



# CODE REQUIREMENTS FOR BUILDING COMMISSIONING

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**BSA**

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# OVERVIEW

- The recent adoption by the Centers for Medicaid and Medicare Services (CMS) of NFPA 99: Health Care Facilities Code, 2012 brings with it commissioning requirements for projects which are subject to a CMS survey.
- This follows the adoption by other jurisdictions in the Midwest of the International Energy Conservation Code (IECC), which also includes requirements for commissioning.
- In this presentation, we will discuss the scope of these requirements and their applicability to new construction and renovation healthcare projects.
- The presentation will also include an overview of the Commissioning Process, the roles and responsibilities of an Owner during the process, as well as a discussion of the benefits of the process to the Owner.

# LEARNING OBJECTIVES

- At the conclusion of the presentation, participants will be able to
  - Define Commissioning
  - Understand the applicability of codes and standards that pertain to Commissioning in healthcare environments
  - Understand the four distinct phases of the Commissioning Process
  - Understand the Owner's roles and responsibilities within the Process
  - Understand the potential benefits of Commissioning to the Owner

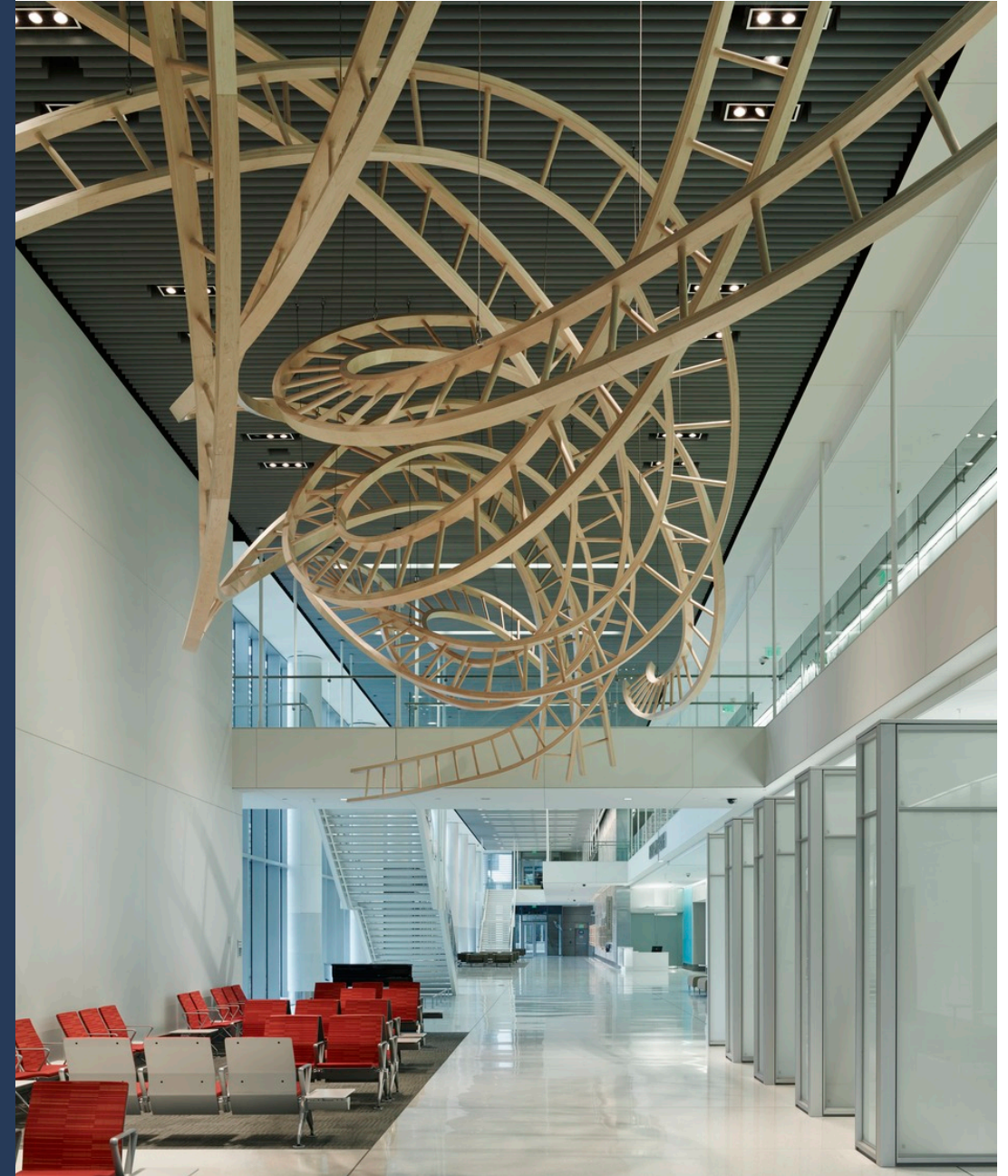


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Commissioning is a Quality-focused Process for enhancing the delivery of a new building and/or major renovation.

