TECHNICAL RETRO-COMMISSIONING

Technical Retro-Commissioning (RCx) prescribes a structured path to find root causes and the most appropriate solutions for existing buildings.

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Images courtesy of the author.

In an ideal world, engineers would design highly efficient HVAC systems that perfectly match a facility's varying outdoor and indoor conditions. These precisely designed systems would then be flawlessly installed by contractors, integrated with other building systems and turned over to a thoroughly trained facility maintenance staff. The maintenance staff would then implement a top-notch preventive maintenance program for the HVAC equipment as per the manufacturer's published specifications.

Unfortunately, we do not live in such a perfect world. Construction projects are often designed and installed under extreme pressure, with a variety of demands placed upon architects, engineers and contractors. All too often, initial budgets for high-efficiency equipment and installation are cut, sacrificing long-term performance and operating costs.

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Once the mechanical systems are installed and the warranty period ends, the building's operation and maintenance staff is frequently left with a facility suffering from serious issues. Issues such as change of space use and occupant density, unacceptably high energy use, poor comfort levels, unsatisfactory Indoor Air Quality (IAQ) and a seemingly endless number of unresolved service calls—which all carry a potential for lawsuits and liability—are, unfortunately, more common than rare. HVACR professionals often end up inheriting problems that are multi-faceted and challenging to discover.

A common issue that is often seen in buildings occurs when significant changes are made in how spaces are utilized. For example, conference rooms are turned into offices, a storage room is converted into a computer server closet, or the number of occupants changes dramatically as the needs of the organization change. As space use changes, the requirements placed on the HVAC system also change. With every problem there is a solution.

Technical Retro-Commissioning (RCx) provides a structured path to find the root cause of problems and the most appropriate solutions for existing buildings. Over the years, the industry has started to use the term Existing Building Commissioning (EBCx), which for all practical purposes is analogous with RCx.

The National Environmental Balancing Bureau (NEBB) is the leading authority of Technical RCx, and defines Technical RCx as: the technical process of improving building systems by inspecting, testing, analyzing, calibrating, repairing, adjusting and optimizing building systems, and training operators for the purpose of improving building performance, including Indoor Environmental Quality (IEQ), energy and water use. As the definition indicates, Technical RCx provides immediate value to customers via testing, calibration, repairing, adjusting and optimizing equipment. NEBB has recently published ANSI Standard S120 *Technical Retro Commissioning of Existing Buildings*. ANSI/NEBB Standard S120-2016 is the only industry standard (ANSI or otherwise) that focuses on commissioning existing buildings.

Customer need, contractor opportunity

The Commercial Buildings Energy Consumption Survey (CBECS) database estimates that there were 5.6 million commercial buildings in the United States in 2012, comprising 87.4 billion sq ft of floor space. The inventory of existing buildings across North America is exponentially greater than new buildings that are constructed each year, and every new building turns into another existing building.

There is a tremendous need for building owners and facility managers to make their existing buildings operate more comfortably, safely and energy efficiently. Buildings are often plagued with ongoing comfort complaints, high energy costs and IEQ issues. The latter includes poor comfort, IAQ, acoustic and lighting concerns.

Commercial HVACR contractors and technicians are perfectly positioned to help building owners and facility managers increase the performance of their existing buildings by making them operate more comfortably, safely and efficiently. They already have many of the necessary skills required to perform Technical RCx, including testing, troubleshooting, analyzing, adjusting, balancing and repairing.

Leveraging the transferable skillsets that HVACR professionals already have, and adding new ones, places the mechanical services industry in the perfect position to provide valuable Technical RCx services to their customers.

Technical RCx vs. energy audit

There is confusion within the industry between RCx and energy audits. There are utility incentive/rebate programs that call for retro-commissioning, however, when you read the requirements of the program the service is essentially an energy audit.

Technical RCx focuses on making a building work safely, comfortably and efficiently, whereas an energy audit focuses on reducing energy costs.

Before diving down this technical rabbit hole, the term "Current Facility Requirements (CFR)" needs to be discussed. The definition of CFR, as per ASHRAE and adopted by NEBB, is: A written document that details the owner's project requirements for the existing building and its systems. These include project goals, measurable performance criteria, cost considerations, benchmarks and environmental criteria for the present use of existing areas of the facility. The CFR is the primary difference that distinguishes Technical RCx from an energy audit. With Technical RCx the focus is on improving the overall performance of the building so that the building is able to achieve the CFR. With an energy audit the focus is on reducing energy costs. The secondary difference is that with Technical RCx, immediate improvements are made to the building and/or system(s). Remember that with Technical RCx, building systems are improved by inspecting, testing, analyzing, calibrating, repairing, adjusting and optimizing building systems. Work is actually performed during the RCx process that brings immediate value to customers.

