International Code Council

Guideline 4

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ICC G4 - 2019 COMMISSIONING PROCESS APPLICATION

DRAFT

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INTERNATIONAL CODE COUNCIL®

ICC Commissioning Guideline 4

1.0 Introduction

1.1 Guideline Purpose and Scope: The purpose and scope of this document is to provide guidance for a code official or regulator to use in order to understand and effectively enforce the commissioning process application on new construction projects, either with in-house staff or the use of a third party agency. It is not intended to specify what the various aspects of the commissioning process are; rather it deals with the issues related to the above goals and criteria ~~(implementation and enforcement)~~ (to accept, implement, enforce and document the commissioning provisions established in codes to accepted national commissioning standards). This guideline can also be used by entities utilizing the commissioning process for complying with code requirements or developing owners project requirements and project documentation. This guideline is not a code and, therefore, is not written in enforceable language. However, this document could be adopted in whole or in part by the authority having jurisdiction (AHJ) and utilized by other entities. In writing this document, an effort was made to make this document as comprehensive as possible, so that it can be used in conjunction with codes and standards that require or include commissioning. ~~This guideline was designed to support the adoption and application of the International Green Construction Code™ (IgCC™) and its alternate compliance paths, ASHRAE 189.1 and the ICC 700, as well as regional green building codes such as CALGreen.~~

In most codes and building standards, the document does not address how building commissioning should be verified by the building official or AHJ, nor does it address the process of commissioning, it simply specifies which systems need to be commissioned. The enforcement and verification is usually determined by the local AHJ.

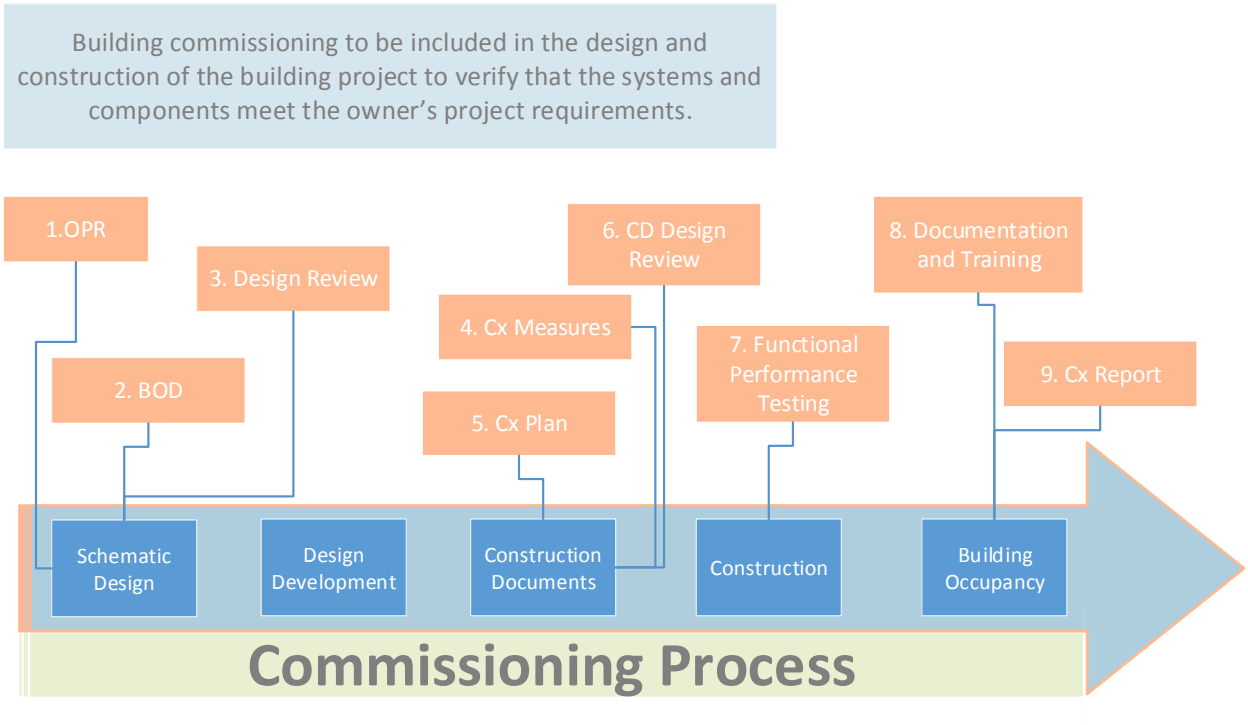
In order to facilitate the building official or enforcement agency's verification that building commissioning is performed appropriately and by qualified personnel, this guideline provides process recommendations to specify the components that must be examined within each system being commissioned, the forms that should be completed, and the information that must be provided in the commissioning plans and reports, as well as other documents. This guideline also provides recommendations on the minimum qualifications, knowledge, equipment, and skills that commissioning providers should have.

1.2 Commissioning Background: Building commissioning has been practiced for many years, but only recently has it become a code requirement in some jurisdictions. As a result, commissioning has not been regulated widely. Commissioning varies in how it is applied with HVAC and energy using systems usually being the focal point. Additionally, industry practices and codes are moving into new areas of commissioning other than HVAC, such as plumbing systems, electrical systems, building envelope, and renewable energy systems. Based on the expansion of building commissioning into other areas, its growing popularity, and the desire to make this document suitable for most codes and standards, the guideline addresses more areas than required by most of the current building codes, such as elevators, building enclosures, and fire suppression systems.

Moreover, the guideline addresses what are deemed essential commissioning activities such as; the owner's project requirements, basis of design, commissioning plans, specifications, design plan and submittal reviews, inspection and verification, functional and performance testing, systems manual, training and reporting. Given their significance to the commissioning process, these activities are appropriate and important to address in this document, and in commissioning enforcement.

Current building commissioning practice does not have a standard for the minimum number of systems or components and equipment within a system that need to be tested. The decision on inclusion of minimum systems to be commissioned is determined by the applicable code. The addition of other systems to be commissioned is left up to the owner and commissioning provider. As part of the commissioning process, a

project commissioning plan is to be provided that will list and include all the components, equipment and systems to be commissioned along with process descriptions, requirements, and responsibilities.



This guideline is intended primarily for new building and major renovation commissioning application. There can be major variations in the commissioning process for existing buildings operations and those variations are not detailed in this guideline.

1.3 **Referenced Standards:**

The standards referenced in this guideline shall be considered part of the process and recommendations of this guideline to the prescribed extent of each such reference

1.3.1 ASHRAE/ANSI Standard 202-2013, The Commissioning Process for Buildings and Systems.

1.3.2 International Energy Conservation Code-2015

1.3.3 International Green Construction Code - 2015

2 Definitions

2.1 a. General. ~~The definitions used in this document are~~ For the purpose of this guideline, the terms listed have the indicated meaning.

b. Undefined terms. The meaning of terms not specifically defined in this document or in

referenced codes and standards shall have ordinarily accepted meanings such as the context implies.

c. Interchangeability. Words, terms and phrases used in the singular include the plural and the plural the singular.

2.2 Acronyms

The following acronyms are used throughout the guideline.

BAS Building Automation Systems
BOD Basis of Design
CF Compliance Form
Cx Commissioning Process
CxA Commissioning Authority
CxP Commissioning Provider
EPA Environmental Protection Agency
FT Functional Test
PT Performance Test
FPT Functional and Performance Test
HVAC Heating, Ventilating and Air Conditioning
LEED Leadership in Energy and Environmental Design
OCx On-Going Commissioning Process
O&M Operations and Maintenance
OPR Owner's project requirements

2. Commissioning Definitions (reference ASHRAE Standard 202)

The following definitions are industry accepted definitions utilized in Commissioning Standards and are presented here to improve the understanding of the commissioning process.

***Acceptance Test*:** 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 are being achieved. Checklists are used for general evaluation, testing, training, and other design and construction requirements.

***Commissioning (Cx)*:** See Commissioning Process.

***Commissioning Provider*:** An entity identified by the Owner who leads, plans, schedules, and coordinates the commissioning team to implement the Commissioning Process.

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

***Commissioning Process*:** A quality-focused process for enhancing the delivery of a project. The 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 and project design.

***Commissioning Process Activities*:** Components of the Commissioning Process.

***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, who through coordinated actions, are responsible for implementing the Commissioning Process.

Functional 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.

Construction Checklist*:** A form used by the commissioning team to verify that appropriate materials and components are on-site, ready for installation, correctly installed, functional, and in compliance with the Owner's Project Requirements. Also see ***Checklists.

***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.

Construction Team: the construction team consists of the professionals responsible for providing materials and labor to construct the systems and assemblies in the project. Where a construction project follows a design/build approach, the construction team includes licensed design professionals who are part of the design team

***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.

Cx Provider Team (CxP Team): The CxP Team is the team of specialists and related support staff who are responsible for the management of actions and the generation of deliverables by the CxP as outlined in the contract between the Owner and the CxP, and the Cx Plan. The CxP Team may consist of several companies, including subcontractors to the CxP who acts as the contact to the owner.

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. Also see ***Checklists***.

Design Review – ***PEER*****:** An independent and objective technical review of the Project design or a part there of 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.

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.

Existing Building Commissioning Process**:** A quality-focused process for developing the Current Facility Requirements of an existing facility and its systems and assemblies being commissioned. 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.

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.

On-Going Commissioning Process (OCx)**:** A continuation of the Commissioning Process that extends well into Occupancy and Operations in order to continually improve the operation and performance of a facility to meet current and evolving Current Facility Requirements or Owner's Project Requirements. On-Going Commissioning Process activities occur throughout the life of the facility.

***Owner's Project Requirements (OPR)*:** A document that details the requirements of a project and the expectations of how it will be used and operated including project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, training requirements, documentation requirements and supporting information. (The term Project Intent or Design Intent is used by some owners for their Commissioning Process Owner's Project Requirements.)

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.

Project Team: the project team consists of select members of all the teams defined in the project documents. The project team provides a venue for coordinating actions and information flows between all staff who are involved in the project and Cx activities.

***Re-Commissioning*:** (See Existing Building Commissioning.) An application of the Commissioning Process requirements to a project that has been delivered using the Commissioning Process.

Retro-Commissioning: (See Existing Building Commissioning.) The Commissioning Process applied to an existing facility that was not previously commissioned.

Sequence of operation. A written description of the intended function and response of each control element and feature of the equipment and associated systems based on a given set of anticipated operating conditions

***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 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.

3 Commissioning Process Fundamentals

3.1 Standard Process for New Building Commissioning– ASHRAE Standard 202

In ASHRAE Standard 202-2013, *The Commissioning Process for Buildings and Systems*, **i**s defined as "A quality-focused process for enhancing the delivery of a project. The 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."

As a process, commissioning has a series of actions for proper completion with each action having specific deliverables. These deliverables define the building requirements, the commissioning requirements, and the documentation of the process and performance results for the building, systems and assemblies commissioned.

The actions in the commissioning process are as follows:

1. INITIATION: The owner initiates the Commissioning Process at the beginning of the project, and determines the roles and responsibilities of the project and commissioning teams. Procedures and contracts should be prepared and executed. The Commissioning Provider should be retained at this time.

2. OWNER'S PROJECT REQUIREMENTS: Next the project requirements should be determined and documented. This includes not only the building scope and use but also the system performance, training, testing, 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. The OPR is updated throughout the design and construction of the project.

3. COMMISSIONING PLAN: The initial Commissioning Process Plan should be developed that shows the commissioning scope, roles and responsibilities, communication procedures, and design and construction requirements for providing and integrating commissioning into the project. The deliverable is the Commissioning Process Plan that is updated throughout the project with checklists, schedules and documentation details.

4. BASIS OF DESIGN: The design team then determines and documents the design approach to meet the Owner's Project Requirements. The deliverable for this action is the Basis of Design (BoD) document which is the guiding technical process for the project on the approach the design team will take to accomplish the OPR. The Commissioning Provider reviews the Basis of Design (BOD) for conformance to the OPR.

5. SPECIFICATIONS: During the design phase the contractor commissioning requirements should be determined for each system and included in the commissioning specifications for the construction documents package. The Commissioning Provider assists the design team in the development of the commissioning specifications.

6. DESIGN REVIEW: In the design phase and at the completion of design the Commissioning Provider reviews the design and documents for conformance to the OPR. These reviews should be assembled in the design review report. The design review by the commissioning provider is not considered a PEER review, or a code review, and does not replace these functions.

7. SUBMITTAL REVIEW: Early in the project construction, the commissioning team reviews the materials and equipment submittals for conformance to the OPR and construction documents This provides familiarity with the building systems for development of testing and commissioning procedures, requirements, and checklists. These reviews should be summarized in the submittal review report.

8. SYSTEM VERIFICATION: As the project is constructed, the commissioning team observes and verifies the installation and performs or witnesses the equipment start up and testing. The air conditioning system test and balance process and report should be reviewed and verified by the Commissioning Provider to assure system operation and compliance with the project documents.

9. FUNCTIONAL AND PERFORMANCE TESTING: At system completion, functional and performance testing is conducted to verify performance compliance with the OPR and design documents. The results of these verification processes should be recorded in the construction checklists and reports. These reports should be included in the project commissioning report.

10. ISSUES and RESOLUTION LOG: One of the main functions and benefits of the commissioning process is the identification and resolution of project issues, both design and construction. These actions should be presented in the issues and resolution log facilitating communications, and project team collaboration, and the ultimate resolution of the issue. The final issues log should be included in

the final commissioning report.

11. SYSTEMS MANUAL: During the design and construction of the project, the design and construction documents should be assembled into the systems manual. This assembly of documents provides the details and history of the design and construction of the building and information needed to properly operate the building. The systems manual includes the project final OPR, BOD, construction record documents, submittals, completed startup, verification checklists, functional and performance checklists, verified sequence of operation, facility guide, training records, and commissioning report. The systems manual should be used in the initial and subsequent training of the building operations staff and occupants. The systems manual should be updated throughout the life of the building.

12. TRAINING: To operate the building in accordance with the OPR and design capabilities, the building staff must be trained on the installed equipment and systems. The suppliers and contractors will normally conduct the training with the training being observed by the commissioning team. The training plans and records should be retained and updated for use in later training.

13. OPERATION PHASE: Commissioning that was not performed due to climatic conditions or equipment availability before initial certificate of occupancy should be conducted during post occupancy. The end of warranty commissioning report documents these activities. The final testing results should be included in the final commissioning report and systems manual.

14. COMMISSIONING REPORT: Commissioning plans and interim reports should be collected and distributed throughout the project as required by the commissioning plan. A preliminary commissioning report should be prepared that shows the commissioning progress and equipment performance to date at the time the Certificate of Occupancy is issued. At the completion of the project the final commissioning report should be assembled and provided to the owner and others as required by the OPR and local jurisdiction requirements. This report includes the final commissioning plan, copy of design and submittal review reports, all startup, inspection, verification, functional and performance test forms and reports, the verified sequence of operation, the final issue and resolution log, and summary of the performance of commissioned systems.

3.2 New Building Commissioning Process Activity, Deliverables, and Responsibilities

The application of the commissioning process can be for the delivery of either all or selected systems and assemblies in a project. The commissioning scope will depend upon how the project will be designed, built, and operated. The scope is defined in the Owner's Project Requirements and the Commissioning Plan, and performed based on the extent of commissioning effort defined and procured. The process described in the following sections and appendices is written for a generic project and must be adapted to each project. The Commissioning Process can be supplemented by companion technical documents and guidelines to describe the specific details and to properly implement the Commissioning Process relative to a specific facility, system, or assembly. This process can be applied to both new and renovation projects. Commissioning of existing buildings, unless covered in a renovation, is not included in this guideline for two reasons. First, the focus of this guideline is on code required commissioning on new projects, and second the commissioning process on an ongoing building operation is much more variable and dependent upon specific building operation and project requirements, and may not be code required.

The requirements of the commissioning process are to:

a) Provide the activities for the application of the Commissioning Process in the design, development, construction, operation, and modification of physical buildings, systems and assemblies.

b) Establish the commissioning process activities and sequence of activities.

c) Establish commissioning deliverables and documentation for the process application.

d) Establish an acceptance procedure for commissioned systems and project completion

Acceptance. The process for each activity and deliverable shall include an acceptance step as defined in the OPR and Commissioning Plan. This step shall formalize the acceptance of the commissioning deliverable by the owner or client, and/or the Authority Having Jurisdiction if required. Under common practice, the Commissioning Provider is not required to "accept" designers or contractors work on behalf of the owner or jurisdiction.

THE COMMISSIONING PROCESS

This chart provides an outline of normal activities, documentation, and responsibility included in the Commissioning Process

THE COMMISSIONING PROCESS ACTIVITIES, DELIVERABLES AND RESPONSIBILITIES (Reference ASHRAE Standard 202 and ASHRAE Guideline 0)

Item	Activity	Deliverable	Normally Provided By	Normally Approved By	For Use By
1.	Project Commissioning Initiation	Contract and work orders: Roles and Responsibilities	Owner	Owner	Owner
2	Owner's Project Requirements	OPR document	Owner with assistance from design and Cx teams	Owner	Owner, Design Team, Cx Team
3	Basis of Design	BoD document	Design team	Owner with review by CxP	Owner, Design Team, Cx Team
4	Commissioning Plan	Cx Plan	Cx provider with input from owner, design team, and contractor	Owner with reviews by design team and contractor team	Cx Team, Construction Team, AHJ
5	Contractor Cx Requirements	Project specifications	Design team and Cx provider	CxP with Owner review	Contractors and Suppliers
6	Design Review	Design review report	Cx provider	CxP with Design Team Response	Owner, Design Team
7	Submittal Review	Submittal review report	Cx provider	CxP with Owner review and contractor response	Design Team, Contractors, Suppliers
8	Cx designated systems inspections, functional and performance testing	Installation, inspection, functional test reports, performance test reports	Contractors, manufacturers, Cx provider and team	CxP with owner review	Contractors and Suppliers
9	Issue and Resolution Log	Issue and resolution logs	Cx provider with input from design and construction team	CxP with Owner, Design Team and Contractor response.	Owner, Design and Cx Teams, Contractors

10	Develop Systems Manual	Systems Manual	Contractors with review by Cx provider	CxP with review by Owner, Operators and Design Team	Owner, Building Operators
11	Training	Training plan and reports	Contactors and manufacturers with review by Cx provider	Owner with CxP review	Building Operators
12	Preliminary Cx Report	Preliminary Cx report	Cx provider	CxP, Owner and if required, AHJ	Owner, Contractors, AHJ
13	Post Occupancy Operation	Additional information, testing, and updates to reports	Cx provider and building operations	Owner	Owner, Building Operators
14	Commissioning Reports	Preliminary and Final Cx reports	Cx provider	CxP, Owner and if required, AHJ	Owner, Operators, AHJ

4 Code Compliance with Building Commissioning Process

4.0 INTRODUCTION: The application of the Commissioning Process starts at the beginning of the project inception and goes through building occupancy. Each project phase has required activities that need to be completed during that phase. During the planning and design process, the Commissioning Provider is retained, the systems to be commissioned are selected, the Owner's Project Requirements are developed, the Basis of Design documents are developed and reviewed, the preliminary commissioning plan is written, and commissioning specifications are included in the construction documents. While the code required building systems must be on the list of selected systems to be commissioned, the owner or designer may also select additional systems.
The AHJ needs assurance that these activities are completed before a permit is issued. The AHJ can request a copy of all the documents for review or rely on the approval by the Commissioning Provider and Owner or owner's representative.

4.1 Commissioning Process Management: A qualified Commissioning Provider is designated at the beginning of the project to coordinate the commissioning process and the work of any Commissioning Specialists, and to submit the documentation required by code. Qualified Commissioning Specialists are designated to commission systems for which specialized technical certification or licenses are required.

Where more than one system and more than one person or entity is involved in the commissioning process the principal Commissioning Provider is selected and coordinates the process and the documentation.

4.2 Documentation of Applicable Commissioning Code Requirements

The following documentation is provided for each instance of an applicable commissioning requirement in an applicable code or standard

a. Applicable code requirements, with code section reference numbers and including any performance, environmental, sustainability, or efficiency requirements of those codes;

b. Description of technical approach to compliance;

c. Equipment and systems to be commissioned; and

d. Specific process requirements for the commissioning of each element, including: plans, reviews,

logs, evaluation, testing, training, reports, and documentation.

