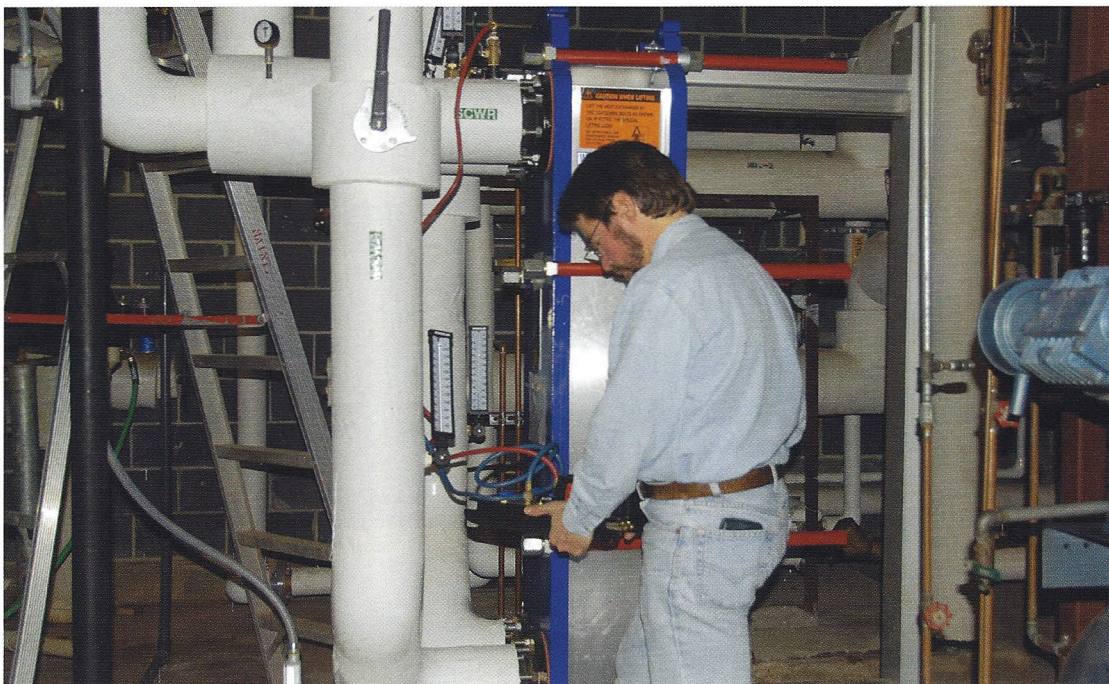


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The Revitalization of Toronto's Waterfront





Measuring the pressure differential of a plate and frame heat exchanger to determine how well it matches the load requirements of the building

Retro Commissioning Optimizes Building Systems to Meet Operational Requirements

Commissioning an educational facility can occur at any time during the lifecycle of the building — during construction (commissioning) or after construction (recommissioning or retro commissioning) — or continue throughout the life of the building (on-going commissioning). In each case, the objective of the process remains the same — to ensure that the school's buildings and its systems are operating efficiently to meet the operational needs of the owner. Equipment is installed and/or tested, data is analyzed and problems are identified and corrected, all in an effort to ensure a building is built and operates as intended.

Commissioning a school at the time of construction is a quality-focused process for enhancing the delivery of a project. The commissioning process actually begins during the design phase and continues through construction, verifying and documenting that the building(s) and all of its systems, components and assemblies are planned, designed, installed, tested and maintained to meet the owner's project requirements. It also provides an opportunity to train facility operators on

the operation and maintenance of the educational building systems.

After a school is commissioned and an operational baseline is established, **on-going commissioning** verifies that the building continues to meet current and evolving facility requirements. Processes occur throughout the life of the facility, some continuously and others scheduled as needed, so the building continues to operate as the owner intends.

However, not every university facility manager engages in an on-going commissioning process. Instead, they may choose to **recommission** a building or multiple buildings several years after the original commissioning process. The decision to recommission may be the result of several factors, including the onset of operational and/or maintenance problems, occupant comfort complaints, higher energy costs, a change in building use or the implementation of new performance codes or objectives.

