

Total Building Commissioning Commissioning Process Latest Trend in North America

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Abstract

Total building commissioning is a rapidly emerging project management practice that is being embraced by public and private organizations because of its benefits in improved project delivery results. Reduction in operating cost, enhanced energy efficiency, improved occupant safety, comfort and health and increased maintainability are only a few of the proven benefits of commissioning.

This presentation addresses differences between:-

1. Building HVAC systems and controls systems commissioning started during construction and
2. Commissioning process that incorporates all building systems and begins at the project inception and continues for the life of the facility.

The commissioning activities during planning, design, construction and post-construction project phases are further elaborated together with estimated service cost and benefits.

About the Author

Boban Ratkovich is the Owner of CES Engineering Ltd. He is a Registered Professional Engineer in British Columbia, Canada. CES Engineering Ltd is the facility consulting firm, specializing in building commissioning, retro-commissioning, facility assessment and mechanical/electrical/plumbing consulting services. Boban has over 15 years experience in building systems commissioning. He specializes in commissioning of integrated building systems on complex and fast track projects. Based on his project records, service attitude and ethics Boban is referred by many in the BC Construction Industry as the leading expert provider of the commissioning services in British Columbia.

History of Commissioning Process in North America

The total building commissioning in the United States and Canada is relatively new field within construction industry. At the present time there are varying perceptions and values associated with it and more importantly a lack of familiarity.

Component pieces of this process have been widely adopted since the early to mid 1970s as an extension of early energy management and power conservation practices.

Exhibit 1 below provides and illustrative timeline of the development of building commissioning in North America.

Exhibit 1

Illustrative Building Commissioning (BC) Timeline

1950	1960	1970	1980	1990	2000	2005
B.C. Introduction in Europe	Growth of environmental consciousness	TAB introduction in North America	Energy crisis	BC introduction in North America	US Energy Policy Act of 1992	TAB of automatic controls and BC growth
						ASHRAE Guideline 0-2005.

The total building commissioning process got its start in North America during the late 1980s and early 1990s.

In 1992 the U.S. Energy Act required the head of each Federal agency to adopt procedures necessary to ensure that new Federal buildings meet or exceed the Federal building energy standards established by the U.S. Department of Energy. From this came the development of the Buildings Commissioning Guide, a model for the total building commission program.

In Canada, similar work by the Canadian Mortgage and Housing Corporation (CMHC) and Canadian Standards Association (CSA) produced the same results.

CMHC have largely pursued establishing a commissioning process following the thousands of leaky condos in British Columbia during the early 1990s.

The commissioning process has gained favor in recent years. Building owners, contractors and vendors are becoming increasingly aware of the many benefits to be derived from a better-managed, quality design and construction program produced by the commissioning process.

Despite the convincing arguments regarding the broad-range benefits, many industry experts have indicated that building commissioning is believed to be case sensitive rather than universally needed. Several issues were identified that present reasons for the slow adoption of building commissioning:-

- Many people are simply unaware of it and assume its being done when it's not.
- Those who have caught on to the benefit have been slow to adopt it, reserving it for extraordinary cases.
- The present lack of standard commissioning processes prevents the application of consistent practices.
- Cost/benefit analyses remain difficult to quantify in many instances.
- Lack of acceptance stems from additional cost associated with the owner.
- Architects and Engineers have yet to embrace the need for commissioning.

HVAC System Commissioning – Predecessor to the Total Building Commissioning Process

Commissioning is often misinterpreted to focus solely on testing during the end of the construction phase.

Historically the term 'commissioning' has often referred to the process by which the building HVAC system was tested and balanced (TAB) according to established standards prior to acceptance by the building owner. For the most part, the HVAC commissioning did not include systems, such as water, lighting, which did not directly affect the performance of the HVAC system. This was largely because the architect/engineer was concerned at the time with the building design not the function. From this, people have mistakenly thought of building commissioning as TAB for HVAC systems. In fact, that is why today most commissioning still resides in the HVAC segment rather than in whole building systems.

Other areas of building sector have exhibited signs of greater commissioning acceptance in recent years. Plumbing, Electrical, Fire and Security systems have started to follow HVAC commissioning practices.

However, HVAC system still remains the top sector for commissioning process application.

Overview of the Total Building Commissioning (TBC) Process

Contrary to the HVAC system and other individual building systems commissioning that focus solely on testing during the end of the construction phase, the total building commissioning process starts at project inception and continues for the life of the facility.