4.3 Commissioning documentation required at permit application. At the time of permit application, the designated commissioning provider verifies that the following documentation is provided for each system requiring commissioning according to the national commissioning standard, applicable codes and jurisdictional requirements:

a. The Commissioning Plan has been developed.

b. Design documents include a requirement to perform commissioning in accordance with this standard and applicable codes, system and equipment performance criteria has been included, and the design documents have been reviewed by the Commissioning Provider.

c. Where an Owner's Project Requirements document is available or required by an applicable code or the code official, or the owner, it is provided.

d. Where a Basis of Design document is available or required by an applicable code or code official, or owner, it is provided.

4.4 Commissioning documentation required before final inspection or issuance of the certificate of occupancy. Prior to final inspection and issuance of the certificate of occupancy, documentation is provided demonstrating that the Commissioning Plan was completed as applicable up to the time of final inspection. The following commissioning work must have been completed according to national commissioning standard for each system for which applicable standards and codes require commissioning, and according to the commissioning plan, project documentation, and standards:

a. Materials and equipment submittals have been reviewed by the commissioning team for conformance to project documentation.

b. Commissioning Issue and Resolution Logs have been maintained and code items completed.

c. Equipment testing has been performed, witnessed, and documented by the commissioning team.

d. Project documents have been assembled and the Systems Manual prepared and provided to the owner.

e. The building operations, maintenance, and facility staff has been trained on the installed and commissioned equipment and systems. The training plans and records have been retained and updated for use in later training.

f. The preliminary commissioning report has been completed and provided to the owner.

4.5 Post Occupancy Commissioning The building commissioning shall be completed with the results and documentation provided to the owner in accordance with the commissioning plan at the end of construction. The authority having jurisdiction may request reports and documentation at their discretion. Subsequent to the commissioning process during construction, an on-going commissioning process can be utilized to verify and maintain continuing building performance. The procedures for the on-going process may vary with the owner's requirements and the type of facility.

4.6 Documentation and Compliance Checklists

4.6.1 DESIGN DOCUMENTS-COMMISSIONED SYSTEMS: Energy and Green Codes usually require

at a minimum that mechanical systems, service water heating systems and lighting control systems be completed and commissioned. The construction documents including notes and specifications shall clearly indicate provisions for commissioning, and system performance and completion requirements. These construction document requirements convey the owner's requirements (OPR) and the designer's criteria (BOD) for the performance and commissioning process for the designated systems.

4.6.2 COMMISSIONING PLAN: The following is an outline of the contents of a typical commissioning plan. The Commissioning Plan is developed by an approved commissioning provider for all systems to be commissioned and/or tested and shall include the following items:

a. A narrative of the commissioning process developed specifically for the project.
b. The roles and responsibilities for the commissioning providers and the commissioning team through final commissioning activities.
c. Documentation of communication channels and processes including the distribution of the commissioning plan, logs, testing documents and reports during the design and construction process.
d. A detailed description of conditions and schedules of the commissioning process activities, and the list of operations, functions, systems, and assemblies that will be commissioned. Measurable performance criteria shall be included where not shown on the construction documents.
e. The project design documentation and submittal review procedures and reports.
f. Inspection checklists and testing forms, issues and resolution log, and commissioning progress reports to be used during the project to communicate and track commissioning and inspection process information, including format, approvals and distribution.
g. The procedures to follow for resolution where the system performance does not meet the Owner's Project Requirements or design documents.

4.6.3 Construction Phase Commissioning Reports Some of the commissioning testing can be done after the certificate of occupancy inspections. Environmental and seasonal condition may not provide adequate testing condition, particularly for mechanical equipment. Construction schedules may not allow testing of incomplete systems. Thus, it is necessary to verify the required commissioning performance up to the point of final AHJ inspection. This can be done by having the revised commissioning and project documents collected along with the testing results up to that time. The preliminary commissioning report and issue logs need to include the project open items including future testing and equipment and systems currently not meeting requirements.

Depending upon the jurisdictional requirements, this preliminary commissioning report or a form approved by the Commissioning Provider and/or Owner or owner's representative is submitted and reviewed by the AHJ.

4.6.4 FUNCTIONAL and PERFORMANCE TESTING REPORTS: Equipment functional and performance testing shall demonstrate the installation and operation of components, systems, and system-to-system interfacing relationships in accordance with approved plans and specifications such that operation, function and maintenance serviceability for each commissioned system is confirmed in all modes of operation.

4.6.5 TESTING and BALANCING REPORT: HVAC systems shall be balanced in accordance with industry accepted engineering standards, and the project documents. A written report shall be submitted and reviewed by the Commissioning Provider describing the activities and measurements completed.

4.6.6 SYSTEMS MANUAL: A Systems Manual **i**ncluding an operations and maintenance manual is provided and includes:

a. Submittal data and intended operation
b. Manufacturer's operations manuals and maintenance manuals
c. Listing of at least one service agency
d. Controls maintenance and calibration information
e. Verified sequence of operation with set points
f. Schedule for inspecting and recalibrating

4.6.7 COMMISSIONING REPORTS: The following are outlines of typical contents for the preliminary and final commissioning reports. Due to project scheduling, it may be necessary to provide a preliminary commissioning report on project commissioning status and equipment operation to obtain a certificate of occupancy. Some codes require that the design professional or approved agency provide the preliminary report to the owner. The code could also require that the owner then provides a letter of receipt for the preliminary report to the AHJ to proceed with final inspection.

4.6.7.1 Preliminary Commissioning Report*:* The commissioning provider submits a Preliminary Commissioning Report to the owner that includes the following information:

a. Performance of commissioned equipment, systems, and assemblies, including a review of the HVAC test and balance report.
b. Issue and resolution logs including itemization of deficiencies found during testing and commissioning that have not been corrected at the time of report preparation.
c. Deferred tests that cannot be performed at the time of preliminary report.
d. A plan for the completion of commissioning including climatic and other conditions required for performance of the deferred tests.

4.6.7.2 Final Commissioning Report: The Commissioning Provider submits a final Commissioning Report to the owner prior to project completion that includes the following information:

a. A copy of the final commissioning plan including functional and performance test procedures used during the commissioning process including measurable criteria for test acceptance.
b. A copy of the design and submittal reviews as required by the commissioning plan
c. Results of all evaluations, startup data, functional and performance tests, reports and checklists by suppliers, contractors, observers, and commissioning providers.
d. Issue logs and disposition of all deficiencies found during testing, including details of corrective measures used or proposed.
e. Equipment, systems, and assemblies repaired and adjustments to calibrations.
f. Equipment and systems sequences and settings shall be documented and submitted in the final sequence of operation with set points and in the O&M or systems manual.
g A resolution plan identifying all the issues unresolved and incomplete at the end of the project.

4.6.8 **COMMISSIONING CHECKLIST FOR PERMIT:** The following checklist is a guide for collecting the information associated with the Commissioning Process activities prior to the issuance of a construction permit. The information should be developed by the project team in collaboration with the owner. All documents are retained and included in the Systems Manual and/or final commissioning report. The recommended contents for the commissioning documents listed are shown in other sections of this guide. The form can be completed

by the owner, CxP or design team. The CxP reviews the subject information and approves the form for submission with the permit request. This assures that the CxP has been engaged before the start of construction.

COMMISSIONING PLAN DOCUMENTATION FOR PERMIT

Project Name: _____

Project Address: _____ Permit Number: _____

Commissioning Provider: _____

Company/Entity address: _____

CxP Phone Number: _____ CxP email address: _____

CxP Certification (if required) _____

ITEM #	COMMISSIONING DOCUMENTATION COMPLETED	APPROVAL
	1. Commissioning Project Design Requirements	
	Project commissioning requirements, listing of equipment to be commissioned, system performance requirements, commissioning specification shown on project contract documents.	
	2. Commissioning Plan	
	Initial commissioning plan (for Permit) completed with required contents and provided for Owner and AHJ review.	
	3. Design Review	
	Commissioning design documents review, report completed with response.	

Commissioning Provider Acknowledgement

I have reviewed the documents and verified that they meet the owner's project requirements:

Name: _____

Company Name _____

CxP Signature: _____ Date: _____

4.6.9 COMMISSIONING CHECKLIST FOR CERTIFICATE OF OCCUPANCY: The checklist below is a guide for collecting the information associated with the Commissioning Process activities up to the time of final or CO inspection. The information should be developed by the project team in collaboration with the Commissioning Provider and owner. All documents are retained and included in the Systems Manual and/or final commissioning report. The recommended contents for the commissioning documents listed are shown in other sections of this guide. The review and approval by the CxP and

Owner assures the AHJ that the Commissioning Process has been implemented and completed to the extent necessary for the issuance of the CO.

Commissioning activities and documentation developed after certificate of occupancy inspection shall also be included in the Systems Manual and final commissioning report. These records are provided to the Owner or owner's representative and, if requested, to the AHJ.

COMMISSIONING DOCUMENTATION for FINAL INSPECTION and CO

Project Name:

Project Address: Permit Number:

Commissioning Provider (CxP):

Company/CxP address :

CxP Phone Number: CxP email address:

CxP Certification (if required)

ITEM #	COMMISSIONING DOCUMENTATION	APPROVAL CxP INITIAL
	1. Project Commissioning Requirements	
	Project commissioning requirements included in project contract documents.	
	2. Commissioning Plan	
	Commissioning Plan with checklists (before start of functional testing) completed.	
	3. Contractor and Construction Instructions	
	Plans and commissioning specifications utilized.	
	4. Design and Construction Submittal Review	
	Design documents review and construction submittal review and reports completed	
	5. Commissioning Issue and Resolution Log	
	Issues and Resolution Logs completed up to time of final inspection with open items shown.	
	6. Commissioning Testing	
	Commissioning checklists completed up to time of final inspection	
	7. Equipment Commissioned and to be commissioned	
	Listing of equipment with commissioning complete. Listing of equipment that remain to be commissioned and deferred tests. Plan for completion.	
	8. Test and Balance Report	
	Test and balance of HVAC completed and report reviewed.	
	9. Systems Manual	
	Project documentation and Systems and O&M Manual completed with available information for use in training program before occupancy	

	10. Commissioning Report	
	Preliminary Commissioning Report available (at time of final inspection for CO) and submitted to Owner and to AHJ (if required).	

Commissioning Provider Acknowledgement

I have reviewed the documents and verified that they meet the owner's project requirements:

CxP Name: _____

Company Name _____

CxP Signature: _____ Date: _____

Owner/Owner's Representative Acknowledgement

The project documents include the items listed in this form and have been received by the owner or owner's representative:

Name: _____

Owner ☐ Owner's Representative ☐

Company Name _____

Signature: _____ Date: _____

5 Commissioning Provider Qualifications and Selection

5.1 Selecting trained personnel for commissioning. This guideline emphasizes that commissioning process is managed and performed by qualified and certified personnel with experience on projects of comparable size and complexity. The approved personnel manage and facilitate the commissioning process. The approved personnel develop and implement the commissioning tasks and documentation relating to systems in the applicable code and project requirements. The commissioning team may include; a commissioning provider, appropriate members of owner's staff, contractor and design team, as well as, other independent commissioning professionals.

It is essential that a single person be designated to lead and manage the commissioning process activities. In practice, this individual has been referenced by various identifiers, such as a commissioning provider, authority, agent, coordinator, lead, manager etc. In this guideline, the term Commissioning Provider "CxP", is used. The designated CxP should be an independent third-party commissioning professional.

Methods of evaluating the designated CxP and trained personnel include review of the following:

- Independent of Design and Construction team
- Technical knowledge.
- Relevant experience.

- Professional certifications and training.
- Communication and organizational skills.
- Reference and sample work products.
- Availability of appropriate testing equipment

Additional information about the commissioning provider skills, knowledge and abilities for specific systems is provided in the appendixes in this guideline.

5.2 Recommended Commissioning Provider Independence & Qualifications

A Commissioning Provider typically has the following qualities to ensure appropriate independence and minimum qualifications on a building project:

1. Independence . The approved commissioning provider is independent from the manufacturers and installers of the systems being commissioned, and the project designers of the systems. The provider is typically asked to disclose possible conflicts of interest so that independence can be confirmed.

2. Equipment. The approved provider possesses, has access to or is requiring others to provide equipment required to perform the functional and performance tests. The equipment is periodically calibrated in accordance with manufacturer's specifications.

3. Personnel Experience. The approved provider employs personnel experienced in conducting or supervising and evaluating functional and performance tests, and when applicable, performing commissioning activities prior to and subsequent to the tests. Where possible, the approved commissioning provider has completed the commissioning process on two or more projects of equal or larger scope and complexity, or can demonstrate adequate experience and training in the fundamentals and application of the commissioning process.

4. Registration, Licensure or Certification. Where available and required, the approved commissioning provider is certified, registered or licensed in a relevant discipline or certified according to the provisions of ISO 17024 or another approved certification process.

APPENDIXES

The following appendixes provide information for the application of the commissioning process.

A.0 Building Commissioning Documentation

A.0.1 Documentation of Commissioning Requirements in Applicable Codes: Code requirements for commissioning should be documented and completed as required by the applicable code or standard.

A.0.2 The following documentation should be provided for each instance of an applicable commissioning requirement in an applicable code or standard:

a. Applicable code requirements, with code section reference numbers and including any environmental, sustainability, or efficiency requirements of those codes;

b. Description of technical approach to compliance;

c. Equipment and systems to be commissioned;

d. Specific process requirements for the commissioning of each element, including: logs, reviews, reports, evaluation, testing and documentation requirements; and

e. Training requirements where required

f. Documentation requirements

A.0.3 The following checklist provided in IECC-2018 could be used to verify the completion and assembly of basic commissioning documents:

COMMISSIONING COMPLIANCE CHECKLIST for FINAL INSPECTION and CO		
Project Name:		
Project Address: Permit Number:		
Commissioning Provider (CxP):		
Company/CxP address:		
ITEM #	**COMMISSIONING DOCUMENTATION**	**APPROVAL**
1.	**Project Commissioning Requirements**	
	Project commissioning requirements included in project contract documents.	
2.	**Commissioning Plan**	
	Commissioning Plan with checklists (before start of functional testing) completed. (Section C408.2.1)	
3.	**Commissioning Plan Utilized**	
	Commissioning Plan was used during construction and includes items required in Section 408.2.1	
4.	**Systems Adjusting and Balancing**	
	Systems Adjusting and Balancing has been completed	

5	**HVAC Equipment**	
	HVAC Equipment Functional Testing has been executed. If applicable, deferred and follow up testing is scheduled to be completed on _____	
6.	**HVAC Controls**	
	HVAC Controls Functional Testing has been executed. If applicable, deferred and follow up testing is scheduled to be completed on _____	
7.	**Economizers**	
	Economizer Functional Testing has been executed. If applicable, deferred and follow up testing is scheduled to be completed on _____	
8.	**Service Water Heating**	
	Service Water Heating Functional Testing has been executed. If applicable, deferred and follow up testing is scheduled to be completed on _____	
9.	**Systems Manual**	
	Project documentation, and Systems and O&M Manual, and training completed or scheduled.	
10.	**Commissioning Report**	
	Preliminary Commissioning Report submitted to Owner and includes all items required in C408.2.4	

Owner/Owner's Representative Acknowledgement

I hereby certify that the commissioning provider has provided me with evidence of mechanical, service water heating and lighting systems commissioning in accordance with the 2018 IECC

Name/Company: _____

Owner ☐ Owner's Representative ☐

Signature: _____ Date: _____

A.1.1 Owner's Project Requirements

Contents. The contents of the Owner's Project Requirements (OPR) should include the following information applicable to the code requirements:

1. Facility size, location, user requirements, including space usage, occupancy, operation and project schedules, codes, standards, and indoor environmental requirements, including temperature, humidity, and ventilation.
2. Commissioning process requirements, including logs, reviews and reports and listing of equipment, systems and assemblies requiring commissioning with installation evaluation and testing requirements.
3. Commissioned equipment, systems and assemblies requirements, including maintainability, access, and operational performance requirements.
4. Environmental, sustainability, and efficiency goals and benchmarks for code requirements.
5. Project documentation requirements and formats including; Basis of Design, Commissioning Plans and Reports, and the Systems Manual.
6. Training requirements for owner's operation and maintenance personnel and occupants.

The OPR documents the functional requirements of a project, and expectations of the building use and operation, as it relates to systems being commissioned. The document describes the physical and functional building characteristics desired by the owner, and establishes performance and acceptance criteria. The OPR is most effective when developed during predesign and used to develop the BOD during the design process. The level of detail and complexity of the OPR will vary according to building use, type and systems.

Template CF-1B provides an optional guide for collecting and documenting the information associated with the Commissioning Process activities. Other formats are acceptable.

OWNER'S PROJECT REQUIREMENTS COMPLIANCE FORM
CF-1B
Submitted with Permit Application if Required

Project Name: _____

Project Address: _____ Permit Number: _____

ITEM #	OWNER'S PROJECT REQUIREMENTS ITEMS	PAGE NUMBER IN OPR DOC.
	Project Program	
a	Facility size, location, user requirements, including space usage, occupancy, operation and project schedules and codes, standards and indoor environment requirements, including temperature, humidity, and ventilation.	
	Commissioning Process	
b	Commissioning process requirements, including logs, reviews, reports and listing of equipment, systems and assemblies requiring commissioning with installation evaluation and testing requirements.	
	Systems and Assemblies	
c	Commissioned equipment, systems and assemblies requirements, and warranty provisions including maintainability, access, and operational performance requirements.	
	Environmental Quality and Efficiency Requirements	
d	Environmental, sustainability, and efficiency goals and benchmarks for code requirements.	
	Documentation	
e	Project documentation requirements and formats including; Basis of Design, Commissioning Plans and Reports, and Systems Manual.	

~~Commissioning Agency~~ Owner Acknowledgement
I have reviewed the OPR document and verified that it meets the owner's project requirements. Name: _____ Company Name: _____ Signature: _____ Date: _____

Enforcement. At their discretion, the building official ~~shall~~ should confirm demonstrated compliance at plan intake by:

- Receipt of a copy of the OPR document; or
- Receipt of a form signed by the owner or owner's representative attesting that the OPR has been completed and approved by the owner.
- Receipt of other documents required by the applicable code

A.1.2 Basis of Design

Basis of Design

Basis of Design (BOD). The BOD ~~shall~~ should be completed at the start of the design phase of the building project, and updated as necessary during the design and construction phases.

Contents. The BOD document shall include compliance with the requirements of the applicable code and the following:

1. Description of the design team's proposed technical method to meet the requirements;
2. Coordination of applicable technical and code requirements as well as the commissioning requirements for systems and assemblies being commissioned;
3. Design criteria and design assumptions in agreement with the OPR and code requirements;
4. Requirements for sustainable design and other certifications when required; and
5. Requirements that systems, assemblies, and equipment be located, installed, commissioned and maintainable, and that training be provided to operations and maintenance staff.

Template CF-1C provides an optional guide for collecting and documenting the information associated with the Commissioning Process activities. Other formats are acceptable.

BASIS OF DESIGN COMPLIANCE FORM CF- 1C Submitted with permit application if required		
Project Name: _____ Project Address: _____ Permit Number: _____		
ITEM #	**BASIS OF DESIGN ITEMS**	**PAGE NUMBER IN BOD DOC.**

	Technical Approach	
a	Description of the design team's technical approach to each of the Owner's requirements.	
	Codes and Commissioning	
b	Coordination of applicable technical and code requirements as well as the commissioning requirements for the systems and assemblies being commissioned.	
	Assumptions	
c	Design criteria and design assumptions in agreement with the OPR and code requirements.	
	Sustainability and Related Criteria	
d	Requirements for sustainable design and other certifications when required.	
	Maintenance and Training	
e	Requirements that systems, assemblies, and equipment be located, installed, commissioned and maintainable, and that training be provided to operations and maintenance staff.	