In the case of a school that has never been commissioned, these same factors may result in the decision to **retro commission** the facility, following a

systematic process by which the facility manager ensures that the building and systems are optimized to perform interactively to meet current operational requirements as closely as possible. In some cases improperly sized equipment, ductwork, piping and electrical service may make it impossible or financially impractical to achieve 100 percent matching of performance and requirements. However, retro commissioning can ensure that existing systems are adjusted to optimize the building's performance and achieve the highest level possible.

In addition to school buildings that have never been commissioned, the list of buildings that are good candidates for retro commissioning includes:

- Buildings with a track record of high energy use or a high number of comfort complaints
- Structures with indoor environmental quality (IEQ) issues
- New buildings that never operated properly
- Structures where space utilization or performance requirements have changed

Even school buildings that were once high-performance structures may benefit from retro commissioning, either because the facilities are no longer used as originally planned or because original operational efficiencies degraded over time. In addition to schools and universities, facilities such as hospitals, laboratories, and military bases are usually excellent choices for retro commissioning, as are office buildings and hotels that use a central boiler/chiller system and direct digital controls.

The retro commissioning process can address a number of pain points common to facility managers, including:

- Organizational pressure to increase profitability and reduce operational costs while promoting a green and sustainable facility
- Occupant comfort and IEQ complaints
- Reduced occupant productivity
- Increased utility costs
- High repair costs and reduced useful life of equipment
- Building systems complexity that is beyond current staff capabilities to operate and maintain

The retro commissioning process can be thought of as a six-phase process, beginning with the **contract phase** that entails a walk-through of the facility. The purpose of the walk-through is to inspect the overall condition of the building(s) and its systems and determine the level of complexity. Areas of focus include details relative to access and construction (e.g. age and type of equipment, hard or lay-in ceilings/high ceilings, etc.), the control system, and construction documents. With respect to the building's heating, ventilation and air-conditioning (HVAC) system the focus narrows to include:

- Whether the building is under positive or negative pressure
- Level of current maintenance and any deferred maintenance issues
- Condition of air filters and their Minimum Efficiency Reporting Values (MERVs)
- Outdoor air dampers that are either struck or frozen closed or wide open
- Airside economizer dampers, actuators and linkages that are disconnected or otherwise not operational
- Variable frequency drives (VFDs) that are in the bypass position
- Balancing valves on pumps that are significantly throttled down

- Duct and pipe modifications that reduce system pressure and increase horsepower inefficiencies

This phase also includes interviews with management and the development of a project proposal.

In the second phase — **pre-site investigation** — the retro commissioning team reviews construction drawings and specifications, operation and maintenance manuals, test and balance reports, utility bills and maintenance records, and repair and replacement orders in an effort to understand the original design intent and owner requirements, differentiate between submitted and installed equipment, analyze energy use and establish operating baselines. Interviews with management, maintenance staff and building occupants also uncover patterns in building operation, including problem areas requiring focus during the next phase — site investigation.

During the **site investigation phase**, the retro commissioning team identifies potential improvement opportunities, based on the document review process, interviews conducted in the pre-site

investigation phase and a more detailed investigation of the school buildings. The investigation targets operating systems, HVAC equipment (including trending systems [BAS] or data-loggers), the building envelope, control systems, air balancing, indoor air quality and other issues that are often the result of installation defects, deferred maintenance, control problems and building pressurization problems.

Quick fixes are made at this time, such as calibrating thermostats and sensors, connecting damper linkages and replacing defective actuators. This phase also provides an excellent opportunity to work with the building's maintenance staff to provide hands-on training.

During the next phase — **analysis** — the team studies problems identified and data recorded during the site investigation, in an effort to move beyond symptoms and identify the source of problems. Analysis results may make it necessary to perform additional testing at the site. The final part of the analysis phase is to recommend solutions, including the estimated costs to

Retro Commissioning Helps Florida Schools Achieve Significant Energy Savings

The Duval County Public School system is one of the largest school districts in the state of Florida. More than 160 schools serve more than 120,000 students in and around Jacksonville. Beginning in 2001, the school system enlisted the expertise of Johnson Controls, a global leader in delivering products, services and solutions that increase energy efficiency in buildings, to provide retro commissioning services to a number of schools within the school system.

Included on the list of structures for retro commissioning was Hendricks Avenue Elementary School. The Jacksonville school presented several challenges, among them an indoor air quality problem evidenced by relative humidity measured at 80 percent. Not surprisingly, the school also exhibited mold and mildew growth and poor comfort conditions.