It focuses on 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.

ASHRAE Building Performance Alliance (BPA)







Commissioning means **another set of eyes during design and construction**, then putting systems to the **test of real performance** to uncover operational issues **before owner occupancy** thereby **improving the delivered quality of a project.**

# CMS ADOPTION OF NFPA 99 AND 101

- Effective July 5, 2016, the Centers for Medicare & Medicaid Services (CMS) adopted by regulation the 2012 Edition of the National Fire Protection Association (NFPA) 101 – Life Safety Code (LSC) and the 2012 edition of NFPA 99: Health Care Facilities Code (HCFC)

# SCOPE

- Adoption amended the fire safety standards for participating Medicare and Medicaid facilities, including:
  - hospitals,
  - critical access hospitals (CAHs),
  - long-term care facilities,
  - intermediate care facilities for individuals with intellectual disabilities (ICF-IID),
  - ambulatory surgery centers (ASCs),
  - hospices which provide inpatient services,
  - religious non-medical health care institutions (RNHCIs), and
  - programs of all-inclusive care for the elderly (PACE) facilities.

# NFPA 99 CHAPTER 9

- The **NFPA 99-2012** edition of the Health Care Facilities Code (including the tentative interim amendments (TIAs) **provides minimum requirements for health care facilities for the installation, inspection, testing, maintenance, performance, and safe practices for facilities, material, equipment, and appliances, including other hazards associated with the primary hazards.**



# NFPA 99 CHAPTER 9

- The NFPA 99-2012 edition of the Health Care Facilities Code references the following American Society for Heating Refrigeration and Air Conditioning Engineers (ASHRAE) publications:
  - ASHRAE Standard 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings, 2010.
  - ASHRAE Guideline 0, The Commissioning Process, 2005.
  - ASHRAE Guideline 1.1, HVAC&R Technical Requirements for The Commissioning Process, 2007.

# NFPA 99 CHAPTER 9

## HEATING, VENTILATION, & AIR CONDITIONING (HVAC)

- Chapter 9 of NFPA 99 requires HVAC that systems serving spaces – defined as a portion of the health care facility designated by the governing body that serves a specific purpose or providing health care functions – to be in accordance with requirements of ASHRAE Standard 170-2008 – Ventilation of Health Care Facilities
- Chapter 9 does not apply to existing HVAC systems.
- Chapter 9 applies to the construction of new health care facilities, and the altered, renovated, or modernized portions of existing systems or individual components.
- Chapter 9 ensures minimum levels of heating, ventilation, and air conditioning performance in patient and resident care areas.

# NFPA 99 CHAPTER 9

- One of the issues specifically discussed in Chapter 9 is:
  - COMMISSIONING.
- Other issues discussed include:
  - HVAC system energy conservation.
  - Piping.
  - Ductwork.
  - Acoustics.
  - Requirements for the ventilation of medical gas storage and trans-filling areas.
  - Waste anesthetic gases.
  - Plumes from medical procedures.
  - Emergency power system rooms.
  - Ventilation during construction.

# NFPA 99 CHAPTER 9

- 9.3.3 Commissioning.
- 9.3.3.1 Heating, cooling, ventilating, and process systems serving spaces or providing health care functions covered by this code shall be **commissioned** in accordance with ASHRAE Standard 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings, 2010.



# NFPA 99 CHAPTER 9

- **9.3.3.2 Commissioning shall follow**
  - ASHRAE Guideline 0, The Commissioning Process, 2005, and
  - ASHRAE Guideline 1.1, HVAC&R Technical Requirements for The Commissioning Process, 2007.
  - **or any other publicly reviewed document acceptable to the authority having jurisdiction.**

# REMINDER: NFPA 99 CHAPTER 9

- HVAC and Process Systems serving spaces or providing health care functions covered by this code shall be **commissioned in accordance with ASHRAE Standard 90.1**, Energy Standard for Buildings Except Low-Rise Residential Buildings, 2010.
- **Commissioning** shall follow
  - ASHRAE Guideline 0, The Commissioning Process, and
  - ASHRAE Guideline 1.1, HVAC&R Technical Requirements for the Commissioning Process,
  - or any other publicly reviewed document acceptable to the authority having jurisdiction.