Owner Acknowledgement

I have reviewed the Basis of Design and verified that it meet the owner's project requirements.

Name: _____

Company Name: _____

Signature: _____ Date: _____

Enforcement. At his discretion, the building official should confirm demonstrated compliance at plan intake by:

- Receipt of a copy of the BOD document; or
- Receipt of a form signed by the architect, engineer or designer of record, attesting that the BOD has been completed and meets the requirements of the OPR.
- Receipt of other documents required by the applicable code

A.1.3 Commissioning Plan

Prior to construction permit issuance a commissioning plan ~~shall~~ should be completed to document how the project will be commissioned.

Commissioning Plan. The Preliminary Commissioning Plan and Final Commissioning Plan should be provided as required in Sections A.1.3.1 and A.1.3.2 and shall be specifically created for each individual project.

A.1.3.1 Preliminary Commissioning Plan. At the time of permit application, a Preliminary Commissioning Plan based on applicable codes should be provided. Contents of the Preliminary Commissioning Plan shall comply with applicable code requirements and include:

1. Overview of the proposed commissioning process;

2. Schedules developed for commissioning activities in the design, construction and occupancy phases of the project;

3. Roles and responsibilities for the Commissioning Team throughout the project. The responsibilities shall delineate the duties of the commissioning provider, commissioning specialists, owner, inspectors, contractors, suppliers, and other agencies;

4. Documentation of communication procedures including the distribution of the Commissioning Plan and other documentation during the design and construction processes, including the development and utilization of the Issues and Resolution Logs and a preliminary listing of required reports, reviews and approvals;

5. Design documentation review procedures, submittal evaluation procedures and report formats;

6. Preliminary list of operations, systems and assemblies that will be commissioned and/or inspected;

7. Format for commissioning checklists, commissioning testing forms and Commissioning Progress Reports;

8. Guidelines and formats that will be used to develop the Systems Manual, Training Plans, and Final Commissioning Report;

9. Procedures to be followed when evaluation results do not meet the code requirements or construction document requirements.

A.1.3.2 Final Commissioning Plan: The Final Commissioning Plan-should be completed before the start of functional and performance testing. It should update the Preliminary Commissioning Plan as required and include the following information:

1. Detailed description of Commissioning Process activities, the schedule of activities and the list of operations, systems and assemblies that will be commissioned or inspected, including evaluation procedures and performance criteria.

2. Final listing of required reports including format, reviews and approvals.

3. Detailed testing procedures and checklists for functional testing and performance testing for all commissioned systems and assemblies, including verification of sequences of operation and, where relevant, conditions under which the testing has been performed.

Template CF-2 provides an optional guide for collecting and documenting the information associated with the Commissioning Plan activities. Other formats are acceptable

COMMISSIONING PLAN COMPLIANCE FORM CF-2		
Project Name:		
Project Address:	Permit Number:	
ITEM #	**PRELIMINARY COMMISSIONING PLAN ITEMS Submitted with permit application**	**PAGE NUMBER IN Cx PLAN**
General Project Information		
a	Overview of the commissioning process and schedules developed for each phase of the project, from design through occupancy.	

Roles and Responsibilities		
b	General roles and responsibilities for the Commissioning Team throughout the project. The responsibilities shall delineate the duties of the commissioning providers, commissioning specialists, inspectors, contractors, suppliers, and other agencies.	
Communication Channels		
c	Documentation of general communication channels including the distribution of the Commissioning Plan and documentation during the design and construction processes. This includes the development and utilization of the Issues and Resolution Logs and a preliminary listing of required reports including format, reviews and approvals.	
Documentation and Submittal Review		
d	Project construction design documentation review and submittal evaluation procedures and report formats.	
Commissioned Equipment and Systems		
e	The preliminary list of operations, equipment and systems that will be commissioned and/or inspected, including performance criteria.	
Checklists, Forms, Logs and Reports		
f	Preliminary format for Commissioning checklists and testing forms and Commissioning Progress Reports.	
Systems Manual, Training Plans and Final Commissioning Report		
g	Guidelines and formats that will be used to develop the Systems Manual, Training Plans, and Final Commissioning Report.	
Resolution Process		
h	Procedures to follow whenever Commissioning Process evaluation results do not meet the code requirements or the construction document requirements.	
ITEM #	**FINAL COMMISSIONING PLAN ITEMS**	**PAGE NUMBER IN Cx PLAN**
a.	Detailed description of Commissioning Process activities, the schedule of activities and the list of operations, systems and assemblies that have been commissioned or inspected, including evaluation procedures and performance criteria.	
b.	Final listing of required reports including format, reviews and approvals.	
c.	Detailed testing procedures and checklists for functional testing and performance testing for all commissioned systems and assemblies, including verification of sequences of operation and, where relevant, conditions under which the testing has been performed.	
d.	All of the Preliminary Commissioning Plan items have been updated as required to reflect any project changes.	

Commissioning Provider Acknowledgement – Preliminary

I have reviewed the Preliminary Commissioning Plan and verified that it meets the requirements of this standard for code-required commissioning.

Name: _____

Company Name _____

Provider Signature: _____ Date: _____

Commissioning Provider Acknowledgement – Final

I have reviewed the Final Commissioning Plan and verified that it meets the requirements of this standard for code-required commissioning.

Name: _____

Company Name: _____

Provider Signature: _____ Date: _____

Enforcement. At his discretion, the building official confirms demonstrated compliance at plan intake by:

- Receipt of a copy of the preliminary commissioning plan; or
- Receipt of a form (see the *Commissioning Plan Compliance Form*) signed by the CxP attesting that the commissioning plan has been completed.
- Receipt of other documents required by the applicable code

A.1.4 Functional and Performance Testing

Commissioning Testing

Checklists and test procedures. The following should be established and fully documented prior to testing.

1. Project-specific construction checklists and commissioning testing procedures;
2. Where test data results are required for specific equipment or systems, there should be an item in the associated Construction Checklist for the test data to be submitted to the Commissioning Provider;
3. A listing of the entities responsible for executing each of the tests; and
4. A uniform and effective process to document Commissioning testing of and interaction between commissioned equipment and systems.

Evaluation. Evaluation of the equipment and systems shall include the following:

1. Verification that the installed equipment and systems match those defined in the construction documents and approved construction submittals;
2. Verification that the equipment and systems were properly installed and are accessible for testing and maintenance; and
3. Test results for the installed equipment and systems should be compared to the relevant requirements of the specifications, submittals and codes;

Test reports. Completed test reports including checklists and test procedures should be submitted to the project team for review and to the Commissioning Provider for evaluation and inclusion in the Commissioning Report.

Functional and Performance Testing (FPT). A documented test of the dynamic functioning operation of equipment and systems with the goal of verifying that the Project Owner's requirements are met. FPT is based on scope of work and contract documents. Test procedures are developed and results documented by the commissioning agency. FPTs shall demonstrate installation and operations of each operating components and system-to-system interface in accordance with the approved design plans and the owner's project requirements.

Code required functional and performance testing usually includes the following systems:

- HVAC systems
- Plumbing hot water systems
- Lighting systems
- Control systems for the above systems

Other systems may be added by the local codes, AHJ, owner, or design team.

The checklists on Appendix B-1 below show some of the possible systems to be commissioned by building type. The system and subsystem commissioning requirements selected in B-1 are listed in the B-2 checklists.

Prior to all functional testing, prerequisite/pre-functional verification and start-up documentation should be provided by the installing contractor and/or factory-trained personnel for each piece of equipment. This information ensures the operating success of each component and proper functionality of all system operations.

This information should contain, but is not limited to:

- Date and responsible party of installation start up.
- Manufacturer model and serial number.
- Design and actual operating information, such as voltage, amperage, wattage, motor nameplate information, sheave, pulleys, belts and air filters, revolutions per minute (RPM) of motors and fans, refrigerant operating conditions, temperature splits, gas pressures, water pressures, and test and balance report.
- Precautionary measures and methods of procedure regarding safety interaction with all personnel.

FPT documentation should address the step-by-step instruction sequence and modes of each operation with interconnecting safety interlocks, temperature sensors, pressure transducers, building management system (BMS) integration, lighting controllers, timers and manually controlled operations.

FPT reports should contain information addressing each of the building components tested; testing methods utilized; and include any readings and adjustments made.

The functional testing documentation should incorporate a signature block information format containing:

- Date.
- Responsible party identifier.
- Required testing instruments.

- Measurable pass-fail of testing sequence.
- Expected response of operating perimeters.
- Results of testing that is performed.
- Operating condition of equipment status upon completion of each test sequence.

A deficiencies list shall be incorporated into the functional testing documentation; this list will track and clarify all failed operating sequences and components. The deficiencies list will act as a living document until all components or sequence of operation have been completed. The building department and building owner / owner's representative will require all parties to perform their duties to correct deficient items.

A.1.4.1 SAMPLE COMPLIANCE FORM FOR FUNCTIONAL TESTING

Template CF-3 provides an optional guide for collecting and documenting the information associated with the Commissioning Testing activities. Other formats are acceptable.

This Form is to be Completed at the Time of Inspection

COMMISSIONING TESTING COMPLIANCE FORM CF-3 Submitted before final inspection		
Project Name:		
Project Address:	Permit Number:	
ITEM #	**COMMISSIONING TESTING ITEMS**	**PAGE NUMBER IN Cx TESTING DOC.**
Checklists and Test Procedures		
a	Project-specific Construction Checklists and Commissioning testing procedures shall be established for review by Owner and appropriate team members.	
b	The test procedures shall list the entities responsible for executing each of the tests.	
c	Whenever a test data result is required for a specific system or assembly, there shall be an item in the associated Construction Checklist for the test data to be submitted to the Commissioning Provider.	
d	There shall be a uniform and effective process for documentation of testing to provide Commissioning testing of and interaction between commissioned equipment, systems, and assemblies. Commissioning team shall refer to applicable Commissioning technical resources tailored to their specific projects.	
Evaluation		
e	Vital information on the equipment or materials supplied. Information shall detail what equipment/material was specified and submitted. What was actually delivered on the site shall be documented and verified.	
f	Proper installation of the systems and assemblies. Evaluation shall focus on the physical installation of the systems and assemblies, on their ability to meet the contract documents requirements, and on accessibility for Commissioning, testing, and maintenance operations.	
g	Testing procedures, conditions and successful Commissioning testing results of systems and assemblies.	

Test Reports		
h	Completed test reports including checklists and test procedures shall be submitted to the project team for review and the Commissioning Provider for evaluation and inclusion in the Commissioning Report.	

Commissioning Provider Acknowledgement

I have reviewed the Commissioning Testing documents and verified that it meets the applicable code requirements.

Name: _____

Company Name _____

Provider Signature: _____ Date: _____

A.1.5 Issues and Resolution Log

Commissioning Issue and Resolution Logs

The Commissioning Provider and Commissioning Team shall develop an Issues and Resolutions Log with supporting documentation.

Contents. The contents of the Issue and Resolution Logs shall include:

1. All open and continuing items, with status and responsible person or organization for resolution;
2. Procedures to maintain and distribute the issues and resolution log throughout the project until all issues are resolved or acknowledged by the Owner; and
3. Resolution(s) shall be included in the log and acknowledged by the owner.

Template CF-4 provides an optional guide for collecting and documenting the information associated with the Issues and Resolution Log activities. Other formats are acceptable.

COMMISSIONING ISSUES AND RESOLUTION LOG COMPLIANCE FORM
CF-4
Submitted before final inspection

Project Name: _____

Project Address: _____ Permit Number: _____

ITEM #	COMMISSIONING ISSUES AND RESOLUTION LOG ITEMS	PAGE NUMBER IN Cx ISSUES LOG
General Project Information		
1	All open and continuing items, with status and responsible person or organization for resolution.	
Log Procedures		
2	Procedures to maintain the log throughout the project until all issues are resolved or accepted by the Owner.	
Log Distribution		
2	Procedures to distribute the logs to the Commissioning Team at intervals prescribed in the Commissioning Plan.	
Resolution		

3	Resolution of each issue in the log with final approval by owner.	

Commissioning Provider Acknowledgement

I have reviewed the Issues Log and verified that it meets the applicable code requirements.

Name:

Company Name:

Provider Signature: Date:

A.1.6 Systems Manual

The systems manual documents information focusing on the operation of the building systems. This document provides information needed to understand, operate, and maintain the equipment and systems; and informs those not involved in the design and construction of the building systems. This document is in addition to the record construction drawings, documents, and the O&M manuals supplied by the contractor. The systems manual is assembled during the construction phase and is available during the contractors' training of the facility staff. The systems manual shall be submitted to the owner prior to project completion and if possible before issuance of the certificate of occupancy. The systems manual ~~shall~~ should include the following information for all commissioned systems:

1. Table of Contents;
2. Information for each commissioned equipment element or system including:
   - Manufacturer's operation and maintenance data for installed equipment, systems and assemblies including wiring diagrams and schematics;
   - Warranties, where provided;
   - Contractor, supplier, or service agency listing and contact information;
3. Facility Operations;
   - Facility guide, including operating plan, building and equipment operating schedules, setpoints and ranges, sequences of operation, and emergency procedures;
   - Maintenance plans, procedures, checklists, schedules and records;
   - Janitorial and cleaning plans and procedures where required.

SYSTEMS MANUAL

Template CF-5 provides an optional guide for collecting and documenting the information associated with the Issues and Resolution Log activities. Other formats are acceptable

SYSTEMS MANUAL COMPLIANCE FORM
CF-5

Submitted before Project Completion

Name: _____

Project Address: _____ Permit Number: _____

ITEM #	SYSTEMS MANUAL ITEMS	PAGE NUMBER IN SYSTEMS MANUAL
	Table Of Contents	
Code-Required Commissioning requirements		
a	Listing of all equipment and systems required by applicable codes to be commissioned.	
Record Documents Evaluation		
b	Construction record documents including; record plans, specifications and approved submittals.	
Systems and Assemblies Information		
c	Facility, systems and assemblies information including: 1. Manufacturer's operation and maintenance data for installed equipment. systems and assemblies including wiring diagrams and schematics. 2. Warranties, where applicable. 3. Contractor, supplier, or service agency listing and contact information.	
Operation Information		
d	A facility operations guide, including an operating plan, building and equipment operating schedules, setpoints and ranges, sequences of operation, system and equipment limitations and emergency procedures.	
	Maintenance Plans and Janitorial plans where required	
Training		
e	Where training is provided, training plans, materials and records shall be provided.	
Preliminary Commissioning Report		
f	A preliminary commissioning report including commissioning plans, FPT requirements and results, systems tested, listing and plans for equipment yet to be commissioned.	

Commissioning Provider Acknowledgement

I have reviewed the Systems Manual and verified that it meets the applicable code requirements.

Name: _____

Company Name: _____

Provider Signature: _____ Date: _____

A.1.7 Systems operations training.

The training of the appropriate maintenance staff for each equipment type and/or system should be documented in the commissioning report and should include the following:

- System/equipment overview (what it is, what it does, and with what other systems and/or equipment it interfaces).
- Review and demonstration of servicing/preventive maintenance.
- Review of the information in the systems manual.
- Review of the record drawings on the system/equipment.

Intent. The systems operation training verifies that a training program is developed to provide training to the appropriate maintenance staff for each equipment type and/or system, and that this training program is documented in the commissioning report. The systems operation training program is specified in the project specifications for the major systems listed. The systems manual, O&M documentation and record drawings are prepared and available to the maintenance staff prior to the implementation of any training or the development of a written training program. The training program is to be administered when the appropriate maintenance staff is made available to receive training. The written training program includes: (a) learning goals and objectives for each session; (b) training agenda, topics and length of instruction for each session; (c) instructor information and qualifications; (d) location of training sessions (on-site, off-site, manufacturer's or vendor's facility); (e) attendance forms; (f) training materials; and (g) description on how the training will be archived for future use.

Systems/equipment overview.

- Review the OPR and BOD related to the major systems and equipment.
- Describe system type and configuration.
- Explain operation all major systems and equipment, and how it interfaces with other systems and equipment.
- Describe operations of critical devices, controls and accessories.
- Review locations of the major systems and equipment.
- Describe operations of the control system for each system, location of critical control elements, and procedures to properly operate control system.
- Review recommendations for implementation to reduce energy and water use.

Review and demonstration of servicing/preventive maintenance.

- Explain location or delivery contact of the O&M manuals.
- Review of all manufacturers' recommended maintenance activities to maintain the warranty.
- Review and demonstrate frequent maintenance activities (air filter replacement, lubrication, fan belt inspection and/or replacement, condenser water treatment, etc.), and suggested schedule.
- Review and demonstrate typical servicing procedures and techniques (electrical current, pressure and flow readings, calibration procedures, point trending, power fail restart procedures, etc.).
- Locate, observe and identify major equipment, systems, accessories and controls.

Review emergency shutoffs and procedures.

Enforcement. At their discretion, the building official confirms demonstrated compliance during on-site enforcement by:

- Receipt of a copy of the written training program and completed attendance forms; and

- Receipt of a form signed by the owner or owner's representative attesting that the training program and delivery of training has been completed.
- Receipt of other forms required by the applicable code or AHJ

DOCUMENTATION AND TRAINING SAMPLE COMPLIANCE FORM

Training

Contract documents. The training of the operating and maintenance staff of the facility should be required in the contract documents and include the development and application of a training plan.

Contents. The contents of the training plan should include:

1. Outline of instructional topics that should address the design, construction, operation, and maintenance of commissioned systems, assemblies, and equipment. A review and utilization of the Systems Manual should be included in the training process;
2. Learning objectives and training delivery methods, training materials and instructor requirements locations and duration for each instructional topic in conformance to the OPR and commissioning Plan; and
3. Requirements and format for training reports, records and recording criteria.

~~**D.301.3**~~ **Records.** Archival of instruction, delivery of instruction, and training materials should be provided as specified in the Contract Documents and per the OPR and commissioning plan. A copy of the Training Plan, training materials, and records should be included in the final Systems Manual.

Template CF-6 provides an optional guide for collecting and documenting the information associated with the Training activities. Other formats are acceptable.

TRAINING COMPLIANCE FORM CF- 6		
Project Name:		
Project Address:		Permit Number:
ITEM #	**TRAINING ITEMS**	**PAGE NUMBER IN TRAINING PLAN**
	General Training Information	
a	Outline of instructional topics should address the design, construction, operation, and maintenance of commissioned systems, assemblies, and equipment. A review and utilization of the Systems Manual ~~shall~~ should be included in the training process.	
	Objectives and Methods	
b	Learning objectives and training delivery methods, training materials and instructor requirements, locations and duration for each instructional topic in conformance to the OPR and commissioning Plan.	
	Materials and Records	
c	Requirements and format for training report, records and recording criteria.	

Commissioning Agency Acknowledgement

I have reviewed the training plan and verified that it meets the owner's project requirements.

Name: _____

Company Name: _____

Agency' Signature: _____ Date: _____

A.1.8 Commissioning report

Preliminary Commissioning Report. The preliminary commissioning report should be delivered to the owner and if required the code official prior to the final inspection or issuance of the Certificate of Occupancy and shall include the following:

1. Table of contents.
2. Documentation of the commissioning activities included in the commissioning plan and those required by code and by this standard, including any delayed testing.
3. The final commissioning plan, including functional test and performance test procedures used and the criteria for test acceptance.
4. The list of code-required commissioning and the design and submittal reviews required by the Commissioning Plan.
5. The results of all evaluations, start-up data, functional tests, and performance tests, and reports for code-required commissioning.
6. Issue logs and disposition of all deficiencies found during testing and evaluation, including corrective measures used or proposed.
7. A resolution plan identifying any tests that are deferred and issues that are unresolved or incomplete, plus the conditions for completion and the individuals responsible for completion.

Final Commissioning Report. The final commissioning report shall be delivered to the owner after final completion of the commissioning work required by code and by this standard, and should include the Commissioning Process activities occurring after issuance of the Certificate of Occupancy and the results from those activities, together with the contents of the Preliminary Commissioning Report.

COMMISSIONING REPORT SAMPLE COMPLIANCE FORM

Template CF-7 provides an optional guide for collecting and documenting the information associated with the Commissioning activities. Other formats are acceptable.

