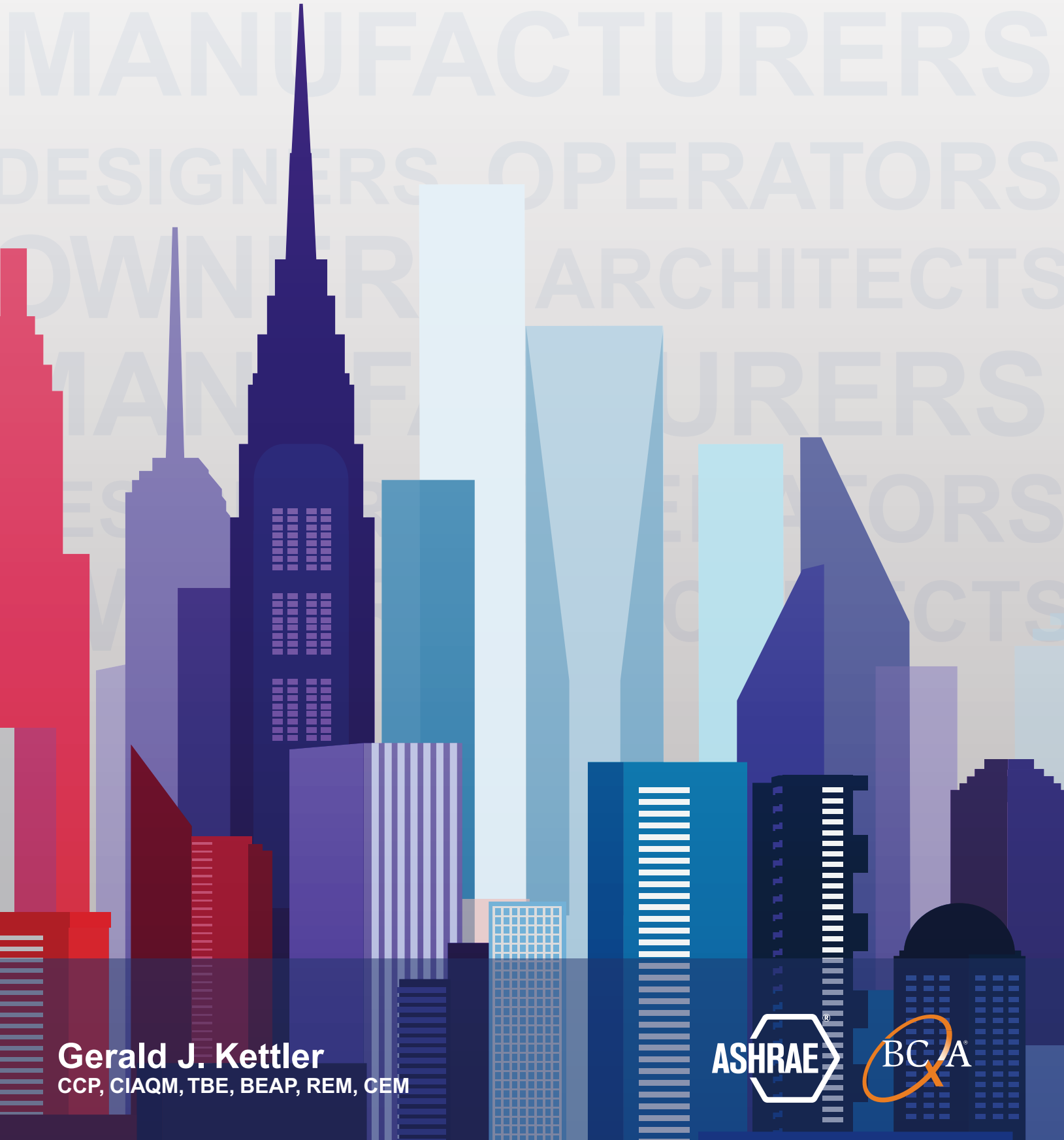
COMMISSIONING
STAKEHOLDERS' GUIDE



Gerald J. Kettler
CCP, CIAQM, TBE, BEAP, REM, CEM

ASHRAE®

BCxA®

Commissioning Stakeholders' Guide

Commissioning Stakeholders' Guide

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ASHRAE
Building Commissioning Association

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ASHRAE and the Building Commissioning Association (BCxA) are pleased to have collaborated in the production of this Commissioning Process Application Stakeholder Guide. In this guide, the author, Gerald J. Kettler, has distilled decades of knowledge and experience in the field, resulting in useful tools for assisting project team members to understand and manage the commissioning process, and to work together with an understanding of each stakeholder's roles and responsibilities in new construction commissioning.

