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12. Building Commissioning Guide

Commissioning is included in the design and construction process of newly constructed nonresidential buildings to verify that the building's energy systems and components meet the owner's or owner representative's project requirements.

Commissioning under Part 6 is required for nonresidential buildings of 10,000 square feet and larger, excluding healthcare facilities (which instead follow a procedure specified in Chapter 7 of the California Administrative Code, Title 24, Part 1). Commissioning is also required for nonresidential portions of mixed-use buildings when the total space of these portions is 10,000 square feet or larger.

Newly constructed buildings with less than 10,000 square feet of nonresidential area are only required to perform a design review, though they may elect to perform a more complete commissioning process. Design review is discussed in Section 12.4.

Part 6 does not require retrocommissioning of existing buildings; neither commissioning nor design review are required for building additions or alterations. That said, this guide may still be useful for projects engaging in retrocommissioning.

12.1 Overview

The following key terms and acronyms refer to important concepts in commissioning:

Acronyms

- BOD - Basis of Design
- Cx - Commissioning
- FPT - Functional Performance Test
- HVAC - Heating, Ventilating, and Air Conditioning
- O&M - Operations and Maintenance
- OPR - Owner's Project Requirements

Glossary

- **Acceptance Criteria** - The conditions that must be met for systems or equipment to meet defined outcomes.
- **Commissioning (Cx)** - Building commissioning as required in this code is a quality assurance process that begins during design and continues to occupancy. Commissioning verifies that the new building and its systems are planned, designed, installed, tested, operated and maintained as the owner intended, and the building staff are prepared to operate and maintain its systems and equipment.

- **Commissioning Coordinator** - The person who plans, schedules and coordinates the commissioning team to implement the commissioning process. This can be either a third-party commissioning provider or an experienced member of the design team or owner's staff.
- **Commissioning Team** - The people designated to provide insight and carry out tasks necessary for commissioning. Team members may include the commissioning coordinator, owner, owner's representative, building staff, design professionals, contractors, manufacturer's representatives, and testing specialists.
- **Complex Mechanical Systems** - Mechanical Systems that includes
 1. fan systems each serving multiple thermostatically controlled zones; or
 2. built-up air handler systems (non-unitary or non-packaged HVAC equipment); or
 3. hydronic or steam heating systems; or
 4. hydronic cooling systems. Complex mechanical systems are NOT the following:
 - a. unitary or packaged equipment listed in Tables 110.2-A, 110.2-B, 110.2-C, and or 110.2-E that each serves one zone, or
 - b. two-pipe, heating only systems serving one or more zones.

NOTE: Mechanical Systems that are not considered, "Complex" are the following:

- a. unitary or packaged equipment listed in Tables 110.2-A, 110.2-B, 110.2-C or 110.2-E that each serves one zone, or
 - b. two-pipe, heating only systems serving one or more zones and is not a Complex Mechanical System
- **Design Reviewer** - The person who reviews the design documents to ensure the design will likely meet the OPR.
 - **Independent Third-Party Commissioning Professional (Authority/Agent/Provider/Lead)** - An entity contracted by the owner who is not responsible or affiliated with any other member of the design and construction team. This professional leads, plans, schedules, and coordinates the commissioning team and activities.
 - **Operation and Maintenance (O&M) Manuals** - Documents that provide information necessary for operating and maintaining installed equipment and systems.
 - **Owner** - The individual or entity holding title to the property on which the building is constructed.
 - **Owner Representative** - An individual or entity assigned by the owner to act and sign on the owner's behalf.

- **Sequence of Operation** - A written description of the intended performance and operation of each control element and feature of the equipment and systems.
- **Scope of the Commissioning Requirements** - All building systems and components covered by §110.0, §120.0, §130.0, and §140.0 must be included in the scope of the commissioning requirements, excluding covered processes.

12.1.1 Selecting Trained Personnel for Commissioning

It is important to designate one person to lead and manage the commissioning activities. This person is referred to as the commissioning coordinator in this manual. Other terms commonly used for this person are commissioning authority, agent, provider, or lead.

The commissioning coordinator must manage the commissioning process, including the development and implementation of the commissioning tasks and associated documents. Trained personnel must execute the tasks and may include members of the owner's staff, contractors, design team, and independent commissioning professionals.