PRELIMINARY COMMISSIONING REPORT COMPLIANCE FORM
CF-7

Project Name: _____

Project Address: _____ Permit Number: _____

ITEM #	PRELIMINARY COMMISSIONING REPORT ITEMS	PAGE NUMBER IN Cx Report
Commissioning Scope		
a	Documentation of the commissioning activities included in the commissioning plan required by adopted codes and the OPR including delayed testing.	
Commissioning Plan		
b	A copy of the final commissioning plan, including functional and performance test procedures used during the commissioning process and measurable criteria for test acceptance.	
Design Documents and Reviews		
c	A copy of the design and submittal reviews as required by the commissioning plan.	
System Evaluations		
d	The results of all evaluations, start-up data, functional and performance tests, and reports by suppliers, contractors, inspectors, and commissioning providers.	
Issues and resolutions		
e	Issue logs and disposition of all deficiencies found during testing, including details of corrective measures used or proposed.	
Open Items		
f	A resolution plan approved by the owner or the owner's representative identifying the deferred tests and issues that are unresolved or incomplete and any required conditions for completion.	

Commissioning Agency Acknowledgement

I have reviewed the training plan and verified that it meets the owner's project requirements.

Name: _____

Company Name: _____

Agency' Signature: _____ Date: _____

Owner Acknowledgement

I have received and reviewed the preliminary commissioning report.

Name: _____

Company Name: _____

Signature: _____ Date: _____

Enforcement. At his discretion, the building official confirms demonstrated compliance by:

- Receipt of a copy of the commissioning report;-or
- Receipt of a form signed by the owner or owner's representative attesting that the commissioning report has been completed.

Receipt of other forms required by the applicable code or AHJ

APENDIX B
Commissioning Checklists for Building Types and Functions

B.1.1 Commercial and Office Building Commissioning

1. INTRODUCTION

The Commissioning Process can be utilized on nearly all building systems. However, each building project selects specific systems to undergo commissioning depending upon project type, and budget. This is done at project inception during the development of the Owner's Project Requirements. This listing is used to plan and implement commissioning during the entire project. Each building type usually has unique systems that benefit from commissioning.

2. COMMISSIONING APPLICATION TO OFFICE FACILITY SYSTEMS

The following chart can be used to make the initial selection of the systems to be commissioned. The extent of the selections will depend upon needs of the project, and budget and schedule limitations. The detail subsystem decision list for many of these systems are shown in Appendix B-2 that follows.

Commercial and Office Building Commissioning

Project: Address:

Owner: Email/Phone

Owner's PM Email/Phone

CX Provider: Email/Phone

Date Initiated: Date Revised:

Item	**Equipment/System**	System Commissioning Required Yes/No	Integrated System Commissioning Required Y/N	Commissioning Completed
1	Air Conditioning and ventilation systems – code required			
2	Plumbing hot water systems – code required			
3	Plumbing Systems			
4	Lighting and control systems – code required			
5	Electrical power systems			
6	Energy monitoring and management systems			

7	Outdoor air and energy recovery systems			
8	Landscape irrigation systems			
9	Fire protection and fire sprinkler systems			
10	Fire alarm systems			
11	Vertical transportation, elevators, escalators			
12	Building enclosures			
13	Roofing systems			
14	Computer and data rooms systems			
15	Security systems			
16	Telephone and communication systems			
17	Renewable Energy Systems			
18				
19				
20				
21				

The approval section below can be used if applicable to the planning process.

I have reviewed the training plan and verified that it meets the owner's project requirements:

Name: _____

Company Name _____

Signature: _____ Date: _____

B.1.2 Health Care Facilities - Medical Office Buildings and Hospitals Commissioning

1. INTRODUCTION

The Commissioning Process can be utilized on nearly all building systems. However, each building project selects specific systems to undergo commissioning. This is done at project inception during the development of the Owner's Project Requirements. This listing is used to plan and implement commissioning during the entire project. Each building type usually has unique systems that benefit from commissioning.

2. COMMISSIONING APPLICATION TO MEDICAL FACILITY SYSTEMS

The following chart can be used to make the initial selection of the systems to be commissioned. The extent of the selections will depend upon needs of the project, and budget and schedule limitations. The detail subsystem decision list for many of these systems are shown in Appendix B-2 below

Medical Buildings and Hospitals Commissioning

Project: Address:

Owner: Email/Phone

Owner's PM Email/Phone

CX Provider: Email/Phone

Date Initiated: Date Revised:

Item	**Equipment/System**	System Commissioning Required Yes/No	Integrated System Commissioning Required Y/N	Commissioning Completed -- Date
1	Air Conditioning and ventilation systems – code required			
2	Plumbing hot water systems – code required			
3	Plumbing Systems			
4	Lighting and control systems-code required			
5	Electrical power systems			
6	Energy monitoring and management systems			
7	Outdoor air and energy recovery systems			
8	Landscape irrigation systems			
9	Fire protection and fire sprinkler systems			
10	Fire alarm systems			
11	Vertical transportation, elevators, escalators			
12	Building enclosures			
13	Computer rooms and data systems			
14	Security systems			
15	Telephone and communication systems			
16	Medical gas systems			
17	Steam Systems			
18	Central Plant			
19	Humidification systems			
20	Nurse call systems			
21	Renewable Energy Systems			
25				
26				

27				
28				
29				
30				

The approval section below can be used if applicable to the planning process.

I have reviewed the training plan and verified that it meets the owner's project requirements:

Name: _____

Company Name _____

Signature: _____ Date: _____

B.1.3 Education Facilities – Schools PreK-12 Commissioning

1. INTRODUCTION

The Commissioning Process can be utilized on nearly all building systems. However, each building project selects specific systems to undergo commissioning. This is done at project inception during the development of the Owner's Project Requirements. This listing is used to plan and implement commissioning during the entire project. Each building type usually has unique systems that benefit from commissioning.

2. COMMISSIONING APPLICATION TO SCHOOL FACILITY SYSTEMS

The following chart can be used to make the initial selection of the systems to be commissioned. The extent of the selections will depend upon needs of the project, and budget and schedule limitations. The detail subsystem decision list for many of these systems are shown in Chapter 6 below.

Education Facilities – Schools PreK-12 Commissioning

Project: _____ Address: _____

Owner: _____ Email/Phone _____

Owner's PM _____ Email/Phone _____

CX Provider: _____ Email/Phone _____

Date Initiated: _____ Date Revised: _____

Item	**Equipment/System**	System Commissioning Required Yes/No	Integrated System Commissioning Required Y/N	Commissioning Completed -- Date
1	Air Conditioning and ventilation systems – code required			
2	Plumbing hot water systems – code required			

3	Plumbing Systems			
4	Lighting and control systems-code required			
5	Electrical power systems			
6	Energy monitoring and management systems			
7	Outdoor air and energy recovery systems			
8	Landscape irrigation systems			
9	Fire protection and fire sprinkler systems			
10	Fire alarm systems			
11	Vertical transportation, elevators, escalators			
12	Building enclosures			
13	Other Structures			
14	Computer and data rooms systems			
15	Security systems			
16	Telephone and communication systems			
17	Time clock and signaling systems			
18	Medical area and isolation systems			
19	Humidity Control Systems			
20	Laboratory Hoods and Exhausts			
21	Shop and Special Exhausts			
22				
23				
24				
25				
26				
27				
28				
29				

The approval section below can be used if applicable to the planning process.

I have reviewed the training plan and verified that it meets the owner's project requirements:

Name: _____

Company Name _____

Signature: _____ Date: _____

B.1.4 Colleges and University Facility Commissioning

1. INTRODUCTION

The Commissioning Process can be utilized on nearly all building systems. However, each building project selects specific systems to undergo commissioning. This is done at project inception during the development of the Owner's Project Requirements. This listing is used to plan and implement commissioning during the entire project. Each building type usually has unique systems that benefit from commissioning.

2. COMMISSIONING APPLICATION TO UNIVERSITY FACILITIES SYSTEMS

The following chart can be used to make the initial selection of the systems to be commissioned. The extent of the selections will depend upon needs of the project, and budget and schedule limitations. The detail subsystem decision list for many of these systems are shown in Chapter 6 below.

Colleges and University Facility Commissioning

Project: Address:

Owner: Email/Phone

Owner's PM Email/Phone

CX Provider: Email/Phone

Date Initiated: Date Revised:

Item	Equipment/System	System Commissioning Required Yes/No	Integrated System Commissioning Required Y/N	Commissioning Completed – Date
1	Air Conditioning and ventilation systems – code required			
2	Plumbing hot water systems – code required			
3	Plumbing Systems			
4	Lighting and control systems – code required			
5	Electrical power systems			
6	Energy monitoring and management systems			
7	Outdoor air and energy recovery systems			
8	Landscape irrigation systems			
9	Fire protection and fire sprinkler systems			
10	Fire alarm systems			
11	Vertical transportation, elevators, escalators			

12	Building enclosures			
13	Computer rooms and data systems			
14	Security systems			
15	Telephone and communication systems			
16	Central plant and connected systems			
17	Shop and Special Exhausts			
18	Humidity control systems			
19	Central Plant			
20				
21				

The approval section below can be used if applicable to the planning process.

I have reviewed the training plan and verified that it meets the owner's project requirements:

Name: _____

Company Name _____

Signature: _____ Date: _____

B.1.5 Municipal and State Buildings Commissioning

1. INTRODUCTION

The Commissioning Process can be utilized on nearly all building systems. However, each building project selects specific systems to undergo commissioning. This is done at project inception during the development of the Owner's Project Requirements. This listing is used to plan and implement commissioning during the entire project. Each building type usually has unique systems that benefit from commissioning.

2. COMMISSIONING APPLICATION TO MUNICIPAL and STATE FACILITY SYSTEMS

The following chart can be used to make the initial selection of the systems to be commissioned. The extent of the selections will depend upon needs of the project, and budget and schedule limitations. The detail subsystem decision list for many of these systems are shown in Chapter 6 below.

Municipal and State Buildings Commissioning

Project: _____ Address: _____

Owner: _____ Email/Phone _____

Owner's PM _____ Email/Phone _____

CX Provider: _____ Email/Phone _____

Date Initiated: _____ Date Revised: _____

Item	**Equipment/System**	System Commissioning Required Yes/No	Integrated System Commissioning Required Y/N	Commissioning Completed -- Date
1	Air Conditioning and ventilation systems – code required			
2	Plumbing hot water systems – code required			
3	Plumbing Systems			
4	Lighting and control systems – code required			
5	Electrical power systems			
6	Energy monitoring and management systems			
7	Outdoor air and energy recovery systems			
8	Landscape irrigation systems			
9	Fire protection and fire sprinkler systems			
10	Fire alarm systems			
11	Vertical transportation, elevators, escalators			
12	Building enclosures			
13				
14	Computer rooms and data systems			
15	Security systems			
16	Telephone and communication systems			
17	Public address systems			
18	Court Systems			
19	Detention areas			
20	Smoke Control Systems			
21	Library Systems			
22	Humidity Control Systems			
23	Fire Stations			
24	Shops and Special Exhaust Systems			
25	Police Stations Special Systems			
26				
27				
28				
29				
30				
31				

The approval section below can be used if applicable to the planning process.

I have reviewed the training plan and verified that it meets the owner's project requirements:

Name: _____

Company Name _____

Signature: _____ Date: _____

B.1.6 Federal Buildings Commissioning

1. INTRODUCTION

The Commissioning Process can be utilized on nearly all building systems. However, each building project selects specific systems to undergo commissioning. This is done at project inception during the development of the Owner's Project Requirements. This listing is used to plan and implement commissioning during the entire project. Each building type usually has unique systems that benefit from commissioning.

2. COMMISSIONING APPLICATION TO FEDERAL FACILITY SYSTEMS

The following chart can be used to make the initial selection of the systems to be commissioned. The extent of the selections will depend upon needs of the project, and budget and schedule limitations. The detail subsystem decision list for many of these systems are shown in Chapter 6 below.

Federal Buildings Commissioning

Project: _____ Address: _____

Owner: _____ Email/Phone _____

Owner's PM _____ Email/Phone _____

CX Provider: _____ Email/Phone _____

Date Initiated: _____ Date Revised: _____

Item	**Equipment/System**	System Commissioning Required Yes/No	Integrated System Commissioning Required – Y/N	Commissioning Completed – Date
1	Air Conditioning and ventilation systems			
2	Plumbing hot water systems			
3	Plumbing Systems			
4	Lighting and control systems			
5	Electrical power systems			
6	Energy monitoring and management systems			
7	Outdoor air and energy recovery			

	systems			
8	Landscape irrigation systems			
9	Fire protection and fire sprinkler systems			
10	Fire alarm systems			
11	Vertical transportation, elevators, escalators			
12	Building enclosures			
13	Roofing systems			
14	Computer rooms and data systems			
15	Security systems			
16	Telephone and communication systems			
17	Public address systems			
18	Court Systems			
19	Detention Facilities			
20	Smoke Control Systems			
21	Libraries			
22	Humidity Control Systems			
23	Fire Prevention and Operation			
24	Shops and Special Exhaust Systems			
25	Law Enforcement and Security Systems			
26				
27				
28				
29				

The approval section below can be used if applicable to the planning process.

I have reviewed the training plan and verified that it meets the owner's project requirements:

Name: _____

Company Name _____

Signature: _____ Date: _____

B.1.7 Industrial Facility Commissioning

1. INTRODUCTION

The Commissioning Process can be utilized on nearly all building systems. However, each building project selects specific systems to undergo commissioning. This is done at project inception during the development of the Owner's Project Requirements. This listing is used to plan and implement commissioning during the entire project. Each building type usually has unique systems that benefit from commissioning.

2. COMMISSIONING APPLICATION TO INDUSTRIAL FACILITY SYSTEMS

The following chart can be used to make the initial selection of the systems to be commissioned. The extent of the selections will depend upon needs of the project, and budget and schedule limitations. The detail subsystem decision list for many of these systems are shown in Chapter 6 below.

Industrial Facility Commissioning

Project: Address:

Owner: Email/Phone

Owner's PM Email/Phone

CX Provider: Email/Phone

Date Initiated: Date Revised:

Item	**Equipment/System**	System Commissioning Required	Integrated System Commissioning Required	Commissioning Completed – Date
1	Air Conditioning and ventilation systems – code required			
2	Plumbing hot water systems – code required			
3	Plumbing Systems			
4	Lighting and control systems – code required			
5	Electrical power systems			
6	Energy monitoring and management systems			
7	Outdoor air and energy recovery systems			
8	Landscape irrigation systems			
9	Fire protection and fire sprinkler systems			
10	Fire alarm systems			
11	Vertical transportation, elevators, escalators			
12	Building enclosures			
13	Roofing systems			
14	Computer rooms and data systems			
15	Security systems			
16	Telephone and communication systems			
17	Storage and transportation systems			
18	Manufacturing equipment and systems			
19	Exhaust Systems			
20	Refrigeration Systems			
21	Warehouse and Storage Systems			

22	Chemical Storage and Use			
23				
24				
25				
26				
27				
28				
29				

The approval section below can be used if applicable to the planning process.

I have reviewed the training plan and verified that it meets the owner's project requirements:

Name: _____

Company Name _____

Signature: _____ Date: _____

B.1.8 High Rise Residential Building Commissioning

1. INTRODUCTION

The Commissioning Process can be utilized on nearly all building systems. However, each building project selects specific systems to undergo commissioning depending upon project type, and budget. This is done at project inception during the development of the Owner's Project Requirements. This listing is used to plan and implement commissioning during the entire project. Each building type usually has unique systems that benefit from commissioning.

2. COMMISSIONING APPLICATION TO OFFICE FACILITY SYSTEMS

The following chart can be used to make the initial selection of the systems to be commissioned. The extent of the selections will depend upon needs of the project, and budget and schedule limitations. The detail subsystem decision list for many of these systems are shown in Chapter 6 that follows.

Residential Building Commissioning

Project: Address: _____

Owner: Email/Phone _____

Owner's PM Email/Phone _____

CX Provider: Email/Phone _____

Date Initiated: Date Revised: _____

Item	**Equipment/System**	System Commissioning Required Yes/No	Integrated System Commissioning Required Y/N	Commissioning Completed

1	Air Conditioning and ventilation systems – code required			
2	Plumbing hot water systems -code required			
3	Plumbing Systems			
4	Lighting and control systems – code required			
5	Electrical power systems			
6	Energy monitoring and management systems			
7	Outdoor air and energy recovery systems			
8	Landscape irrigation systems			
9	Fire protection and fire sprinkler systems			
10	Fire alarm systems			
11	Vertical transportation, elevators, escalators			
12	Building enclosures			
13	Roofing systems			
14	Security systems			
15	Telephone and communication systems			
16				
17				
18				
19				
20				
21				

The approval section below can be used if applicable to the planning process.

I have reviewed the training plan and verified that it meets the owner's project requirements:

Name: _____

Company Name _____

Signature: _____ Date: _____

B.1.9 Retail Building and Area Commissioning

1. INTRODUCTION

The Commissioning Process can be utilized on nearly all building systems. However, each building project selects specific systems to undergo commissioning depending upon project type, and budget. This is done at project inception during the development of the Owner's Project Requirements. This listing is used to plan and implement commissioning during the entire project. Each retail building type usually has unique systems, such as lighting, communication and air conditioning, that benefit from commissioning.

2. COMMISSIONING APPLICATION TO OFFICE FACILITY SYSTEMS

The following chart can be used to make the initial selection of the systems to be commissioned. The extent of the selections will depend upon needs of the project, and budget and schedule limitations. The detail subsystem decision list for many of these systems are shown in Chapter 6 that follows.

Commercial and Office Building Commissioning

Project: Address:

Owner: Email/Phone

Owner's PM Email/Phone

CX Provider: Email/Phone

Date Initiated: Date Revised:

Item	**Equipment/System**	System Commissioning Required Yes/No	Integrated System Commissioning Required Y/N	Commissioning Completed
1	Air Conditioning and ventilation systems – code required			
2	Plumbing hot water systems if included – code required			
3	Plumbing Systems if included			
4	Lighting and control systems - code required			
5	Electrical power systems			
6	Energy monitoring and management systems			
7	Outdoor air and energy recovery systems			
8	Special communication systems			
9	Fire protection and fire sprinkler systems			
10	Fire alarm systems			
11	Vertical transportation, elevators, escalators if included			
12	Building enclosures			
13	Roofing systems			

14	Computer and data rooms systems			
15	Security systems			
16	Telephone and communication systems			
17				
18				
19				
20				
21				

The approval section below can be used if applicable to the planning process.

I have reviewed the training plan and verified that it meets the owner's project requirements:

Commissioning Provider Name: _____

Company Name _____

Signature: _____ Date: _____

B.1.10 Justice Buildings Commissioning

1. INTRODUCTION

The Commissioning Process can be utilized on nearly all building systems. These projects may include detention, jail or prison buildings, courthouses, police facilities and other related facilities. Due to their special functions and safety requirements, there are unique systems include that must be commissioned. However, each building project selects specific systems to undergo commissioning. This is done at project inception during the development of the Owner's Project Requirements. This listing is used to plan and implement commissioning during the entire project. Each building type usually has unique systems that benefit from commissioning.

2. COMMISSIONING APPLICATION TO FEDERAL FACILITY SYSTEMS

The following chart can be used to make the initial selection of the systems to be commissioned. The extent of the selections will depend upon needs of the project, and budget and schedule limitations. The detail subsystem decision list for many of these systems are shown in Chapter 6 below.

Justice Buildings Commissioning

Project: _____ Address: _____

Owner: _____ Email/Phone _____

Owner's PM _____ Email/Phone _____

CX Provider: _____ Email/Phone _____

Date Initiated: Date Revised:

Item	**Equipment/System**	System Commissioning Required Yes/No	Integrated System Commissioning Required – Y/N	Commissioning Completed – Date
1	Air Conditioning and ventilation systems			
2	Plumbing hot water systems			
3	Plumbing Systems			
4	Lighting and control systems			
5	Electrical power systems			
6	Energy monitoring and management systems			
7	Outdoor air and energy recovery systems			
8	Landscape irrigation systems			
9	Fire protection and fire sprinkler systems			
10	Fire alarm systems			
11	Vertical transportation, elevators, escalators			
12	Building enclosures			
13	Roofing systems			
14	Computer rooms and data systems			
15	Security systems			
16	Telephone and communication systems			
17	Public address systems			
18	Court Systems			
19	Detention Facilities			
20	Smoke Control Systems			
21	Libraries			
22	Humidity Control Systems			
23	Fire Prevention and Operation			
24	Shops and Special Exhaust Systems			
25	Law Enforcement and Security Systems			
26				
27				
28				

The approval section below can be used if applicable to the planning process.

