

# — ISSUETRAK —

A CEFPI Brief on Educational Facility Issues

Topic: Commissioning School Construction Projects  
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## CEFPI BRIEF

The building construction industry has experienced an increasing interest in verifying the installation and performance of building systems prior to delivery and final acceptance by the building owner. This interest in quality assurance has spawned a new and distinct professional construction discipline referred to as *building commissioning*. The principal objective of commissioning is to define, develop and integrate a formal and fully documented process of review, inspections and testing into the standard project delivery methods. Several states have required a formal commissioning plan be implemented as part of the construction process on all major school district projects, and in some cases, commissioning has become a prerequisite to final project acceptance. In addition, the requirements for commissioning included within the popular Leadership in Energy and Environmental Design (LEED) and the Collaborative for High Performance Schools (CHPS) programs have also increased awareness. As this growing trend continues, the scope of available commissioning related services has broadened. It is now common to find professional commissioning service providers engaged early in the project design stages, with a scope of work that often extends beyond project completion.

Issues identified during the commissioning process are typically documented and monitored until they are resolved. When database software is used for this purpose, it becomes a relatively easy task to separate and sort issues by type and responsibility. Analysis of this data can provide valuable insight into the root causes of common and reoccurring issues. With this knowledge in hand, and a willingness to apply it, owners should be able to reduce the number of problematic issues on future projects and generally improve the quality of project delivery.

### **BUILDING COMMISSIONING**

The naval construction industry defines the term *commissioning* as a formal and well-established quality assurance process used to verify the sea worthiness of ships prior to their release into active service. According to ASHRAE Guideline 1-1996, building commissioning is defined as “the process of ensuring that (building) systems are designed, installed, functionally tested, and capable of being operated and maintained to perform in conformity with the design intent.” It is of particular interest to note that ASHRAE has duly considered the need to verify the intended operational and maintenance criteria as a significant component of the commissioning process.

The most common application for building commissioning is for newly constructed projects and systems. The term *retro-commissioning* describes the application of commissioning procedures to existing building systems that have never been formally commissioned, and the term *re-commissioning* refers to all or part of the process being repeated on a previously commissioned building. *Continuous commissioning* has recently been used to describe scheduled and sometimes automated commissioning procedures that become integrated as part of a building's preventive maintenance program.

The firm and/or individual responsible for developing and managing the commissioning process is referred to as the *Commissioning Agent* or *Commissioning Authority* (CA). The scope of services commonly available under the CA's contract can include the following:

#### ***Pre-Design Phase***

- Assist owner with development of specification guidelines.
- Assist owner with selection of design firms.

### ***Design Phase***

- Assist project team with development of *basis of design* and *design intent* documents.
- Review project design documents for issues related to commissioning, maintenance and operations.
- Develop and provide all commissioning related specifications for inclusion in the project documents.
- Participate in pre-bid meetings with potential contractors.

### ***Construction Phase***

- Review contractor submittals for commissioned systems.
- Fully develop the formal *Commissioning Plan* document and distribute to the project team.
- Conduct on-going site inspections to verify workmanship and compliance with the project specifications.
- Witness and verify start-up and testing procedures as specified by the contractors.

### ***Post-Construction Phase***

- Complete a comprehensive and documented installation inspection to verify readiness for functional testing.
- Complete a comprehensive and documented functional testing of all commissioned systems.
- Verify resolution of all issues as documented and tracked during the commissioning process.
- Verify the delivery of specified training, operations and maintenance documentation.
- Provide a final report that compiles all commissioning documentation and describes the final status of all issues.
- Conduct a final project team meeting to discuss the results of the commissioning process and identify responsibility for resolution of any remaining issues.

