

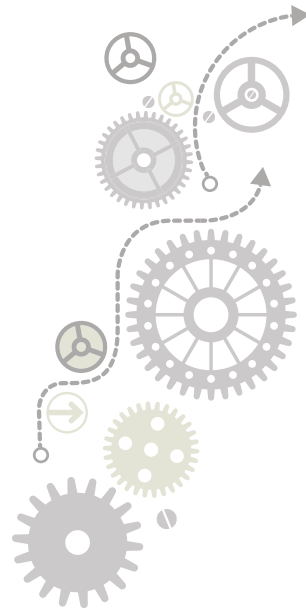


The Strategic Guide to Commissioning

Report from the ASHRAE Presidential Ad-Hoc Committee
Building Performance Alliance on Commissioning

Presented to ASHRAE Board of Directors
June 24, 2014





The Building Performance Alliance Committee on Commissioning The Strategic Guide to Commissioning

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Foreword

This is the first edition of the Strategic Guide to Commissioning produced by the Building Performance Alliance committee on Commissioning. BPA began as a Presidential Ad Hoc committee appointed by ASHRAE President Thomas E. Watson, and completed under the direction of ASHRAE President William P. Bahnfleth. Its charge was to “meet with interested and affected parties in the commissioning industry and identify ways to improve the commissioning process through working together”.

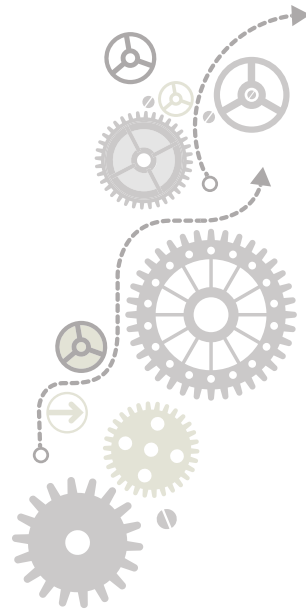
This guide was developed in collaboration with twenty-eight ASHRAE members with direct representatives from fourteen major commissioning related organizations and stakeholders (“BPA team”) that can best represent the common needs of the commissioning industry. The “Roadmap”, or outline, was created during its 2012–13 term (Figure 2); this guide was created during its 2013–14 term, based on that “Roadmap”.

The BPA team collaborated with industry leaders to develop a strategic document that communicates over-arching commissioning goals and objectives. This effort will lead to improving overall building and system performance, as well as protecting the existing and established industry interests and processes/procedures.

This guide serves as a quality-focused, high level strategic commissioning document that provides stakeholders with a basis for understanding enhanced delivery of new and existing building projects. It describes the value, benefits and rationale for verifying and documenting that all of the commissioned systems and assemblies are planned, designed, installed, tested, operated, and maintained to meet the Owner’s Project Requirements (OPR) for new buildings and/or major renovations, and the Current Facility Requirements (CFR) for existing buildings.

Key users of this guide are anyone involved in design, construction, optimizing and operating buildings, including:

- | | |
|---|---|
| Owners | Design-Build Contractors |
| Facility Managers | Construction Managers |
| Maintenance and Operations Personnel | Subcontractors |
| Architects and Engineers | Utility Operators and Providers |
| Commissioning Authorities and Providers (Certified) | Inspectors and Code Officials (Authorities Having Jurisdiction, or AHJ’s)Developers |
| Facility Design Engineers | Occupants, Users, and Visitors |
| Building Controls Contractors | |
| General Contractors | |



Types of Commissioning (Figure 1) addressed by this guide include, but are not limited to::

- Site Development and Land Use
- Construction, Demolition, and Renovation Waste Management
- Enclosure (including Roofing, Exterior Walls, Openings and Ground Floor)
- Building Pressurization (including Thermography and Air Tightness testing),
- Interior Systems (including Architectural Walls, Ceilings, Floors/ Interior Doors, Windows, Openings)
- Structural
- Heating, Ventilation, Air Conditioning and Refrigeration
- Energy Systems (including renewables)
- Indoor Environmental Quality (IEQ)
- Electrical Systems and Emergency Power/Generation, Smoke Control, Fire Protection, Fire Suppression, Fire Alarm, Lighting Systems
- Specialty Processes
- Vertical Conveyances (including Elevators, Hoist Ways, and Escalators)
- Plumbing, Domestic Water, and non-potable Systems
- Security Systems
- Telecommunications, IT, Audio Visual

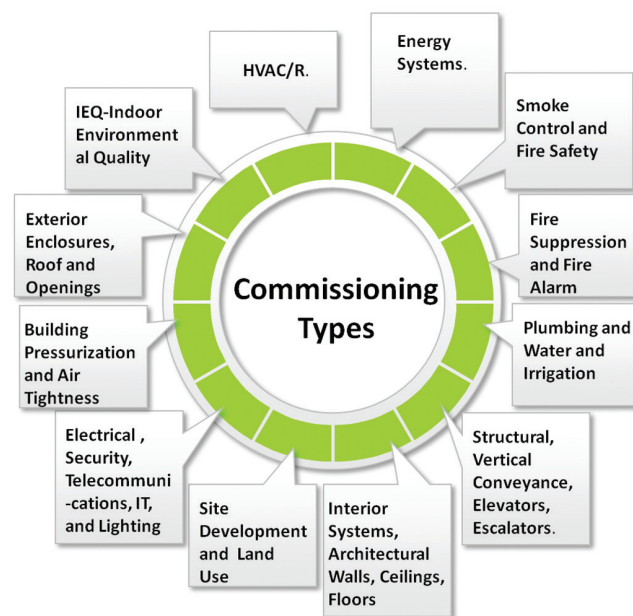


Figure 1: Commissioning Types

This guide is intended to have far-reaching impact on the Industry to establish and maintain consistent high level goals and objectives, including performance, cost effectiveness, consistency, and best practice.