I have reviewed the training plan and verified that it meets the owner's project requirements:

Commissioning Provider Name: _____

Company Name _____

Signature: _____ Date: _____

B.2. Commissioning Functional Systems Checklist

- The following are a list of equipment/items/components that could be tested/verified when installed or where applicable. These lists can be used to designate commissioning process items and tracking the completion of the process

B.2.1 Site development and land use

RELATED SYSTEMS, EQUIPMENT, ASSEMBLIES AND COMPONENTS	TASKS/COMMENTS
Landscape Irrigation: • Landscape irrigation design. • Static pressure verification. • Point of connection. • Backflow prevention. • Flow meter. • O&M manual.	Verify the availability of required static pressure Backflow O&M manual
Irrigation Design and Systems:	
• Irrigation controllers with weather or moisture-based capabilities.	• Check irrigation controllers for compliance with the plans and specifications.
• Irrigation design.	Check for proper irrigation proper water spray coverage, and appropriate overlap and spacing in accordance with the plans
• Sprinkler head layout at perimeter of building:	• Check for correct sprinkler head emitters with appropriate head rotation to prevent over spraying onto building walls. • Verify sprinkler head per approved plans.

Outdoor Ornamental Fountains and Water Features:
• System Calibration System Performance Testing of system of related components in-pool items Testing of mechanical room Erosion Control Systems
	• Verify the following per plans
	  • Outdoor Ornamental Fountains and Water Features:
	  • Design of water feature or fountain.
	  • Available water source.
	  • Available electrical voltage.
	  • Electrical components.
	  • Mechanical components.
	  • Plumbing components.
	• Verify calibration of all components, including, but not limited to, pumps, filters, chemical controllers, motors, electrical panels, pipe installation, geo-membranes, surface materials.
	• Verify performance of Leakage tests.

	• Verify performance of the system as a unit. • Verify performance of all modes of operation. • Verify test of in-pool items, including, but not limited to, nozzles; suction and inlet fittings; overflows and weirs; control valves; lights; junction boxes; cord seals; and level sensors. • Verify test of mechanical room, including, but not limited to, control panel terminations, lighting panel, disconnects and ground-fault device wiring to all equipment, valve tags and flow directional arrows, piping and pressure gauges.

Site drainage	• Verify Storm water pollution prevention plan (SWPPP) , when required, is on site
	• Verify drainage system is installed in accordance with site drainage plan
	• Check when required by the plans:
	  • Silt fencing.
	  • Construction drive.
	  • Erosion control blankets.
	  • Erosion control straw logs.
	• Observation and documentation that all BMP pertaining to erosion control were successfully utilized.
	• Observation and documentation during construction that all elements of the erosion control plan are in place such that the soil on the site is contained with no chance of run-off.
	• Verification that collected water after a rain event will move through the site in accordance with the site drainage plan.
	• Verification and documentation that the drainage system components meet or exceed those specified in the site drainage plan.
	• Verification and observation that the O&M and systems manual as submitted meets the criteria and needs of the end user.

Topography and Grading (cut/fill): • Grading plan. • Soil analysis/compaction plan. • . • Site safety plan. • Tree removal/mitigation plan. • Soil stabilization and erosion control plan. • Re-vegetation plan, slope-control planting. • Equipment utilization plan. • Ground water and infiltration.	• Verify that soils reports are complete and in accordance with local rules and regulations • Verify site waste reduction plan is consistent with IgCC and/or local ordinance including tree removal • Verify vegetation meets the re-vegetation plan • Ensure air quality plan is part of SWPPP or soil erosion control plan • Check to ensure site safety plan is in place • Verify that earth-moving equipment has been maintained and repaired in accordance with the O&M manual pertaining to each piece of equipment. • Verify that all elements of site erosion control are monitored daily for deficiencies or necessary repairs. • Verify that areas of fill are compacted to a level that meets or exceeds the soil compaction plan. • Verify that sufficient soil samples representing a true cross section of the cut and fill areas, and of the material to be used as fill, have

	been taken and tested under the supervision of a certified soils engineer. • Verify of all field and laboratory tests of the land to be covered with fill to confirm that the characteristics of the soil, including its expansive qualities, and bearing value of the land, consolidation potential, can support the proposed fill and structures. • Verify laboratory analysis and related data support the proposals to replace, rework or blend, or to stabilize or modify with additives support the proposed work. • Periodic site inspections for verify that the previously disturbed areas are maintaining their slopes and compaction rates.
Land-clearing Debris and Soil Reuse: • Waste management communication plan. • Waste inventory. • Salvage. • Disposal. • Source-separated construction, demolition and land-clearing recycling. • Waste management report.	• Verify that the materials on the site are handled as outlined in the waste management plan. • Verify that the recyclables and salvage items are packaged for removal and transported as outlined in the waste management plan. • Verify that hazardous construction materials are handled as outlined in the construction waste management plan. • Verify that the waste management goals and the waste prevention goals meet the requirements of the waste management plan. • Verify that the waste inventory reconciles with all disposal manifests or weight tickets. • Verification and documentation that the waste management report correctly reflects the outcome of the waste management plan.
Heat Island Mitigation: • Energy consumption. • Air pollutant emissions. • Greenhouse gases. • Trees and vegetation.	• Verify cool roof complies with thermal emittance, solar reflectance, or SRI values per the code • Verify structural and vegetative elements of the green roof • Verification of the water quality as it pertains to the mitigation techniques utilized in the original construction of the site. • Verify that the O&M manual meets the needs of the property owner. • Check and document the energy consumption savings as they pertain to the mitigation techniques used in the construction of the site. • Check and document the decreased air pollutant emissions and greenhouse gases produced and released as they pertain to the mitigation techniques utilized in the original construction of the site. • Verification and documentation of the water quality as it pertains to the mitigation techniques utilized in the original construction of the site.
Lighting: • Site lighting. • Security lighting. • Area lighting. • Landscape lighting. • Sports lighting.	• Verify exterior lighting meets light pollution plan • Check and document that all fixtures are in compliance with the definitions as defined by the IESNA. • Check Peripheral vision enhancement. • Check and document that the smallest wattage lamp source available is used to meet the desired lighting levels. • Check and document that the ratios of illuminance and luminance

	values are in compliance with the IESNA's *9th Edition Handbook Recommended Standards*. • Verify that all fixtures installed have been either selected from the specified product group or submitted as approved alternatives, as approved by the governing body of the local area. • Check and document that primary entry lighting, exterior emergency egress lighting, service area lighting, surface parking, parking garage and roadways are in compliance with the final lighting commissioning plan. • Verification and documentation that the O&M manual meets the goals of the owner.
Brownfield Mitigation: • Baseline risk assessment. • Corrective action plan. • Remedial action plan. • Remedial investigation/feasibility study. •	• Verification and documentation that the baseline risk assessment clearly and correctly identified and evaluated the threat to human health and the environment. • Verification and documentation that the recommended cleanup criteria and alternatives for remediation are aligned with the extent of contamination on the site. • Observation, verification and documentation that the cleanup of the site is at a level determined to be health protective for its intended use.

B.2.2 Materials (architectural building assembly)

RELATED SYSTEMS, EQUIPMENT, ASSEMBLIES AND COMPONENTS	TASKS/COMMENTS
Foundations subsoil drainage system.	Verify compliance with approved plans, specifications, and construction documents
Foundation damp proofing and waterproofing.	
Flashing at: exterior doors, skylights, wall flashing and drainage systems.	
Exterior wall coverings.	
Optional systems:	
• Moisture envelopes.	Meet OPR, BOD, Cx specifications.
• Exterior below-grade walls.	Check for proper drainage system at exterior wall perimeter to keep water from entering the building.
• External floor and soffits, slab-on-grade.	• Check for thermal resistance or insulation when required. • Check the IECC, when applicable. • Slabs: Check drainage for moisture penetration.
• Exterior walls.	• Check drawings for wall assembly requirements and any sound transmission class (STC) requirements in accordance with ASTM E 90 and ASTM E 413. • Check for compliance with applicable section of the International Building Code (IBC).
• Exterior glazed window fenestration: windows, glazed doors and skylights.	Drawing reviews and contractor submittal reviews: • Check that fenestration products are labeled with a *U*-factor (see NFRC 100) and a solar heat gain coefficient (SHGC) (see NFRC 200), and certification for the air infiltration requirement

	of 0.3 cfm/ft^2 or other approved standards. • Check for proper flashing and caulking at walls and roof assemblies. Glazed doors: • Check for proper flashing, and seals and gaskets; and proper pull force, if provided with a closer. • Check for proper door swing. • Check for STC requirements, if applicable.
• Site-built fenestration: curtain walls and store-front systems, and atrium roof systems.	• Check for a label certificate issued by the National Fenestration Rating Council (NFRC) or a label certificate issued by the glazing fabricator that meets the default U-factor of the SHGC; or an NFRC component modeling approach (CMA) label certificate or another approved standard. • Check for proper door swing. • Check for STC requirements, if applicable.
• Field-fabricated fenestrations: fenestration made at the site, not preformed or cut.	Check for compliance with the default *U*-factor and the default SHGC in accordance with the applicable approved standard.
• Exterior doors	• Check for proper flashing installation at header, walls and floor. • Check for U-factor requirements for swinging and non-swinging doors. • Check for appropriate manufacturer's referenced standard (American Architectural Manufacturer's Association (AAMA); Canadian Standards Association (CSA); and Window and Door Manufacturer's Association (WDMA) or other approved standard) product data sheets.
• Sealants, control joints and flashing (stationary and moveable).	• Check for proper installation in accordance with the manufacturer's written instructions. • Check for proper flashing installation.
• Shading devices (stationary and moveable).	• Check for proper anchoring to building with proper flashing at wall connections. • At mechanical devices: check for proper installation and controls.
• Structural systems.	Check for proper anchoring in accordance with construction documents, including metal connectors and beam supports.
• Materials and finishes.	• Check for compliance with allowed volatile organic compound limits and proper manufacturer's installation application • Review product data sheets.

For SI: 1 cubic foot per minute per square foot = 0.00508 m^3/(s · m^2).

Other Project Requirements

Structural systems.	Check for proper anchoring in accordance with the construction documents, including metal connectors and beam supports.

Structural requirements for mechanical systems and renewable energy systems.	Pre-functional checklists, site observations and construction testing.

B.2.3 Energy—Management and monitoring systems

• Workstation graphic displays.	Verify the following is consistent with the commissioning plan: • Systems design. • System specifications. • System submittals. • System installations. • System pre-startup inspection checklist. • System functional performance testing. • Systems training. • Device Point to Point checkout (Static Testing) • Device Point to Point checkout (Dynamic Testing) • Sensor calibration • Valve and damper stroke setup and check • Coil valve leak check • Isolation valve or system valve leak check
• Public display systems.	
• Central processing/monitoring hardware and software.	
• Network communications/alarm functions.	
• User interface with emergency medical services.	
• Monitoring functions required for facility operations.	
• Local control panels and individual monitoring points.	
Integrated Automation Instrumentation for HVAC Systems: • Actuators and operators. • Sensors and transmitters. • Control valves. • Control dampers. • Flow meters.	
Integrated Automation Instrumentation for Plumbing Systems: • Domestic water metering. • Grey water metering. • Fuel system (gas, oil) metering.	
Integrated Automation Instrumentation and Terminal Devices for Electrical Systems: • Power meters. • Kilowatt (kW) transducers. • Current sensors. • Battery monitors. • Lighting relays. • UPS monitors.	
Integrated Automation of Renewable Energy Systems: • Solar photovoltaic. • Wind generation. • Geothermal.	
• Building management systems.	
• Electrical systems.	
• Lighting systems.	

• Alternative power systems.	
• On-site renewable energy.	
• Whole-building energy analysis.	
• Controllability of lighting systems.	
• Controllability of thermal systems.	

B.2.4 Energy—HVAC Systems

RELATED SYSTEMS, EQUIPMENT, ASSEMBLIES AND COMPONENTS	TASKS/COMMENTS
Instrumentation and Control for HVAC: • Actuators and operators. • Sensors and transmitters. • Control valves. • Control dampers. • Direct-digital control system.	(tasks included on previous page)
Unitary HVAC Equipment: • Packaged terminal air conditioners. • Room air conditioners. • Self-contained air conditioners. • Computer room air conditioners. • Split-system air conditioners. • Air-source unitary heat pumps. • Water-source unitary heat pumps.	• Verify air system balancing • Verify hydronic system balancing • Verify duct system testing. • Verify mechanical system manuals and construction documents required by the O&M manual are submitted. • Verify that functional performance testing of HVAC equipment and associated controls and control systems. • Verify acceptance of HVAC systems and equipment/system verification report. • Verify preparation and distribution of final HVAC system completion; documentation that construction documents require drawings, manuals, balancing reports and commissioning report are provided to the owner and that they have been provided. • Verify air-handling system access. • Verify air-handling system filters. • Verify temperature and humidity in occupied spaces. • Verify specific indoor air quality and pollutant control measures. • Verify listing, instillation and venting of fireplaces and combustion appliances. • Verify mechanical and emergency generator equipment located outside building or located where expose to exterior environment.
Humidity Control Equipment: • Humidifiers. • Heated-pan humidifiers. • Wetted-element humidifiers. • Atomizing humidifiers. • Direct-steam-injection humidifiers. • Jacketed, steam humidifiers. • Self-contained steam humidifiers. • Portable humidifiers, mechanical dehumidification units. • Outdoor, mechanical dehumidification units. • Indoor, mechanical dehumidification units. • Portable dehumidifiers. • Desiccant dehumidification units.	

Convection Heating and Cooling Units: • Chilled beams. • Air coils. • Fan coil units. • Unit ventilators. • Induction units. • Radiators convectors. • Finned-tube radiation heaters. • Unit heaters. • Cabinet unit heaters. • Propeller unit heaters. • Wall and ceiling unit heaters. Water-to-water heat pumps.	• Verify air system balancing • Verify hydronic system balancing • Verify mechanical system manuals construction documents required by the O&M and systems manual are submitted. • Verify that functional performance testing of HVAC equipment and associated controls and control systems. • Verify acceptance of HVAC systems and equipment/system verification report. • Verify preparation and distribution of final HVAC system completion; documentation that construction documents require drawings, manuals, balancing reports and commissioning report are provided to the owner and that they have been provided. • Verify air-handling system access. • Verify air-handling system filters. • Verify temperature and humidity in occupied spaces. • Verify specific indoor air quality and pollutant control measures. • Verify listing, instillation and venting of fireplaces and combustion appliances. • Verify mechanical and emergency generator equipment located outside building or located where expose to exterior environment.
Humidity Control Equipment: • Humidifiers. • Heated-pan humidifiers. • Wetted-element humidifiers. • Atomizing humidifiers. • Direct-steam-injection humidifiers. • Jacketed, steam humidifiers. • Self-contained steam humidifiers. • Portable humidifiers. • Mechanical dehumidification units. • Outdoor, mechanical dehumidification units. • Indoor, mechanical dehumidification units. • Portable dehumidifiers. • Desiccant dehumidification units.	
Radiant Heating Units: • Radiant-heating electric cables. • Radiant-heating electric mats. • Radiant-heating hydronic piping. • Radiant-heating electric panels. • Gas-fired radiant heaters. • Electric radiant heaters.	
Central Heating Equipment—Breechings, Chimneys and Stacks: • Draft control devices. • Draft-induction fans. • Vent dampers. • Barometric dampers. • Fabricated breechings and accessories. • Fabricated stacks. • Gas vents. • Insulated sectional chimneys. • Flue-gas filtration equipment. • Gaseous filtration.	• Verify air system balancing and a means for providing the system balancing. • Verify hydronic system balancing and a means for providing the system balancing. • Verify duct system testing. • Verify mechanical system manuals and construction documents required by the O&M manual are submitted. • Verify that functional performance testing of HVAC equipment and associated controls and control systems. • Verify acceptance of HVAC systems and equipment/system verification report. • Verify preparation and distribution of final HVAC system

• Particulate filtration.	completion; documentation that construction documents require drawings, manuals, balancing reports and commissioning report are provided to the owner and that they have been provided. • Verify air-handling system access. • Verify air-handling system filters. • Verify temperature and humidity in occupied spaces. • Verify specific indoor air quality and pollutant control measures. • Verify listing, instillation and venting of fireplaces and combustion appliances. • Verify mechanical and emergency generator equipment located outside building or located where expose to exterior environment.
Fuel-fired Heaters: • Fuel-fired duct heaters. • Oil-fired duct heaters. • Gas-fired duct heaters. • Gas-fired radiant heaters. • Fuel-fired unit heaters. • Oil-fired unit heaters. • Gas-fired unit heaters.	• Verify air system balancing and a means for providing the system balancing. • Verify hydronic system balancing and a means for providing the system balancing. • Verify duct system testing. • Verify mechanical system manuals and construction documents required by the O&M manual are submitted. • Verify that functional performance testing of HVAC equipment and associated controls and control systems. • Verify acceptance of HVAC systems and equipment/system verification report. • Verify preparation and distribution of final HVAC system completion; documentation that construction documents require drawings, manuals, balancing reports and commissioning report are provided to the owner and that they have been provided. • Verify air-handling system access. • Verify air-handling system filters. • Verify temperature and humidity in occupied spaces. • Verify specific indoor air quality and pollutant control measures. • Verify listing, instillation and venting of fireplaces and combustion appliances. • Verify mechanical and emergency generator equipment located outside building or located where expose to exterior environment.
Furnaces: • Electric-resistance furnaces. • Fuel-fired furnaces. • Gas-fired furnaces. • Oil-fired furnaces.	
Heat Exchangers for HVAC: • Steam-to-steam heat exchangers, steam-to-water heat exchangers. • Liquid-to-liquid heat exchangers. • Plate-type, liquid-to-liquid heat exchangers. • Shell-type, liquid-to-liquid heat exchangers. • Direct-geo-exchange heat exchangers.	
Heating Boiler Feedwater Equipment: • Boiler feedwater pumps. • De-aerators.	
Heating Boilers: • Electric boilers. • Condensing boilers. • Stainless-steel condensing boilers. • Aluminum condensing boilers. • Low-mass boilers. • Pulse combustion boilers. • Cast-iron boilers. • Water-tube boilers. • Finned water-tube boilers. • Steel water-tube boilers.	