Technical RCx identifies problems and implements solutions that are typically overlooked under the scope of an energy audit. For example, by measuring the outdoor air flow it can be determined if a building is over-ventilated based on current occupancy. Technical RCx will make the necessary tests and adjustments to bring immediate resolution to the problem.

Technical RCx overview

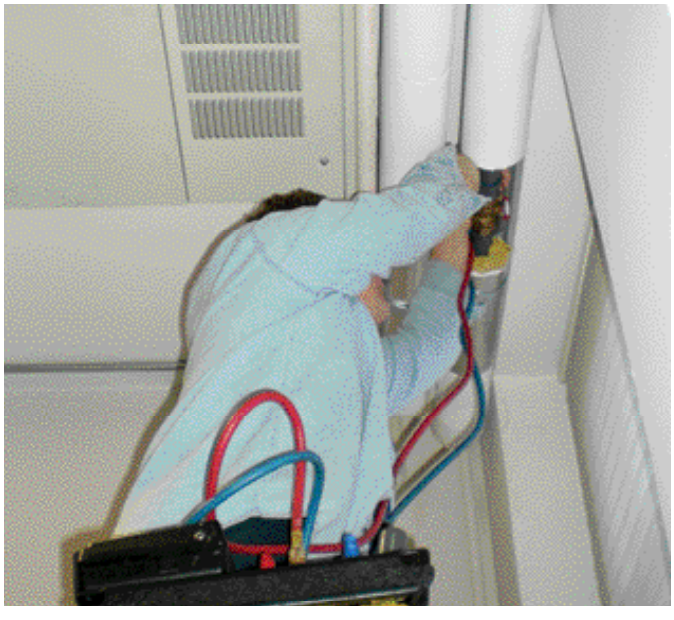
Performing Technical RCx requires the ability to view situations through multiple shades of glasses without having tunnel vision. Problems associated with building performance are generally an accumulation of issues. To identify the root cause of an issue requires the ability to view situations from multiple perspectives.

For example, if a customer has a problem with a building that has high temperature and relative humidity levels during the summertime, who do they call? If the customer calls a design engineer, the engineer will likely break out a psychrometric chart and analyze what is going on with the system from a design perspective, possibly suggesting that a heat load analysis or engineering study is required. If the customer calls a service company, the service technician generally starts at the equipment, checking the condition of filters and coils, then measures operating pressures, temperatures, and amps/volts to determine how the equipment is operating.

If the customer calls the control contractor, the control technician goes right to the computer and starts checking code, set points, alarm history and trends. The technician may start to override set points in order to exercise the control system and see how it responds to various changes in control parameters.

If the customer calls a Testing, Adjusting and Balancing (TAB) company, the TAB technician will break out the flow hood to determine air flow, then begin measuring air pressures, or possibly use a differential pressure water manometer to measure water flow through a branch piping loop.

The point is that when a building has a problem related to energy, comfort, IAQ, excessive repairs, or any other number of issues, each HVACR professional looks at the situation through their own shade of glasses. The accumulation of



TAB technician measuring water flow through a circuit setter.

issues that drive down overall building performance requires skillsets from all of the disciplines previously listed. Any one of the above listed disciplines can make an excellent RCx professional, as long as they have the necessary *working knowledge* from the other disciplines, or have team members that are able to provide the necessary technical support.

The Technical RCx process provides the framework to understand what is going on with a single building, or a number of buildings that make up a facility. By following the steps of Technical RCx, problem areas are identified in a systematic manner, along with the most appropriate solution to resolve the issues.

It is important to mention that the Technical RCx process, although laid out as a sequential step-by-step process, in reality is often a non-sequential process. For example, equipment is tested to establish a baseline of current performance, and then the test data is analyzed to determine the most appropriate recommendation for improvement and optimization. Sometimes further testing may be required to verify that the recommendation the data is leaning towards is correct. Then once the recommendation is completed, further testing is performed to verify that the expected performance is achieved.

ANSI/NEBB Standard S120

The ANSI/NEBB Standard S120 for Technical RCx includes the following phases:

1. Planning;
2. Assessment;
3. Discovery;
4. Issue Analysis and Recommendations;
5. System Improvement and Optimization;
6. Performance Verification (PV); and
7. Continuous Performance Tracking (CPT).

Below is a brief description of each phase:

Planning—The Technical RCx process starts with the Planning phase by understanding building characteristics and system design through review of available construction and renovation plans, approved equipment submittal data, control system drawings, previous engineering studies and testing/adjusting/balancing (TAB) reports. The review process discovers any design issues that may be present in the existing systems. Past utility data is also reviewed to determine the current baseline of energy performance.

