

# Building Commissioning and Maintenance

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## SUMMARY

Building commissioning evaluates the performance of a building's systems and typically consists of four distinct phases: predesign, design, construction, and warranty. Effective commissioning of a sustainable building requires open communication between the design and construction teams and proper training of the building's operational staff. Efficient, operational equipment and good indoor air quality are essential elements too.

## IMPROVING BUILDING PERFORMANCE

Building owners spend more on complex building systems than ever before, yet many find they do not get the performance they expect. A 1994 study of 60 commercial buildings found that more than half had control problems. In addition, 40 percent had problems with heating, ventilating, and air conditioning (HVAC) equipment, and one-third had sensors that were not operating properly.<sup>1</sup> An astonishing 15 percent of the buildings were actually missing specified equipment. About one-fourth of them had energy management control systems, economizers, and/or variable-speed drives that did not run properly. Problems also frequently occurred in the envelope, structural, and electrical systems of many new buildings.

Building commissioning is one way to improve the outcome of a construction project and increase the likelihood that the building will meet the owner's expectations. Neither the design team nor the owner desires a poorly performing building. Building owners, however, are invariably the ones left to deal with the results, including excessive repair and replacement costs, temporary loss of use or rental income, indoor air quality problems, and construction team liability. Building commissioning can help ensure that a new building begins its life cycle at optimal productivity and increase the likelihood that this level of performance will be maintained throughout its useful life.

## WHAT IS BUILDING COMMISSIONING?

Commissioning is a systematic process of ensuring that all building systems perform interactively according to the contract documents, the design intent, and the building's operational needs. Commissioning may help optimize a building's energy-efficient design features, improve overall building performance, reduce change orders during construction, help ensure that building equipment reaches its life expectancy, and reduce the liability exposure of the building's original design professionals. Commissioning also helps ensure that the building's operational staff is properly trained, with correctly compiled operation and maintenance manuals delivered at the completion of construction.

Ideally, commissioning begins in the predesign phase, with design development and documentation, and continues through the design, construction, and warranty periods with verification through review, testing, and performance documentation. The commissioning process integrates and enhances the traditionally separate functions of design peer review; equipment start-up; control system calibration, testing, adjusting, balancing; equipment documentation; and facility staff training. It also includes documented functional testing and verification.

Commissioning is occasionally confused with the routine testing, adjusting, and balancing of HVAC systems, which measure building air and water flows. Commissioning, however, encompasses a much broader scope of work. It typically involves four distinct phases in which various team members perform specific tasks throughout the design and construction process. The four phases are predesign, design, construction, and warranty. As part of the construction phase, commissioning involves functional testing to determine how well mechanical and electrical systems meet the operational goals established during the design process. Although commissioning can begin during the construction phase, building owners receive the most benefit at the lowest cost if the process begins

when the project team is assembled during the predesign phase.

### **IMPROVING COMMUNICATION**

In recent California focus group studies, building owners and their representatives repeatedly emphasized that lack of communication between the design team and the construction team is a major problem. This lack of communication means that the original design intent of a project is unlikely to be carried through to project completion. Documenting the design intent—the expectations for building performance—is a critical component of commissioning.

Commissioning links the traditionally fragmented design and construction phases because it encourages the project team to view the project holistically and to communicate and solve problems earlier in the construction process.

Although commissioning works best when it begins during design, projects already under construction can still benefit from commissioning. Bringing a commissioning provider into a project during the construction phase can be invaluable in solving start-up problems that have stumped both designers and contractors. The commissioning provider can also document the start-up and functional testing results, thereby reducing future liability exposure for the design professionals and the owner. In addition, the provider can oversee the training of operation and maintenance staff, thus improving the operating procedures of the facility. However, some of the principal benefits of commissioning, such as saving time and money during construction, cannot be realized if the commissioning process is delayed until the equipment start-up phase of a project.