• Copper water-tube boilers. • Fire-tube boilers. • Scotch marine boilers. • Steel fire-tube boilers. • Boiler blowdown systems.	
Solar Energy Heating Equipment: • Heating solar collectors. • Heating solar flat-plate collectors. • Heating solar concentrating collectors. • Heating solar vacuum-tube collectors. • Packaged solar heating equipment.	
Central Cooling Equipment: • Refrigerant compressors. • Centrifugal refrigerant compressors. • Non-condensable, gas-purge equipment. • Reciprocating refrigerant compressors. • Scroll refrigerant compressors. • Rotary-screw refrigerant compressors. • Compressor and condenser units packaged air/water-cooled refrigerant compressor and condenser units.	• Verify air system balancing and a means for providing the system balancing. • Verify hydronic system balancing and a means for providing the system balancing. • Verify duct system testing. • Verify mechanical system manuals and construction documents required by the O&M manual are submitted. • Verify that functional performance testing of HVAC equipment and associated controls and control systems. • Verify acceptance of HVAC systems and equipment/system verification report. • Verify preparation and distribution of final HVAC system completion; documentation that construction documents require drawings, manuals, balancing reports and commissioning report are provided to the owner and that they have been provided. • Verify air-handling system access. • Verify air-handling system filters. • Verify temperature and humidity in occupied spaces. • Verify specific indoor air quality and pollutant control measures. • Verify listing, instillation and venting of fireplaces and combustion appliances. • Verify mechanical and emergency generator equipment located outside building or located where expose to exterior environment.
Cooling Towers: • Forced-draft cooling towers. • Open-circuit, forced-draft cooling towers. • Closed-circuit, forced-draft cooling towers. • Natural-draft cooling towers. • Liquid coolers.	
Packaged Water Chillers • Absorption water chillers. • Direct-fired absorption water chillers. • Indirect-fired absorption water chillers. • Centrifugal water chillers. • Air-cooled centrifugal water chillers. • Water-cooled centrifugal water chillers reciprocating water chillers. • Scroll water chillers. • Rotary-screw water chillers.	
Thermal Storage: • Chilled-water thermal storage. • Ice thermal storage. • Ice-slurry thermal storage.	• Verify hydronic system balancing and a means for providing the system balancing. • Verify duct system testing. • Verify mechanical system manuals and construction documents required by the O&M manual are submitted. • Verify that functional performance testing of HVAC equipment and associated controls and control systems. • Verify acceptance of HVAC systems and equipment/system verification report. • Verify preparation and distribution of final HVAC system completion; documentation that construction documents require

	drawings, manuals, balancing reports and commissioning report are provided to the owner and that they have been provided. • Verify air-handling system access. • Verify air-handling system filters. • Verify temperature and humidity in occupied spaces. • Verify specific indoor air quality and pollutant control measures. • Verify listing, instillation and venting of fireplaces and combustion appliances. • Verify mechanical and emergency generator equipment located outside building or located where expose to exterior environment.
Air Outlets and Inlets: • Diffusers, registers and grilles. • HVAC gravity ventilators. • HVAC gravity dome ventilators. • HVAC gravity-louvered penthouse ventilators. • HVAC gravity up-blast ventilators. **Air Terminal Units:** • Constant-air-volume units. • VAV units. **Electronic Air Cleaners:** • Washable electronic air cleaners. • Self-contained electronic air cleaners. **Gas-phase Air Filtration:** • Activated-carbon air filtration. • Chemically impregnated adsorption air filtration. • Catalytic-adsorption air filtration. **HVAC Air Cleaning Devices—Particulate Air Filtration:** • Panel air filters. • Renewable-media air filters. • Washable air filters. • Extended surface filters. • High-efficiency particulate filtration. **HVAC Air Distribution:** • Dampers. • Volume-control dampers. • Fire dampers. • Smoke-control dampers. • Backdraft dampers. • Duct silencers. • Turning vanes. • Duct- access doors. • HVAC fans. • Axial HVAC fans.	• Verify air system balancing • Verify hydronic system balancing • Verify duct system testing. • Verify mechanical system manuals and construction documents required by the O&M and systems manuals are submitted. • Verify that functional performance testing of HVAC equipment and associated controls and control systems. • Verify acceptance of HVAC systems and equipment/system verification report. • Verify preparation and distribution of final HVAC system completion; documentation that construction documents require drawings, manuals, balancing reports and commissioning report are provided to the owner and that they have been provided. • Verify air-handling system access. • Verify air-handling system filters. • Verify temperature and humidity in occupied spaces. • Verify specific indoor air quality and pollutant control measures. • Verify listing, instillation and venting of fireplaces and combustion appliances. • Verify mechanical and emergency generator equipment located outside building or located where expose to exterior environment.

• Centrifugal HVAC fans. • HVAC power ventilators. • Air curtains.	
Special Exhaust Systems: • Dust-collection systems. • Sawdust collection systems. • Engine exhaust systems. • Positive-pressure engine exhaust systems. • Mechanical engine exhaust systems.	(Included in above tasks/comments) • Verify compliance with local codes
Ventilation Hoods: • Commercial kitchen hoods. • Listed commercial kitchen hoods. • Standard commercial kitchen hoods. • Fume hoods.	
HVAC Piping and Pumps; **Hydronic Piping and Pumps:** • Hydronic piping. • Underground hydronic piping. • Above-ground hydronic piping. • Ground-loop heat-pump piping. • Hydronic piping specialties. • Hydronic pumps. • In-line centrifugal hydronic pumps. • Base-mounted, centrifugal hydronic pumps. • Vertical-mounted, double-suction centrifugal hydronic pumps. • Vertical-turbine hydronic pump, automatic.	• Installed in compliance with contract document • Flushing and cleaning plan submitted and approved • System properly flushed and cleaned and temp piping removed • Piping pressure tested according to contract document • Isolation valves provided at all branches and main takeoffs as required by the contract documents • Valves installed in the proper direction • Valves that require a positive shut-off are verified to not leak when closed at normal operating pressure • Valves tagged and valve schedule submitted and displayed per contract documents • Temperature, pressure and flow gages and sensors installed • Piping gages, BAS and associated panel temperature and pressure readouts match
HVAC Water Treatment: • Water treatment for Closed-loop hydronic systems. • Water treatment for open hydronic systems. • Water treatment for steam system feedwater.	
Internal-combustion Engine Piping: • Internal-combustion engine remote-radiator coolant piping. • Internal-combustion engine exhaust piping.	
Refrigerant Piping: • Refrigerant piping valves. • Refrigerant piping specialties. • Refrigerant safety relief valve discharge piping. • Refrigerants.	

Steam and Condensate Piping and Pumps: • Steam and condensate pump units. • Steam and condensate heating piping. • Steam and condensate heating piping specialties. • Steam condensate pumps. • Electric-driven steam condensate pumps. • Pressure-powered steam condensate pumps.	

B.2.5 Energy—Lighting and electrical

Lighting and Electrical:	
• Automatic demand-reduction control system functionality. • Plug load controls. • Connection of appliances to switched receptacles. • Verification of transformer nameplate efficiency. • Lamps (lighting installations). • Ballasts (lighting installations).	• Devices installed per manufacturer's instructions and specifications
• Lighting control systems (low voltage).	• Verify a representative sample of zones for sweep warning effectiveness, override capability and zone size. • Test accuracy of schedule, sweep warning system and sweep override switches.
Automatic daylight harvesting.	• Verify photosensors are properly placed and aimed. • Verify daylight control zones correspond to available daylight. • Calibrate dimming set points without the presence of daylighting. • Calibrate dimming gain in presence of daylighting. • Calibrate switching dead-bands and set points. • Performance test a representative sample of daylight zones.
Occupancy and vacancy sensors.	• Calibrate sensitivity sensor and time delay adjustment. • Performance test a representative sample of control zones, including entry tests, hand-motion tests and perimeter tests.

Optional Items

RELATED SYSTEMS, EQUIPMENT, ASSEMBLIES AND COMPONENTS	**TASKS/COMMENTS**
Medium-voltage: • Substations. • Switches. • Circuit breakers. • Switchgear. • Switchboards. • Panel boards.	• Verify coordination study is complete, and that breaker and relay settings are set in accordance with the study. • Witnessing of factory tests, as appropriate. • Ensure all necessary representatives are present, e.g., installer, factory representative, etc. • Review start-up checklist. • Test transformers. • Test protective devices.

• Emergency systems.	• Test control circuits, e.g., potential transformers and current transformers. • Test switchgear, e.g., electrical and mechanical operations. • Test circuit breakers. • Local operational tests. • Remote operational tests, if applicable. • Verify training of operating personnel for O&M of equipment.
Low-voltage: • Substations. • Disconnects. • Circuit breakers. • Motor control centers. • Panel boards. • Emergency systems.	• Verify coordination study is complete, and that breaker and relay settings are set in accordance with the study. • Witnessing of factory tests, as appropriate. • Ensure all necessary representatives are present e.g., installer, factory representative, etc. • Review start-up checklist. • Test transformers. • Test protective devices, e.g., potential transformers and current transformers. • Test control circuits. • Test switchgear, e.g., electrical and mechanical operations. • Test circuit breakers. • Local operational tests. • Remote operational tests, if applicable. • Verify training of operating personnel for O&M of equipment.
Motors, motor starters and drives (VFD).	• Witnessing of factory tests, as appropriate. • Ensure all necessary representatives are present, e.g., installer, factory representative, etc. • Review start-up checklist. • Verify motor and starter data match specification and each other. • Inspect the installation. • Take voltage and current reading; compare with nameplate and manufacture's specifications. • Test for proper motor rotation; if VFD, verify proper motor rotation when in VFD bypass mode. • Local operational tests. • Remote operational tests, if applicable. • Verify training of operating personnel for O&M of equipment. • Monitor operations.
Emergency generators and distribution systems.	• Verify coordination study is complete, and that breaker and relay settings are set in accordance with the study. • Witnessing of factory tests, as appropriate. • Ensure all necessary representatives are present, e.g., installer, factory representative, etc. • Review start-up checklist and factory commissioning plan. • Inspect the installation. • Follow factory commissioning plan. • Local operational tests. • Remote operational tests, if applicable. • Load and duration tests (increasing loads over increasing durations).

	• Verify training of operating personnel for O&M of equipment. • Monitor operation.
UPS.	• Witnessing of factory tests, as appropriate. • Ensure all necessary representatives are present, e.g., installer, factory representative, etc. • Review start-up checklist and factory commissioning plan. • Inspect the installation. • Follow factory commissioning plans (transfer testing, to generator, to bypass, to maintenance bypass, etc.). • Verify training of operating personnel for O&M of equipment. • Monitor operation.
Grounding equipment and building grounding systems.	• See IEEE 81. • Ensure all necessary representatives are present, e.g., installer, factory representative, etc. • Inspect the installation. • Verify training of operating personnel for O&M of equipment.
Lightning protection equipment and systems.	• Ensure all necessary representatives are present, e.g., installer, factory representative, etc. • Inspect the installation. • Ensure installer is listed by UL, and that a master label application is submitted to UL for the installation. • Ensure owner signs the master label application. • Ensure receipt of master label from the installer. • Place master label on the protected structure, as requested. • Take voltage and current reading; compare with nameplate and manufacture's specifications. • Test for proper motor rotation; if VFD, verify proper motor rotation when in VFD bypass mode. • Verify training of operating personnel for O&M of equipment. • Monitor operation.

B.2.6 Energy—Other electrical systems (communications, including telecom, intercom, public address, television, video, etc.)

- Optional items

RELATED SYSTEMS, EQUIPMENT, ASSEMBLIES AND COMPONENTS	TASKS/COMMENTS
Medium-voltage: • Transformers. • Substations. • Switches. • Circuit breakers. • Switchgear. • Switchboards. • Panel boards. • Emergency systems.	• Verify coordination study is complete, and that breaker, fuse and relay settings are set in accordance with the study. • Witnessing of factory tests, as appropriate. • Ensure all necessary representatives are present, e.g., installer, factory representative, etc. • Review start-up checklist. • Test transformers. • Test protective devices. • Test control circuits, e.g., potential transformers and current transformers. • Test switchgear, e.g., electrical and mechanical operation. • Test circuit breakers. • Local operational tests. • Remote operational tests, if applicable. • Test all mechanical connections using an infrared camera after initial energizing and after the system is loaded. • Verify training of operating personnel for O&M of equipment.
Low-voltage: • Transformers. • Substations. • Disconnects. • Bus duct. • Circuit breakers (air circuit breakers not molded case circuit breakers). • Motor control centers. • Panel boards. • Emergency systems.	• Verify coordination study is complete, and that breaker, fuse and relay settings are set in accordance with the study. • Witnessing of factory tests, as appropriate. • Ensure all necessary representatives are present, e.g., installer, factory representative, etc. • Review start-up checklist. • Test transformers. • Test protective devices, e.g., potential transformers and current transformers. • Test control circuits. • Test switchgear, e.g., electrical and mechanical operation. • Test circuit breakers. • Local operational tests. • Remote operational tests, if applicable. • Test all mechanical connections using an infrared camera after initial energizing and after the system is loaded. • Verify training of operating personnel for O&M of equipment.

Motors, motor starters and drives (VFD).	• Witnessing of factory tests, as appropriate. • Ensure all necessary representatives are present, e.g., installer, factory representative, etc. • Review start-up checklist. • Verify motor and starter data match specification and each other. • Inspect the installation. • Take voltage and current reading, compare with nameplate and manufacture's specifications. • Test for proper motor rotation; if VFD, verify motor proper motor rotation when in VFD bypass mode. • Local operational tests. • Remote operational tests, if applicable. • Verify training of operating personnel for O&M of equipment. • Monitor operation.
Emergency generators and distribution systems.	• Verify coordination study is complete, and that breaker, fuse and relay settings are set in accordance with the study. • Witnessing of factory tests, as appropriate. • Ensure all necessary representatives are present, e.g., installer, factory representative, etc. • Review start-up checklist and factory commissioning plan. • Inspect the installation. • Follow factory commissioning plan. • Local operational tests. • Remote operational tests, if applicable. • Test all mechanical connections using an infrared camera after initial energizing and after the system is loaded. • Load and duration tests (increasing loads over increasing durations). • Verify training of operating personnel for O&M of equipment. • Monitor operation.
UPS.	• Witnessing of factory tests, as appropriate. • Ensure all necessary representatives are present, e.g., installer, factory representative, etc. • Review start-up checklist and factory commissioning plan. • Inspect the installation. • Follow factory commissioning plans (transfer testing, to generator, to bypass, to maintenance bypass, etc.). • Test all mechanical connections using an infrared camera after initial energizing and after the system is loaded. • Verify training of operating personnel for O&M of equipment. • Monitor operation.
Grounding equipment and building grounding systems.	• Ensure all necessary representatives are present, e.g., installer, factory representative, etc. • Inspect the installation. • Verify training of operating personnel for O&M of equipment.

Lightning protection equipment and systems.	• Ensure all necessary representatives are present, e.g., installer, factory representative, etc. • Inspect the installation. • Ensure installer is listed by UL and that a master label application is submitted to UL for the installation. • Ensure building owner signs the master label application. • Ensure receipt of master label from the installer. • Place master label on the protected structure, as requested. • Take voltage and current reading, compare with nameplate and manufactures specifications. • Test for proper motor rotation; if VFD, verify proper motor rotation when in VFD bypass mode. • Verify training of operating personnel for O&M of equipment. • Monitor operation.

B.2.7 Water—Plumbing systems (water distribution, sanitary/storm water, rainwater, gray water, etc.)

RELATED SYSTEMS, EQUIPMENT, ASSEMBLIES AND COMPONENTS	TASKS/COMMENTS
Facility Water Distribution Piping: • Domestic water piping. • Domestic water piping specialties. • Domestic water pumps. • Domestic water-packaged booster pumps.	• Installed in compliance with contract document • Flushing and cleaning plan submitted and approved • Piping pressure tested according to contract document
Facility potable-water-storage tanks.	Installed in compliance with contract document
Facility Sanitary Sewerage: • Sanitary waste piping specialties. • Sanitary drains. • Fats, oils and grease disposal systems. • Grease removal devices. • Backwater valves. • Air admittance valves. • Sanitary waste interceptors and separators. • Sanitary sewerage pumps. • Wet pit-mounted, vertical sewerage pumps. • Submersible sewerage pumps. • Sewerage pump basins and pits. • Facility septic tanks. • Facility gray water tanks.	• Installed in compliance with contract document • Flushing and cleaning plan submitted and approved • System properly flushed and cleaned and temp piping removed • Piping pressure tested according to contract document • Valves installed in the proper direction • Valves that require a positive shut-off are verified to not leak when closed at normal operating pressure • Valves tagged and valve schedule submitted and displayed per contract documents
Facility Storm Drainage: • Facility storm drainage piping. • Sump pump discharge piping. • Sump pumps. • Submersible sump pumps. • Sump-pump basins and pits.	

• Packaged, pedestal drainage pump units. • Packaged, submersible, drainage pump units. • Rainwater storage tanks.	
General service compressed-air systems.	
Domestic Water Heat Exchangers: • Instantaneous domestic water heat exchangers. • Heating fluid-in-coil, instantaneous domestic water heat exchangers. • Domestic water-in-coil, instantaneous domestic water heat exchangers. • Heating fluid, instantaneous domestic water heat exchangers. • Circulating, domestic water heat exchangers. • Circulating, compact domestic water heat exchangers. • Circulating, storage domestic water heat exchangers. • Noncirculating, domestic water heat exchangers. • Noncirculating, storage domestic water heat exchangers. • Domestic water brazed-plate heat exchangers. • Domestic water frame-and-plate heat exchangers. • Domestic water heat reclaimers.	• Comply with manufacturer's recommended checkout and startup procedures • Manufacturer's recommended spare parts are provided • Equipment label permanently affixed • Pumps in place and properly supported • Pressure / temperature relief valves installed per contract documents • Shaft seal is leak free • Insulation installed per contract documents • All electrical connections are tight • Grounding installed and operational • Safeties installed and operational • Control system interlocks connected and functional • Pump rotates in correct direction • Temperature and pressure gages and sensors installed per contract documents

Domestic Water Softeners; **Domestic Water Filtration Equipment;** **Electric Domestic Water Heaters:** • Instantaneous electric domestic water heaters. • Flow-control, instantaneous electric domestic water heaters. • Thermostat-control, instantaneous electric domestic water heaters. • Electric domestic water heaters. • Small-capacity electric domestic water heaters. • Residential, storage electric domestic water heaters. • Collector-to-tank, solar-electric domestic water heaters. • Collector-to-tank, heat-exchanger-coil, solar-electric domestic water heaters. • Light-commercial electric domestic water heaters. • Commercial domestic water electric booster heaters. • Commercial domestic water electric booster heaters. • Commercial storage electric domestic water heaters.	• Comply with manufacturer's recommended checkout and startup procedures • Manufacturer's recommended spare parts are provided • Equipment label permanently affixed • Pumps in place and properly supported • Pressure / temperature relief valves installed per contract documents • Shaft seal is leak free • Insulation installed per contract documents

Fuel-fired Domestic Water Heaters: • Instantaneous, tankless, gas domestic water heaters. • Residential gas domestic water heaters. • Residential, atmospheric, gas domestic water heaters. • Residential, direct-vent, gas domestic water heaters. • Residential, power-vent, gas domestic water heaters. • Commercial gas domestic water heaters. • Commercial, atmospheric, gas domestic water heaters. • Commercial, power-burner, gas domestic water heaters. • Commercial, power-vent, gas domestic water heaters. • Commercial, high-efficiency, gas domestic water heaters. • Commercial, coil-type, finned-tube, gas domestic water heaters. • Commercial, grid-type, finned-tube, gas domestic water heaters. • Oil-fired domestic water heaters. • Large-capacity, oil-fired domestic water heaters. • Dual fuel-fired domestic water heaters.	• All electrical connections are tight • Grounding installed and operational • Safeties installed and operational • Control system interlocks connected and functional • Pump rotates in correct direction • Temperature and pressure gages and sensors installed per contract documents
Commercial Plumbing Fixtures: • Commercial water closets, urinals and bidets. • Commercial water closets. • Commercial urinals. • Commercial lavatories and sinks. • Commercial lavatories. • Commercial sinks. • Commercial bathtubs. • Commercial showers. • Commercial disposers. • Wash fountains. • Commercial faucets, supplies and trim. • Flushometers.	• Installation is per manufacturer's instructions • Pipe fittings complete and properly supported • Faucet / Flush handles secure and properly aligned • Associated trim and accessories consistent with contract documents • Joints between fixtures, walls and floors and counters sealed • Insulation installed per contract documents • Fixtures consistent with ADA • Water pressure meets contract documents • Hot Water temperature meets contract documents • Automatic flush valves and sensors verified for proper operation and sensitivity adjustment
Emergency Plumbing Fixtures: • Emergency showers. • Eyewash equipment. • Self-contained eyewash equipment.	• Installation is per manufacturer's instructions • Water pressure meets contract documents • Hot Water temperature meets contract documents

Drinking Fountains and Water Coolers: • Drinking fountains. • Pressure water coolers. • Water-station water coolers. • Remote water coolers.	• Installation is per manufacturer's instructions • Water pressure meets contract documents • Water temperature meets contract documents
Fountain Plumbing Systems: • Fountain piping. • Fountain pumps. • Fountain water treatment equipment. • Fountain equipment controls.	• Comply with manufacturer's recommended checkout and startup procedures • Manufacturer's recommended spare parts are provided • Equipment label permanently affixed • Pumps in place and properly supported • Pressure / temperature relief valves installed per contract documents • Shaft seal is leak free • Insulation installed per contract documents • All electrical connections are tight • Grounding installed and operational • Safeties installed and operational • Control system interlocks connected and functional • Pump rotates in correct direction
Swimming Pool Plumbing Systems: • Swimming pool pumps. • Swimming pool water treatment equipment. • Swimming pool equipment controls.	