The commissioning coordinator may be an independent third-party commissioning professional, a project design team member (e.g. engineer or architect), an owner's engineer, contractor, or specialty sub-contractor. Evaluation of the designated commissioning coordinator and trained personnel includes reviewing:

- Technical knowledge.
- Experience.
- Potential conflict of interest.
- Professional certifications and training.
- Communication and organizational skills.
- Reference and sample work products.

12.2 Owner's Project Requirements (OPR)

§120.8(b)

The Owner's Project Requirements document (OPR) establishes the owner's goals, requirements and expectations for everything related to energy consumption and operation. The energy-related expectations and requirements of the building must be documented before the design phase of the project. This document includes:

1. Energy efficiency goals.
2. Ventilation requirements.
3. Project program, including facility functions and hours of operation, and need for after-hours operation.
4. Equipment and systems expectations.

12.2.1 Intent

The OPR documents the functional requirements of the project and expectations of the building use and operation as it relates to systems being commissioned. The OPR 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 pre-design and used to develop the BOD during the design process. The detail and complexity of the OPR will vary according to building use, type, and systems.

12.2.2 Compliance

The owner or owner's representative shows compliance by developing or approving the OPR before the design phase. An OPR template is available in the NRCC-CXR-E document. The OPR should include:

A. Energy Efficiency Goals - Establish energy efficiency goals, which may include:

1. Overall energy efficiency.
2. Lighting system efficiency.
3. HVAC equipment efficiency & characteristics.
4. Any other measures affecting energy efficiency desired by the owner
 - a. Building orientation and siting
 - b. Daylighting
 - c. Facade, envelope, and fenestration
 - d. Roof
 - e. Natural ventilation
 - f. Onsite renewable power generation and zero net energy use
 - g. Landscaping and shading

B. Ventilation Requirements - Describe indoor ventilation requirements including intended use and schedule for each program space.

C. Project Program, including facility functions and hours of operation, and need for after-hours operation - Describe primary purpose, program, and use of proposed project, such as:

1. Building size, number of stories, construction type, occupancy type, and number.
2. Building program areas including intended use and anticipated occupancy schedules.
3. Future expandability and flexibility of spaces.
4. Quality and/or durability of materials and building lifespan desired.
5. Budget or operational constraints.

6. Applicable codes.

D. Equipment and Systems Expectations - For each system commissioned describe the:

1. Level of quality, reliability, equipment type, automation, flexibility, maintenance, and complexity desired.
2. Specific efficiency targets, desired technologies, or preferred manufacturers for building systems.
3. Degree of system integration, automation, and functionality for controls (i.e. load shedding, demand response, and energy management).

E. Building Envelope Performance Expectations – For each assembly that contains a special feature describe the:

1. Assembly type, such as, floors, foundations, walls, ceilings, and roofs.
2. Characteristics that merit special attention.

F. Enforcement - The building official confirms compliance at *plan review* by either:

1. Receipt of a copy of the OPR (optional).
2. Receipt of a completed NRCC-CXR-E indicating the OPR was reviewed at the design review kickoff.

12.3 Basis of Design (BOD)

§120.8(c)

A written explanation of how the design of the building systems meets the OPR must be completed at the design phase of the building project, and updated as necessary during the design and construction phases. The BOD covers following systems and components:

1. HVAC systems and controls.
2. Indoor lighting system and controls.
3. Water heating systems and controls.
4. Any building envelope component considered in the OPR.

12.3.1 Intent

The BOD describes the building systems to be commissioned and outlines design assumptions not indicated in the design documents. The design team develops the BOD to describe how the building systems design meets the OPR, and why the systems were selected. The BOD is most effective when it is developed early and updated during the design process.

12.3.2 Compliance Method

Compliance requires the completion of the BOD, which should include:

A. HVAC Systems and Controls

1. Provide a description of system –type, location, controls, efficiency features, outdoor air ventilation strategy, indoor air quality features, environmental benefits, and other special features.
2. Describe reasons for system selection – why chosen system is better than alternatives, considering issues such as comfort, performance, efficiency, reliability, flexibility, simplicity, cost, owner preference, site constraints, climate, maintenance, and acoustics.
3. Provide design criteria including:
 - a. Load calculation method/software.
 - b. Load calculation assumptions.
 - c. Summer outdoor design conditions, °F drybulb and °F wetbulb.
 - d. Winter outdoor design conditions, °F drybulb and °F wetbulb.
 - e. Indoor design conditions, °F drybulb cooling, %RH cooling; °F drybulb heating, % RH heating.
 - f. Applicable codes, guidelines, regulations and other references used.
4. Sequence of Operations – operating schedules and setpoints (may refer to plans or specifications).

