Overview

- Building Commissioning Process and Implementation
- Commissioning Provisions in the IECC and 90.1 Compliance
- Commissioning Provisions in the IgCC and 189.1

Objectives

Upon completion of this presentation, participants will be able to:
- Describe an overview of a code related commissioning (Cx) process.
- Identify key provisions relating to commissioning contained in the International Energy and Green Codes and ASHRAE Energy and Green standards.
- Identify the relevant industry standards and guidelines for commissioning.
- Understand implementation strategies through the use of forms and templates.
Building Commissioning and the Process

What is Commissioning
Commissioning ensures that the new building operates initially as the owner intended and that building maintenance staff are trained to operate and maintain its equipment and systems as designed.

What is Commissioning
• The term *commissioning* comes from shipbuilding
• The commissioning of buildings initially focused on energy performance
• Cx now includes an increasing number of systems
**Commissioning Codes, Standards, and Rating Systems**

- International Green Construction Code (IgCC)
- International Energy Conservation Code (IECC)
- ASHRAE Standard 189.1 and 90.1
- CALGreen & California Energy Code
- LEED and other rating systems

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**Types of Commissioning**

- **Commissioning (Cx)**
  - Building Commissioning (new)
- **Re-Commissioning (ReCx)**
  - Commissioning a building that has been previously commissioned
- **Retro-Commissioning (RetroCx)**
  - Commissioning an existing building that has never been commissioned

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**What is Commissioning?**

- Commissioning validates the design!
  - That the design works and meets the "design intent"
- "Inspections" validate construction
  - This is not commissioning!

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Definitions

• Building Commissioning (IGCC/IECC) – A process that verifies and documents that the selected building and site systems have been designed, installed, and function in accordance with the owner’s project requirements and construction documents, and minimum code requirements.

Definitions

• Commissioning Process: (ASHRAE 189.1) A quality-focused process for enhancing the delivery of a project. The process focuses upon verifying and documenting that the facility and all of its systems and assemblies are planned, designed, installed, tested, operated, and maintained to meet the owner’s project requirements. (See owner’s project requirements.)

Acronyms

<table>
<thead>
<tr>
<th>ACRONYMS</th>
<th>DESCRIPTION</th>
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<tr>
<td>BOZ</td>
<td>Basis of Design</td>
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<td>CxA</td>
<td>Commissioning Authority</td>
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<td>Cx</td>
<td>Commissioning</td>
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<td>FPT</td>
<td>Functional Performance Test</td>
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<td>HVAC</td>
<td>Heating, Ventilating, and Air Conditioning</td>
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<td>O&amp;M</td>
<td>Operations and Maintenance</td>
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<td>OPP</td>
<td>Owner’s Project Requirements</td>
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Elements of Cx Process

- Owner’s Project Requirements (OPR)
- Basis Of Design (BOD)
- Cx Plan
- Design Phase Design Review
- Construction Docs
- Functional Performance Testing (FPT)
- Doc. & Training
- Cx Report

Phases of Commissioning

- Pre-Design Phase
- Design Phase
- Construction Phase
- Acceptance Phase
- Post-Acceptance Phase

Owners Project Req. (OPR)

Documents the expectations and requirements:
1. Environmental and sustainability goals
2. Energy efficiency goals
3. Indoor environmental quality requirements
4. Project program, including facility functions and hours of operation, and need for after hours operation
5. Equipment and systems expectations
6. Building occupant and operation and maintenance (O&M) personnel expectations
Basis of Design (BOD)
A written explanation of how the design of the building systems meets the OPR shall be completed at the design phase of the building project. The BOD document covers systems required by code to be commissioned when used in a project:

Systems may include the following:

- HVAC systems and controls
- Indoor lighting system and controls
- Water heating system
- Renewable energy systems
- Water reuse systems

Functional Performance Test (FPT)

- Functional performance tests shall demonstrate the correct installation and operation of each component, system
- Functional performance testing reports shall contain information:
  - Addressing each of the building components tested
  - The testing methods utilized,
  - Include any readings and adjustments made.

Documentation and Training

A ‘systems manual’ should at a minimum include the following:

a) Site, Facility, and History information
b) Site Contact information
c) Instructions for basic O&M
d) Description of Major Systems
e) Site Equipment Inventory
f) Copy of all special inspection verifications required
Documentation and Training

Training materials should at a minimum include the following:

a. System and Equipment Overview
b. Review and demonstration of operation, servicing, and preventative maintenance
d. Review of the drawings on the systems and equipment

- This should be documented in Cx Report

Commissioning Report

Preliminary Report/Final Report

A report of commissioning process activities undertaken through the design and construction phases of the building project shall be completed and provided to the owner or representative. A copy may also be required to be provided to the code official.