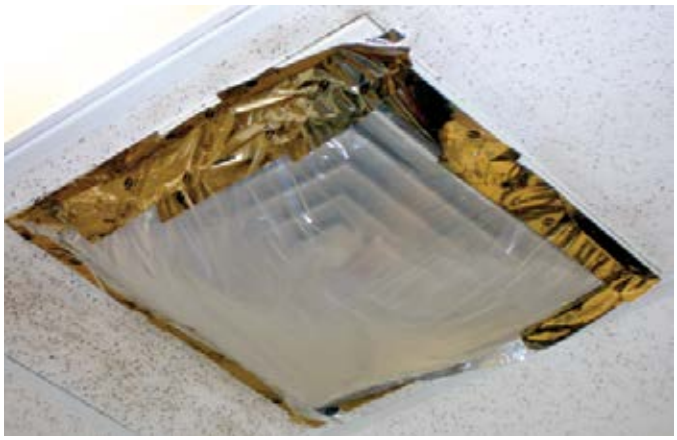
Technicians verifying the correct operation of a chilled water control valve.

Assessment—Following the RCx plan developed in the Planning phase, an assessment of the main HVAC equipment and control systems is made.

Every major piece of HVAC equipment is inspected to identify visually obvious maintenance or operational issues that need to be addressed prior to taking measurements and tests of systems. Maintenance issues will be recorded such as:

- →Vibrating fan or pump motors;
- →Worn sheaves;
- →Dirty filters;
- →Dirty coils;
- →Damaged ductwork that restricts air flow; and
- →Disconnected damper motors.

Discovery—After maintenance issues identified in the Assessment phase are resolved, the Discovery phase identifies which equipment and systems are not working correctly. Discovery is when components, equipment and systems are tested to adequately diagnose the root cause of issues, and to find solutions for corrections. The control system is tested with a point-to-point verification and calibration of all major control points. Calibration of sensors is critical so that the Building Automation System (BAS) can be trusted and used to analyze issues.



An operational issue identified during the Assessment phase, an occupant-installed damper on diffuser serving office that was too cold.

Issue Analysis and Recommendation—Each issue identified during the Discovery phase is analyzed to fully understand what is causing the issue and what is the best solution for its correction. Each issue has a root-cause analysis performed so that it is correctly addressed by the recommended solution. Although listed as a separate phase, often issues are analyzed during the Discovery phase of the Technical RCx process. Detailed descriptions and calculations are performed during the Issue Analysis and Recommendation phase.

System Improvement and Optimization—The main focus of the Technical RCx process is to make existing systems perform as well as possible without the large capital costs associated with replacing major equipment. Similar to tuning up a car to improve fuel mileage, each HVACR system is optimized to allow the existing system to perform better than before the RCx project was done. The term "optimization" is used to mean

making equipment and systems perform at a higher level than before RCx was completed. Examples of optimization are:

- →Modifying equipment schedules and set points;
- →Adding reset sequences;
- →Activating economizers if not currently used;
- →Verifying outdoor air flow is correct for both ventilation and pressurization requirements; and,
- →On Variable Air Volume (VAV) systems, adjusting minimum and maximum flow set points to meet the CFR.

Performance Verification (PV)—It is important that the final results and benefits of all the Technical RCx project activities are proven by evaluating the final performance at the individual system level and the total facility. A PV system is used to achieve this. Each of the system improvements implemented will be tested to demonstrate that the systems are performing as required by the functional description and achieving the predicted benefit.

Continuous Performance Tracking (CPT)—Once the PV is complete, tracking the final results and benefits of the Technical RCx project activities is necessary to maintain the level of energy performance achieved by the RCx effort. CPT is a program that monitors energy performance of the facility over time.

Conclusion

Technical RCx is a process that provides true value to customers by solving problems associated with existing buildings, with the goal of improving performance. Improved performance includes enhancing comfort, improving occupant safety, reducing energy costs, reducing excessive service calls and extending equipment life. When mechanical retrofits are necessary, the RCx process identifies the most appropriate retrofit(s), and provides cost savings to show the customer the actual return on investment. Technical RCx requires multiple skillsets, many of which HVACR contractors and technicians already have. Additional skills can be acquired through training and supported by building a strategic RCx team. HVACR contractors and technicians are perfectly positioned to provide Technical RCx to both current and future customers.

Scott Gordon owns EBCx Services, and has more than 40 years of HVAC industry experience. He learned the trade from his father, Cal Gordon, founder of Tropic Air Conditioning in Miami, FL. Gordon obtained his Journeyman license at the age of 19, and earned his Class-A Certified Air Conditioning Contractor license (FL) at the age of 21. His career couples decades of real world experience with continuous training. He holds certifications with NEBB for TAB, Cx, RCx and Building Enclosure Testing. Additionally, he holds multiple certifications with the Association of Energy Engineers (AEE), and is a LEED AP Operations & Maintenance. For more information, email scott@ebcxservices.com or call 423-737-5085.