# ASHRAE 90.1 2010

- *ASHRAE 90.1-2010, Energy Standard for Buildings Except Low-Rise Residential Buildings discusses Commissioning in Chapter 6 under Submittals.*
  - Chapter 6 Heating, Ventilating, and Air Conditioning
    - **6.7 Submittals**
      - **6.7.1 General.** The Authority having jurisdiction may require submittal of compliance documentation and supplemental information in accord with ... this standard.

# ASHRAE 90.1 2010

- **6.7.2.1 Record Drawings.**
- **6.7.2.2 (Systems) Manuals** including Submittal Data, Operation and Maintenance Manuals, Service Agency contact info, and HVAC controls system maintenance and calibration information, including wiring diagrams, schematics, and control sequence descriptions.
  - Desired or field-determined setpoints shall be permanently recorded on control drawings at control devices or, for digital control systems, in programming comments.
  - A complete narrative of how each system is intended to operate, including suggested setpoints.



# ASHRAE 90.1 2010

- **6.7.2.3 System Balancing**

All HVAC systems be balanced in accordance with generally accepted engineering standards.

A written balance is to be provided...for HVAC systems serving zones with a total conditioned area exceeding 5000 ft<sup>2</sup>.

# ASHRAE 90.1 2010

- **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 ft<sup>2</sup> conditioned area, except warehouses and semi heated spaces, detailed instructions for commissioning HVAC systems shall be provided by the designer in plans and specifications.

# REMINDER: NFPA 99 CHAPTER 9

- HVAC and Process Systems serving spaces or providing health care functions covered by this code shall be **commissioned in accordance with ASHRAE Standard 90.1**, Energy Standard for Buildings Except Low-Rise Residential Buildings, 2010.
- **Commissioning shall follow**
  - **ASHRAE Guideline 0, The Commissioning Process**, and
  - ASHRAE Guideline 1.1, HVAC&R Technical Requirements for the Commissioning Process,
  - or any other publicly reviewed document acceptable to the authority having jurisdiction.

# ASHRAE GUIDELINE 0: 2005

## Purpose

- The purpose of the guideline is to describe a Commissioning Process capable of verifying that a facility and its systems meet the Owner's Project Requirements (OPR).



# ASHRAE GUIDELINE 0: 2005

## Scope

- The procedures, methods, and documentation requirements in the guideline describe each phase of the project delivery and the associated Commissioning Processes from predesign through occupancy and operation, **without regard to specific elements, assemblies, or systems**, and provide the following:
  - Overview of Commissioning Process Activities
  - Description of each phase's processes
  - Requirements for acceptance of each phase
  - Requirements for documentation of each phase
  - Requirements for training of operation and maintenance personnel

# ASHRAE GUIDELINE 0: 2005

## Utilization

- The application of the guideline depends on the Owner's Project Requirements and how the project is designed, built, and operated. The process described in the **guideline is written for a generic project and must be adapted to each project.**
- **The guideline is not written in code language.**
- The guideline describes the Commissioning Process, **and is supplemented by companion technical guidelines including ASHRAE Guideline 1.1 HVAC&R Technical Requirements for the Commissioning Process.**
- A technical guideline describes the specific details to properly implement the Commissioning Process relative to a specific facility system or assembly.

# REMINDER: NFPA 99 CHAPTER 9

- HVAC and Process Systems serving spaces or providing health care functions covered by this code shall be **commissioned in accordance with ASHRAE Standard 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings, 2010.**
- **Commissioning shall follow**
  - **ASHRAE Guideline 0, The Commissioning Process, and**
  - **ASHRAE Guideline 1.1, HVAC&R Technical Requirements for the Commissioning Process,**
  - or any other publicly reviewed document acceptable to the authority having jurisdiction.

# ASHRAE GUIDELINE 1.1-2007

HVAC&R Technical Requirements for the Commissioning Process

- **Purpose:**  
The purpose of this guideline is to describe the technical requirements for the application of the commissioning process described in ASHRAE Guideline 0-2005 that will verify that the heating, ventilating, air-conditioning, and refrigerating (HVAC&R) systems achieve the Owner's Project Requirements.



