EnergyIdeas Clearinghouse

Energy Efficiency FACTSHEET

Building commissioning provides benefits such as a smoother construction process, reduced operation and maintenance costs, lower energy costs, and satisfied building occupants and tenants.

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Building Commissioning for New Buildings

Building commissioning for new buildings is a quality assurance process to verify and document that building systems function as designed and meet the operational needs of the building owner and building users. The initial costs of commissioning are recovered many times over through operating savings, improved staff performance, and avoidance of costly construction problems.

Photo courtesy of DOE/NREL

What is building commissioning?

The key elements in building commissioning include:

- Thoroughly documenting system design intent, operating sequences and test procedures.
- Verifying system performance based on extensive functional testing and measurement.
- Ensuring that building operations staff members receive the training and resources they need on system operation and maintenance procedures.

It is important to realize that building commissioning is not standard practice, although it is becoming more common for large or complicated buildings. Building commissioning goes beyond standard testing, adjusting, and balancing and beyond traditional inspections. The Building Commissioning Association describes building commissioning as *"a quality based process with documented confirmation that building systems are planned, designed, installed, tested, operated and maintained in compliance with the owner's project requirements."*

Why perform building commissioning?

Commissioned buildings are more likely to perform as intended and avoid operational problems. Poorly performing buildings inherently have high costs. Benefits from commissioning include a smoother construction process (from improved communication, fewer change orders, and avoided litigation), reduced operation and maintenance costs, lower energy costs (through improved energy efficiency) and satisfied building occupants and tenants (through improved indoor air quality and thermal comfort).

Experience has shown that a building that is not commissioned will cost 8 to 20 percent more to operate than a commissioned building. A 2004 report[1] showed that, on average, the cost of performing commissioning was paid back in 4.8 years from energy savings alone. When other benefits were accounted for (from improved equipment lifetimes, reduced change-orders due to early detection of problems, prevention of premature equipment breakdown by timely correction of problems, reduced operation and maintenance costs, and improved indoor environment), they essentially offset the entire cost of new-building commissioning.

As buildings and systems have become more complex and occupant requirements have increased, the need for commissioning is even greater. Informed building owners recognize that a high performance building is a key element for business success. It gives them a competitive advantage.

In addition, the Washington State and Seattle Energy Codes for non-residential buildings require systems commissioning for mechanical and lighting systems (see sections 1416 and 1513.7). For lighting and simple HVAC systems, the requirements are limited to controls[2]. The code states that drawing notes specify commissioning, that specifications and plans identify the equipment to be tested and the procedures to be used, that systems be tested to ensure they operate in accord with the approved plans, and that a commissioning report be submitted to the owner. For complex mechanical systems, a preliminary commissioning report is to be completed prior to the building official issuing a final certificate of occupancy.

Photo courtesy of DOE/NREL, Photographer Kenneth Shipp, DOE

It is important to recognize that these minimum requirements fall short of the level of commissioning recommended by many commissioning providers and that the local jurisdictions often do not have the resources to fully enforce all the requirements in the energy code. A building owner needs to be sure they are receiving an adequate level of commissioning from a qualified commissioning provider in order to obtain the benefits that commissioning offers.

When should building commissioning start?

Ideally, building commissioning should begin early in the design phase of the project. This allows the commissioning provider to work with the design team and become familiar with the project goals and design intent as decisions are made. Plans can be made to effectively incorporate commissioning into the development process. This helps to ensure success and avoid problems and additional work later in the project. Commissioning can occur in the construction process or after construction is complete, but this makes it more difficult to document the design intent, identify design problems, develop testing plans and conduct tests. This can compromise the potential for success.

Who should perform building commissioning?

Who actually performs commissioning depends on the owner and the project. Typically, the building owner hires an independent third party to perform commissioning. This individual is often referred to as the commissioning provider (or authority).