B. Describe how the system meets the OPR Indoor Lighting System and Controls

1. Provide a description of system – type of fixtures, lamps, ballasts, and controls.
2. Describe reason for system selection – why chosen system is better than alternatives, considering issues such as visual comfort, performance, efficiency, reliability, cost, flexibility, owner preference, color rendering, integration with daylighting, and ease of control.
3. Provide design criteria for each type of space including:
 - a. Applicable codes, guidelines, regulations and other references used.
 - b. Illumination design targets (footcandles) and lighting calculation assumptions.
4. Provide lighting power design targets for each type of space
 - a. Lighting power allowance and lighting power design target (watts/ft²).
5. Describe how system meets the OPR.

C. Water Heating Systems and Controls

1. Provide a description of system – system type, control type, location, efficiency features, environmental benefits, and other special features.

2. Describe reason for system selection – why chosen system is better than alternatives, considering issues such as performance, efficiency, reliability, space constraints, cost, utility company incentives, owner preference, and ease of maintenance
3. Water heating load calculations.
4. Describe how system meets the OPR.

D. Building Envelope Components

1. Provide a description of system – type, energy savings, and payback period.
2. Describe reason for system selection – why chosen system is better than alternatives, considering issues such as performance, efficiency, reliability, flexibility, simplicity, expandability, cost, payback period, utility company incentives, and owner preference.
3. Describe how system meets the OPR.

12.3.3 Enforcement

The building official confirms compliance at plan review by either:

1. Receipt of a copy of the BOD document (optional).
2. Receipt of a completed NRCC-CXR-E indicating the BOD was reviewed at the design review kickoff attesting that the BOD has been completed and meets the requirements of the OPR.

12.4 Design Phase Review

§120.8(d)

1. Design reviewer requirements are based on the project size and complexity of the mechanical systems, as follows:
 - a. For newly constructed buildings less than 10,000 square feet, design phase review may be completed by the engineer or architect of record.
 - b. For newly constructed buildings between 10,000 and 50,000 square feet, it may be completed by a qualified in-house engineer or architect with no other project involvement or a third party engineer, architect, or contractor.
 - c. For newly constructed buildings larger than 50,000 square feet or buildings with complex mechanical systems, an independent review by a third-party engineer, architect, or contractor.
2. Design Review. During the schematic design phase of the building project, the owner or owner's representative, design team and design reviewer must meet to discuss the project scope, schedule and how the design reviewer will coordinate with the project team. The building owner or owner's representative must include the Design Review Checklist in the Certificate of Compliance (see §10-103).

3. Construction Documents Design Review. The design review forms list the items that must be checked by the design reviewer during the construction document review. The completed forms must be returned to the owner and design team for review and sign-off. The building owner or owner's representative must include the design review forms in the Certificate of Compliance (see §10-103).

12.4.1 Intent

The intent of design phase review is to improve compliance with the Energy Code, encourage adoption of best practices in design, and lead to designs that are constructible and maintainable.

12.4.2 Compliance Method

Compliance requires completion of the Design Review Kickoff and Construction Document checklists by the design reviewer. Requirements for the design reviewer are provided in §120.8(d)1. The following steps are required to complete this requirement:

A. Design Review Kickoff - Initial Schematic Review

1. A meeting is held between the project owner (or owner's representative), design team representatives (including mechanical and electrical design engineers, project architect), commissioning coordinator, and design reviewer.
2. Meeting topics to be discussed include:
 - a. Project coordination, including design reviewer involvement.
 - b. Project scheduling, including design review.
 - c. Project scope.
 - d. OPR and BOD.
 - e. Design Elements and assumptions.
 - f. HVAC system selection.
 - g. Construction documents design review checklists to be completed.
 - h. Energy Efficiency Measures.
 - i. Complete and Sign Certificate of Compliance – Cx Design Review Kickoff NRCC-CXR-E.