The Total Building Commissioning Process is a quality-based method that is adopted by an Owner to achieve successful construction projects. It is not an additional layer of construction or project management. In fact, its purpose is to reduce the cost of delivering construction projects and increase value to owners, occupants, and users.

Due to the integration and interdependency of facility systems, a performance deficiency in one system can result in less than optimal performance by other systems. The use of Total Building Commissioning (TBC) recognizes the integrated nature of all building systems' performances, which impact sustainability, workforce productivity, occupant safety and security. The TBC process uncovers deficiencies in design or installation using peer review and field verification. Commissioning also accomplishes higher energy efficiency, environmental health, and occupant safety and improves indoor air quality.

Implementing the Total Building Commissioning Process is intended to reduce the project capital cost through the first year of operation and also reduce the life-cycle cost of the facility. Using this integrated process results in a fully functional, fine-tuned facility, with complete documentation of its systems and assemblies and trained operating and maintenance personnel.

Emphasis is placed on documentation of the Owner's Project Requirements at the inception of the project and the proper transfer of this information from one party to the next. Owners adopt the Commissioning Process to achieve their stated objectives and criteria – starting with the inception of a project instead of after a facility is occupied.

While circumstances may require owners to adopt the Commissioning Process during the Design or Construction Phase of a project, such later implementation must capture the information that would have been developed had the Commissioning Process begun at the project inception. Beginning the Commissioning Process at project inception will achieve the maximum benefits.

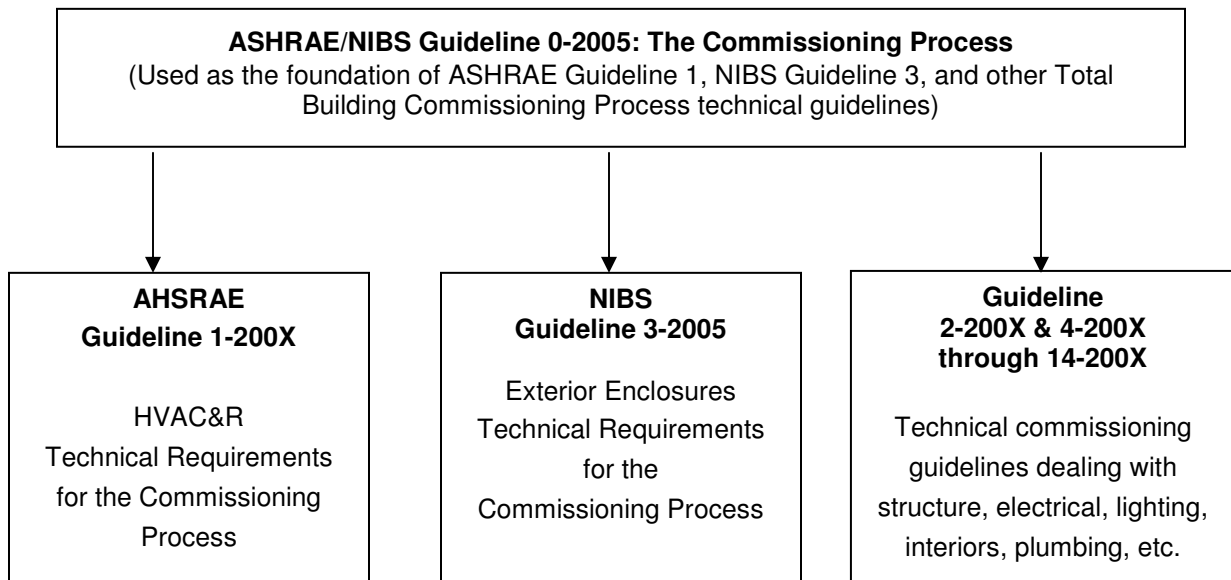
Industry Standards and Guidelines

Currently, no building code requirements exist at a national level for Building Commissioning.

Some governmental agencies, have adopted formal requirements, standards or criteria for commissioning of their capital construction projects. However, the extent of commissioning utilized will depend on project funds available.

ASHRAE Guideline 0 – 2005 represent currently the most comprehensive tool for implementing the TBC process.