Section 1: Introduction

The Building Performance Alliance Roadmap, Figure 2 – next page, was developed through a cooperative process by a wide spectrum of building performance stakeholders. The twenty eight members and fourteen organizations that participated in the development of the Roadmap and this guide over the course of two years are bound together in the belief that our industry, and ultimately our clients, are evolving to expect a higher level of performance from their buildings. Evidence of this evolution is seen in the emergence of performance benchmarking and energy reduction incentives from both public and private sources. The Roadmap is a tangible commitment to prepare the users of this guide for a future where building performance and functionality is the baseline foundation and a fundamental need of our industry.

Section 2: Strategic Overview

Buildings often do not perform as expected, in spite of the best efforts put forth by the parties involved in the process. In order for a building to meet its true performance potential, all facets of the planning, design, construction, maintenance and operation must work holistically, focused on common goals for the building’s performance.

The reasons that many buildings do not perform properly are sometimes complex. Historically, the building industry has not placed enough importance about addressing building performance early in the project development. Waiting too long to engage the commissioning process at project inception can result in “fixing” problems and delivering performance at the end of the project in lieu of preventing them from happening from the beginning. At times in the past the process has been approached in a very prescriptive manner with segregated duties and responsibilities, resulting in performance expectations that may not be communicated well enough and thus are sometimes not met. This guide chooses an all-inclusive path by concentrating on building performance as the priority outcome.

Interpretation of the OPR or CFR is a shared responsibility of the Commissioning Authority, owner/client, and designer, and is a sensitive area for all participants in the commissioning process. It is valuable to consider that a commissioned project must have the cooperation and collaboration of all parties in the facility planning, design and construction efforts.

Consistently achieving high levels of building performance, given the current state of the design, construction and facilities management professions, is difficult and complicated, but obtainable.

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Figure 2: The Roadmap

The Building Performance Alliance Strategic Building Performance Alliance (BPA) Guide to Commissioning Forum 'Roadmap' for Commissioning

Authors: The entire BPA committee / September, 2013

Create a quality-focused, high level strategic commissioning document for enhancing the delivery of new and existing building projects. The overall deliverable is to focus on verifying and documenting that all of the commissioned systems and assemblies are planned, designed, installed, tested, operated, and maintained to meet the Owner's Project Requirements (OPR) of a new building and/or major renovation, and the Current Facility Requirements (CFR) of an existing building.

Vision: To collaborate with industry leaders to develop a plan that will lead to strategic document(s) that will communicate over-arching Commissioning goals and objectives. This effort will lead to increasing overall building and system performance, protecting the existing and established industry interests and processes/procedures.

- Site Development and Land Use
- Construction, Demolition, and Renovation Waste Management
- Enclosure (including Roofing, Exterior Walls, Openings and Ground Floor)
- Building Pressurization (including Thermography and Air Tightness testing)
- Interior Systems (including Architectural Walls, Ceilings, Floors/ Interior Doors, Windows, Openings)
- Structural
- HVAC/R
- Energy Systems (including renewables)
- Indoor Environmental Quality (IEQ)
- Electrical Systems and Emergency Power/Generation
- Smoke Control, Fire Protection, Fire Suppression, Fire Alarm
- Lighting Systems
- Specialty Processes
- Vertical Conveyances (including Elevators, Hoist Ways, and Escalators)
- Plumbing, Domestic Water, and non-potable Systems
- Security Systems
- Telecommunications, IT, Audio Visual

BEGINNING

New Building/Major Renovation or Existing Building

Key Customers and Stakeholders

- Owners
- Facility Managers/ Maintenance and Operations Personnel
- Architects
- Engineers
- Contractors
- Utility Operators and Providers
- Inspectors and Code Officials
(Authority having Jurisdiction)
- Developers/Occupants
- Users and Visitors

BPA COMMISSIONING

New Building/Major Renovation and Existing Building Commissioning

New Building/Major Renovation Commissioning:

The application of the Commissioning Process requirements and Owners Project Requirements (OPR) to a new construction and/or major renovation project.

Existing Building Commissioning (includes re-, retro, and on-going commissioning activities):

An application of the Commissioning Process requirements for attaining the Current Facility Requirements (CFR) of an existing facility and/or its systems and assemblies. The process focuses on planning, investigating, implementing, verifying, and documenting that the facility and/or its systems and assemblies are operated and maintained to meet the Current Facility Requirements, with a program to maintain the enhancements for the remaining life of the facility.

Commissioning Plan Created

- Define "Commissioning" (not the process or procedures)
- Technical high level goals and objectives
- Ethical goals and best practice objectives
- Value added benefits and features to Owner
- OPR/CFR/BOD- Owners Project Requirements/ Current Facility Requirements/Basis of Design
- Value added benefits and features of a consensus deliverable that the commissioning industry can adopt
- Credentialing of the Commissioning Agent/Authority
Accreditation, Education, Training, Licensure
- Reasons why Building Commissioning is necessary
- Develop business cases why Building Commissioning is valuable
- Commissioning Protocols between owner, designer, contractor, vendor, operator
- Training and education to end users, customers, facility managers, O&M staff, etc.