### ***Warranty Phase***

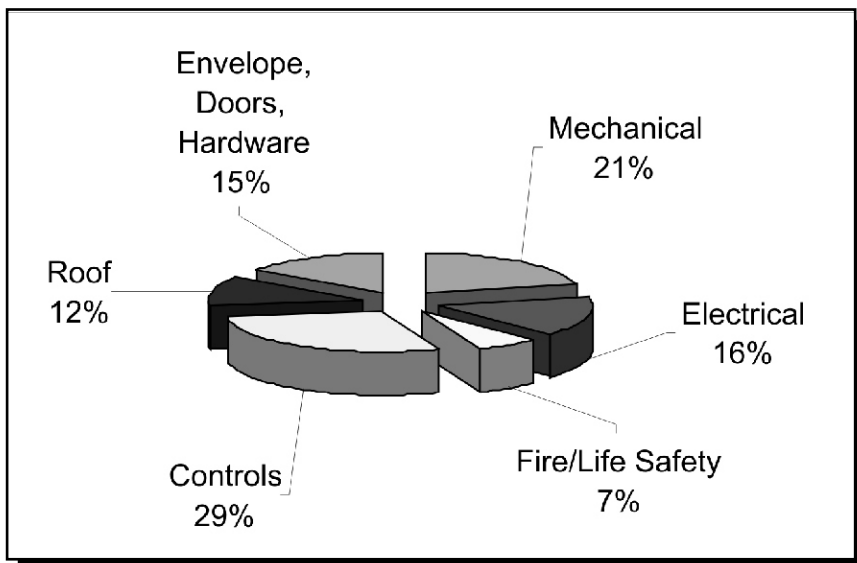
- Develop and provide a re-commissioning procedural manual to allow the owner to repeat all or portions of the commissioning process at a future time.
- Conduct a site review near the time of warranty expiration to assess on-going operational performance and to assist the owner with resolving any remaining or new issues.

### **COMMON ISSUES AND SOLUTIONS**

Having completed commissioning procedures on over 200 K-12 school projects, a significant amount of data related to common and reoccurring issues has been discovered. Because of the complexities involved in all major construction projects, it is certainly understandable that things will occasionally go wrong. However, it is somewhat disturbing to see common mistakes repeated.

The majority of issues in school construction projects are related to mechanical systems, specifically the mechanical related controls. Therefore, it is most cost-effective to design a commissioning plan identifying the mechanical systems as the priority.

### **COMMISSIONING ISSUES BY TRADE:**



The following list represents typical issues discovered in the commissioning process. Recommendations for overcoming the issues and improving the project are also provided. This list is presented in the anticipated order of occurrence during the course of a typical school building project.

### **TYPICAL ISSUES IN THE PRE-DESIGN AND DESIGN PHASES**

Project design plans and specifications frequently suffer from the following common deficiencies:

- Designers are often at least somewhat unfamiliar with the products they are specifying, especially in the area of HVAC related control systems.

- *Boilerplate* specification language that is not precise or accurate and is not appropriate for the equipment and systems scheduled.
- Superficial or non-existent requirements for adequate and relevant training on systems.
- Contradictions between specifications.
- Lack of specific direction and/or confusing language regarding desired control sequences.
- Inadequate or non-existent requirements for the contractor to provide documented start-up and check-out procedures for all equipment and systems installed.
- Project drawings with critical details missing or which are incomplete.
- Equipment placement with little regard for maintenance requirements.