Cx Standards

- ICC 1000 Cx Standard
- ASHRAE 202 Cx Process
- NFPA 3: Fire Protection and Life Safety Systems
- ASTM E2813 Standard Practice for Building Enclosure Cx
**ICC 1000 Cx Standard**
- Standard being developed through the ANSI standards process
- Focuses on the application of the Cx process to assist code officials implement and enforce commissioning
- Relies on other standards for the specifications of the overall Cx process

**ASHRAE 202 Cx Process**
- Standard 202-2013 describes how to plan, conduct, and document commissioning of a project.
- Informative appendices provide sample documentation, including checklists, systems manual, reports, training plan, and more.
- Provides specifics of the overall Cx process
- Provides details within each element of the Cx process
- Based on ASHRAE Guideline 0

- Establishes the elements of Cx for these systems
- Recommended practice for procedures, methods, and documentation
- Verification of active and passive safety systems
- Defines a commissioning team and spells out qualifications for team members.
ASTM E2813 Standard Practice for Building Enclosure Cx

Building Enclosure Commissioning (BECx) based upon:
- The Owner Project Requirements;
- Clearly defined and enforceable levels of BECx;
- Minimum core competencies required of the BECxA
- An independently applied standard for new buildings and structures, or as part of a more broadly based “Whole” Building Commissioning Program.

Commissioning Guidelines
- ICC G4 Guideline for Commissioning
  - Focused on commissioning requirements in code
- ASHRAE Guideline 0-2005: The Commissioning Process
- Project management
- ASHRAE Guideline 1.1 –2007: The HVAC&R Commissioning Process
- Guideline 1.5-2012 -- The Commissioning Process for Smoke Control Systems

ICC G4-2012 Guideline for Commissioning
- Describes the Cx Process
- Cx Forms and Templates
- Examples of Qualifications of Cx personnel
- Examples of system Testing
ASHRAE Guideline 0

- Describes the Commissioning Process capable of verifying that a facility and its systems meet the Owner’s Project Requirements.
- The procedures, methods, and documentation requirements in this guideline describe each phase of the project delivery and the associated Commissioning Processes from pre-design through occupancy and operation.

ASHRAE Guideline 1.1 - 2007

- HVAC&R Technical Requirements for the Commissioning Process
  - Consistent with the Cx process in 202
  - Focuses upon HVAC&R systems
  - Guideline 1.1-2007 focuses on HVAC&R systems while addressing total building commissioning processes by validating interfaces and possible interferences between all building systems.

ASHRAE Guideline 1.5 - 2012

- Guideline 1.5-2012 -- The Commissioning Process for Smoke Control Systems
- Guideline 1.5 describes the technical requirements for the application of the Commissioning Process described in ASHRAE Guideline 0
- For verification that a smoke control system meets the Owner’s Project Requirements (OPR
IAS AC 476

- Accreditation for:
- Commissioning Training Organizations
- Commissioning Certification Organizations
- Meets ISO17024
- Approved February 2014

**Commissioning**

- **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.

  *Other industry names include provider, agent, authority, professional.*

- **Commissioning Specialist**
  A certified party who works on a specific project to conduct commissioning of a specific technical area.

**COMPLIANCE TEMPLATES AND FORMS**

**Owner’s Project Requirements (Sample)**

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
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<tbody>
<tr>
<td>1</td>
<td>Summarize building information w/ info, sites, stories, construction type, occupancy type and duration</td>
</tr>
<tr>
<td>2</td>
<td>Integrate uses and schedules</td>
</tr>
<tr>
<td>3</td>
<td>Ensure responsibility and flexibility of owners</td>
</tr>
<tr>
<td>4</td>
<td>Update and verify materials and desired building design</td>
</tr>
<tr>
<td>5</td>
<td>Establish operational control</td>
</tr>
<tr>
<td>6</td>
<td>Environmental and Sustainability Goals</td>
</tr>
<tr>
<td>7</td>
<td>Level of compliance with the G&amp;C</td>
</tr>
</tbody>
</table>
Compliance for Code

For code required Cx -
- Similar to Special Inspector Program
- Utilize Forms for consistency
- Templates are available in the ICC G4 Guideline and other sources
  - Modify to fit local needs

Commissioning Compliance Tools

Guidelines and Standards
- ICC 1000 and ICC G4 Guideline
- ASHRAE Standard 202 and Guideline 0
- ASTM E2813
- NFPA 3

Personnel Certifications
- Building Commissioning Association
- AABC Commissioning Group (ACG)

Accreditation
- International Accreditation Service (IAS) AC 476

C101.2 Scope. This code applies to commercial buildings and the buildings' sites

C101.4.1 Mixed occupancy. Where a building includes both residential and commercial occupancies, each occupancy shall be separately considered and meet the applicable provisions of IECC—Commercial Provisions or IECC—Residential Provisions.