Following retro commissioning in 2001, the school's relative humidity dropped to 50 percent, a reduction of 30 percent from the pre-retro commissioning high of 80 percent. In other schools the improvements in energy consumption were equally impressive:

SCHOOL	ELECTRIC ENERGY CONSUMPTION		
	Before RCx	After RCx	Reduction
Neptune Beach Elementary	18.7	11.7	37%
Crown Point Elementary	21.4	12.6	41%
Mayport Elementary	24.5	12.1	51%
Fletcher High	15.6	11.0	29%
Fletcher Middle	14.2	11.9	16%
Forrest High	14.6	10.6	27%
Wolfson High	13.6	10.5	23%
Andrew Robinson Elementary	15.2	11.4	25%

Industry Feature

implement them and any associated energy/operations savings that the solutions will provide.

The **corrective action phase** provides an opportunity to study these recommended solutions and prioritize them based on return on investment and simple payback, available resources, budgetary constraints and facility impacts. The facility management may decide to implement all or only some of the recommendations. Once a list of recommendations are determined, the selected solutions are then implemented.

At this point, the implemented solutions are themselves commissioned to verify their effectiveness, ensuring they are achieving the desired results.

During the final **follow-up phase**, a "lessons learned" workshop helps the building operating staff maintain the performance of facility improvement measures and develop an on-going commissioning plan. An important part of the on-going commissioning plan includes a performance verification plan. Performance verification establishes an expected level of performance that can be monitored over time. When degradation of performance is identified through monitoring of the BAS, action is taken to determine the cause and re-establish peak system performance.

The final retro commissioning report is provided, and any off-season testing that may be required is noted.

Following these steps or phases and completing the retro commissioning

process benefits a school in a number of ways, beginning with improved indoor air quality (IAQ), which helps reduce absenteeism and creates a better learning environment for students. With improved IAQ comes improved comfort and occupant productivity.

The optimization strategies that produced improved IAQ also result in reduced energy consumption and lower utility costs. Additionally, pro-active maintenance and repairs reduce operational and repair costs.

Other retro commissioning benefits include:

- Staff becomes more qualified to operate and maintain complex building systems
- Process directly addresses the *causes* of problems rather than the symptoms
- Building meets current facility requirements (as closely as possible)
- Improves the performance of building equipment and building systems interactions
- Aligns strategic business goals and objectives with facility operations/infrastructure
- Assists in achieving Leadership in Energy and Environmental Design (LEED®) certification for existing buildings
- Improves a building's ENERGY STAR® rating

For all these reasons, the retro commissioning process is beneficial to a building owner, providing an opportunity to resolve problems that occurred during

design or construction or address problems and/or changes that have developed or occurred during the building's life. Conducted properly by a qualified commissioning agent or service provider, the process will improve a building's operations and maintenance procedures, resulting in enhanced overall building performance.

As these results would indicate, schools and universities are good candidates for retro commissioning. The process provides opportunities to address high energy costs, indoor environmental quality issues and changes in the way space is used as enrollments fluctuate and educational goals evolve.

For additional information, please visit <http://www.johnsoncontrols.com>. **GBD**

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Selecting a Commissioning Agent

In most cases, a building owner hires an independent third party commissioning service provider or commissioning agent to retro commission a building. To provide a successful retro commission project, the service provider or commissioning agent must first understand the current facility requirements. In addition, the service provider or commissioning agent will be expected to conduct an effective building and building system analysis, develop recommendations that lead to solutions, deliver those solutions and verify that performance is achieved through functional performance testing and the implementation of an on-going process to sustain performance.

In selecting a service provider or commissioning agent to meet these expectations, the building owner should look for an organization that offers the following:

- Single source responsibility with the ability to provide a holistic approach to retro commissioning
- Proven, documented experience
- The ability to service all control systems
- Remote monitoring capabilities
- Fault detection diagnosis
- In-house capabilities that include retro commissioning certified professionals, professional engineers, energy engineers, measurement and verifications engineers,

control technicians, service technicians and test and balance technicians

- An extensive service organization that offers stringent training and certification, as well as predictive maintenance capabilities

By selecting a provider that meets these criteria, the building owner increases the chances for a successful retro commissioning and the benefits it delivers – improved efficiencies, optimized performance, increased occupant satisfaction, comfort, safety and productivity and reduced operational and repair costs, all in a building that meets the current requirements of the building owner and its occupants.