Scope - including, but not limited to:

Technical areas/ Disciplines Included in Commissioning Plan

Boundaries

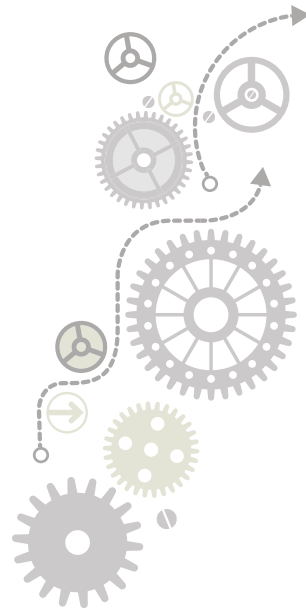
Specific Commissioning Tasks Addressed

- Requirements of Submittal review, System Verification checklists, Performance Testing
- Phases: New Construction/Major Renovation; such as Pre-design, Design, Construction, Acceptance, Post Occupancy, Seasonal Testing
- System manual requirements
- Commissioning team membership
- Outreach to other stakeholders, such as end users, architects, community or public at large
- Near end of warranty period review/ seasonal testing and review, etc.
- Final commissioning report
- RFQ's (Request for Qualifications), RFP's (Request for Proposals), Contracts
- Differentiate and qualify/quantify conditions relevant to new and existing building commissioning
- Conflict resolution

END RESULT

A strategic document that :

- a) provides over-arching commissioning goals and objectives that can be used as a common foundation for all providers of commissioning services.
- b) provides a path that produces the building (new and existing) as designed, constructed, and that meets the Owners Project Requirements (OPR)/Current Facility Requirements (CFR).



This guide:

- Demonstrates that the commissioning process is a good tool to begin efforts to achieve consistently higher building capabilities according to intent, which can provide the most direct path to improving building performance.
- Provides a strategic outline and vision for commissioning new and existing projects by providing a common foundation for use by all providers of commissioning services.
- Assists and informs building project participants on how to produce and sustain high-quality buildings by ensuring that all of the commissioning systems and assemblies are planned, designed, installed, tested, operated and maintained to meet the Owner's Project Requirements (OPR) for a new building and the Current Facility Requirements (CFR) for an existing building.

Section 3: The Commissioning Process

Building Commissioning is a process, defined as “a quality-focused process for enhancing the delivery of a new and existing building project. The overall process focuses upon verifying and documenting that all of the commissioned systems and assemblies are planned, designed, installed, tested, operated, and maintained to meet the Owner's Project Requirements (OPR) of a new building and/or major renovation, and the Current Facility Requirements (CFR) of an existing building.”

It is recognized that specific and detailed commissioning procedural methods and means may differ slightly from organization to organization, and we have agreed these variations are outside the scope of this high level strategic document.

In terms of building performance, the commissioning process helps owners and project teams achieve quality performance in new and existing buildings. Post-occupancy on-going commissioning can also contribute to sustaining optimal performance over time, delivering energy efficiency and operational savings.

The commissioning process includes defined activities and deliverables that are accomplished throughout the pre-design, design, construction and operations of the building. The commissioning actions and documents provide the plans, procedures, coordination, verification, and project records that will produce high performing buildings.

Special systems and assembly commissioning expertise, such as building enclosure commissioning (BECx), is often required for commercial facilities due to the complex nature and interface of enclosure materials and assemblies.

The new building construction commissioning (NCx) process differs from existing building commissioning (EBCx), because the forensic (investigative) components of EBCx are unnecessary for new projects. EBCx is also variously known as retro commissioning (RCx), and recommissioning.

On-going commissioning is a process of continuously testing and/or tuning building systems to maintain building performance as expected, in keeping with the OPR/CFR.

Refer to Appendix A for definitions of terms.

Refer to Appendix B for a description of the commissioning process activities and deliverables.

Refer to Appendix C for commissioning resources.

Section 4: Value and Benefits

Commissioning provides value and benefits to the owner, the project design and construction team, and ultimately the occupants and building operators in many ways as described herein.

The added value and many benefits to the owner by commissioning a building are manifested in higher-performing buildings that efficiently serve the occupants and, by extension, the economies they serve.

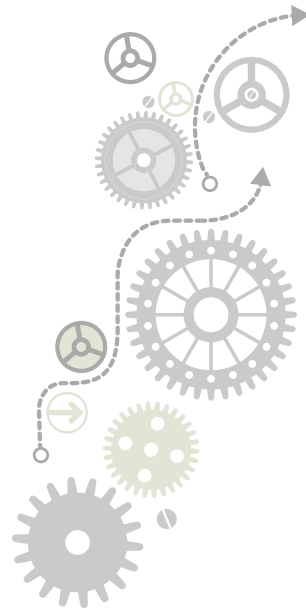
Our Appendix C has many examples and resources that explain in great detail how commissioning can be credibly proven to be valuable and useful, but perhaps is best expressed by the author of resource #8 citing, “16% median whole-building energy savings in existing buildings and 13% in new construction, with payback times of 1.1 years and 4.2 years, respectively. Median benefit-cost ratios of 4.5 and 1.1, and cash-on-cash returns of 91% and 23% were achieved”; and goes on to say that “commissioning is arguably the single most cost effective strategy for reducing energy, costs, and greenhouse gas emissions in buildings today”.