Includes all commercial buildings regardless of size.

COMMERCIAL BUILDING. For this code, all buildings that are not included in the definition of "Residential building."

RESIDENTIAL BUILDING. For this code, includes detached one- and two-family dwellings and multiple single family dwellings (townhouses) as well as Group R-2, R-3 and R-4 buildings three stories or less in height above grade plane.

C104.2.6 Final inspection. The building shall have a final inspection and shall not be occupied until approved. The final inspection shall include verification of the installation and proper operation of all required building controls, and documentation verifying activities associated with required building commissioning have been conducted and findings of noncompliance corrected. Buildings, or portions thereof, shall not be considered for a final inspection until the code official has received a letter of transmittal from the building owner acknowledging that the building owner has received the Preliminary Commissioning Report as required in Section C408.2.4.
2015 IECC System Cx

- For commercial Buildings as defined in this code
- C408.1 General. This section covers the commissioning of the building mechanical systems in Section C403 and electrical power and lighting systems in Section C405. Service water-heating systems, swimming pool water-heating systems, spa water-heating systems and the controls for those systems shall be commissioned and completed in accordance with Section C408.2.
  - With some exceptions for smaller systems

2015 IECC Cx Plan

- C408.2.1 Commissioning plan. A commissioning plan shall be developed by a registered design professional or approved agency and shall include the following items:
  - A narrative description of the activities that will be accomplished during each phase of commissioning.
  - A listing of the specific equipment, appliances or systems to be tested
  - Functions to be tested
  - Conditions under which the test will be performed.
  - Measurable criteria for performance.

2015 IECC System Balancing

- C408.2.2 Systems adjusting and balancing.
  - HVAC systems shall be balanced in accordance with generally accepted engineering standards.
  - C408.2.2.1 Air systems balancing.
    - Each supply air outlet and zone terminal device shall be equipped with means for air balancing
  - C408.2.2.2 Hydronic systems balancing.
    - Individual hydronic heating and cooling coils shall be equipped with means for balancing and measuring flow.
C408.2.3 Functional performance testing.
- Sections C408.2.3.1 through C408.2.3.3

C408.2.3.1 Equipment.
- Equipment functional performance testing shall in accordance with approved plans and specifications
- Testing shall include all modes and sequence of operation, including under full-load, part-load and emergency conditions

C408.2.3.2 Controls.
- HVAC and service water-heating control systems shall be tested to document that control devices, components, equipment and systems are calibrated and adjusted and operate in accordance with approved plans and specifications.

C408.2.3.3 Economizers.
- Air economizers shall undergo a functional test to determine that they operate in accordance with manufacturer’s specifications.

C408.2.4 Preliminary commissioning report.
- A preliminary report of commissioning test procedures and results shall be completed and certified by the registered design professional or approved agency
- C408.2.4.1 Acceptance of report.
  - Buildings, or portions thereof, shall not be considered acceptable for a final inspection pursuant to Section C104.3. (letter from owner)
- C408.2.4.2 Copy of report.
  - The code official shall be permitted to require that a copy of the Preliminary Commissioning Report be made available for review by the code official.
C408.2.5 Documentation requirements.
- The construction documents shall specify that the documents described in this section be provided to the building owner within 90 days of the date of receipt of the C/O.

C408.2.5.1 Drawings.
- Construction documents shall include the location and performance data on each piece of equipment.

C408.2.5.2 Manuals.
- An operating and maintenance manual shall be provided and include all of the following:
  - Equipment size and selected options for each piece of equipment requiring maintenance.
  - Manufacturer’s operation manuals and maintenance
  - Name and address of at least one service agency.
  - HVAC and service hot water controls system maintenance and calibration information, including wiring diagrams, schematics and control sequence descriptions.
  - Submittal data indicating all selected options for each piece of lighting equipment and lighting controls.
  - Operation and maintenance manuals for each piece of lighting equipment. Required routine maintenance actions, cleaning and recommended retamping shall be clearly identified.
  - A schedule for inspecting and recalibrating all lighting controls.
  - A narrative of how each system is intended to operate, including recommended set points.
  - Submittal data indicating all selected options for each piece of lighting equipment.
  - Maintenance and calibration information, including wiring diagrams, schematics and control sequence descriptions.
  - Submittal data indicating all selected options for each piece of lighting equipment.
  - Operation and maintenance manuals for each piece of lighting equipment. Required routine maintenance actions, cleaning and recommended retamping shall be clearly identified.
  - A schedule for inspecting and recalibrating all lighting controls.
  - A narrative of how each system is intended to operate, including recommended set points.

