



BEYOND
SMART CITIES

**ENERGY AND ATMOSPHERE - GREEN BUILDING
TECHNOLOGY TRAINING PROGRAM
FOR ENERGY AND GREEN BUILDING SPECIALISTS**

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ENERGY SPECIALIST CURRICULUM



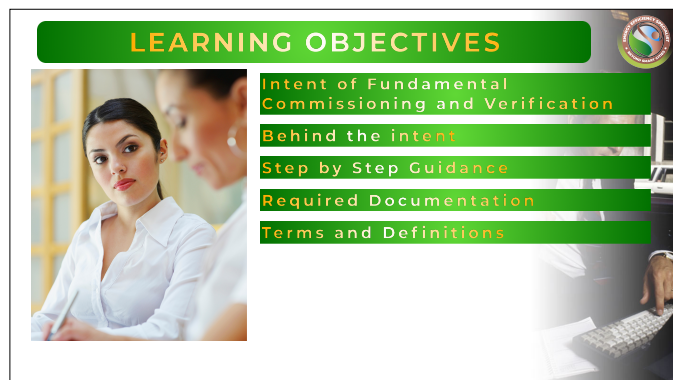


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**FUNDAMENTAL COMMISSIONING AND
VERIFICATION - PREREQUISITE -1
FOR ENERGY AND GREEN BUILDING PROFESSIONALS**

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LEARNING OBJECTIVES



- Intent of Fundamental Commissioning and Verification
- Behind the intent
- Step by Step Guidance
- Required Documentation
- Terms and Definitions

EA - PR- CONSTRUCTION

INTENT

To support the design, construction, and eventual operation of a project that meets the owner's project requirements for energy, water, indoor environmental quality, and durability.

POTENTIAL TECHNOLOGIES & STRATEGIES

The qualified commissioning authority (CA) chosen to represent the owner's needs should be brought in early in the design process. As a third party, the CxA can verify early on that the architect's and engineers' designs meet the owner's project requirements. During the construction phase, the commissioning team, led by the CxA, will verify that contractors install and program the systems correctly according to the design.

FUNDAMENTAL COMMISSIONING AND VERIFICATION

REQUIREMENTS

Complete the following commissioning (Cx) process activities for mechanical, electrical, plumbing, and renewable energy systems and assemblies, in accordance with ASHRAE Guideline 0-2013 and ASHRAE Guideline 1.1-2007 for HVAC&R Systems, as they relate to energy, water, indoor environmental quality, and durability.
Develop the OPR.
Develop a BOD.

IMPLEMENTATION

REQUIRED DOCUMENTATION

Documentation	All projects
Owner's project requirements (OPR)	X
Commissioning plan	X
List of systems to be commissioned	X
Verification of Cx activities and results	X
Cx plan	X
Documentation of testing and verification	X
OPR, OPR-Log	X
Cx report	X

BEHIND THE INTENT

The commissioning (Cx) process is an integrated set of activities intended to ensure that the project meets both the design intent and the owner's operational needs. An owner's goals and objectives should drive the project team. The value of Cx lies in its power to verify that those goals and objectives are met and that building systems perform as intended.

A properly executed Cx process clearly expresses the owner's project requirements, often leading to fewer change orders and system deficiencies, fewer corrective actions implemented while contractors are on-site, improved planning and coordination, reduced energy consumption during building operation, and overall lower operating costs. Another potential benefit of Cx is occupants' health and comfort because of better temperature and ventilation control. For a mission-critical facility like a data center, the most significant benefit is the reduced risk of information technology (IT) equipment downtime caused by power or cooling system design or performance issues, faulty installation or calibration, or software programming errors that go undetected until after the building is on line.

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STEP-BY-STEP GUIDANCE

STEP 1. DEVELOP OWNER'S PROJECT REQUIREMENTS

The owner, with the help of the design team and other stakeholders, should develop the initial owner's project requirements (OPR) in the pre-design stage (see the Integrative Process Credit and Further Explanation, Owner's Project Requirements). >

- This document establishes the owner's goals and the building's intended function and operation.
- The owner will use this document as the foundation for all design, construction, acceptance, and operational decisions.
- The OPR must include all systems to be commissioned plus the building envelope, even if full envelope commissioning is not pursued.

STEP 2. DEVELOP BASIS OF DESIGN

Create a basis of design (BOD) to provide clear technical guidance for the project. Start this in the schematic design phase and update it throughout the design and construction process (see Further Explanation, Basis of Design). >

- The BOD is the project team's interpretation of the OPR.
- Any revisions to the OPR should also be reflected in the BOD so that both documents align.
- The BOD must include all systems to be commissioned plus the building envelope, even if full envelope commissioning is not pursued. The project engineer, architect, structural engineer, and other team members must work together to document building envelope thermal performance, load-bearing capabilities, and construction.

STEP 3. ENGAGE COMMISSIONING AUTHORITY

Identify a CxA with the proper experience and credentials to develop and implement effective commissioning. Though the CxA must be engaged by the design development phase, earlier engagement allows the CxA to be involved in the development of the OPR and BOD and see the design intent through to completion.

- The CxA should have direct experience with at least two similar projects and must have been involved from the early design phase through at least 10 months after occupancy begins (see Further Explanation, Commissioning Authority Qualifications). >
- Cx requirements differ depending on the scope and size of the project. The project team should engage a CxA that has appropriate qualifications for the goals of the program.