Buildings are as diverse as the people who utilize them. The value and benefits of the commissioning process can be demonstrated in direct proportion to the cost and advantages of performing commissioning weighed against the cost and risks of not performing commissioning. The design and construction process is enhanced by the expertise and facilitation of the commissioning authority in integrating its multi-faceted levels and phases in order to obtain its maximum potentials.

Facilitation of the design and construction phases, and review from phase to phase, add value to the process and the building performance outcome. These activities are performed by a commissioning authority that is an experienced professional using industry “standards of care” and accepted best practices. Issues and their resolutions are facilitated and documented with communication to all members of the commissioning team. The Owner can then receive the design and construction results at the scheduled time period, and within its budget. All of this provides a direct path toward informed and good practices during maintenance & operations.

Commissioning documentation and verification can lead to obtaining various energy, comfort, IAQ, and IEQ, and high performing building awards, while enhancing the learning experience, and helping to perpetuate the buildings' sustainability aspects.





4.1 Value and Benefits: Owner's Project Requirements/Current Facility Requirements (OPR/CFR)

The process of developing the OPR/CFR, updating, and validating fulfillment of the OPR/CFR from conception through occupancy and operation, keeps the owner, design team, and construction team focused on the delivery of the end product. The commissioning authority focuses on the OPR/CFR at every stage of project delivery, diminishing or eliminating undocumented changes in design requirements.

The commissioning authority monitors, and reports the metrics of performance and operation for the commissioning process, creating the path that produces the building as designed and constructed to meet the Owners OPR and/or CFR.

4.2 Value and Benefits: Process

The commissioning process streamlines and accelerates the work flow of the project from start to finish. Scheduling and meeting milestones are enhanced by monitoring and intervention/facilitation by the commissioning authority. For example:

- Design and submittal reviews assure compliance with OPR/CFR and plans and specifications, as well as prequalification of equipment, systems, personnel, and code/standards compliance.
- Checklists are issued and documented, establishing prerequisites for timely provision of equipment and systems installation.
- Performance testing assures compliance with design objectives and requirements.
- Start-ups are performed as an integral part of the process and documented before any performance testing is started.
- Training is facilitated to ensure continued operations.

4.3 Value and Benefits: Project Team (Planning, Design, Construction)

As a result of the commissioning process, the owner, designer, contractor, and operator realize fewer costs due to downtime, delays, change orders, clarifications, and requests for extension of time for completion. Owners, designers and contractors realize that the commissioning authority is working in their best interests to assist in facilitating and executing the project schedule and milestones based on unbiased execution of the OPR and/or CFR.

Designers benefit by commissioning review due to commissioning diligence by verifying the design works properly and is provided in accordance with the OPR/CFR. Designers experience reduced requests for clarification, information, and questions about system design and its intended operations.

The commissioning process, including testing, identification of premature equipment failures, and due diligence, benefits contractors, equipment vendors and subcontractors by reducing material and labor costs, punch lists, callbacks, and warranty work.

Performance testing and any re-testing of poor results assure that the project works in compliance with the project requirements. The construction team, vendors and product manufacturers realize the benefit of concentrating on products and activities that meet the OPR/CFR as a guideline, forefront in everyone's mind, which can reduce product substitutions and value engineering. Vendors and material providers benefit from proper equipment start-ups, performance testing, and operation/maintenance training to verify compliance with contract documents which accelerates the successful project turnover process. Finally, warranty claims, completion delays, call-backs, and building down-time due to repairs are reduced because the systems are tested and performance is verified prior to occupancy.

4.4 Value and Benefits: Performance and Operation Outcomes

The operational outcomes in terms of minimizing costs and maximizing building performance are many. Results include, for example:

- Training is facilitated and enhanced by requiring a plan and curriculum followed by monitoring and documentation of results.
- O&M staffs are provided with comprehensive systems manuals and O&M documentation that allows seamless transfer of knowledge base about its equipment and systems understanding.
- Users and occupants of facilities benefit from having a working or living environment in which conditions are designed, constructed, and efficiently and sustainably operated with their specific uses in mind.

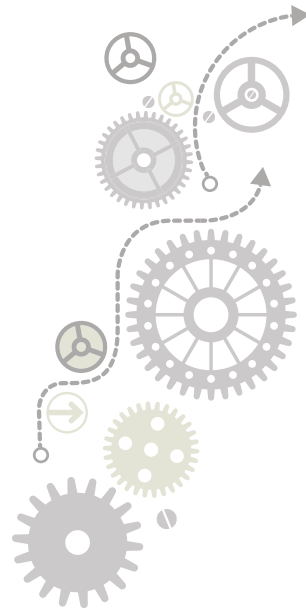
Section 5: Performance Requirements

Commissioning performance requirements are a function of the specific project. The performance requirements document goals, expectations, values, and benefits that will be achieved in a successful project. Performance requirements will be different for a new building as opposed to an existing building. Both new and existing types of buildings can benefit from the commissioning process.

In general, these requirements are intended to maximize the effective performance of the building by allowing people to optimize their productivity as the facility operates properly, and mandating that the building meets performance thresholds determined by established metrics and specific owner's needs.

