

# Building Systems Commissioning

**A**n important factor in making a green building project successful for owner operation, maintenance and occupant comfort is independent, third-party review services during the building pre-design development, construction and warranty stages.

*Building commissioning is a quality-assurance process of ensuring that all the subsystems for HVAC, plumbing, electrical, fire/life safety and security are operating as intended by the design architect and their subcontractors for new construction. Normally, the commissioning firm is involved from project initiation to project completion. The commissioning process involves a synergy of pre-construction review of design documents, periodic site observations during the construction phase and systems performance testing as the project nears completion. The ultimate goal of the commissioning agent is to deliver a project that is on schedule and under budget, in a building that is fully operational and optimized systems on day one.*

LEED™ new construction certification has two commissioning components under the Energy and Atmosphere Credits category.

## 1. Fundamental building commissioning required:

- Engaging a commissioning authority.
- Developing a design intent and basis of design documentation; including requirements in construction documents.
- Developing and using a commissioning plan.
- Verifying installation, performance, training and documentation.
- Completing required reporting.

## 2. Enhanced commissioning required:

- Completing focused review prior to construction/demolition and 95 percent CD completion.
- Making a selective review of submittals.
- Developing a system and energy management manual.
- Having a contract in place for near-warranty end or post-occupancy review.

**Commissioning specifications were developed to be integrated into the project contract documents. These specs were designed to clearly indicate:**

- The scope of commissioning activities.
- The features and systems to be commissioned.
- Requirements for submittal review including inspection, start-up testing and training; operations & maintenance documentation and warranty period activities.

The specifications were also designed to ensure that all other related sections had a brief summary of commissioning requirements with a complete description. All necessary commissioning team members were to be identified with a description of their duties throughout the commissioning process.

**Besides those items required of the LEED™ commissioning credits, the following specific items were to be addressed during commissioning as per the contract language:**

- HVAC system.
- Energy Management System and all DDC controls.
- Electrical distribution system, including transformers, switchgear and distribution panels.
- Testing, adjusting and balancing of the air and hydronic systems.

**A**n independent, third-party commissioning agent, Sys-tec Consulting Engineers of Kansas City, Mo., was hired prior to the project design development stage. Sys-tec performed the fundamental building and enhanced commissioning. The firm also provided a technical design review for mechanical and electrical disciplines designed to identify constructability issues including conflicting information, potential design flaws and clarity of documentation. The primary goal of this peer review was to optimize the life cycle cost and performance of the building systems. Secondary, but no less important, commissioning was needed to assure reduced energy use and to improve indoor air quality, occupant comfort and productivity — major factors in the sustainable design of the building.

A draft construction phase commissioning plan and manual were also developed, including documentation requirements, verification and test procedures and a commissioning schedule.

The design intent for all building systems was developed and documented with the assistance of the consultant and owner. The design intent documented the ideas, concepts and criteria established for each system's performance in the building.

Sys-tec was also required to work with the mechanical sub-consultant to ensure that test and balance specifications were complete and that all necessary control apparatuses (dampers, actuators, control valves, etc.) were properly detailed on the drawings.

**D**uring the construction phase, the commissioning agent worked with all the contractors to help them understand the scope of commissioning for the project. Systems to be commissioned were identified, as well as the documentation that would be required by the contractor for the commissioning manual. The commissioning manual was developed and assembled throughout the construction process. The manual consisted of: Equipment specific pre-installation check sheets for all equipment requiring such sheets. Pre-startup check sheets that were system/equipment specific and based on manufacturers' operating manuals. Check/Test/Start (CTS) and Functional Test procedures, as well as forms to document the start-up and testing of each commissioned system. Sheets were to be comprehensive, meaningful and system-specific.

**The contractor was provided with the commissioning schedule for incorporation of all commissioning events into the project's CPM schedule. Specific duties included the following:**

- Development of a logical order and timing for each commissioning event.
- Impact assessment of each system on the project schedule.
- Equipment or systems identified that required the development of an installation sequence.
- Assurance that installation sequences were incorporated into the project's CPM schedule.