B. Construction Document Review

1. The design team provides the design reviewer with a set of plans and specifications late in design as agreed upon in design review kickoff, typically around 90 percent construction document completion.
2. The design reviewer provides a review of the commissioning documents - NRCC-CXR-E:

3. Completed form is submitted to the design team and project owner for consideration.
4. The designer provides a response on the Construction Document compliance documents. The design reviewer is not required to provide a second review of the construction documents for compliance purposes.
5. Certification of Completion - The design reviewer, design engineer, and owner/owner's representative sign the Certificate of Compliance – Cx Design Review Signature Page, NRCC-CXR-05-E, indicating that the construction documents design review has been completed.

The commissioning coordinator who meets the requirements may also complete the construction documents design review.

12.4.3 Enforcement

Compliance is shown by completion of the NRCC-CXR-E.

12.5 Commissioning Measures

§120.8(e)

This section includes commissioning measures or requirements in the construction documents (plans and specifications) for newly constructed nonresidential buildings. Commissioning measures or requirements should be clear, detailed, and complete. These requirements should include:

- The list of systems and assemblies commissioned.
- Testing scope.
- Roles and responsibilities of contractors.
- Requirements for meetings.
- Management of issues.
- The commissioning schedule.
- O&M manual development and training.
- Checklist and functional test compliance document development, execution and documentation.
- Roles of non-contractor parties (for information only).

12.5.1 Intent

Include commissioning measures or requirements in the construction documents (plans and specifications). Commissioning measures or requirements should be clear, detailed and complete to clarify the commissioning process.

12.5.2 Existing Law or Regulation

The Energy Code requires specific functional test compliance documents (Certificate of Acceptance) to be included in the construction documents. These functional test compliance documents are a part of the commissioning requirements.

12.5.3 Compliance

Compliance is achieved by including commissioning requirements in the project plans and specifications. The commissioning specifications should include:

- A. Primary (and optionally all) commissioning requirements are included in the general specification division (typically Division 1) and clear cross references of all commissioning requirements to and from the general division are included to ensure all subcontractors are held to them.
- B. A list of the systems and assemblies covered by the commissioning requirements.
- C. Roles and responsibilities of all parties including:
 - 1. General contractor, subcontractors, vendors, and construction manager.
 - 2. Commissioning coordinator.
 - 3. Owner and facility staff.
 - 4. Architect and design engineers.
 - 5. Non-contractor parties (for information only to provide the contractor with context for their work).
 - 6. The individual who writes checklists, tests, reviews and approves functional test compliance documents, directs and executes tests, records test results, and approves completed tests. These roles may vary by system or assembly.
- D. Meeting requirements.
- E. Commissioning schedule management procedures.
- F. Issues and non-compliance management procedures.
- G. Requirements for execution and documentation of installation, checkout, and start up, including control point-to-point checks and calibrations.
- H. Specific testing requirements by system, including:
 - 1. Monitoring and trending.
 - 2. Opposite season or deferred testing requirements, functions and modes to be tested.
 - 3. Conditions of test.
 - 4. Acceptance criteria and any allowed sampling.

- 5. Details of the format and rigor of the functional test compliance documents required to document test.
- 6. Example compliance documents (recommended).
- I. Submittal review and approval process.
- J. Content, authority, and approval process of the commissioning plan.
- K. Commissioning documents and reporting requirements.
- L. Facility staff training requirements and verification procedures.
- M. O&M manual review and approval procedures.
- N. System's manual development and approval requirements and procedures.
- O. Definitions section.

12.5.4 Enforcement

The building official can confirm compliance at plan review by a receipt of a copy of the commissioning specifications.

12.6 Commissioning Plan

§120.8(f)

Prior to permit issuance, a commissioning plan must be completed to document how the project will be commissioned and must be started during the design phase of the building project. The commissioning plan must include:

- A. General project information.
- B. Commissioning goals.
- C. Systems to be commissioned.
- D. Plans to test systems and components:
 - 1. An explanation of the original design intent.
 - 2. Equipment and systems to be tested, including the extent of tests.
 - 3. Functions to be tested.
 - 4. Conditions under which the test is performed.
 - 5. Criteria for acceptable performance.
 - 6. Commissioning team information including roles.
 - 7. Commissioning activities, schedules, and responsibilities. Plans for the completion of commissioning requirements listed in §120.8(g) through §120.8(i).