B.2.8 Indoor environmental quality

- For IEQ requirements for individual systems see the following sections:
  - See Subsection Energy—HVAC systems.
- Optional systems
  - See Subsection Materials (architectural building assembly).

B.2.9 Fire suppression systems

RELATED SYSTEMS, EQUIPMENT, ASSEMBLIES AND COMPONENTS	TASKS/COMMENTS
General:	Person must be familiar with the governing laws, codes, regulations, or standards.
• Building permit and building inspection record on site.	Verify type of system to be installed iIn accordance with governing laws, codes, regulations, or standards and the owner.
• Approved fire sprinkler plans, hydraulic calculations and architectural plans shall be on site.	Commissioning provider shall be proficient in all applicable codes. See NFPA 3, NFPA 4, NFPA 12, NFPA 12A ,NFPA 13, NFPA 13D, NFPA 13R, NFPA 14, NFPA 15, NFPA 16, NFPA 17, NFPA 17A,,NFPA 20, NFPA 22, NFPA 24, NFPA 25, NFPA 30, NFPA 30B, NFPA 33, NFPA 45, NFPA 54, NFPA 90A, NFPA 90B, NFPA 92, NFPA 96, NFPA 211, NFPA 214, NFPA 307 NFPA 409, NFPA 750, NFPA 853, and NFPA 2001.
• All materials and equipment.	Verify all materials and equipment used are listed and approved in

	accordance with the owner's needs as well as governing laws, codes, regulations or standard
Overhead piping:	See NFPA 13, *Standard for the Installation of Sprinkler Systems*
• All piping.	Witness hydrostatic test for all piping systems.
• Pipe sizing.	Verify pipe sizes are in accordance with the approved plans.
• Sprinklers.	Verify sprinkler spacing and positions are in accordance with the approved plans, listing and locally adopted codes.
• Hangers.	Verify spacing is in accordance with the approved plans and listing.
• Seismic bracing.	Verify spacing is in accordance with the approved plans and listing.
• Branch line supports	Verify spacing is in accordance with the approved plans.
• Flow switches.	Verify location, listing and operation.
• Inspector's test connection.	Witness operation and verify annunciation of alarm in required time.
• Sprinkler control valves and tamper switches.	Witness operation and verify annunciation of alarm in required time.
• Sprinkler Fire Alarm control panel indication.	Witness operation and verify annunciation of alarm in required time.
• Drainage for riser drain and inspector's test.	Verify drain pipe size.
Underground Piping:	See NFPA 24, *Standard for the Installation of Private Fire Service Mains*
• Underground pipe.	Witness hydrostatic test for all piping.
• Pipe size.	Verify pipe size installed in accordance with the approved plans, and in accordance with the owner's project documents as well as governing laws, codes, regulations or standard
• Depth of cover.	Verify pipe is installed to proper depth.
• Piping restrain.	Verify pipe is restrained properly.
• Fire department inlet connection.	Verify fire department connection (FDC) piping is properly sized.
• Back flush fire department inlet connections.	Witness flushing.
• Pipe flushing.	Witness flushing.
• Protection for mechanical damage.	Verify pipe is protected properly from mechanical damage.
Standpipe Systems:	See NFPA 14.
• Underground piping.	Witness hydrostatic test.
• Pipe sizing.	Verify pipe size installed in accordance with the approved plans
• Hangers.	Verify hangers are installed in accordance with the approved plans and listing, and locally adopted codes.
• Seismic bracing.	Verify braces are installed in accordance with the approved plans and listing, and locally adopted codes.
• Standpipe.	Verify standpipe outlets are installed in accordance with locally adopted codes.
• Isolation valves and access.	Verify standpipe outlets are installed in accordance with locally adopted codes.
• Flush and flow test.	Witness test meets flow requirements in accordance with locally adopted codes.
• Hose connection and pressure rating.	Check for listing, damage, leakage, missing caps and obstructions.
Fire Pump Systems:	See NFPA 20.

• Certified curve for the fire pump.	Obtain certified curve from pump manufacturer.
• Fire pump identification number.	Compare approved plans and curve to pump nameplate.
• Pump room: floor drain, ventilation and rating.	Verify drainage, ventilation and rating of room is adequate inspection by others.
• Pipe hangers.	Verify hanger location in accordance with the approved plan and installed in accordance with locally adopted codes.
• Seismic bracing.	Verify braces in accordance with the approved plan and locally adopted codes.
• Test header outlets.	Verify location pipe size in accordance with the approved plan and installed in accordance with locally adopted codes.
• Relief valves	Verify size and location in accordance with the approved plans and installed in accordance with locally adopted codes.
• Jockey pump.	Verify suction and discharge is installed in correct locations in accordance with locally adopted codes.
• Controller and pressure-sensing piping.	Verify installation in accordance with locally adopted codes.
Water Storage Tank:	See NFPA 22
• Water in tank.	Check water level and water condition.
• Water level alarms.	Verify high- and low-level alarms.
• Water level indicators.	Verify location, accuracy and freedom of movement.
• Drain valve.	Verify flow.
• Tank vent.	Verify size in accordance with the approved plan and vent screen.
• Tank overflow.	Verify size in accordance with the approved plan.
• Supervised alarms.	Verify connection to a constantly attended location.
• Tank exterior.	Inspect damage exterior paint, foundation or supporting structure, catwalk or ladders.
• Area around the tank.	Free of combustible storage, trash, debris or other materials that could present a fire exposure hazard.
• Expansion joints.	Verify listing and check for cracks.
Pre-action Automatic Sprinkler Systems:	See NFPA 13
• Control valves (locked or supervised).	• Verify listing. • Verify position.
• Water flow alarm devices.	• Operate to verify initiation and receipt of alarm. • Verify alarm test valve alignment and tamper switch.
• Pre-action valve and trim.	• Inspect exterior of valves, gauges and trim alignment. • Verify valve pressure and legibility of hydraulic nameplate.
• Main drain.	Conduct main drain test to verify supply (valve position).
• FDC.	• Verify accessibility and condition. • Check for obstructions, and missing or removed caps.
Deluge Sprinkler Systems:	See NFPA 13
• Control valves (locked or supervised).	• Verify listing. • Verify position (open/close).
• Water flow alarms devices.	• Operate to verify initiation and receipt of alarm. • Verify alarm test valve alignment and tamper switch.
• FDC.	• Inspect exterior of valves, gauges and trim alignment. • Verify valve pressure and legibility of hydraulic nameplate.
• Main drain.	Conduct main drain test to verify supply (valve position).

• FDC.	• Verify accessibility and condition. • Check for obstructions, and missing or removed caps.
Dry Pipe Automatic Sprinkler Systems:	See NFPA 13
• Control valves.	• Verify listing. • Verify position (open/close).
• Water flow alarm devices.	• Verify listing. • Operate to verify initiation and receipt of alarm. • Verify alarm test valve alignment and tamper switch.
• Dry pip alarm valve and trim.	• Verify listing. • Visually inspect exterior of valves, gauges and trim alignment. • Verify valve pressure and legibility of hydraulic nameplate.
• Main drain.	Conduct main drain test to verify supply (valve position).
• FDC.	• Verify accessibility and condition. • Check for obstructions, and missing or removed caps.

B.2.10 Fire alarms See NFPA 72, *National Fire Alarm and Signaling Code*

RELATED SYSTEMS, EQUIPMENT, ASSEMBLIES AND COMPONENTS	TASKS/COMMENTS
Approved plans on-site.	
Pretest sheet completed.	Make sure forms are completed by installation contractors and field inspectors.
Permanent power to Fire Alarm (FA) system.	Verify permanent power is provided to FA and accessory systems.
Test booklet/list of devices on-site.	Verify FA device list is prepared, accurate and categorized by type of device and by floor.
Approved sequence of operations posted.	Verify the sequence of operation is accurate and posted adjacent to FA panel.
Operating instructions posted for FA system.	
Label all FA panels with the electrical circuit number.	Verify the presence of labels.
Lock-ons all FA electrical circuits.	Verify that circuits serving FA system have lock devices.
Date all batteries in FA system.	Verify all batteries have installation dates.
Approval of panel layout in fire control room.	Verify that layout accurately depicts location of life safety systems.
Inspect construction of fire control room.	Fire control room shall have the correct fire rating.
Access keys.	Obtain keys for building access; fire control room and FA panels/manual pull stations for key box. A lock box shall be provided at building entrance and at fire control room with required access keys.
Approval of matrix annunciator.	Verify the annunciator panel matches the approved plans.
Test operation of remote annunciators, if provided.	Verify that annunciation is synchronized with (matches) activated devices.
Fire alarm control panel (FACP) to monitor connection to matrix/remote annunciators.	Verify electrical supervision of circuits to remote annunciator.
FACP clear and trouble free prior to start of testing.	System shall be free of device and supervisory troubles.
FACP to monitor ground faults/power supply-battery troubles.	Verify that ground-fault power supply/battery troubles/notification circuits annunciate as trouble signals to FACP.

FACP to monitor troubles on initiating and notification circuits.	
FACP to monitor fire pump, water storage tank levels, fuel, emergency generator, smoke control panel switch status's supervisory signals.	Verify that FACP indicates trouble on non-normal status of these systems.
FACP to monitor elevator heat shunt trip breaker as supervisory signal.	Verify proper operation to match approved fire department plans.
Primary and alternate floor elevator recall programming to be tested.	
Central Station Signaling System (CSSS) to be tested.	Verify signals from FACP are properly sent by CSSS to monitor company and verify that the monitor company has correct jurisdictional contact.
24-hour battery test.	To be performed (5 or 15 minutes). Perform voltage check after discharge test.
Voice evacuation, where required.	Test all zones, elevators and stairwells to make sure they operate as indicated on the voice evacuation panel.
Voice evacuation/notification zones shall match each other and be tested.	Verify proper operation.
Fire-fighter communication system.	Shall be tested (sound powered, amplified, bi-directional antenna (BDA), etc.). Test handsets and input jacks.
Handsets.	Verify proper number of handsets is provided for fire-fighter communication system.
Initiating devices.	All initiating devices to be tested to verify programming and sequence of operations. All initiating devices to be installed in accordance with NFPA 72.
Subsequent alarm/sequence of operation.	Subsequent alarm/sequence of operation programming to be tested sequence of operations to be verified include: FACP programming, annunciation on matrix annunciator, signal sent to CSSS, smoke control activation, activation of notification devices, magnetic door holder release, activation of smoke/fire dampers, HVAC shutdown, audio-visual shunt, elevator recall, release of door locks in the path of egress, release of stairwell door locks, restoration of egress lighting in assembly occupancies.
Duct detectors.	Remote light-emitting diodes (LED's) for duct detectors to be tested.
Elevator lobby door locks.	Elevator lobby door locking systems to be tested.
Flow devices and tamper devices.	Test all water flow devices and tampers. Verify the correct signal to the FACP.
Special extinguishing systems, e.g., pre-action and deluge systems.	Test interaction/connection of special extinguishing systems to FACP.

Inspect signage on FA panels, doors to rooms with FA panels inside.	Ensure signage is in accordance with the approved plans.
Notification devices.	Inspect correct locations in accordance with the approved plans. Notification device candela ratings to be inspected. Audibility and Intelligibility levels to be tested for notification devices.
Mass notification systems.	Shall be tested for proper operation.

B.2.11 Elevators

RELATED SYSTEMS, EQUIPMENT, ASSEMBLIES AND COMPONENTS	TASKS/COMMENTS
Building permit and building inspection record on site.	Verify Documents
Approved elevator plans shall be on site.	
All materials and equipment shall be listed/approved.	
Elevator speed.	Verify contract speed.
Stopping zones.	Verify zones with the manufacturers testing procedures and specifications.
Door open speed.	Measure door open speed time.
Short hold open.	Verify door operation in accordance with the manufacturer's specifications.
Interrupted ray hold.	Verify operation of door reopening device.
Nudging hold open.	Verify operation.
Stall pressure.	Measure door torque.
Long hold open.	Measure door-open time in accordance with the manufacture's specifications.
Lanterns call notification.	Verify operation of hall lantern functions [in accordance with the Americans with Disabilities Act (ADA)].
Acceleration.	Verify car acceleration specification with the manufacturer.
Quality of stop.	Subjection to the manufacturer's specifications.
Door operation (how smooth).	Subjective to the manufacturer's specifications.
Door-open buttons.	Verify operation of door-open buttons.
Alarm buttons.	Verify operation of alarm buttons.
Emergency light.	Verify operation of emergency lighting.
Fire service, Phase 1.	Verify operation.
Fire service, Phase 2.	
Standby power.	
Telephone.	
Intercom.	
Car lighting guarded/mounted.	Car interior lighting in accordance with locally adopted codes and the manufacturer's specifications.
False call cancel.	If provide, verify operation.
Seismic operators.	Verify operation.
Door restriction.	

B.2.12 Escalators

RELATED SYSTEMS, EQUIPMENT, ASSEMBLIES AND COMPONENTS	TASKS/COMMENTS
General:	Verify Documents
• Building permit and building inspection record on site.	
• Approved escalator plans shall be on site.	
• All materials and equipment shall be listed/approved.	
External Evaluation:	
• Handrail.	Inspect condition, tracking and clearances.
• Handrail entry devices.	Inspect operation of safety devices.
• Comb-plate condition/contrast.	Inspect in accordance with the manufacturer's specifications.
• Indexing of steps/alignment in comb teeth.	Inspect in accordance with the manufacturer's specifications.
• Floor plates and landing plates.	Tripping hazards, lighting, mounted in accordance with the manufacturer's specifications.
• Deck.	Mounted, anti-slide, gaps and edge hazards in accordance with the specifications.
• Balustrade panels.	Mounted in accordance with the manufacturer's specifications.
• Skirt panels.	Check with locally adopted codes for compliance with the performance index and the manufacturer's specifications.
• Skirt brushes.	Inspect operation of safety devices.
• Emergency stop switches and audible alarms.	
• Start switches/direction reversal.	Inspect markings and operation of safety device.
• Comb-plate lighting.	Meet illumination requirements.
• Under-step demarcation lighting.	Verify operation of the demarcation (minimum two green lights).
• General lighting requirements.	Verify minimum illumination levels [5 foot-candles (53.82 lux)].
• Steps.	Check treads clearances.
• Ride quality.	Verify compliance with the manufacturer's specifications.
• Newel ends.	Check for entry guards and operations.
• Deck barricades.	Install in accordance with locally adopted codes: low-deck escalators.
• Ceiling guards at intersections.	Verify proper installation.
• Caution signage.	Verify location and verbiage.
Testing:	
• Measured speed steps.	Verify speed of steps within the manufacturer's specifications .
• Handrails.	Verify speed of handrail.
• Stop-slide directions, both directions if possible—load/no load.	Verify for consistency with the manufacturer's specifications.
• Stop-chain length—10 steps nose-to-nose.	In accordance with the manufacturer's specifications.
• Handrail—speed monitoring devices.	Inspect operation of safety devices in accordance with locally adopted codes.
• Skirt-to-step clearance.	Verify minimum and maximum required clearances.
Internal Evaluations:	

• Skirt switches.	Inspect operation of safety devices.
• Track pressure switches.	
• Machine—lubrication, gears, bearings and couplings.	In accordance with the manufacturer's specifications.
• Machine area stop switches.	Inspect operation of safety devices in accordance with locally adopted codes.
• Brakes.	In accordance with locally adopted codes and the manufacturer's specifications.
• Machine break torque.	Measure break torque.
• Handrail chain-tensioning systems.	Check tensioning devices.
• Handrail chain lubrication.	Check automatic lube in accordance with the manufacturer's specifications.
• Step chain lubrication.	
• Broken drive—chain devices.	Check operation of safety devices.
• Step rollers.	Check that it meets the manufacturer's specifications.
• Step up-thrust devices.	Inspect operation of safety devices.
• Pit light.	Verify operation and location.
• Pit receptacle.	
• Missing step devices.	Inspect operation of safety devices.
• Pit stop switches.	Inspect operation of safety devices.
• Step guard.	Verify position and materials.
• Broken step-chain devices (step-chain tension carriage switches).	Inspect operation of safety devices.
• Step level devices.	
• Comb-step impact devices.	
• Access cover switches.	
• Step lateral displacement devices.	

APPENDIX C

Commissioning Provider Skills and Qualifications

The following listings include sample skills, knowledge and abilities that Commissioning Providers and inspectors should have or be knowledgeable of to facilitate the commissioning process in the specific area listed. They should be knowledgeable in the tasks listed in the appropriate section in Appendix B-2 in this guideline.

C.1 Site development and land use

- **Knowledge of:**
    - Landscape design and systems.
    - Codes, standards and local regulations pertaining to landscape irrigation systems.
    - Codes, standards local regulations pertaining to outdoor fountains and water features.
    - Codes, principles and practice of controlling sediment, erosion and other storm water pollutants.
    - Hydrology, water quality, air quality, habitat conservation and site grading.
    - Codes, standards and principles pertaining to topography and site grading.
    - Codes, standards and local regulations pertaining to construction waste management.
    - Codes, standards and local regulations pertaining to heat island mitigation.
    - Codes, standards and local regulations pertaining to outdoor and site lighting.
    - Flood plain development.

- **The following is a list of qualifications that the Building Official may use in evaluating the CxP. The Building Official may consider one or more of the qualifications in this list:**
    - Third party certification acceptable to the AHJ
    - State licensure or reciprocity may not be a manufacturer of components; may not be the installer.
    - Prior experience within the landscape irrigation industry.
    - Civil Engineer.
    - National Pollutant Discharge Elimination System Level 1A Certification.
    - Civil engineer experienced and knowledgeable in the practice of soil engineering (soils engineer).
    - Professional Certification: International Waste Manager – Technical status or equal.
    - Building Commissioning Certifications with experience requirements

C.2 Materials (architectural building assembly)

- **Knowledge of:**
    - Third party certification acceptable to the AHJ

- The *International Building Code* (IBC®).
- Building assemblies
- Architectural detailing .
- Energy codes, ASHRAE 90.1.Related Standards
- Material Safety Data Sheets (MSDS) and other product verification.
- Egress requirements.

- **The following is a list of qualifications that the Building Official may use when evaluating the CxP. The Building Official may consider one or more of the qualifications in this list :**

  - Licensed architect.
  - Licensed engineer.
  - ICC certified inspector.
  - ICC certified CALGreen inspector.

C.3 Energy

- **Management and monitoring systems.**
  - Knowledge of:
    - Energy policy.
    - Codes and standards.
    - Energy audits.
      - Benchmarking.
      - General audit.
      - Investment-grade audit.
    - Life cycle analysis.
    - Energy financing, accounting and economics.
    - Building automation and control systems.
    - Energy procurement.
    - Green buildings, LEED and Energy Star.

- **The following is a list of qualifications that the Building Official may use in evaluating the CxP. . The Building Official may consider one or more of the qualifications in this list :**
  - Green Building Engineer certification or Licensed Engineer.

- **HVAC systems.**

  - Knowledge of:

    - Design and construction phase commissioning process
    - Construction communication protocol.
    - Facility requirements.
    - Sustainability and energy requirements.
    - Facility design and construction requirements.
    - Design conditions (climatic conditions, room conditions, temperature humidity levels, and pressure requirements, etc.).
    - Design methods, techniques and software applications.
    - National, state and local building codes, standards and guidelines.