ASHRAE Guideline 0 has been adopted by both ASHRAE and NIBS (National Institute of Building Science) and does not focus upon specific systems or assemblies, but presents a standard process that can be followed to commission any building system that may be critical to the function of a project. The NIBS Total Building Commissioning Program is currently working with industry organizations to develop commissioning guidelines for various systems and assemblies.



TBC Process Components

The following is the summary of procedures, methods and documentation requirements for each project phase from the pre-design through occupancy and operation without regard to specific elements, assemblies or systems as per ASHRAE Guideline 0-2005:-

Pre-Design Phase

The pre-design phase commissioning objectives include the following:-

- Developing the Owner's Project Requirements
- Identifying a scope and budget for the Commissioning Process
- Developing the initial Commissioning plan
- Acceptance of the Pre-Design Phase Commissioning Process activities
- Review and use of lessons – learned from previous projects.

Design Phase

The design phase commissioning objectives include the following:-

- Verify the basis of design documents with the owner's project requirements documents
- Updating the commissioning plan to include Construction and Operation phase commissioning process activities
- Developing Commissioning process requirements for inclusion in the Construction documents.
- Developing draft construction checklist
- Updating the scope and format of the project System manual
- Defining training requirements
- Performing commissioning focused design review.
- Acceptance of design phase commissioning process activities.

Construction Phase

The construction phase commissioning objectives include the following:-

- Updating the owner's project requirements.
- Updating the commissioning plan.
- Verifying that submittals meet the Owner's project requirements.
- Developing Commissioning process requirements for inclusion in the Construction documents.
- Developing detail test procedures and data forms.
- Verifying that systems and assemblies comply with the Owner's project requirements.
- Delivering the System Manuals
- Verifying the training of the Owner's operation and maintenance personnel and occupants.
- Acceptance of construction phase commissioning process activities.

Occupancy and Operations Phase

The occupancy and operation phase commissioning objectives include the following:-

- Using the commissioning authority project knowledge and experience to minimize contractor's callback.
- Providing ongoing guidance on operation and maintenance to achieve the Owner's project requirements.
- Completing seasonal testing of facility systems and assemblies.
- Documenting lessons learned from applying the commissioning process for application to the next project.
- Acceptance of occupancy and operations phase commissioning process activities.

Establishing Commissioning Costs

Commissioning costs vary considerably with project size and building type, equipment type, commissioning scope and traveling requirements. However some general rules of thumb can provide some guidance. The costing guidelines must be used with great caution. Understanding what is and is not included in each cost number is critical. The total building commissioning cost for Commissioning Provider services can range from 0.5% to 1.5% of total construction cost (according to U.S. Department of Energy's Rebuild America Program, written by the Portland Energy Conservation, Inc. (PECI). The National Association of State Facilities Administrators (NASFA) recommends budgeting 1.25% to 2.25% of the total building construction costs for total building commissioning provider services.

Design Phase Commissioning Costs

Design phase commissioning may consist of a variety of tasks. For the typical office building and with "standard" commissioning task by the commissioning provider, the cost of commissioning services range from one tenth to three tenths of 1% of the total construction cost . The above costs include total cost by the commissioning provider and the designer costs. Buildings over 100,000 square feet will typically be near the bottom of the range and buildings less than 100,000 square feet in the top end of the range. More complex building types and larger scopes may cost considerably more. As a percentage, the commissioning provider's design phase costs will be roughly 75% of the total, and the designer's 25%.

Construction Phase Commissioning Costs

The following numbers cover the commissioning agent's costs for the construction and warranty phases, including submittal review, construction checklist development, construction observation, writing, overseeing and documenting functional tests (initial and seasonal), verifying that staff training and O&M manuals are per specification and conducting a near-warranty-end review. Commissioning of the HVAC system includes all systems, including fire, life, safety and controls. Commissioning of the electrical system includes lighting controls, emergency power and limited connection and grounding checks. It does not include infrared scanning, power quality, switchgear, transformer, or low voltage system testing. Complex systems are critical applications will have higher costs.

