control.

The chilled beam coils are sized utilizing heated hot water and chilled water supply temperatures that optimize system efficiencies. This along with the standardized parts in the pumping modules were both aspect that facilities maintenance staff appreciated.

Dedicated Outdoor Air System (DOAS)

High efficiency DOAS's provide pre-conditioned ventilation air to the chilled beams. The DOAS's utilize hot water coils, chilled water coils, total energy recovery wheels, and desiccant dehumidification wheels to efficiently precondition and dehumidify the outdoor air being delivered to the zones. All system dehumidification is handled at the DOAS unit by dehumidifying the supply air down to 42-grains.

The DOAS for each school was evaluated for the unique requirements of each facility. For instance, due to accessibility restraints at Hyde Park Elementary, the DOAS unit was stick built in the school's basement.

Stick Built DOAS
The DOAS unit was brought together and assembled piece by piece in the school's basement.

Condensing Boilers

Condensing boilers with O2 trim were selected to take full advantage of the condensing/ efficiency benefits of the 100°F heating hot water supply temperatures required by the chilled beams. Because the chilled beam mains require a constant flow, the boiler circulation system was designed as a primary flow system eliminating the need for secondary pumps. Altogether, this approach saved construction costs and decreased energy usage.

Chilled Water Plant

The new ultra-quiet, oil-free, magnetic bearing chillers minimized chiller maintenance while achieving industry leading efficiencies. Where water cooled chillers were used, they were coupled with adiabatic fluid coolers in place of traditional cooling towers.

By utilizing this closed circuit technology, the need for a tower water treatment program, the risk of legionella, and Department of Health inspection requirements were all eliminated. Adiabatic fluid coolers have dramatically lower water consumption compared to traditional cooling towers and because of the adiabatic pads, they typically have a smaller footprint than closed-circuit fluid coolers.

Construction Challenges

Major HVAC renovation projects in historic facilities are challenging in the best of times. However, the majority of construction for this project occurred during the summer of 2020, which was, as the world now knows, a time with additional unforeseen construction challenges due to the COVID-19 pandemic. Furthermore, because the owner had a lack of swing space, it was imperative that the schools were ready for instruction for their fall semester.

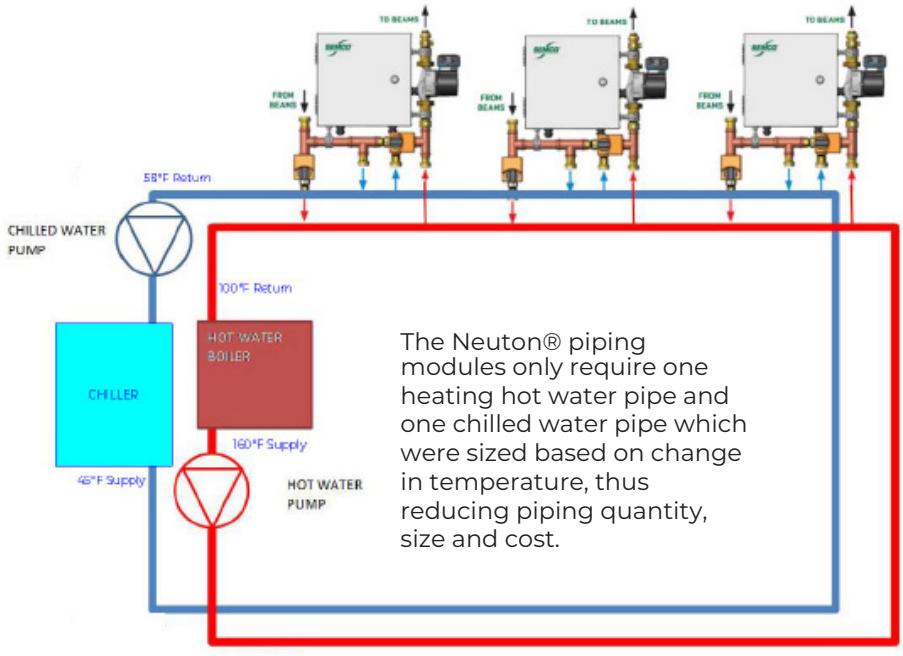
CPL worked closely with the owner, construction manager and contractors to overcome these challenges and successfully keep the construction process on schedule and within budget.

Conclusion

The initial constraints of this historic school renovation project combined with a tight construction window, became the catalyst for a creative and collaborative approach that met the owner's priorities. Discovering the need for maintenance friendly, energy efficient, minimally invasive renovations, CPL defined a high-performing solution for the Niagara Falls City School District.

Utilizing this client-centered design approach, CPL provided extensive, district-wide HVAC upgrades, including the addition of cooling to four schools. CPL was proud to have been part of a project that will have a positive impact on student experiences for decades to come.

> **"This collaborative process brought superior energy efficiency and thermal performance to aging K-12 buildings—an outcome that wouldn't have been possible without the engaged partnership between us and the district.**
>
> **– Mike Pena, P.E.**
> **CPL Mechanical Engineer**



The Neuton® piping modules only require one heating hot water pipe and one chilled water pipe which were sized based on change in temperature, thus reducing piping quantity, size and cost.