#### **SUGGESTIONS FOR IMPROVEMENT**

- The owner should develop and maintain a well-defined specification guideline that clearly identifies the desired product, installation and performance criteria for all potential building equipment and systems. This guideline should then be distributed to the design team with the expectation that either the guidelines will be followed or the designer will be required to provide an acceptable alternative. The owner should “interview” all proposed design team members with this document in hand, and verify their willingness to comply with the requirement.
- The designer should be required to develop and provide a *Basis of Design / Design Intent* document for all building systems for which they are responsible. The continuous update and circulation of this document during the design development phase will help to ensure that everyone on the project team is aware of the designer's intentions, as well as the limitations that exist and the compromises to their intended design that may have occurred.
- All project plans and specifications should be subjected to a formal and comprehensive third-party *constructability review* at the point where the construction documents are approximately 95% complete. When conducted by qualified peers with expertise in the related design fields, these reviews can provide an invaluable new perspective, and often uncover significant design related issues that would otherwise be included in the bid set of project documents. It is always a good practice to circulate the documents among the operations and maintenance staff, and request their written comments; include the commissioning consultant as part of the review team as they can often spot issues related to those they have encountered while commissioning previous projects. Finally, make sure the entire project team is aware of the time required to complete a review; a rushed review of incomplete documents is a waste of everyone's time.

#### **TYPICAL ISSUES IN THE BID AND CONSTRUCTION PHASES**

The following issues arise during the project bid and construction phases:

- Contractors are not fully aware of their specified responsibilities regarding quality assurance and commissioning, and often complain that they “did not budget for it.”
- Installation issues are often undetected until they have been repeated, and in some cases faulty work is hidden by additional construction.
- When issues are noted during inspections, they are sometimes passed along via word-of-mouth with no formal and documented means of tracking the specific concern.

#### **SUGGESTIONS FOR IMPROVEMENT**

- The commissioning consultant should be required to attend pre-bid meetings with potential contractors in order to clearly define the commissioning requirements and identify owner expectations in this regard.
- The commissioning consultant and mechanical designer should inspect installation work with enough regularity to ensure that issues are identified early and are not covered up.
- Issues discovered during installation should be documented and then clearly and immediately relayed to the contractors (use digital pictures when possible) to avoid confusion regarding responsibility for resolution.

#### **TYPICAL ISSUES IN THE FUNCTIONAL TESTING AND POST CONSTRUCTION PHASES**

- Experience has shown that the designers of the systems often do not participate in any portion of the actual functional testing process.
- Representatives from the owner's maintenance and operations staff are absent during the functional testing process and miss a valuable training opportunity.
- Training provided by the contractors is very superficial and poorly presented.
- Contractors request resolution of issues be handled during the warranty period in order to allow for *substantial completion*.
- Previously identified mistakes on past projects are repeated.

## SUGGESTIONS FOR IMPROVEMENT

- The designers should monitor the functional testing process on a regular basis so that they can respond more effectively to issues related to design and verify compliance with the design intent.
- The owner's maintenance and operations staff should participate in the commissioning process to every extent possible in order to gain a better understanding of the systems installed and issues that were identified during the commissioning process.
- Contractors should be required to provide a topical agenda, proposed schedule and an instructor's resume for training on all systems.
- The owner should maintain a reasonable reserve of project funds until all critical issues have been successfully resolved. Do not rely on the *warranty period* to resolve critical issues.
- Once the project is complete, the commissioning consultant should assist the owner in revising their specification guidelines based on the results of the commissioning process. Review the results with entire project team. Avoid making the same mistakes on future projects!

## THE BOTTOM LINE

An effectively implemented commissioning process can significantly improve the results of all building projects. Success of the commissioning process depends on:

- A well-defined and clearly understood commissioning plan (specification)
- A highly organized and committed commissioning project manager with strong systems operational experience and expertise, and excellent communication skills
- Unwavering client (owner) support for the process
- A cooperative attitude and acceptance of the process demonstrated by all project participants

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Pete Keithly is a 1975 graduate of the University of Washington with over 24 years experience in the field of facilities engineering. He has spent seven years as a full time commissioning agent, with extensive experience in specification writing, commissioning oversight, and test engineering on over fifty separate facilities. Pete has taught technical college courses on HVAC controls, and has presented several workshops on Building Commissioning. He serves on the Board of Directors for the Building Commissioning Association (BCA) and played a leading role in defining the "Essential Attributes of Building Commissioning" for the BCA and is a CSI-Certified Construction Documents Technologist.

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