C408.2.5.3 System balancing report.
- A written report describing the activities and measurements completed

C408.2.5.4 Final commissioning report.
- A report of test procedures and results identified as “Final Commissioning Report” shall be delivered to the building owner
- The report shall be organized with mechanical system and service hot water system findings in separate sections.
6.7.2.4 System Commissioning.

HVAC control systems shall be tested to ensure that control elements are calibrated, adjusted, and in proper working condition. For projects larger than 50,000 ft² conditioned area, except warehouses and semiheated spaces, detailed instructions for commissioning HVAC systems (see Informative Appendix E) shall be provided by the designer in plans and specifications.

Informative Appendix E:

6.8.2.4 ASHRAE Guideline 1.1-2007 HVAC&R Technical Requirements for the Commissioning Process

International Green Construction Code (IgCC) and ASHRAE 189.1

101.3 Scope. The provisions of this code shall apply to all buildings and structures except

1. Detached one- and two-family dwellings and multiple single-family dwellings (townhouses) not more than three stories in height above grade plane with a separate means of egress, their accessory structures, and the site or lot upon which these buildings are located.

2. Group R-3 residential buildings, their accessory structures, and the site or lot upon which these buildings are located.

3. Group R-2 and R-4 residential buildings four stories or less in height above grade plane, their accessory structures, and the site or lot upon which these buildings are located.

4. The code shall not apply to equipment or systems that are used primarily for industrial or manufacturing.

5. The code shall not apply to temporary structures approved under Section 3103 of the International Building Code.
901.1 Scope.
The provisions of chapter 9 are intended to facilitate pre- and post-occupancy commissioning, operation and maintenance of buildings and structures.

902.1 Approved agency.
An approved agency shall provide all of the information necessary for the code official to determine that the agency meets the applicable requirements.
The code official shall be permitted to be the approved agency.

902.1.1 Independence.
An approved agency shall be objective, competent and independent from the contractor responsible for the work being inspected.
An approved agency shall have adequate equipment to perform the required commissioning.
An approved agency shall employ experienced personnel educated in conducting, supervising and evaluating tests and commissioning.

903.1 General.
The registered design professional in responsible charge or approved agency shall perform commissioning during construction and after occupancy as required by Table 903.1.
The approved agency shall be qualified and shall demonstrate competence, to the satisfaction of the code official.
The registered design professional in responsible charge and engineers of record involved in the design of the project are permitted to act as the approved agency.
903.1.1 Preoccupancy report requirement.
- The approved agency shall keep records of the commissioning required by Table 903.1. The approved agency shall furnish commissioning reports to the owner and the registered design professional in responsible charge and, upon request, to the code official.
- Prior to the issuance of a Certificate of Occupancy, a final commissioning report shall be submitted to and accepted by the code official.

903.1.2 Post-occupancy report requirement.
- Post-occupancy commissioning shall occur as specified in the applicable sections of this code. A post-occupancy commissioning report shall be provided to the owner within 30 months after the Certificate of Occupancy is issued for the project and shall be made available to the code official upon request.

Chapter 9 – Table 903.1
- Site Development and Land Use
- Material Resource and Efficiency
- Energy (chapter 6)
- Lighting
- Water Resource Conservation, Quality, & Efficiency
- Indoor Environmental Quality & Comfort

Re-Commissioning (Post Occupancy)
- Required within 30 months of occupancy
- Report is provided to the owner with no action required by the code official.
2012 IgCC Scope Ch. 9

- 904.2 Record documents.
  - 3. For sites that have previously been copies of engineering and institutional control information shall be provided.
- 904.3 Building operations and maintenance documents.
  - The building O&M documents shall consist of:
    - The manufacturer’s specifications and recommendations.
    - Programming procedures illustrating to the owner how the building, site and systems are intended to be maintained and operated.
  - The information listed in items 1-6 of this section shall be included in the materials, as applicable to the specific project.