The author is grateful for the expertise and support of Bruce Pitts, Past President, and Liz Fischer, Executive Director, of the Building Commissioning Association (BCxA). We would also like to thank Bradley Brooks and Karl Stum, both highly regarded commissioning providers, for their technical review and professional input. In the code application areas, we also thank Jason Vandever of SPEER, and Dave Walls of the International Code Council (ICC) for reviews and suggestions. Additionally, we want to recognize the leadership of Ross Montgomery in the creation of the ASHRAE document used for the introduction to the commissioning process chapter. The guide could not have been completed without the editorial contributions and review by Diana Bjornskov of the BCxA and production management by Cindy Michaels, Editor of Special Publications at ASHRAE.

Resources for this guide, primarily from the author's extensive personal files and activities, also include information from ASHRAE publications, standards and guidelines including ANSI/ASHRAE/IES Standard 202, *The Commissioning Process for Buildings and Systems*, and related guidelines, the BCxA/APPA *Building Commissioning Handbook* 3rd Edition, and information developed with and for the ICC.

Preface

The *Commissioning Stakeholders' Guide* provides information, checklists, and sample documentation for users and participants in the application of the commissioning process. This guide is not intended to be a user's manual for commissioning providers. It is intended to be used by stakeholders, including project developers and other participants such as members of the building community, Owners, architects, engineers, contractors, manufacturers, suppliers, program administrators, and building officials.

The addition of commissioning requirements to building, energy, and green codes makes the application of an effective and uniform commissioning process mandatory. This guide provides recommendations and methodologies for applying the commissioning process. Building officials, authorities having jurisdiction (AHJs), and sustainability program reviewers will find the resources of this guide helpful, as commissioning is now a requirement.

This guide describes the type and scope of process and documentation that a commissioning stakeholder can reasonably expect during project application. It provides a brief description of the actions required from each stakeholder and a set of checklists to organize and monitor their progress within the commissioning process on a project. The guide also offers selected resources in the form of sample documents, guidelines, and links to outside sources to assist stakeholders in completing their roles. The checklists and sample documents in this guide can be used as starting points for organization, management, and approval of the commissioning process, for document development, and for review of project documents ultimately submitted.

This guide is specifically directed at new construction and major renovation process documentation. The existing building commissioning process can be substantially different from the new construction process and is not covered in this guide.

The commissioning process described and explained in this guide is based on the processes shown in ANSI/ASHRAE/IES Standard 202 and ASHRAE Guideline 0. Many requirements, lists, and examples herein are compiled from these and other ASHRAE, Building Commissioning Association (BCxA) documents, and additional industry sources. Commissioning process best practices are summarized in the Building Commissioning Association's New Construction Commissioning Best Practices documents available free of charge at www.bcxa.org/knowledge-center/best-practices/.

Every commissioning project is unique. Each project requires full cooperation of the building owner and the commissioning team directed by an experienced commissioning provider. The commissioning scope must be set at the project inception, and then scaled and performed based on the owner's project requirements and scope. Each document must be customized to suit the specific project.

Once the decision has been made to include commissioning in the project, the following activities can be conducted using this guide:

- The owner uses the checklist for the type of building being constructed and selects the systems to be commissioned. See Tables 5.1 through 5.10.