12.6.1 Intent

The commissioning (Cx) plan establishes the guidelines for the project and commissioning team's level of effort. It identifies the required Cx activities to ensure

that the OPR and the BOD are met. The Cx plan also includes a commissioning schedule from design to occupancy.

12.6.2 Existing Law or Regulation

Review local county, city, or jurisdiction ordinances for any applicable commissioning planning requirements.

12.6.3 Compliance

Compliance is shown by completing the Cx Plan. The following gives guidance for developing the Cx plan:

- A. General project information** - Provide project identifying information, including:
 - 1. Project name, owner, and location.
 - 2. Building type and area.
 - 3. Project schedule.
 - 4. Contact information of individual or company providing the commissioning services.
- B. Commissioning Goals** – Record the commissioning goals, including:
 - 1. Code requirements.
 - 2. OPR and BOD requirements.
 - 3. Requirements for commissioning activities in plans and specifications.
- C. Systems to be commissioned** – See BOD
 - 1. *An explanation of the original design intent* - Document the performance objectives and design intent for each system to be commissioned
 - a. Refer to the OPR and BOD documents.
 - 2. *Equipment and systems to be tested, including the extent of tests*
 - a. Provide a list of equipment and systems to be tested.
 - b. Describe the range and extent of tests to be performed for each system component, and interface between systems
 - 3. *Functions to be tested* - Provide example functional test procedures to identify the level of testing detail required.
 - 4. *Conditions under which the test must be performed* - Identify the conditions under which the major operational system functions are to be tested, including:
 - a. Normal and part-load operations.
 - b. Seasonal testing requirements.
 - c. Restart of equipment and systems after power loss.

d. System alarm confirmations.

5. *Measurable criteria for acceptable performance* - Include criteria for acceptable performance of each system to be tested.

D. Commissioning Team Information - Provide a contact list for all Commissioning team members, including:

1. Owner and/or owner's representative.
2. Architect and engineers.
3. Designated commissioning representative.
4. General contractor, sub-contractors, and construction manager.

E. Commissioning process activities, schedules, and responsibilities

1. Establish commissioning steps and activities to be accomplished by the Cx team throughout the design to occupancy.
2. Define the roles and responsibilities for each member of the Cx team for each phase of work.
3. List the required Cx deliverables, reports, compliance documents, and verifications expected at each stage of commissioning.
4. Include the confirmation process for the O&M manual, systems manual, and the facility operator and maintenance staff training.

12.6.4 Enforcement

The building official can confirm compliance at plan review by receipt of a copy of the Cx plan.

12.7 Functional Performance Testing

§120.8(g)

Functional performance tests must show the correct installation and operation of each component, system, and system-to-system interface in accordance with the acceptance test requirements. Functional performance testing reports must include information addressing each of the building components tested, the testing methods used, and any readings and adjustments made.

12.7.1 Intent

Functional performance tests ensure that all components, equipment, systems, and system-to-system interfaces were installed as specified, and operate according to the OPR, BOD, and plans and specifications.

The systems to be functionally tested and listed in the BOD:

1. HVAC systems and controls.
2. Indoor lighting system and controls.
3. Water heating system and controls.

4. Building envelope components.

12.7.2 Existing Law or Regulation

Acceptance testing requirements call for functional testing of some systems and equipment. Refer to Chapter 13, Acceptance Requirements, in this manual for further guidance.

Although functional performance testing for commissioning under §120.8 is related to acceptance testing, the systems to be functionally tested are based on systems described in the BOD. Not all of the systems described in the BOD will have acceptance testing requirements per the Energy Code. Some acceptance tests must be performed by a certified acceptance test technician, see Chapter 13 for more details.

12.7.3 Compliance

Compliance is shown by developing and implementing test procedures for each piece of commissioned equipment and interface between equipment and systems according to the building-specific Cx plan. The tests should verify the proper operation of all equipment features, each part of the sequence of operation, overrides, lockouts, safeties, alarms, occupied and unoccupied modes, loss of normal power, exercising a shutdown, startup, low load through full load (as much as possible) and back, staging and standby functions, scheduling, energy efficiency strategies, and loop tuning. Acceptance requirements, discussed in Chapter 13, are required and contribute toward compliance with §120.8(g), but do not cover all necessary testing.