2012 IgCC Commissioning

CH. 6 ENERGY SYSTEMS COMMISSIONING AND COMPLETION

- All of the following items are consistent with ’15 IECC except post-occupancy recommissioning
  - 611.1 Mechanical systems commissioning
    - 611.1.1 Commissioning plan.
    - 611.1.2 Systems adjusting and balancing.
    - 611.1.3 Functional performance testing.
    - 611.1.4 Preliminary commissioning report.
    - 611.1.5 Completion requirements.
      - 611.1.5.4 Final commissioning report.
      - 611.1.5.5 Post-occupancy recommissioning.

2011 ASHRAE 189.1 Scope

- Scope
  - 2.1 This standard applies to the following elements of building projects:
    - New buildings and new portions of buildings and their systems
    - New systems and equipment in existing buildings
  - 2.2 The provisions of this standard do not apply to:
    - Single-family houses, multi-family structures of three stories or fewer above grade, manufactured houses (mobile homes) and manufactured houses (modular), and
    - Buildings that do not use electricity, fossil fuel, or water.
10.1 Scope.
This section specifies requirements for construction and plans for operation, including the commissioning process.

10.3 Mandatory Provisions

10.3.1 Construction

10.3.1.1 Building Acceptance Testing.
Acceptance testing shall be performed on all buildings using generally accepted engineering standards and handbooks acceptable to the AHJ. An acceptance testing process shall be incorporated into the design and construction of the building project.

10.3.1.2 Building Project Commissioning.
Buildings that exceed 5000 ft² (500 m²), commissioning shall be performed using generally accepted engineering standards. Buildings complying with the commissioning process will be deemed to comply with the requirements “Building Acceptance Testing.” A commissioning process shall be incorporated into the predesign, design, construction, and first year occupancy of the building project that verifies that the components, assemblies, and systems comply with the documented OPR.

10.3.1.2.1 Activities Prior to Building Permit
Designate a project commissioning authority (CxA). The owner, in conjunction with the design team as necessary, shall develop the OPR during predesign.

The design team shall develop the BOD.

The CxA shall review both the OPR and BOD.

Construction phase commissioning requirements shall be incorporated into project specifications and other construction documents developed by the design team.

The CxA shall conduct two focused OPR reviews.

Develop and implement a commissioning plan containing...
2012 ASHRAE 189.1

10.3.1.2.2 Activities Prior to Building Occupancy.
- Verify the installation and performance of the systems to be commissioned, including completion of the construction checklist and verification.
  - Exception to 10.3.1.2.2(a): Systems that, because their operation is seasonally dependent,
  - It shall be verified that the owner requirements for the training of operating personnel and building occupants is completed...
  - Complete preliminary commissioning report.
  - Verify a system manual has been prepared that includes O&M documentation

2012 ASHRAE 189.1

10.3.1.2.3 Post-Occupancy Activities.
- Complete any commissioning activities called out in the commissioning plan.
- Verify the owner requirements for training operating personnel and building occupants are completed.
- Complete a final commissioning report.
- 10.3.1.2.4 Systems. The following systems, if included in the building project, shall be commissioned:
  - Heating, ventilating, air-conditioning, IAQ, and refrigeration systems (mechanical and/or passive) and associated controls.
  - Building envelope systems, components, and assemblies to verify the thermal and moisture integrity.

2012 ASHRAE 189.1

10.3.1.2.4 Systems cont’d
- Building envelope pressurization for air-tightness
- Lighting systems.
- Automatic controls for fenestration shading devices and dynamic glazing.
- Service water heating systems, irrigation and plumbing
- Domestic and process water pumping and mixing systems.
- Renewable energy systems.
- Water measurement devices, as required in Section 6.3.3.
- Energy measurement devices, as required in Section 7.3.3.
- 10.3.1.2.5 Documentation. Owner shall retain the System Manual and Final Commissioning Report.
**Commissioning**  
*ASHRAE 2011 Standard 189.1*

**Building Project Commissioning – Section 10**
- Buildings exceeding 5000 ft² of gross floor area
  - Mech systems: HVAC, IAQ, and refrigeration systems
  - Lighting systems: daylighting controls, occupancy sensing devices, and, automatic shut-off controls
  - Renewable energy systems.
  - Water measurement devices
  - Energy measurement devices
- Re-Commissioning (Post Occupancy)

**Summary**
- Commissioning Process
- Compliance tools
  - Guidelines
  - Accreditation
  - Certification
- Commissioning in codes and standards

**Questions & Answers**

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Code interpretations are a benefit of ICC Membership