- The Owner uses the commissioning activities checklist to select the commissioning process activities to be utilized on the project. See Tables 3.9 and B.1.
- These first two checklists are utilized to select and contract the commissioning provider. See Selecting a Commissioning Provider in Chapter 7.
- Using the OPR checklist the Owner's team, along with assistance from the commissioning provider, and design team if engaged at this time, completes the initial Owner's Project Requirements (OPR). See Table B.2.
- These activities and documents can be used to assist in the selection and contracting of the design and/or construction teams.
- With the assistance of the Commissioning Plan checklist, the commissioning provider assembles the initial Commissioning Plan. See Tables B.3 and B.4.
- With the above information and the Basis of Design (BOD) Checklist, the design team can assemble the BOD. See Table B.5.
- The Owner can then review and approve the Basis of Design and the initial Commissioning Plan.
- During the design process, the design team, along with the assistance of the commissioning provider and utilizing the stakeholder participation checklists and the system commissioning checklists (Tables 6.1 through 6.13), includes the commissioning requirements and specifications in the construction documents.
- During the cost development and proposal process, the contractors, manufacturers and suppliers include the costs and schedules to implement their actions in the commissioning process.
- Where required by code, the building official can use the checklists (See Tables 4.1 and 4.2) to verify construction commissioning requirements and then issue the construction permit.
- During construction, the construction team and the commissioning team conduct the activities of the commissioning process based on the Commissioning Plan. The various checklists (See Tables 6.1 through 6.13) can be used to monitor and check off activity completions.
- Using the provided checklists, the commissioning team assembles the Systems Manual and the training plans that are reviewed by the commissioning provider and Owner. (See Tables B.13 and B.14).
- Depending upon local requirements, the building official could review a preliminary Commissioning Report document or require a document certifying the Owner's receipt of the report before issuing a Certificate of Occupancy.
- At the end of construction, the Systems Manual and final Commissioning Reports are submitted to the Owner and other designated parties. The checklists that have been used to monitor the progress of commissioning should also be included in the Commissioning Report.

This guide is accompanied by downloadable and printable versions of the checklists contained in each chapter, which can be **accessed upon purchase**. These files enable practitioners in the field to use and reuse checklists to fit their specific projects. If the files or information at the link are not accessible, please contact the publisher.

1. Strategic Guide to the Commissioning Process

The following *Strategic Guide to Commissioning* was developed by the ASHRAE Building Performance Alliance to explain the needs, results, and benefits of the Commissioning Process as applied to new construction. It is replicated here with minor changes from the original document, which can also be found at www.ashrae.org//File%20Library/About/Governance/BPABrochureFinalCopy-1.pdf.

1.1 INTRODUCTION TO THE COMMISSIONING PROCESS

This chapter serves as a high-level strategic commissioning description 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 construction and/or major renovations.

This guide is intended to establish and maintain consistent high-level commissioning goals and objectives, including performance, cost-effectiveness, consistency, and best practices. Commissioning can be applied to nearly all building systems and equipment.

1.1.1 STRATEGIC OVERVIEW

Buildings often do not perform as expected, in spite of the best efforts by the parties involved in the building and design process. 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 perform only sometimes or not at all are complex. Historically, the building industry has not stressed enough addressing building performance starting early in project development. Waiting too long to start the Commissioning Process instead of starting at inception can result in fixing problems and delivering performance at the end of the project in lieu of preventing these problems from happening from the beginning. The process, at times in the past, has been approached in a very prescriptive manner, with segregated duties and responsibilities resulting in performance expectations that may not be communicated and are thus many times not met. This guide has chosen a completely different and inclusive path by concentrating on building performance as a priority outcome.

Interpretation of the OPR is a shared responsibility of the Commissioning Provider (CxP), 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.

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; and
- assists and informs building project participants on how to produce and sustain high-quality buildings by ensuring all of the commissioned systems and assemblies are planned, designed, installed, tested, operated, and maintained to meet the OPR for new construction.

1.1.2 USE OF THE COMMISSIONING PROCESS

Building commissioning is a process defined in ASHRAE Guideline 0, *The Commissioning Process* (ASHRAE 2013, pp. 3), as follows:

> *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 Building Commissioning Association (BCxA) also advocates that CxPs include a provision for training building operations personnel in the Commissioning Process.

The Commissioning Process includes defined activities and deliverables that are accomplished throughout the predesign, design, construction, and operations phases of new construction projects. The commissioning actions and documents in this guide provide the plans, procedures, coordination, verification, and project records that will produce a high-performance building. It is recognized that specific and detailed commissioning procedural methods and means may differ slightly from organization to organization.