### **EFFICIENT EQUIPMENT DESIGN AND OPERATION**

Commissioning verifies that equipment is installed and operating properly. Equipment that operates as intended lasts longer, works more reliably, consumes less energy, and needs fewer repairs during its lifetime. A good design includes systems that are sized correctly, unlike the oversized mechanical systems found in many commercial buildings.<sup>2</sup> On many projects, a lack of understanding and coordination among the design, installation, and operational team members can result in systems that function inefficiently. Commissioning allows for a broad perspective and consistent focus throughout the design and construction phases on whether the building will function as intended, and it identifies the best long-

term solutions for problems that arise during the project. Commissioning may facilitate improved integration and communication among team members throughout these phases and may also help ensure that correctly sized systems function as intended and specified.

Many building owners mistakenly believe that adding the quality assurance procedure of commissioning to the design process will delay the project's schedule and increase costs. But many of those who have incorporated commissioning into the design phase of their projects have discovered that commissioning can significantly reduce change orders, minimize project delays, and reduce project cost.<sup>3</sup> Paradoxically, incorporating commissioning into the early design phases may actually foster on-time and on-budget completion of projects.

### **AIR QUALITY, COMFORT, AND PRODUCTIVITY**

Surveys indicate that comfort problems are common in many U.S. buildings. A recent report of the U.S. Occupational Safety and Health Administration noted that 20 percent to 30 percent of commercial buildings suffer from indoor air quality (IAQ) problems. Building occupants complain of symptoms ranging from headaches and fatigue to severe allergic reactions. In the most severe cases, occupants have developed Legionnaire's disease, a potentially fatal bacterial illness. The National Institute of Occupational Safety and Health surveyed 350 buildings with deficient IAQ and found that more than half of the complaints stemmed from HVAC systems that were not operating properly.

Ventilation rates are a primary factor affecting IAQ. HVAC commissioning typically includes testing these flow rates under varying load conditions to ensure that the ventilation systems are operating properly. If a building has deficiencies, the commissioning provider documents the original condition and records the repairs or system modifications made.

Building commissioning may help reduce or even eliminate occupant discomfort and the expense, productivity loss, and illness associated with poor IAQ. Because commissioning ensures that HVAC and other building systems are installed and operating properly, commissioned buildings tend to have fewer IAQ- and comfort-related problems.

Commissioning also helps prevent many IAQ problems by training occupants and maintenance staff in the proper operation and maintenance of building systems. Properly maintained HVAC systems, with clean coils and air intakes as well as

regularly changed filters, are less likely to contribute to IAQ problems. In addition, trained building staff can spot potential air quality and ventilation problems before they develop.

**NOTES**

1. Mary Ann Piette, “Quantifying Energy Savings from Commissioning: Preliminary Results from the Northwest,” in *Proceedings of the National Conference on Building Commissioning*, 1996.



2. Dan York, “Commissioning Green Buildings,” in *Proceedings of the National Conference on Building Commissioning*, 1998.

3. Jerry Savage, “Commissioning a Materials Research Laboratory,” in *Proceedings of the National Conference on Building Commissioning*, 2000.

To obtain a complete copy of the *National Best Practices Manual for Building High Performance Schools*, visit the following Web site:

[www.chps.net/manual/index.htm](http://www.chps.net/manual/index.htm)

**RESOURCES**

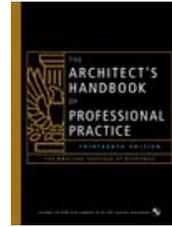
**More Best Practices**

The following AIA Best Practices provide additional information related to this topic:

- 16.01.01 Green Roofs
- 11.08.02 Building Commissioning: Analyzing Costs and Benefits
- 11.08.03 The Building Commissioning Provider

**For More Information on This Topic**

See also “Commissioning,” by Larry Lord, FAIA, *The Architect’s Handbook of Professional Practice*, 13th edition, Chapter 19, page 663.



See also the 14th edition of the *Handbook*, which can be ordered from the AIA Bookstore by calling 800-242-3837 (option 4) or by email at [bookstore@aia.org](mailto:bookstore@aia.org).



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**Key Terms**

- Building performance
- Sustainability
- Sustainable business practices
- Maintenance