- #### STEP 4. DEVELOP PRELIMINARY COMMISSIONING PLAN

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Establish a preliminary plan for the Cx to outline the scope of commissioning and systems to be tested

- #### STEP 5. REVIEW OPR, BOD, AND DESIGN DOCUMENTS

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The CxA completes a review of the OPR, BOD, and design documents to verify that the program's goals are properly included in the design documents.

- #### STEP 6. DEVELOP CX REQUIREMENTS AND INCORPORATE INTO CONSTRUCTION

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DOCUMENTS

Before construction begins, develop commissioning requirements based on the systems included in the design and incorporate them into the construction documents.

STEP 8. CONDUCT CX KICKOFF MEETING

- Installation verification (construction) checklists

- ## STEP 9. DEVELOP CONSTRUCTION CHECKLISTS

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- ## STEP 10. CONDUCT PREFUNCTIONAL INSPECTIONS

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- The CxA may conduct site visits as necessary to inspect the installation of individual systems and components. Site visits are an important opportunity to observe equipment installation and identify issues before a system becomes difficult to access or change.

- ## STEP 11. DEVELOP FUNCTIONAL TEST SCRIPTS

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The CxA, with the design team or contractor, must write and develop the functional test scripts for the project.

STEP-BY-STEP GUIDANCE +

STEP 12. EXECUTE FUNCTIONAL TESTING

Perform functional performance testing once all system components are installed, energized, programmed, balanced, and otherwise ready for operation under part- and full-load conditions.

- Some systems may require deferred or seasonal testing or verification for proper operation in each mode.
- The systems or modes that require seasonal or deferred testing must be noted in the Cx report. A report addendum discusses the deferred testing results can then be issued.
- The functional performance testing follows the functional performance test scripts developed by the CxA in Step 11.
- The CxA generally oversees the testing; the contractors execute the testing.
- Sampling strategies may be implemented for functional testing. An acceptable sampling rate is "10 or 10%," meaning that for multiple units of the same type with the same components and sequences (e.g., fan coil units or variable air volume systems), the commissioning team may test only 10 units or 10% of the units, whichever is greater.
- When possible, include the building engineer or owner in the testing execution to provide training for future operation of the systems.

STEP 13. DOCUMENT FINDINGS

Use the issues log to track any deficiencies discovered and any benefits identified through functional testing.

- The CxA is responsible for documenting the test results and maintaining the issues log.
- Documentation should include the status and responsible party for the correction or improvement actions.

STEP 14. PREPARE CX REPORT

The CxA should write the Cx report after installation inspections and functional performance test verification. The report covers all components of the commissioning process, including the following:

- Executive summary of commissioning process and results, system deficiencies identified and resolution, and outstanding issues
- Project directory



STEP-BY-STEP GUIDANCE +

- Cx process overview
- Owner's project requirements
- Basis of design
 - Submittals
- Design review log
- Cx specifications
- List of systems commissioned
- Installation verification checklists
- Functional performance tests
- Issues log, detailing open and closed issues

STEP 15. COMPLETE CURRENT FACILITY REQUIREMENTS AND OPERATIONS AND MAINTENANCE PLAN

Prepare and maintain a current facility requirements (CFR) and operations and maintenance (O&M) plan that contains the information necessary to operate the building efficiently. This information is covered in the OPR, BOD, and functional test scripts, but more information may be taken from specific submittals or equipment operations and maintenance manuals. The plan must include the following:

- Sequences of operation for the building
- Building occupancy schedule
- Equipment run-time schedules
- Setpoints for all HVAC equipment
- Lighting levels throughout the building
- Minimum outside air requirements
- Changes in schedules or setpoints for different seasons, days of the week, and times of day
- Systems narrative describing the mechanical and electrical systems and equipment
- Preventive maintenance plan for building equipment described in the systems narrative
- Cx program that includes periodic Cx requirements, ongoing Cx tasks, and continuous tasks for critical facilities

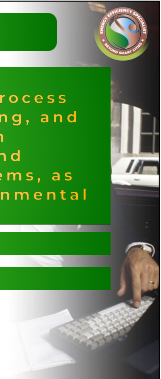


REQUIREMENTS

Commissioning Process Scope :
Perform the following commissioning (Cx) process activities for mechanical, electrical, plumbing, and renewable energy systems and assemblies in accordance with ASHRAE Guideline 0-2013 and ASHRAE Guideline 1.1-2007 for HVAC&R Systems, as they pertain to energy, water, indoor environmental quality, and durability.

✓Develop the OPR

✓Develop a BOD



REQUIREMENTS +

The commissioning authority (CxA) must do the following:

- ✓ Review the OPR, BOD, and project design.
- ✓ Develop and implement a CX plan.
- ✓ Confirm incorporation of Cx requirements in to the construction documents.
- ✓ Develop construction checklists.
- ✓ Develop a system test procedure.
- ✓ Verify system test execution.
- ✓ Maintain an issues and benefits log through out the Cx process.
- ✓ Prepare a final CX process report.
- ✓ Document all findings and recommendations and report directly to the owner throughout the process.

REQUIREMENTS +

Exterior enclosure requirements are limited to inclusion in the owner's project requirements (OPR) and basis of design (BOD) and review of the OPR, BOD, and project design. Standard Guide for Building Enclosure Commissioning (ASTM E2947-16) provides additional guidance.

The review of the exterior enclosure design may be conducted by a qualified independent member of the design or construction team (or an employee of that firm) who is not directly responsible for the building enclosure design for the project.

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