- Schematic, design development, construction phase documents.
- Design of mechanical, electrical and plumbing systems.
- Electrical—Power distribution, motor control centers, power monitoring, etc.
- Building automation systems, diagrams, points and sequences.
- Specification formats.
- Commissioned systems and equipment.
- Construction submittals.
- Installation requirements of mechanical, electrical and plumbing (MEP) equipment and systems.
- O&M requirements.
- Equipment manufacturer's start-up procedures.
- Mechanical/electrical equipment and system operation.
- BAS control diagrams, points, sequences and configuration.
- TAB process and procedures.
- O&M documentation.
- System manual components and assembly.
- Delivery of training.

o Record test data and results.
o Develop trending and analysis trend reports.
o Facilitate the FPT process.

- **The following is a list of qualifications that the Building Official may use in evaluating the CxP. . The Building Official may consider one or more of the qualifications in this list :**

  o Licensed Engineer
  o An independent third-party commissioning certification program

C.4 Lighting

- **Knowledge of:**

  o Skills and abilities to verify that the systems listed are designed, installed and operate as intended.
  o Lighting control systems
  o IEEE and IES standards.
  o NFPA 70.
  o Arc flash safety requirements.
  o Lockout tag-out procedures and medium-voltage power distribution equipment and controls.
  o Motors, starters and VFDs.
  o Generator systems and their associated subsystems [battery charging and starting; lubrication; fuel; ignition; cooling; prime-mover engine (Diesel/turbine); reduction gear; exciter ; and generator] of UPS systems and their associated subsystems (back-up generator; input/output switch gear; battery and charging).

- The following is a list of qualifications that the Building Official may use in evaluating the CxP**.** The Building Official may consider one or more of the qualifications in this list :

    - ~~o~~ Licensed Engineer
    - o Third party certification acceptable to the AHJ

C.5 Water

- **Knowledge of:**

- Verification that the systems listed are designed, installed and operate as intended.
- Plumbing Codes
- Plumbing system design
- Plumbing fixture performance criteria and testing

- **The following is a list of qualifications that the Building Official may use when evaluating the CxP. The Building Official may consider one or more of the qualifications in this list** :

    - o Licensed Engineer
    - o Third party certification acceptable to the AHJ

C.6 Indoor environmental quality

- See corresponding sections under HVAC, Lighting and Materials.

C.7 Fire suppression systems

- **Knowledge of the following as required for specific system designed and installed:**

    - o Pressure and flow testing.
    - o NFPA 3, *Standard for Commissioning of Fire Protection and Life Safety Systems*
    - o NFPA 4, *Standard for Integrated Fire Protection and Life Safety System Testing*
    - o NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems*
    - o NFPA 12A, *Standard on Halon 1301 Fire Extinguishing Systems*
    - o NFPA 13, Standard for the *Installation of Sprinkler Systems*.
    - o NFPA 13D, Standard for *Installation of Sprinkler Systems in One- and Two family Dwellings*.
    - o NFPA 13R, Standard for the *Installation of Sprinkler Systems in Group R Occupancies Four or Fewer Stories*.
    - o NFPA 14, *Standard for the Installation of Standpipes and Hose Systems*.
    - o NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*

- NFPA 16, *Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems*
- NFPA 17, *Standard for Dry Chemical Extinguishing Systems*
- NFPA 17A, *Standard for Wet Chemical Extinguishing Systems*
- NFPA 20, *Standard for the Installation of Stationary Pumps for Fire Protection*.
- NFPA 22, *Standard for Water Tanks for Private Fire Protection*.
- NFPA 24, *Standard for the Installation of Private Fire Service Mains and their Appurtenances*.
- NFPA 25, *Standard for the Inspection, Testing, Maintenance of Water-based Fire Protection Systems*.
- NFPA 30, *Flammable and Combustible Liquids Code*.
- NFPA 30B, *Code for the Manufacturing and Storage of Aerosol Products*.
- NFPA 33, *Standard for Spray Application Using Flammable or Combustible Materials*
- NFPA 45, *Fire Protection for Laboratories*.
- NFPA 54, ANSI Z223.1-2018 *National Fuel Gas Code*.
- NFPA 90A, *Standard for the Installation of Air-conditioning and Ventilation Systems*.
- NFPA 90B, *Standard for the Installation of Warm Air-heating and Air-conditioning Systems*.
- NFPA 92, *Standard for Smoke Control Systems*
- NFPA 96, *Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations*.
- NFPA 211, *Standard for Chimneys, Fireplaces, Vents and Solid Fuel-burning Appliances.*
- NFPA 214, *Standard on Water-cooling Towers*.
- NFPA 307, Standard for the Construction and Fire Protection of Marine Terminals, Piers, and Wharves
- NFPA 409, *Standard on Aircraft Hangars*.
- NFPA 750, *Standard on Water Mist Fire Protection Systems*
- NFPA 853, *Standard for the Installation of Stationary Fuel Cell Power Systems*.
- NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems*

- **The following is a list of qualifications that the Building Official may use when evaluating the CxP. The Building Official may consider one or more of the qualifications in this list :**
  - Licensed fire sprinkler contractor.
  - Registered or licensed Professional engineer in other disciplines with sufficient knowledge of the applicable fire protection or life safety systems included as part of the commissioning process.

- .
- Registered or licensed Fire Protection Engineer with sufficient knowledge of the applicable fire protection or life safety systems included as part of the commissioning process
- Third party certification acceptable to the AHJ

C.8 Fire alarms

- **Knowledge of:**
  - NFPA 72.
  - NFPA 70.
- **The following is a list of qualifications that the Building Official may use in evaluating the CxP. The Building Official may consider one or more of the qualifications in this list :**
  - Licensed Fire Alarm contractor.
  - v Licensed electrical engineer.
  - Licensed Fire Protection Engineer

C.9 Vertical conveyance systems

- **Elevators.**
  - Knowledge of:
    - ASME A17.1.
    - ASME A17.2.
    - ASME A17.3.
  - The following is a list of qualifications that the building official may use when evaluating the CxP:
    - Qualified Elevator Inspector (QEI) certification.
    - Third-party license.
- **Escalators.**
  - Knowledge of:
    - ASME A17.1.
    - ASME A17.2.
    - ASME A17.3.
    - Speed measurements as related to escalators.
  - **The following is a list of qualifications that the Building Official may use when evaluating the CxP. The Building Official may consider one or more of the qualifications in this list** :
    - QEI certification.
    - State licensing, if applicable.

INFORMATIVE APPENDIX D

ICC CODE COMMISSIONING REQUIREMENTS

The following is a summary of the requirements for or references to the commissioning process in the International Code Council Codes. See the current codes for updates and details.

IBC-2015 International Building Code

- International Building Code - 2015 includes Special Inspector Requirements 'to verify proper commissioning of Smoke Control Systems' in Section 909.3.
- Commissioning shall be by accepted engineering practice and published standards.
- 1703 Approved agency qualifications include: independence, adequate calibrated equipment, experienced personnel
- No ASHRAE Standards are referenced

IMC – 2015 International Mechanical Code

- *Section 513.3 refers to special inspection to verify proper Commissioning of Smoke Control Systems as in IBC section 909
- *Commissioning shall be IAW generally accepted engineering practice and published standards.
- ASHRAE Standards referenced = 15, 34, 62.1, 170, 180

IFC -2015 International Fire Code

- 3.3.3.1 Commissioning (Cx). A systematic process that provides documented confirmation that building systems function according to the intended design criteria set forth in the project documents and satisfy the owner's operational needs, including compliance with applicable laws, regulations, codes, and standards.
- 3.3.3.2 Commissioning Authority (CxA). The qualified person, company, or agency that plans, coordinates, and oversees the entire commissioning process.
- 3.3.3.3 Commissioning Plan. The document prepared for each project that identifies the processes and procedures necessary for a successful commissioning process.
- 3.3.3.4 Commissioning Record. The complete set of commissioning documentation for the project that is turned over to the owner at the end of the construction phase.
- 3.3.3.5 Fire and Life Safety Commissioning (FCx). A systematic process that provides documented confirmation that fire and life safety systems function according to the intended design criteria set forth in the project documents and satisfy the owner's operational needs, including compliance with any applicable laws, regulations, codes, and standards requiring fire and life safety systems.
- 3.3.3.6 Fire Commissioning Agent (FCxA). A person or entity identified by the owner who leads, plans, schedules, documents, and coordinates the fire protection and life safety commissioning team and who implements the fire protection and life safety commissioning process.
- 3.3.3.7 Recommissioning (Re-Cx). For existing fire protection and life safety systems that were previously subject to FCx, the process of verifying system performance continues to meet the OPR and BOD.
- 3.3.3.8 Retro-commissioning (RCx). For existing fire protection and life safety systems that were not previously subject to FCx, the process of verifying system performance and operation meets

the original design intent, current owner requirements, and applicable laws, regulations, codes, and standards.

- IFC Section Topic
- 510.5.3 Emergency responder radio coverage system
- 510.6.1 Emergency responder radio coverage system
- 603.1.6 Oil-burning equipment
- 604.5 Emergency power systems
- 604.6.1 Emergency lighting systems (monthly)
- 606.6 Refrigeration systems
- 606.6.1 Refrigeration systems: emergency systems
- 703.4 Fire doors
- 901.6.1 Carbon dioxide systems
  Halon 1301 systems
  Dry-chemical fire extinguishing systems
  Wet-chemical fire extinguishing systems
  Water-based fire protection systems
  Smoke and heat vents
  Fire alarm and detection systems
  Water mist systems
  Clean-agent extinguishing systems
  Stationary fire pumps
- 904.4.2 Fire alarm systems
- 904.4.3 Fire alarm system monitoring service connections
- 904.5.1 Wet chemical systems (^-month
- 904.6 Dry chemical systems (6-month)
- 904.7 Foam suppression systems (per NFPA 25)
- 904.8 Carbon dioxide systems (per NFPA 12 annual)
- 904.9 Halon systems (per NFPA 12A annual)
- 904.10 Clean agent systems (per NFPA 2001 annual)
- 904.11.3 Water mist per manufacturer's requirements and IFC 901.6.1
- 904.12.6 Commercial cooking systems
- 905.2 Standpipes per NFPA 14
- 905.2 Standpipes per NFPA 25
- 907.7 Fire alarm systems per NFPA 72
- 907.8.2 Fire alarm systems per NFPA 72
- 909.3 Smoke control systems
- 909.18 Smoke control systems
- 909.19 Smoke control systems
- 910.5.2.2 Mechanical smoke removal systems
- 915.5 Fire pumps per NFPA 25
- 913.5.1 Fire pumps per NFPA 20
- 2306.7.4 Fuel dispenser impact valves
- 2306.7.4 Fuel dispenser impact valves (annual)
- 2907.5 Organic coating manufacture process piping
- 3103.7 Tent, air-supported, air-inflated or tension membrane structures
- 3105.6 Temporary stage canopies
- 5003.2.9.1 Hazardous materials equipment: gas detection, automatic shutoff valves, limit control valves, emergency alarm systems
- 5003.2.9.2 Previous list (annual)
- 5703.6.3 Flammable and combustible liquid pipe systems
- 5704.2.12 Flammable and combustible liquid tanks

IECC -2015 International Energy Conservation Code

- Building Commissioning : A process that verifies and documents that the selected building systems have been designed, installed, and function according to the owner's project requirements and construction documents, and to minimum code requirements.

- C408.2 Mechanical and Service Water Heating System Commissioning and Completion- Prior to final mechanical and plumbing inspections, the registered design professional or approved agency shall provide evidence of mechanical system commissioning and completion

    - Excludes air conditioning systems less than 40 tons
    - Excludes hotel room and apartments

- Construction documents must include commissioning requirements

- C408.2.1 Mechanical Systems Commissioning

  Commissioning Plan developed by registered design professional or approved agency

    - Narrative of activities and personnel included
    - Listing of equipment and systems
    - Functions to be tested
    - Test conditions
    - Measurable criteria

- C408.2.2 HVAC Systems Test and Balance

    - Test and Balance required to accepted engineering standards.
    - Air and water flow rates measured and adjusted to tolerances provided in product specifications
    - Air supply outlets and zone terminal devices shall be equipped with means for balancing.
    - Hydronic heating and cooling coils shall be equipped with means for balancing and measuring flow
    - Written test and balance report required
        - Should be reviewed by Commissioning Provider
        - Should be included in Systems Manual
        - Should be available for review by Building Official

- C405.2.3 Mechanical Systems Commissioning
  Functional Performance Testing – Equipment

    - - Installation and operation
    - - Sequence of operation
    - - Maintenance serviceability

  Controls and Economizers

    - - Calibrated
    - - Adjusted
    - - Operate to approved plans and specifications

- C408.2.4 Preliminary Commissioning Report
    - Preliminary Commissioning Report (by Design Professional or Approved Agency) with deficiencies, deferred testing and conditions required.

- Owner shall certify receipt of the preliminary report prior to final inspection
- Code official can request a copy

- C408.2.5 Documentation
  - DOCUMENTATION: Construction documents shall require delivery to owner within 90 days of Certificate of Occupancy:
    - Record Drawings with performance data
    - Systems Manual with submittals, O&M manuals, control system data with sequence of operation, service and maintenance data and schedules
    - Systems Balancing Report
    - Final Commissioning Report with functional and performance testing procedures, final results, and open issues

- C408.3 Lighting Commissioning
  - Lighting system functional testing- Prior to final inspection, registered design professional shall provide evidence of lighting control system testing including hardware and software programming and adjustment.
    - Occupant sensor controls
    - Time switch controls
    - Daylight responsive controls
  - This evidence shall be provided to the building official
  - Lighting System Construction documents shall require a final report to owner within 90 days of CO.
    NOTE: This report does not need to be presented to the Building Official unless requested.

- C502 Additions shall comply with new construction requirements
- C503 Alterations shall comply with new construction requirements with some variations
- C504 Repairs not normally required to comply.
- C505 Change in Occupancy requires IECC compliance if energy use is increased

IGCC-2015 International Green Construction Code

- Section 611: Energy System Commissioning- Prior to Final Inspection, Registered Design Professional or Approved Agency shall provide evidence of system Commissioning per IECC including:
  - Construction documents include commissioning
  - Commissioning Plan by RDP or Approved Agency
  - Air & Hydronic Systems Balancing and Reports
  - Functional and Performance Testing
  - Documentation – O&M
  - Preliminary Commissioning Report with written Owner letter acknowledging receipt.
  - Lighting and Building Enclosure Commissioning included
  - Final Commissioning Report at project completion.

- Section 902 – Special Inspection and Commissioning
  - The Registered Design Professional in Responsible Charge or Approved Agency Shall Perform Commissioning during Construction and After Occupancy per Table 902.1
    •Approved Agency:(AHJ to approve Qualifications)
    - Objective, Competent and Independent from Contractor
    - Adequate, Calibrated Equipment
    - Experienced, Educated Personnel

- Section 902 – Special Inspection and Commissioning includes detail requirements on:
  - Commissioning Plan
  - Pre-Certificate of Occupancy Report
  - Commissioning Performance Requirements
  - Final Commissioning Report
  - Systems Manual
  - Record Documents
- Table 902.1 Commissioning Plan includes:
  - List of Construction or Systems requiring inspection, verification and commissioning of all the building systems in IGCC plus other items.
  - Methods and Occurrence /Scheduling

INFORMATIVE APPENDIX E

INDUSTRY COMMISSIONING RESOURCES

(Reference ASHRAE Standard 202)

These following organizations, documents, and web sites can provide additional guidance on the commissioning process:

PUBLICATIONS:

ASHRAE Standard 202-2013, *The Commissioning Process for Buildings and Systems.* ASHRAE

ASHRAE. Guideline 0-2013, *The Commissioning Process*. Atlanta: ASHRAE.

ASHRAE. Guideline 0.2-2016, *Commissioning Process for Existing Buildings and Systems*. Atlanta: ASHRAE.

ASHRAE. Guideline 1.1-2007, *HVAC&R Technical Requirements for The Commissioning Process*. Atlanta: ASHRAE.

ASHRAE. Guideline 1.4-2014, *Systems Manual for Facilities*. Atlanta: ASHRAE

ASHRAE. Guideline 1.5-2017, *The Commissioning Process for Smoke Control Systems*. Atlanta: ASHRAE.

ASHRAE. 2015. *ASHRAE Handbook—HVAC Applications*, Chapter 43, HVAC Commissioning. Atlanta: ASHRAE.

The following guidelines are being developed by ASHRAE to support the commissioning process:

ASHRAE. Guideline 1.2-201X, *Commissioning Process for Existing HVAC&R Systems*. Atlanta: ASHRAE.

ASHRAE. Guideline 1.3-2018*, Building Operation and Maintenance Training for the HVAC&R Commissioning Process*. Atlanta: ASHRAE.

Organizations

The following organization and agencies have produced publications and resources relating to the Commissioning Process that are available from the publishing organization. These publications and resources may or may not conform to the requirements of ASHRAE Standard 202-2013. This list is provided as a resource for those using and providing commissioning services. Since publications can change frequently, the organization websites are the best source of current documents.

AABC Commissioning Group (ACG), 1518 K Street, NW, Suite 503,Washington DC, *http://www.commissioning.org/commissioningguideline.*

ASTM International, 100 Bar Harbor Drive, PO Box C700, West Conshohocken, PA, 19428-2959 E2813-12, *http:// www.astm.org/DIGITAL_LIBRARY/index.shtml.*

Building Commissioning Association (BCA), 1600 NW Compton Drive, Suite 200, Beaverton, OR 97006, *http://* www.bcxa.org/knowledge-center

California Commissioning Collaborative (CCC), *http:// www.cacx.org/resources/index.html.*

Canadian Standards Association, CSA Group Head Office, 178 Rexdale Blvd., Toronto, Ontario, Canada M9W 1R3, http://www.csa.ca/cm/ca/en/standards and search for Z320-11 Building Commissioning.

Chartered Institution of Building Services Engineers (CIBSE), 222 Balham High Road, London, SW12 9BS, *http://www.cibseknowledgeportal.co.uk/cibse-commissioning- codes.*

Energy Systems Laboratory, TAMU, College Station, Texas, *http://www.esl.tamu.edu/continuous-commissioning.*

Illuminating Engineering Society of North America (IESNA) 120 Wall Street, 17th floor, New York, NY 10005, *http://www.iesna.org/store/product/the-commissioning- process-applied-to-lighting-and-control-systems-1251.cfm.*

International Code Council (ICC), 500 New Jersey Ave. NW, 6th Floor, Washington, DC 20001, *http:// www.shop.iccsafe.org/icc-G4-2012-guideline-forcommissioning- 1.html*.

International Energy Agency (IES), Energy Conservation in Buildings and Community Systems (ECBCS) Programme, 9, rue de la Federation, 75739 Paris Cedex 15, France, *http://www.ecbcs.org/annexes/annex40.htm* and *http://www.ecbcs.org/annexes/annex47.htm.*

National Environmental Balance Bureau (NEBB), 8575 Grovemont Circle, Gaithersburg, MD 20877, *http:// www.nebb.org/resources/standards/.*

National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 82169, *http://nfpa.org/codes.*

National Institute of Building Science (NIBS)1090 Vermont Ave, Suite 700, Washington, DC, 20005, *http:// www.nibs.org* and *http://www.wbdg.org/project/buildingcomm. php.*

Sheet Metal and Air Conditioning Contractors National Association (SMACNA) 4201 Lafayette Center Drive, Chantilly, VA, 20151, *http://www.smacna.org/technical.*

The State of Minnesota, Sustainable Building Guidelines, Design & Construction Phase Commissioning Plan Template, *http://www.msbg.umn.edu.*

University of Michigan, *http://www.plantext.bf.umich.edu/for.archs/com.html.*

University of Wisconsin – Madison, *http://www.epdweb. engr.wisc.edu*

United States Department of Veterans Affairs (VA), *www.cfm.va.gov/til/commissioning/CxManual.PDF* and *www.virtualcx.com/blog/2011/3/17/ whole-building-commissioning-process-manual-department- of-ve.html.*

United States Army Corps of Engineers, *www.wbdg.org/ project/buildingcomm.php.*

United States Department of Energy (USDOE), *http://www.eere.energy.gov/femp/reconstructionguide/comm_process.html*

United States General Services Administration, (GSA), *http://www.gsa.gov/portal/category/21064.*