Those involved in the building commissioning field generally believe the commissioning provider should work for the owner and should represent the owner's interest. However, there are numerous options. As commissioning becomes

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[1] *The Cost-Effectiveness of Commercial-Buildings Commissioning: A Meta-Analysis of Energy and Non-Energy Impacts in Existing Buildings and New Construction in the United States*, Report Number 56637, Lawrence Berkeley National Laboratory, Portland Energy Conservation Inc., Texas A&M University Energy Systems Laboratory, December 2004. http://eetd.lbl.gov/emills/PUBS/Cx-Costs-Benefits.html

[2] ASHRAE Standard 90.1-2004, the model for the energy codes in many states, includes a minimum level of systems commissioning as part of the completion requirements (6.7.2) for mechanical systems that is less detailed than the Washington and Seattle Energy Codes. California and Massachusetts have commissioning-like provisions in their codes and Oregon has considered a commissioning requirement for their energy code.

more popular, a greater number of firms are offering building commissioning as part of their services. These include construction managers, test and balance contractors, design engineers, and mechanical contractors. The nature of the project will determine which option is best.

Trained and certified commissioning providers can be located through the Building Commissioning Association (see list of resources at the end of this factsheet).

What are the steps in a commissioning process?

The extent of the commissioning process can vary as well as the roles of those involved in the project. A comprehensive process beginning in pre-design and running through post-occupancy is justified for large, complex projects. The commissioning process for smaller buildings should be simpler, focusing on system balancing, simple functional tests of key systems, and documentation. The commissioning process, with an emphasis on the roles of the commissioning provider (CP), is described below for the phases of the design and construction process.

Predesign

The CP, working with the owner, establishes the parameters and expectations for the commissioning process. The CP may have a limited input and review role in this phase.

Design Phase

The CP outlines the scope of design requirements and design intent, describes the systems to be installed, outlines the documentation requirements for each party involved in the commissioning process, defines subsequent commissioning procedures, and documents the process. This includes design review to identify design issues and the development of a commissioning specification that describes the roles and responsibilities of the contractor in the commissioning process.

Photo courtesy of DOE/NREL, Photographer David Parsons

Construction Phase

The CP completes the commissioning plan at the beginning of the construction phase. The CP obtains project schedules and develops a commissioning project schedule. The CP gathers and reviews the contractor submittals and operation and maintenance manuals. The CP writes detailed functional performance test plans for each system and piece of equipment involved in the commissioning process.

The CP makes site visits to observe construction, notes details that might affect equipment and system performance or operation, and coordinates with the various contractors to perform the pre-functional performance tests. The CP oversees all start-up tests and ensures that the pre-functional performance tests and checklists are completed and all deficiencies resolved.

Acceptance Phase

Using the functional performance test plans, the CP observes and verifies the proper operation of equipment, systems, and controls per contract documents; verifies that corrective measures are taken; and ensures the presence of completed operation and maintenance manuals. The actual performance testing is usually carried out by the various contractors. The CP oversees this process and may be actively involved. Shortly after the functional performance test is complete, the CP finishes the draft commissioning report, including all documentation, and submits it to the owner.

Training for the building operation staff generally occurs near the end of the acceptance phase or shortly after building occupancy. It can be performed prior to, or as part of, the functional performance testing. This provides an opportunity for hands-on experience that can reinforce the training. The training should be done by the installation contractors, designers and manufacturers' representatives, and may include the CP. The CP should be involved in establishing

the training needs of the building operation and maintenance staff and ensuring those needs are met.

Post-Acceptance Phase

Building operation and maintenance staff ensure that the facility's systems function properly, adapt the systems to changing occupancy and use, maintain a facility history, and document all changes. The CP can be involved in establishing the documentation methods for this phase and can review performance and recommend improvements. The CP may also be involved in conducting any seasonal performance testing that could not be performed when the building was completed. Results from the post-acceptance phase are added to the commissioning report. The tools and resources developed during the commissioning process provide the basis for ongoing performance monitoring by building and operation staff to ensure that the benefits of commissioning are maintained.

How much does building commissioning cost?

The price of building commissioning varies depending on the size of the project, complexity of building systems, the systems to be commissioned, when commissioning begins, and the level of detail required in the commissioning process. A good rule of thumb is between two to four percent of the construction cost of the systems being commissioned. In the 2004 study referenced in footnote 1, the median cost for new-building commissioning was $1.00/square foot (0.6 percent of total construction costs).

Owners often say they cannot afford to pay for building commissioning. It is important to recognize the potential costs of *not* commissioning. These costs can include schedule overruns, change orders, litigation costs, high vacancy levels, uncomfortable occupants, excessively long shakedown periods, costly post-occupancy corrections, inability to perform adequate operation and maintenance, and high operation costs. These costs can far exceed the price paid for commissioning. Commissioning reduces the risk of incurring these costs.