Acceptable test procedures include:

1. Date and Party - Identification of the date of the test and the party conducting the test.
2. Signature Block - Signature of the designated commissioning lead and the equipment installing contractor attesting that the recorded test results are accurate.
3. Prerequisites - Any conditions or related equipment checkout or testing that needs to be completed before conducting this test.
4. Precautions - Identification of the risks involved to the test team members and the equipment and how to mitigate them.
5. Instruments - List of the instruments and tools needed to complete the test.
6. Reference - In each procedure, identify the source for what is being confirmed (e.g., sequence of operation ID, operating feature, specification requirement, etc.).
7. Test Instructions - Step-by-step instructions of how to complete the test, including functions to test and the conditions under which the tests should be performed.

8. Acceptance Criteria - Measurable pass / fail criteria for each step of the test, as applicable.
9. Results - Expected system response and space to document the actual response, readings, results and adjustments.
10. Return to Normal - Instructions that all systems and equipment are to be returned to their as-found state at the conclusion of the tests.
11. Deficiencies - A list of deficiencies and how they were mitigated.

12.7.4 Enforcement

The building official confirms compliance during *field inspection* by either:

1. Receipt of a copy of the completed and signed Functional Performance Tests that indicate any deficiencies have been corrected (optional).
2. Review of acceptance certificates (NRCA's) attesting that the Functional Performance Tests have been completed and any deficiencies corrected. Although there are no field forms for commissioning requirements, authorities having jurisdiction can review issues logs or the certificates of acceptance to verify field testing was completed and issues resolved.

12.8 Documents and Training

§120.8(h), *Documentation and Training.*

A systems manual and systems operations training are required.

§120.8(h)1, *Systems Manual.*

The operation of the building and its systems must be included in the systems manual and delivered to the building owner or representative and facilities operator. The systems manual must include:

1. Site information, including facility description, history, and current requirements.
2. Site contact information.
3. Instructions for basic O&M, including general site operating procedures, basic troubleshooting, recommended maintenance requirements, and site events log.
4. Description of major systems.
5. Site equipment inventory and maintenance notes.

A copy of all special inspection required by the enforcing agency or the Energy Code.

12.8.1 Intent

The systems manual provides information needed to understand, operate, and maintain the equipment and systems. It informs those not involved in the design and construction of the building systems. This manual 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 available during the contractors' training of the facility staff.

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 this training program is documented in the commissioning report. The systems operations training program is specified in the project specifications for the major systems listed. The System Manual, O&M documentation, and record drawings are prepared and available to the maintenance staff prior to implementation of any training or the development of a written training program. The training program is to be administered by the commissioning coordinator or other responsible party when the appropriate maintenance staff is made available to receive training.

12.8.2 Compliance Method

Compliance is shown by providing the systems manual. The systems manual includes:

A. Site information, including facility description, history and current requirements

1. Site Information
 - a. Location of property - Address
 - b. Site acreage
 - c. Local utility information:
 - i. Water service provider
 - ii. Natural/LPG gas service provider
 - iii. Electrical service provider
 - iv. Telecommunications service provider
 - v. Other service provider
2. Facility Description
 - a. Use/function
 - b. Square footage
 - c. Occupancy Type
 - d. Construction Type
 - e. BOD
 - f. Location of major systems & equipment
3. Project History
 - a. Project requirements
 - i. OPR
 - ii. BOD

- b. Project undocumented events
- c. Record drawings and documents
- d. Final control drawings and schematics
- e. Final control sequences
- f. Construction documents - Location or delivery information:
 - i. Mechanical & electrical drawings
 - ii. Specifications
 - iii. Submittals
 - iv. Project change orders and information
- 4. Current requirements
 - a. Building operating schedules
 - b. Space temperature, humidity, & pressure, CO₂ setpoints
 - c. Summer and winter setback schedules
 - d. Chilled & hot water temperatures
 - e. As-built control setpoints and parameters

B. Site contact information

- 1. Owner information
- 2. Emergency contacts
- 3. Design team: architect, mechanical engineer, electrical engineer, etc.
- 4. Prime contractor contact information
- 5. Subcontractor information
- 6. Equipment supplier contact information

C. Basic operation and maintenance, including general site operating procedures, basic trouble shooting, recommended maintenance requirements site events log

- 1. Basic operation
 - a. Equipment operation instructions
 - b. Interfaces and interlocks
 - c. Initial maintenance provided by contractor
- 2. General site operating procedures
 - a. Instructions for changes in major system operating schedules
 - b. Instructions for changes in major system holiday and weekend schedules
- 3. Basic troubleshooting
 - a. Cite any recommended troubleshooting procedures specific to the major systems and equipment installed in the building.