Commissioning System	Commissioning Cost
HVAC and controls	2.0-3.0% of total mechanical cost
Electrical system	1.0-2.0% of total electrical cost
HVAC, controls and Electrical	0.5-1.5% of total construction cost

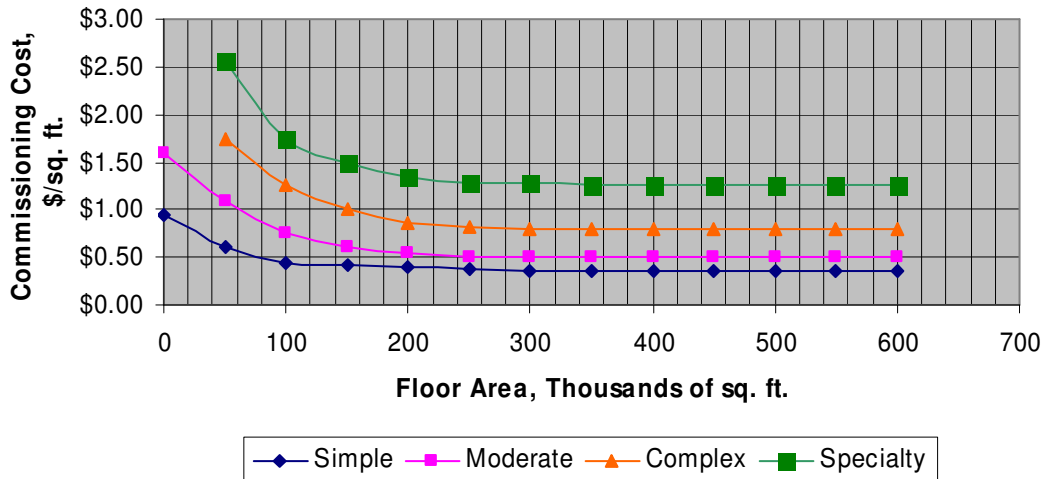
Source for the first two line items: Ron Wilkinson, ASHRAE Journal, Feb. 2000. Third line: PECI

The above costs cover only the commissioning agent's fees. There are also costs to the contractor, the designers and Owner staff for their part in the commissioning process. The costs for the contractor attending meetings, documenting the construction checklists and assisting with testing will be roughly offset by the savings to the contractor in callback costs and holding of final payment retention. The designer's cost for construction phase commissioning is fairly insignificant when their scope is limited to review of the commissioning plan and a few meetings.

The NIBS Guideline 3-2006 estimates that project with construction budgets in excess of \$20 Million require typically 0.2% of the construction budget for building exterior enclosure commissioning. The building exterior enclosure commissioning cost on the projects with construction budgets less than \$20 Million ranges from 0.3% to 1% of the construction budget.

Estimating by floor area is another method often used for rough estimates. The costs indicated in the chart below include the cost of the commissioning agent from early construction through warranty. These costs are averages and can vary considerably, since the number of pieces of equipment and commissioning rigor vary.

Estimates of Construction Phase Commissioning Costs
 (Costs for the commissioning authority in new construction, per square foot)
 Portland Energy Conservation Inc. (PECI), 2000



Simple – Office buildings, classrooms, packaged equipment and controls; common systems.

Moderate – More complex offices, classrooms with some labs, building automation, more control strategies, fewer packaged equipment; more complex systems (fire, emergency power, etc.)

Complex – Moderate plus most of floor area in complex systems (hospitals, labs, operating rooms, clean rooms, fume hoods or other non-HVAC systems are commissioned such as electrical quality, transformers, security, communications, etc. Traveling requirements and high cost of living locations increased costs.

Specialty – Very complex facilities like prisons. (Doesn't include security systems commissioning costs).

Cost-Benefit Analysis for Commissioning

The industry studies indicate that on average the operating cost of a commissioned building range from 8% to 20% below that of a non-commissioned building. BOMA (Building Operation and Management Association) cost data for office building suggests that building commissioning can result in energy savings from 20 to 50% and maintenance savings of 15 to 35%.

Beyond operating efficiency, successful building commissioning has been linked to reduced occupant complaints and increased occupant productivity.

Reduced Change Orders is one of the more commonly acknowledged benefits of commissioning (especially design phase commissioning). The commissioning process will reduce the number of change-orders encountered in a typical construction cycle.

Many commissioning related improvements simply make the systems and equipment in a building easier to service and maintain. A design phase commissioning finding that makes an equipment room easily accessible for equipment replacement can easily save tens of thousands of dollars any time the machinery in the room undergoes a major repair or replacement.

Commissioning related savings typically extend beyond the construction budget and will show up year after year as reduced operating and maintenance costs. Thus, it is important to show the savings in terms of present worth or future value justifies commissioning expense when dealing with financial professionals.

References

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