The OPR or CFR must clearly define the expected building performance and outcomes from the commissioning process. These documents will require considerable effort from the owner or project manager and the Commissioning Authority working collaboratively. These define the project criteria to be used in developing an appropriate commissioning plan for systems that are to be commissioned. The purpose of the facility, activities performed, and operator's ability must be some of the many items to be included in the commissioning plan.





Commissioning can be used to document and achieve these goals without jeopardizing other performance requirements such as indoor environmental quality. The commissioning process can be utilized to assure that the goals of technology integration, interoperability, sustainability, and coordination are achieved while, at the same time, minimizing effects of unintended consequences.

5.1 The Owner's Project Requirements should contain performance requirements for the building, such as:

- Performance requirements needed to achieve a high performance energy rating/label in an energy rating system.
- The performance requirements needed to prove compliance with energy codes and statutes.
- Certain requirements with regard to indoor environmental quality (IEQ), building envelope performance, or other requirements specific to the new building.
- Adequate scoping to explicitly list the inclusion of "green" building commissioning as a subset of the total building commissioning scope.

5.2 Existing facilities may have a wide variety of requirements. These requirements may differ from the original project requirements when the building was originally designed and built due to a number of reasons, such as:

- The building, or parts of the building, may be used for a different purpose.
- Some changes in occupancy type may differ from the way the building was being used for the same purpose.
- Technology enhancements with respect to better performing equipment and systems may be available.
- New regulations or codes may impose new requirements and/or energy goals.
- The owner may want to include additional "green" building requirements, in the change, retrofit, or upgrade.

Section 6: Commissioning Authority Characteristics

The Commissioning Authority is in charge of the commissioning process and makes the final recommendations to the owner regarding functional and practical performance of the commissioned building systems. In the selection of a commissioning authority it is important that it be based on the qualifications and experience of the proposed candidate. For each project, the commissioning purpose and scope should be clearly defined in the Commissioning Authority's contract for services. There are many key skills, characteristics, and ethics required to perform successful and effective commissioning, as discussed herein.

The Commissioning Authority is an objective and independent advocate for the owner. The Commissioning Authority should work directly for the owner, keeping the owner's objectives and best interests as the top priority. The Commissioning Authority does not provide peer review, but ensures that OPR/CFR is being met by all parties involved in the project. The Commissioning Authority is to facilitate the process, to insure that all parties provide good communication, demonstrate good judgment and professionalism, resolve issues as a team approach, and document performance.

In addition to having good written and verbal communication skills, the Commissioning Authority should have current engineering knowledge, with extensive and relevant hands-on field experience in the area of expertise of their commissioning discipline. The commissioning authority should be credentialed and certified by a reliable, nationally recognized, and credible professional association/organization specializing in the commissioning business.

The Commissioning Authority recommends clearly defined roles and scope for all members of the design and construction teams for the execution of the commissioning process; this allows for each team member to have a better understanding of the commissioning process. Additionally, it helps to identify and resolve problems in the process, and document the performance of the building. Since the commissioning authority provides constructive input for the resolution of system problems and deficiencies, diplomacy and consensus building during these discussions are critical. However, this role does not give the Commissioning Authority any rights or responsibilities to overrule and/or perform the specific work of this team of professionals.

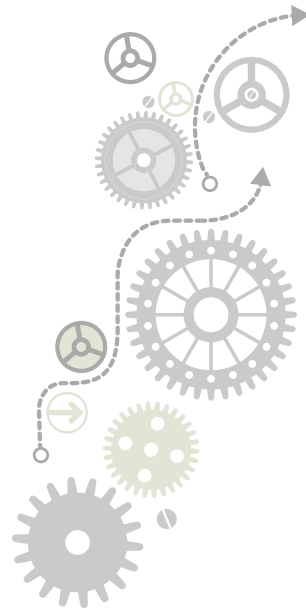
The Commissioning Authority must also know how to interview building staff on their knowledge of the systems they maintain to determine the appropriate level of training once the project is complete. Training and mentoring the building staff during the turnover phase combines the Commissioning Authority's technical skills with communication skills which are critical to the long term success of the building.

A conflict of interest may exist if the Commissioning Authority's firm has other project responsibilities or function, and/or is not under direct contract to the owner. The commissioning authority needs to be a provider without any financial or business interests or potential conflicts of interest that would interfere with the faithful execution of his/her duties. Wherever this occurs the Commissioning Authority should disclose, in writing, the nature of the conflict and the means by which the conflict shall be managed.

Situations may arise during many of the decision-making points in the commissioning process that may require that the Commissioning Authority address some difficult decisions, deliberations, and/or conversations; these should be handled with the utmost professionalism and ethics.

Quality assurance and optimization are essential elements of any commissioning effort, including efforts to improve energy efficiency, indoor environmental quality, comfort, and operations.





Section 7: Commissioning Expectations

Utilizing the commissioning process as outlined in this Strategic Guide to Commissioning will result in better buildings and building systems. It will support a quality focused mutually acceptable commissioning process and procedure. The ultimate intent is to make the owner confident and satisfied that “they got what they paid for,” reduced risk, and met/exceeded their scheduling targets and financial goals.

The strategic commissioning suggestions outlined herein will provide benefits to the key customers and stakeholders of buildings, most importantly being the owner. Commissioning has been proven to save time and costs for the owner, designer, and contracting team members. Studies and resources listed in this guide have provided results and research that has concluded that commissioning is beneficial and should be used as much as possible.