Where can I get more information about building commissioning?

The following resources provide more information on building commissioning for new commercial buildings.

Programs and Organizations

BetterBricks.com – Articles, success stories, and other resources on commissioning from BetterBricks, an initiative of the Northwest Energy Efficiency Alliance.
www.betterbricks.com/commissioning

Building Commissioning Association – BCA promotes building commissioning practices that maintain high professional standards and fulfill building owners' expectations. Site includes *White Paper on Commissioning*, February 2005.
www.bcxa.org

Portland Energy Conservation, Inc. (PECI) Resource Library – Access to commissioning documents and links to other information resources. *www.peci.org/library.htm*

The National Conference on Building Commissioning – An annual forum of owners, contractors, designers, and commissioning professionals to further the practices of building commissioning. *www.peci.org/ncbc/index.htm*

National Clearinghouse for Educational Facilities (NCEF) – Created in 1997 by the U.S. Department of Education, NCEF is a free public service that provides information about K-12 school planning, design, financing, construction, operations and maintenance.
www.edfacilities.org/rl/commissioning.cfm

U.S. General Services Administration Commissioning Program – Provides resources including a guide for building commissioning.
www.gsa.gov/Portal/gsa/ep/channelView.do?pageTypeId=8195&channelPage=%2Fep%2Fchannel%2FgsaOverview.jsp&channelId=-15374

Documents

Commissioning for Better Buildings in Oregon (pdf file) – A comprehensive 44-page introduction to building commissioning. *www.energy.state.or.us/bus/comm/commintr.pdf*

The Cost-Effectiveness of Commercial-Buildings Commissioning: A Meta-Analysis of Energy and Non-Energy Impacts in Existing Buildings and New Construction in the United States, Report Number 56637, Lawrence Berkeley National Laboratory, Portland Energy Conservation, Inc., Texas A&M University Energy Systems Laboratory, December 2004. *http://eetd.lbl.gov/emills/PUBS/Cx-Costs-Benefits.html*

Energy User News Fundamentals Series – "Understanding the Commissioning Process." *www.energyusernews.com/CDA/Article_Information/Fundamentals_Item/0,2637,27467,00.html*

State and Local Resources

Idaho Department of Water Resources Energy Division – For information on building commissioning in Idaho. *www.idwr.state.id.us/energy/builders/index.htm*

Montana Department of Environmental Quality – For information on building commissioning and related activities in Montana. *www.deq.state.mt.us/Energy/buildings/index.asp*

Oregon Department of Energy – Activities in Oregon to promote building commissioning including handbooks for new and existing building commissioning, a commissioning toolkit, and case studies. *www.energy.state.or.us/bus/comm/bldgcx.htm*

Washington State Department of General Administration Building Commissioning – Information on the department's building commissioning program, success stories, and resources. *www.ga.wa.gov/Eas/bcx/index.html*

The California Commissioning Collaborative – Government, utility and building services organizations and professionals have come together to create a viable market for building commissioning in California. The website includes a comprehensive library and hundreds of resources for building owners and service providers. *www.cacx.org/index.html*

Commissioning for Nonresidential Mechanical and Lighting Systems (pdf file), Seattle Department of Planning and Development. *www.ci.seattle.wa.us/dclu/Publications/cam/cam419.pdf*

Seattle City Light Building Commissioning Assistance – Assistance and support for building commissioning projects. This includes a link to Seattle City Light's Building Commissioning Handbook, which has case studies and standard commissioning procedures. *www.cityofseattle.net/light/conserve/business/bdgcoma/cv5_bca.htm*

Technical Assistance

If you are a commercial or industrial customer of a Northwest utility, you can call the EnergyIdeas Clearinghouse with your specific questions about building commissioning or other energy efficiency issues.

The EnergyIdeas Clearinghouse provides information on a broad range of energy technologies for commercial and industrial customers of Pacific Northwest utilities. The EnergyIdeas Clearinghouse provides a searchable website and has a team of energy specialists ready to respond to technical information requests by phone or email. Sponsored by the Northwest Energy Efficiency Alliance.

Web: *www.EnergyIdeas.org*
Regional Hotlline: 1-800-872-3568
Email: *info@energyideas.org*

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