# ASHRAE GUIDELINE 1.1-2007

## HVAC&R Technical Requirements for the Commissioning Process

- **Scope:**

The procedures, methods, and documentation requirements in **this guideline describe the application of the commissioning process for each project delivery phase from Pre-Design through Owner Occupancy and Operations for all types and sizes of HVAC&R systems to support the commissioning process activities described in ASHRAE Guideline 0-2005, *The Commissioning Process***

- This includes requirements for:

- HVAC&R systems to fully support the commissioning process activities,
- Verification during each phase of the commissioning process,
- Acceptance during each phase,
- Documentation during each phase,
- Systems Manual, and Training for operations

# ASHRAE GUIDELINE 1.1-2007

## HVAC&R Technical Requirements for the Commissioning Process

- **Utilization:**

- This guideline describes specific details required to properly implement the commissioning process relative to HVAC&R systems.
- This includes documentation, test procedures, and checklists.
  - Pre-Design (Programming) Review Checklist
  - First Design (DDs) Review Checklists
  - Construction Checklists for
    - Boilers, Chillers, Cooling Towers, Coils, Piping, Ductwork, Insulation, Energy Recovery Wheels, Exhaust Fans, Fan Coils, Fire Dampers, GRDs, Humidifiers, VAVs, Fan Powered VAVs, Pumps, Split Systems, Unit Heaters, VFCs, Energy Efficiency checklists

# REMINDER: NFPA 99 CHAPTER 9

- **9.3.3.1** Heating, cooling, ventilating, and process systems serving spaces or providing health care functions covered by this code shall be commissioned in accordance with ASHRAE Standard 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings, 2010.
- **9.3.3.2 Commissioning shall follow**
  - ASHRAE Guideline 0, The Commissioning Process, and
  - ASHRAE Guideline 1.1, HVAC&R Technical Requirements for the Commissioning Process,
  - or any other publicly reviewed document acceptable to the authority having jurisdiction.
  - What could the above include?
    - ASHRAE Standard 202?
    - International Energy Conservation Code?
    - LEED V4?
    - Local requirements?

# ASHRAE STANDARD 202-2013

ASHRAE Standard 202 Commissioning Process for Buildings & Systems

- **Purpose:**  
The purpose of the standard is to identify a minimum acceptable Commissioning Process for buildings and systems.
- *Similar to Guideline 0, however it is a Standard instead of a Guideline. It is written in more formal Code language.*
- *It lists the minimum requirements for a Commissioning Process.*
- *Similar to Guideline 0, it is a Process that is not specific to any particular systems or equipment*
- *It does not include requirements for which systems.*
- *Informative Appendix does list recommended sampling rates based on complexity and criticality*

# ASHRAE STANDARD 202-2013

ACTIVITY	DELIVERABLE
Initiate Cx Process	Roles & Responsibilities
Decide Project Requirements	Owner's Project Requirements
Develop Cx Plan	Cx Plan
Design Approach to Requirements	Basis of Design
Set Contractor Cx Requirements	Cx Specifications
Review Design against requirements	Design Review Report
Review submittals	Submittal Review Report
Observe and Test	Construction Checklist and Reports
Resolve Issues	Issues and Resolutions Log
Assemble Systems Manuals	Systems Manual
Conduct Training	Training Plan and Records
Post-Occupancy Operation	End of Warranty Cx Report
Assemble Cx Report	Cx Report

# COMMISSIONING REQUIREMENTS IN THE ENERGY CODE

State	Current Energy Code (Commercial)
Indiana	<a href="#">2010 Indiana Energy Conservation Code</a> , based on ASHRAE 90.1-2007 with state-specific amendments* *state-specific amendment deletes Commissioning requirements
Illinois	2015 IECC and ASHRAE 90.1-2013 with <a href="#">state-specific amendments</a>
Kentucky	<a href="#">2013 Kentucky Building Code</a> , based on the 2012 IECC; ASHRAE 90.1-2010 is still an acceptable compliance path as allowed by section C401.2 in the 2012 IECC
Michigan	<a href="#">2009 Michigan Uniform Energy Code (MUEC), Part 10a</a> Based on the 2009 IECC with amendments and ASHRAE 90.1-2007
Ohio	<a href="#">Ohio Building Code (OBC) Chapter 13</a> , based on the 2012 IECC and ASHRAE Standard 90.1-2010 with amendments.