It is expected that this guide will provide principles of commissioning for a broad audience of users of the building commissioning verification approach to improving building performance and the built environment. These principles can be used to enhance building performance at many levels, such as benchmarking, exploring opportunities for increased efficiencies, achieving goals and objectives of management, exploring alternatives, and promoting best practices. With the use of these principles and methodologies, the benefits of better building performance, enhanced maintenance and operations, improved occupant comfort, and energy efficiency/reduction can be achieved.

Effective commissioning provides opportunities for enhanced integrated design, improved and timely construction procedures, lower warranty costs, and proper operator training which all lead to satisfied building occupants. The systems that the owner decides to commission on each project may differ.

Commissioning is the most reliable path and process to produce properly performing building systems and assemblies that are as planned, designed, installed and operated.

It is intended that this guide can be used to communicate over-arching commissioning goals and objectives that can be used as a common foundation for all providers of commissioning services. A fully utilized commissioning process and procedure from project inception through to building testing and occupancy is the best and most cost effective way to improve building performance and operation.

APPENDIX A: Definitions¹

Acceptance: A formal action, taken by a person with appropriate authority (which may or may not be contractually defined) to declare that some aspect of the project meets defined requirements, thus permitting subsequent activities to proceed.

Basis of Design (BOD): A document that records the concepts, calculations, decisions, and product selections used to meet the Owner's Project Requirements and to satisfy applicable regulatory requirements, standards, and guidelines. The document includes both narrative descriptions and lists of individual items that support the design process.

Checklists: Project and element-specific checklists that are developed and used during all phases of the commissioning process to verify that the Owner's Project Requirements or Current Facility Requirements (CFR) are being achieved. Checklists are used for general evaluation, testing, training, and other design and construction requirements.

Commissioning Authority (or Agent): An entity identified by the Owner who leads, plans, schedules, and coordinates the commissioning team to implement the Commissioning Process.

Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the Commissioning Process.

Commissioning Process: A quality process for enhancing the delivery of new and existing building projects. It focuses on verifying and documenting that all of the commissioned systems and assemblies are planned, designed, installed, tested, operated, and maintained to meet the Owner's Project Requirements (OPR) of a new building and/or major renovation, and the Current Facility Requirements (CFR) of an existing building.

Commissioning Progress Report: A written document that details activities completed as part of the Commissioning Process and significant findings from those activities, and is continuously updated during the course of a project.

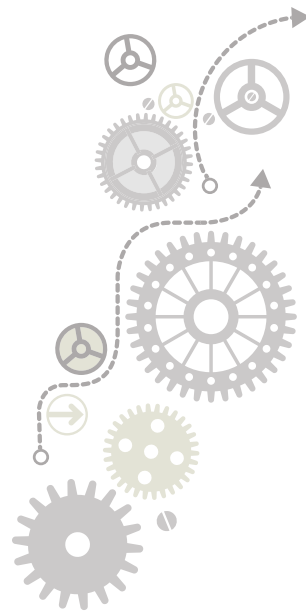
Commissioning Team: The individuals and agencies, which through coordinated actions, are responsible for implementing the Commissioning Process.

Commissioning Testing: The evaluation and documentation of the equipment and assemblies: delivery and condition; installation; proper function according to the manufacturer's specifications, and project documentation to meet the criteria in the Owner's Project Requirements or Current Facility Requirements (CFR).

Commissioning: New Building/Major Renovation: The application of the Commissioning Process requirements and Owners Project Requirements (OPR) to a new construction and/or major renovation project.

Commissioning: Existing Building: (includes re-, retro, and on-going commissioning activities): An application of the Commissioning Process requirements for attaining the Current Facility Requirements (CFR) of an existing facility and/or its systems and assemblies. The process focuses on planning, investigating, implementing, verifying, and documenting that the facility and/or its systems and assemblies are operated and maintained to meet the Current Facility Requirements, with a program to maintain the enhancements for the remaining





life of the facility. Re-commissioning refers to commissioning performed on an existing building that had commissioning performed when it was new. Retro-commissioning methodology is identical to that for re-commissioning, except that it occurs when the building was not commissioned when new, and is being commissioned for the first time. On-going commissioning is a process of continuously testing and/or tuning building systems to maintain building performance as expected and previously commissioned.

Construction Documents: This includes a wide range of documents, which will vary from project to project, and with the Owner's needs and regulations, laws, and jurisdictional requirements. Construction documents usually include the project manual (specifications), plans (drawings), and General Terms and Conditions of the contract.

Contract Documents: This includes a wide range of documents, which will vary from project to project and with the Owner's needs, regulations, laws, and jurisdictional requirements. Contract Documents frequently include price agreements, construction management process, sub-contractor agreements or requirements, requirements and procedures for submittals, changes, and other construction requirements, timeline for completion, and the Construction Documents.

Coordination Drawings: Drawings showing the work of all trades to illustrate that equipment can be installed in the space allocated without compromising equipment function or access for maintenance and replacement. These drawings graphically illustrate and dimension manufacturers' recommended maintenance clearances.

Current Facility Requirements (CFR): A written document that details the current functional requirements of an existing facility and the expectations of how it should be used and operated. This includes goals, measurable performance criteria, cost considerations, benchmarks, success criteria, and supporting information to meet the requirements of occupants, users, and owners of the facility.