- b. Manual operation procedures
 - c. Standby/backup operation procedures
 - d. Bypass operation procedures
 - e. Major system power fail resets and restarts
 - f. Trend log listing
- 4. Recommended maintenance events log
 - a. HVAC air filter replacement schedule & log
 - b. Building control system sensor calibration schedule & log
 - 5. Operation & Maintenance Manuals - Location or delivery information

D. Major Systems

- 1. HVAC systems & controls
 - a. Air conditioning equipment (chillers, cooling towers, pumps, heat exchanges, thermal energy storage tanks, etc.)
 - b. Heating equipment (boilers, pumps, tanks, heat exchanges, etc.)
 - c. Air distribution equipment (fans, terminal units, accessories, etc.)
 - d. Ventilation equipment (Fans, accessories, and controls)
 - e. Building automation system (workstation, servers, panels, variable frequency drives, local control devices, sensors, actuators, thermostats, etc.)
- 2. Indoor lighting systems & controls
 - a. Lighting control panels
 - b. Occupancy sensors
 - c. Daylight harvesting systems
- 3. Renewable energy systems
 - a. Photovoltaic panels & inverters
 - b. Wind powered electrical generators & inverters
- 4. Landscape irrigation systems
 - a. Water distribution diagrams
 - b. Control system
- 5. Water reuse systems
 - a. Reclaimed water system for indoor use
 - b. Reclaimed water for irrigation use

E. Site equipment inventory and maintenance notes

- 1. Spare parts inventory
- 2. Frequently required parts and supplies

3. Special equipment required to operate or maintain systems
4. Special tools required to operate or maintain systems

F. *A copy of all special inspection verifications required by the enforcing agency of this code*

G. *Other resources and documentation*

While not required, an issues log is a useful tool to keep track of the status of equipment repairs and it should be maintained by the facilities indefinitely. The log, in conjunction with an equipment inventory, can be used to track and manage issues with specific pieces of equipment or systems over time. An issues log is a formal and record of problems or concerns discovered within a facility and the recommended solution to those problems. This living document could be created by the Cx team and maintained throughout the course of the investigation and implementation phase of a Cx project. The issues log should list the following:

1. Issue number
2. Building name or number
3. Floor
4. Location or room number
5. Equipment tag
6. Observation method
7. Issues description
8. Recommended resolution
9. Resolution responsibility
10. Action taken
11. Date of action taken
12. Resolution status
13. Verified by
14. Verification date

12.8.3 Enforcement

The building official can confirm compliance during field inspection by a receipt of a copy of the systems manual.

12.9 Systems Operations Training

§120.8(h)2

The training of the maintenance staff for each equipment type or system must be documented in the commissioning report. Training materials must include:

1. System and equipment overview (i.e. what is the equipment, its function, and with what other systems or equipment does it interface).
2. Review and demonstrate operation, servicing, and preventive maintenance.
3. Review of the information in the systems manual.
4. Review of the record drawings on the systems and equipment.

12.9.1 Compliance

The written training program includes:

- Learning goals and objectives for each session.
- Training agenda, topics, and length of instruction for each session.
- Instructor information and qualifications.
- Location of training sessions (onsite, off-site, manufacturer's or vendor's facility).
- Attendance forms.
- Training materials.
- Description of how the training will be archived for future use that includes:

A. Systems/equipment overview

1. Review OPR and BOD related to the major systems and equipment
2. Describe system type and configuration
3. Explain operation of all major systems and equipment and how it works with other systems and equipment
4. Describe operation of critical devices, controls, and accessories
5. Review location of the major systems and equipment
6. Describe operation of control system for each system, location of critical control elements, and procedures to properly operate control system
7. Review recommendations for implementation to reduce energy and water use

B. Review and demonstration of servicing/preventive maintenance

1. Explain location or delivery contact of the Operation & Maintenance manuals
2. Review of all manufacturer's recommended maintenance activities to maintain warranty
3. Review and demonstrate frequent maintenance activities (air filter replacement, lubrication, fan belt inspection and/or replacement, condenser water treatment, etc.), and suggested schedule