In terms of building performance, the Commissioning Process helps Owners and Project Teams achieve quality performance in new and existing buildings. The new construction Commissioning Process differs from Existing Building Commissioning (EBCx), because the forensic (investigative) components of EBCx are unnecessary for new projects. EBCx may also be referred to as *retrocommissioning* (RCx) or *recommissioning* (ReCx). For simplicity, this guide does not specifically address EBCx.

Postoccupancy Ongoing Commissioning (OCx) can also contribute to sustaining optimal performance over time, delivering energy efficiency and operational savings. OCx is a process of continuously testing and/or tuning building systems to maintain building performance as expected, in keeping with the OPR.

Special systems and assembly commissioning expertise, such as building enclosure commissioning (BECx), can be required for buildings. This process is often complex and requires review and testing of enclosure materials and assemblies interfaces.

1.1.3 VALUE AND BENEFITS OF COMMISSIONING

Commissioning provides value and benefits to the Owner, the project design and Construction Teams, and ultimately the occupants and building operators in many ways.

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.

This guide has many examples and resources that explain in detail how commissioning has proven to be valuable and useful. According to Mills, "[Commissioning results in] 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% [are] achieved." The author goes on to say that "commissioning is the single most cost-effective strategy for reducing energy, costs, and greenhouse gas emissions in buildings today" (Mills 2009). An update to the

Mills study is underway, spearheaded by BCxA in collaboration with Lawrence Berkeley National Laboratory. The will modernize the findings of 2009 to 2018.

Buildings are as diverse as the people who use 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 CxP in integrating its multifaceted levels and phases to achieve a project's maximum potential.

Facilitation of the design and construction phases, and third-party independent review from phase to phase, add value to the process and the building performance outcome. These activities are performed by a CxP who 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 and operations. Commissioning documentation and verification can lead to obtaining various energy, comfort, indoor air quality (IAQ), indoor environmental quality (IEQ), and high-performing building awards, while enhancing the learning experience and helping to perpetuate the buildings' sustainability aspects.

OWNER'S PROJECT REQUIREMENTS (OPR)

The process of developing the OPR and updating and validating fulfillment of the OPR from conception through occupancy and operation keeps the Owner, Design Team, and Construction Team focused on delivery of the end product. The CxP focuses on the OPR at every stage of project delivery, reducing or eliminating undocumented changes in design requirements.

The CxP 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 OPR.

COMMISSIONING PROCESS FUNCTIONS

The Commissioning Process streamlines and accelerates the project workflow from start to finish. Scheduling and meeting milestones are enhanced by monitoring and intervention/facilitation by the CxP, for example:

- Design and submittal reviews ensure compliance with OPR 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 ensures 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.

PROJECT TEAM (PLANNING, DESIGN, CONSTRUCTION)

As a result of the Commissioning Process, the Owner, designer, contractor, and operator encounter fewer costs caused by downtime, delays, change orders, clarifications, and requests for extension of time for completion. Owners, designers, and contractors realize the independent CxP is working in their best interests to facilitate and assist in executing the project schedule and milestones based on unbiased execution of the OPR.

Designers benefit by commissioning review because commissioning diligence verifies the design works properly and is provided in accordance with the OPR. 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 retesting of poor results ensure the project works in compliance with the OPR.

The Construction Team, vendors, and product manufacturers realize the benefit of concentrating on products and activities that meet the OPR 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, callbacks, and building downtime caused by repairs are reduced because the systems are tested and performance is verified prior to occupancy.

PERFORMANCE AND OPERATION OUTCOMES

The operational outcomes in terms of minimizing costs and maximizing building performance are numerous. Training is facilitated and enhanced by requiring a training plan and curriculum followed by monitoring and documentation of results. Operation and maintenance (O&M) staff are provided with comprehensive Systems Manuals and O&M documentation that allow seamless transfer of knowledge and understanding of the building's equipment and systems. Building users and occupants 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.

1.1.4 PERFORMANCE REQUIREMENTS

Commissioning performance requirements are a function of the specific project. The performance requirements document goals, expectations, values, and benefits expected to be achieved in a successful new construction project.