Design Checklist: A form developed by the commissioning team to verify that elements of the design are in compliance with the Owner's Project Requirements.

Design Review – PEER: An independent and objective technical review of the design of the Project or a part thereof, conducted at specified stages of design completion by one or more qualified professionals, for the purpose of enhancing the quality of the design.

Design Review – Constructability: The review of effective and timely integration of construction knowledge into the conceptual planning, design, construction and field operation of a project to achieve project objectives efficiently and accurately at the most cost effective levels to reduce or prevent errors, delays and cost overruns.

Design Review – Code or Regulatory: A review of a document conducted by staff or designated entity of an Authority Having Jurisdiction to determine whether the content of the document complies with regulations, codes, or other standards administered by the Jurisdiction.

Design Review – Commissioning: A review of the design documents to determine compliance with the Owner's Project Requirements, including coordination between systems and assemblies being commissioned, features and access for testing, commissioning and maintenance, and other reviews required by the OPR and commissioning plan.

Existing building commissioning: An application of the Commissioning Process requirements for attaining the Current Facility Requirements (CFR) of an existing facility and/or its

systems and assemblies. The process focuses on planning, investigating, implementing, verifying, and documenting that the facility and/or its systems and assemblies are operated and maintained to meet the Current Facility Requirements, with a program to maintain the enhancements for the remaining life of the facility.

Evaluation: The process by which specific documents, components, equipment, assemblies, systems, and interfaces among systems and their performance are confirmed with respect to the criteria required in the Owner's Project Requirements and/or the Current Facility Requirements (CFR).

Facility Guide: A basic building systems description and operating plan with general procedures and confirmed facility operating conditions, set points, schedules, and operating procedures for use by facility operations to properly operate the facility.

Final Commissioning Report: A document that records the activities and results of the Commissioning Process and is developed from the final Commissioning Plan with all of its attached appendices.

Issues and Resolution Log: A formal and on-going record of problems or concerns and their resolutions that have been raised by members of the Commissioning Team during the course of the Commissioning Process.

New building commissioning: the application of the commissioning process requirements and owners project requirements to a new construction and/or major renovation project.

Owner's Project Requirements (OPR): A written document that details the requirements of a project and the expectations of how it will be used and operated. This includes project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, and supporting information.

Performance Test (PT): Performance Testing is the process of verifying that a material, product, assembly, or system meets defined performance criteria. The methods and conditions under which performance is verified are described in one or more test protocols.

Record Documents: (the term "as-builts" have been previously used): Documents prepared by the architect, engineer, and/or contractor that reflect on-site changes the contractor noted in the as-built drawings. They are often compiled as a set of on-site changes made for the owner per the contract requirements.

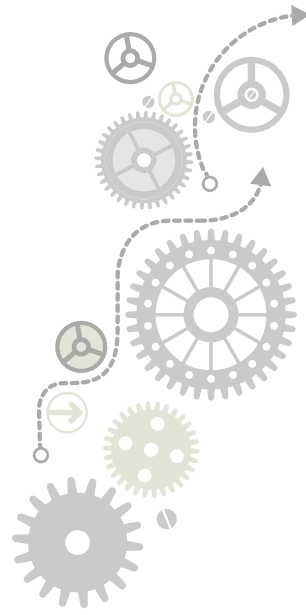
Systems Manual: A system-focused composite document that includes the design and construction documentation, facility guide and operation manual, maintenance information, training information, commissioning process records, and additional information of use to the Owner during occupancy and operations.

Test Procedure: A written protocol that defines methods, personnel, and expectations for tests conducted on components, equipment, assemblies, systems, and interfaces among systems to verify compliance with the Owner's Project Requirements.

Training Plan: A written document that details the expectations, schedule, duration and deliverables of Commissioning Process activities related to training of project operating and maintenance personnel, users, and occupants.

¹ These definitions are taken directly from the BPA "Roadmap", and ASHRAE Standard 202-2013.





APPENDIX B: Commissioning Process Activities and Deliverables.

The Commissioning Process is defined as a quality-focused process for enhancing the delivery of a new and existing building project. The overall process focuses upon verifying and documenting that all of the commissioned systems and assemblies are planned, designed, installed, tested, operated, and maintained to meet the Owner's Project Requirements (OPR).

The commissioning process has a series of actions and schedules for proper completion. Each action has specific deliverables. These define the building and commissioning requirements, the documentation of the performance results, training for the systems, and assemblies commissioned. The actions in the commissioning process shall be:

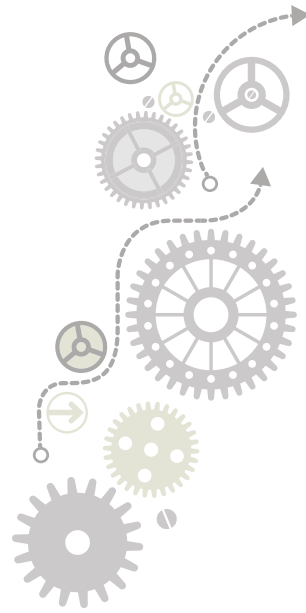
1. The owner initiates the Commissioning Process and retains the commissioning authority at the beginning of the project. The roles and responsibilities of the project and commissioning teams are determined. Procedures and contracts are prepared and executed.
2. Project requirements are then determined and documented, including not only the site and building scope and use but also the performance, training, commissioning and documentation requirements. The deliverable for this action is the Owner's Project Requirements (OPR) document, which is the guiding instruction for the project, and is updated throughout the project.
3. The initial Commissioning Plan is developed in the next step showing the commissioning scope, roles and responsibilities, communication procedures, and design and construction requirements for providing and integrating commissioning into the project. This Commissioning Plan is updated throughout the project with checklists, functional, and performance testing protocols and procedures, schedules and documentation details.
4. The design team then determines and documents the design approach to meet the Owner's Project Requirements. The commissioning authority reviews this Basis of Design (BOD) for conformance to the OPR.
5. During the design phase, the contractor commissioning requirements are determined for each commissioned system, and commissioning specifications are included in the construction documents package.
6. Also in the design phase, the commissioning authority reviews the design documents for conformance to the OPR, and provides the design review report.
7. Early in the project construction, the commissioning team reviews the materials and equipment submittals for conformance to the OPR and construction documents. Discrepancies, problems or inadequacies should be reported. This submittal review and report provides familiarity with the building systems for development of testing and commissioning requirements.
8. As the project is constructed, the commissioning team observes and verifies the installation and witnesses the equipment start up and testing. At system completion, performance testing is conducted and documented in checklists, logs and reports to verify performance compliance with the OPR and design documents.

9. One of the main functions and benefits of commissioning process is the identification and resolution of project issues, in both the design and construction phases, using the Issues and Resolution Log and project team collaboration. The design team and contractors should provide responses to the issues.
10. During design and construction the project documents are assembled into the systems manual that provides the details and history of the design and construction of the building, and information needed to properly operate the building. The systems manual is used in the training of the operations and facility staff and occupants, and is updated throughout the life of the building.
11. In order to operate the building in accordance with the OPR and design capabilities. The building operations, maintenance, and facility staff should be trained on the installed and commissioned equipment and systems. The training plans and records are retained and updated for use in later training.
 - Commissioning logs and interim reports are collected throughout the project and distributed as required by the commissioning plan.
 - At the completion of the project, the commissioning report is assembled and provided to the owner and others as required by the OPR, project documents, and local jurisdiction requirements.

Existing building commissioning processes involve planning, development of Current Facility Requirements (CFR), investigating, testing, project selection and implementation followed by system testing, commissioning, training and final documentation.

To maintain building performance, an on-going commissioning plan is developed and documented during the commissioning process for the use of building staff and occupants.





APPENDIX C: Commissioning Resources

This list of commissioning resources and providers, either published by or recommended by this committee, is intended to provide the user of this guide where to find the best sources of information about the commissioning industry and practices, procedures, means and methods from credentialed and reliable sources.

1. ACG Commissioning Guideline for Building Owners, Design Professionals and Commissioning Service Providers, 2nd Edition, AABC Commissioning Group (ACG), 2005.
2. ASHRAE Guideline 0-2013: The Commissioning Process Guideline.
3. ASHRAE Guideline 1.1, The HVAC Commissioning Process Guideline
4. ASHRAE Standard 202-2013 -- Commissioning Process for Buildings and Systems
5. ASTM E2813 – 12 Standard Practices for Building Enclosure Commissioning
6. Building Commissioning Association (BCA): New Construction Building Commissioning Best Practice
7. Building Commissioning Association (BCA): Best Practices in Commissioning Existing Buildings
8. "Building Commissioning; A Golden Opportunity for Reducing Energy Costs and Greenhouse Gas Emissions", Evan Mills, Ph.D., Lawrence Berkeley National Laboratory; July 21, 2009
9. California Commissioning Guide, 2006
10. Canadian Commissioning Manual, 2006
11. DOE Commissioning Guide, 2011
12. GSA Commissioning Guide, 2005
13. ICC G4- 2012 Guideline for Commissioning
14. ICC/IAS AC 476 Accreditation Criteria for Organizations Providing Training and/or Certification of Commissioning Personnel
15. ICC 1000 – 201X Standard for Commissioning
16. IECC (various commissioning requirements), 2012
17. IgCC (various commissioning requirements), 2012
18. IESNA, The Commissioning Process Applied to Lighting and Control Systems; 2011
19. NAVFAC Design Build Commissioning Manual, 2009
20. NECA 90-2009 Standard for Commissioning Building Electrical Systems.

21. NEBB; Procedural Standards for Whole Building Systems Technical Commissioning for New Construction, National Environmental Balancing Bureau (NEBB), 2014.
22. NEBB; Procedural Standards for the Technical Retro-Commissioning of Existing Building Systems, National Environmental Balancing Bureau (NEBB), 2014.
23. NIBS Guideline 3-2012 Building Enclosure Commissioning Process BECx, National Institute of Building Sciences, 2012.
24. NFPA Commissioning Fire Protection Systems. David R. Hague., 2005
25. SMACNA/ANSI HVAC Systems Commissioning Manual.
26. The Building Commissioning Guide, U.S. General Services Administration, 2005.
27. VA Commissioning Manual, 2010



This guide was developed by a BPA team consisting of twenty-eight ASHRAE members and direct representation by fourteen organizations who are major stakeholders in the commissioning industry. This collaborative effort will lead to improved overall building and system performance while maintaining established industry interests and practices which has led to continuing advances in its technology.