4. Review and demonstrate typical service procedures and techniques (electrical current, pressure, flow readings, calibration procedures, point trending, power fail restart procedures, etc.)
5. Locate, observe, and identify major equipment, systems, accessories and controls
6. Review emergency shut-offs and procedures

C. Review the Systems Manual

1. Describe use of Systems Manual
2. Review elements of Systems Manual
3. Explain how to update and add revisions to Systems Manual

D. Review record drawings on the systems/equipment

1. Explain location or delivery contact of the record drawings
2. Review record drawings, revisions, and changes to original design drawings
3. Review equipment schedules and compare with actual installed systems

12.9.2 Enforcement

The building official can confirm compliance during field inspection by:

1. Receipt of a copy of the written training program and completed attendance forms.
2. Receipt of a copy of the training program provided to the owner or owner's representative.

12.10 Commissioning Report

§120.8(i)

A complete report of commissioning process activities undertaken through the design, construction and reporting recommendations for post-construction phases of the building project must be completed and provided to the owner or representative.

12.10.1 Intent

The commissioning report documents commissioning and test results. The report includes confirmation from the commissioning coordinator that commissioned systems meet the conditions of the OPR, BOD, and contracts.

12.10.2 Compliance Method

The commissioning report includes:

- A. Executive summary of process and results of commissioning – including observations, conclusions, and any outstanding items.
- B. History of any system deficiencies and how resolved

1. Include outstanding deficiencies and plans for resolution
2. Include plans for seasonal testing scheduled for a later date
- C. System performance test results and evaluations
- D. Summary of training completed and scheduled
- E. Attach commissioning process documents
 1. Commissioning Plan
 2. OPR
 3. BOD
 4. Executed installation checklists
 5. Executed functional performance test compliance documents
 6. Recommendations for end-of-warranty review activities

12.10.3 Enforcement

The building official can confirm compliance during *field inspection* by receipt of a copy of the commissioning report.

Example 12-1

Question

I am constructing a 100,000 ft² mixed occupancy building. 10 percent of the conditioned floor area is for commercial/retail use, and the remaining spaces are residential. Since the building is primarily residential, does it need to be commissioned?

Answer

Yes. Because the nonresidential portion of the building is 10,000 square feet or greater, it will need to be commissioned. However, the commissioning requirements of Section 120.8 only apply to the nonresidential portions of the building.

Example 12-2

Question

I am constructing a mixed occupancy building which has both residential and nonresidential spaces. The water heating system serves both the residential and nonresidential spaces of the building. Do I need to include the water heating system in the building commissioning?

Answer

Yes. Since the water heating system is serving both residential and nonresidential spaces, the water heating system must be included in commissioning.

Example 12-3

Question

Is commissioning required for nonresidential buildings which have less than 10,000 ft² of conditioned space?

Answer

No, although the design review portion of commissioning is required.

Example 12-4**Question**

Do the commissioning requirements apply to tenant improvements (first time buildouts) for multi-tenant buildings such as a strip mall?

Answer

Possibly, it depends on the local enforcement agency's policy. Commissioning may be completed for the entire building prior to tenant improvements, or for each individual tenant improvement. Check with your local enforcement agency for their commissioning policies for multi-tenant buildings.

Example 12-5**Question**

Do the commissioning requirements apply to unconditioned nonresidential buildings?

Answer

No, the scope of the Energy Standards does not include commissioning (Section 120.8) for unconditioned nonresidential buildings in Section 100.0(e)2C.

Example 12-6**Question**

Is third party design review required for buildings with complex systems that serve less than 10,000 square feet?

Answer

No, the licensed professional engineer who completes and signs the Design Review Kickoff Certificate(s) of Compliance, and the Construction Document Design Review Checklist Certificate(s) of Compliance does not need to be a third party (see Section 10-103(a)1).

Example 12-7**Question**

Are covered processes required to be included in commissioning?

Answer

No, covered processes are excluded from the commissioning requirements (see Section 120.8). Covered processes can be included in the Basis of Design document (see Section 120.8(c)), however it is not required.

Example 12-8**Question**

Can the person responsible for commissioning also perform acceptance testing?

Answer

It depends. A commissioning professional can perform acceptance testing provided that they have also gained certification as an Acceptance Test Technician (or ATT). A commissioning professional that is not an ATT cannot perform acceptance tests that are reserved to ATTs.