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

The OPR must clearly define the expected building performance and outcomes from the Commissioning Process. These documents can require considerable effort from the Owner or project manager and the CxP working collaboratively. They define the project criteria to be used in developing an appropriate Commissioning Plan (Cx Plan) for systems to be commissioned. The purpose of the facility, commissioning activities to be performed, and operator's capabilities are some of the many items that must be included in the Cx Plan.

Commissioning can be used to document and achieve these goals without jeopardizing other performance requirements such as IEQ. The Commissioning Process can be used to ensure the goals of technology integration, interoperability, sustainability, and coordination are achieved while at the same time minimizing effects of unintended consequences.

OWNER'S PROJECT REQUIREMENTS

The OPR should contain performance requirements for the building, such as the following:

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

1.1.5 COMMISSIONING PROVIDER CHARACTERISTICS

The CxP 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. It is important that the selection of a CxP 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 CxP's contract for services. There are many key skills, characteristics, and ethics required to perform successful and effective commissioning.

The CxP is an objective and independent advocate for the Owner. The CxP should work directly for the Owner, keeping the Owner's objectives and best interests as the top priority.

A conflict of interest may exist if the CxP's firm has other project responsibilities or functions and/or is not under direct contract to the Owner. The CxP needs to be a third-party, independent provider without any financial or business interests or potential conflicts of interest that would interfere with the faithful execution of their duties. Wherever this occurs, the CxP should disclose, in writing, the nature of the conflict and the means by which the conflict will be managed.

The CxP does not provide peer review but ensures that the OPR is being met by all parties involved in the project. The CxP's function is to facilitate the process, ensure 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 CxP should have current engineering knowledge, with extensive and relevant hands-on field experience in the area of expertise of their commissioning discipline. The CxP should be credentialed and certified by a reliable, nationally recognized, and credible professional association/organization specializing in the commissioning business.

The CxP 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 the building. Situations may arise during decision-making points in the Commissioning Process that require the CxP to address difficult decisions, deliberations, and/or conversations; these should be handled with the utmost professionalism and ethics. Because the CxP facilitates 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 CxP any rights or responsibilities to overrule and/or perform the specific work of the project's professional teams.

The CxP 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 CxP's technical skills with communication skills that are critical to the long-term success of the building.

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

The most critical players for accomplishing the Commissioning Process are the CxP and the individuals performing the commissioning work. The criteria for CxPs include knowledge, skill, experience, equipment, independence, and integrity.

It is not the purpose of this guide to define or recommend certification programs. However, it is universally recommended that a CxP be selected and retained by the use of a qualifications-based system. For building performance, the selection of the CxP is as important as the design and Construction Team selection. Several United States national certification programs accredited to ISO/IEC 17024:2012 (ISO 2012) exist, which determine that an individual has demonstrated expertise in knowledge and experience in the Commissioning Process and technical knowledge to deliver the tasks, with the skills and abilities using the required equipment and resources available.

1.1.6. COMMISSIONING EXPECTATIONS

Using the Commissioning Process as outlined in this guide will result in better buildings and building systems. It will support quality-focused, mutually acceptable Commissioning Processes and procedures. The ultimate intent is to make the Owner confident and satisfied that "they got what they paid for," at minimized risk, and with met/exceeded scheduling targets and financial goals.

The strategic commissioning suggestions outlined in this guide provide benefits to the key customers and stakeholders of buildings, most importantly the Owner. Commissioning has been proven to save time and costs for the Owner, designer, and contracting team members.

This guide provides principles of commissioning for a broad audience of users who are associated with the building commissioning verification approach to improving performance and the built environment after building turnover. These principles can be used to enhance building performance at many levels: establishing benchmarks, exploring opportunities for increased efficiencies, achieving the goals of these metrics and methodologies, improving overall building performance, enhancing maintenance and operations, improving occupant comfort, and achieving energy efficiency/reduction.

Effective commissioning provides opportunities to enhance integrated design, improve timely construction procedures, lower warranty costs, and properly train operators—all leading to satisfied building occupants.

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

This guide is useful for communicating overarching commissioning goals and objectives that can be used as a common foundation for all providers and users of commissioning services. Fully applied Commissioning Processes and procedures, from project inception through building testing and occupancy, are the best and most cost-effective way to improve building performance and operation.

REFERENCES

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