The commissioning agent participated in the shop drawing and submittal review process to assure that equipment complied with the contract specifications and to determine the impact on the project's commissioning process. The owner and the design consultant were to be advised of any areas of concern.

Monthly on-site commissioning meetings were conducted in conjunction with the monthly construction progress meeting. The frequency of meetings was increased to weekly, bi-weekly, or on an as-needed basis to assure that commissioning issues were dealt with in a timely manner. The commissioning agent was responsible for meeting agendas and for taking meeting minutes for distribution.

Monthly commissioning reports and other documentation were submitted to the state project manager to verify that the project was being properly commissioned. The project manager was kept informed of the commissioning progress, especially regarding issues related to design intent. The project manager also participated in all commissioning activities.

### **The commissioning agent was required to witness and verify the commissioning of each system by:**

- Providing a leadership role to assure the contractor completely commissions each system.
- Witnessing the testing of all system functions, controls and safeties.
- Advising the owner of design problems.
- Verifying that equipment operates per the design intent and that documented problems are corrected.
- Documenting all problems revealed as a result of commissioning and those in particular that could not be corrected within the project scope.
- Assuring the system was installed with adequate maintenance accessibility

### **Specifically, the commissioning agent was required to:**

- Identify equipment and systems requiring factory or on-site testing and/or other special documentation.
- Assure such tests were performed and any necessary documentation was provided for inclusion in the project commissioning manual.
- Review and provide comments on equipment test reports or similar reports significant to the commissioning effort.
- Verify that issues brought to light as a result of testing or reports were resolved.
- Assist the construction contractor in developing logical and adequate flushing and cleaning plans for plumbing and hydronic piping systems.
- Witness flushing and cleaning of those systems and coordinate testing of the cleaned systems.
- Verify the initial water treatment of each hydronic system.
- Perform test and balance of air and water systems and verify that system deficiencies were identified and rectified. *This endeavor also included a complete test and balance report.*
- Review the project, systems and equipment operations and maintenance manuals to ensure that they were logically organized, comprehensive and project specific.
- Ensure that all manuals were distributed to the appropriate facility maintenance personnel.
- Confirm that preventive and routine maintenance tasks were identified so that Facility Management's maintenance personnel could incorporate them into its computerized maintenance management software. (FM is currently using MS2000 by MicroMain Corp.)
- Verify that the contractor had organized all vendor equipment training required by the specification.
- Ensure each training session included appropriate facilities maintenance personnel.
- Provide overview training on each system, in conjunction with equipment-specific training provided by equipment vendors.
- Document each training session by attendance logs, a brief report and video, if applicable.

### **Final duties of the commissioning agent were to:**

- Perform commissioning closeout.
- Review the final Cx Manual submittal.
- Review, in parallel with the AE, as-built drawings, as they relate to commissioned systems.
- Verify that all project commissioning requirements had been met.

Once construction was completed, the commissioning agent confirmed the warranty period performance on all equipment and materials. Sys-tec engineer, Dan Pigotti, was an elite partner who performed professional commissioning services. Pigotti provided the design team with suggestions to improve design specifications and assessed equipment problems during installation by providing responsive feedback during construction. Further services were provided to develop training packages and manuals that enhanced Facilities Management's O&M staff expertise.

Building systems were more or less fully operational once commissioning efforts had been completed except some software bugs in the automated system. As a result, FM staff were familiar with all the systems, which improved their job efficiency at the time of building start-up and occupancy. Warranty issues were not common,

but were handled in a timely manner, requiring no down time as a result.

State Facilities Management staff was involved in every step of the commissioning process and participated with the commissioning agent in assessing and resolving problems. Essentially, Facilities Management staff developed an intimate knowledge of the building and systems prior to taking possession of the building due to their excellent relationship with the commissioning agent.

*Again, developing partnerships throughout the design and construction greatly enhanced the success of the project.*



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