# INTERNATIONAL ENERGY CONSERVATION CODE

- ***Commissioning is required if heating and cooling capacity exceeds minimum thresholds***
  - Commissioning of HVAC&R is required per IECC 2012 and later, per IECC 2015 it is required for systems in buildings where the total mechanical equipment capacity is 40 tons cooling capacity OR 600,000 Btu/h (combined space and service water) heating capacity and greater. Systems that serve dwelling units and sleeping units are exempt.
- ***The code lists which HVAC equipment must be included***
  - All HVAC equipment listed in IECC C403.2.3 Tables 1-10 are to be included, except small packaged or unitary equipment listed in Tables 1-3 which do not require an economizer. This includes but is not limited to air conditioners and condensing units, heat pumps, PTACs, PTHPs, gas and oil fired furnaces and unit heaters, boilers, chillers, heat rejection equipment, CRACs, and heat exchangers
- **Commissioning of Lighting Controls is required per IECC 2012 and later.**
- **Commissioning of Service Water heating equipment is required per IECC 2015 and later.**

# INTERNATIONAL ENERGY CONSERVATION CODE

## IECC 2012 / IECC 2015

### **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.**

*The code defines commissioning as a process that verifies minimum code requirements. This is not historically a commissioning function.*



# INTERNATIONAL ENERGY CONSERVATION CODE

## IECC 2012

*IECC 2015 requires that the owner notifies the code official that the owner has received a preliminary commissioning report, prior to final inspection.*

## IECC 2015

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.**

# INTERNATIONAL ENERGY CONSERVATION CODE

## IECC 2012

C403.2.9 Mechanical systems commissioning and completion requirements. Mechanical systems shall be commissioned and completed in accordance with Section C408.2.

*IECC 2015 requires commissioning of service water heating and defines it to include service (domestic hot) water, swimming pool and spa heating systems and controls.*

## IECC 2015

403.2.11 Mechanical systems commissioning and completion requirements. Mechanical systems shall be commissioned and completed in accordance with Section C408.2.

**C404.11 Service water-heating system commissioning and completion requirements. 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.**

# INTERNATIONAL ENERGY CONSERVATION CODE

## IECC 2012 / IECC 2015

### SECTION C408 - SYSTEM COMMISSIONING

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.

# INTERNATIONAL ENERGY CONSERVATION CODE

## IECC 2012

C408.2 Mechanical systems commissioning and completion requirements.

Prior to passing the final mechanical inspection, the registered design professional shall provide evidence of mechanical systems commissioning and completion in accordance the provisions of this section.

## IECC 2015

C408.2 Mechanical systems **and service water-heating systems** commissioning and completion requirements.

Prior to the final mechanical and plumbing inspections, the registered design professional **or approved agency** shall provide evidence of mechanical systems commissioning and completion in accordance with the provisions of this section.

# INTERNATIONAL ENERGY CONSERVATION CODE

## IECC 2012

Construction document notes shall clearly indicate provisions for commissioning and completion requirements in accordance with this section and are permitted to refer to specifications for further requirements. Copies of all documentation shall be given to the owner and made available to the code official upon request in accordance with Sections C408.2.4 and C408.2.5.

## IECC 2015

Construction document notes shall clearly indicate provisions for commissioning and completion requirements in accordance with this section and are permitted to refer to specifications for further requirements. Copies of all documentation shall be given to the owner **or owner's authorized agent** and made available to the code official upon request in accordance with Sections C408.2.4 and C408.2.5.

# INTERNATIONAL ENERGY CONSERVATION CODE

## IECC 2012

Exception: The following systems are exempt **from the commissioning requirements:**

1. Mechanical systems in buildings where the total mechanical equipment capacity is less than 480,000 Btu/h (40 tons) cooling capacity and 600,000 Btu/h heating capacity.
2. Systems included in Section C403.3 that serve dwelling units and sleeping units **in hotels, motels, boarding houses or similar units.**

## IECC 2015

Exceptions: The following systems are exempt:

1. Mechanical systems **and service water heater systems** in buildings where the total mechanical equipment capacity is less than 480,000 Btu/h (40 tons) cooling capacity and 600,000 Btu/h **combined service water-heating and space-heating capacity.**
2. **Systems included in Section C403.3 that serve individual dwelling units and sleeping units.**

# INTERNATIONAL ENERGY CONSERVATION CODE

## IECC 2012 / IECC 2015

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:

1. A narrative description of the activities that will be accomplished during each phase of commissioning, including the personnel intended to accomplish each of the activities.
2. A listing of the specific equipment, appliances or systems to be tested and a description of the tests to be performed.
3. Functions to be tested including, but not limited to, calibrations and economizer controls.
4. Conditions under which the test will be performed. Testing shall affirm winter and summer design conditions and full outside air conditions.
5. Measurable criteria for performance.

# INTERNATIONAL ENERGY CONSERVATION CODE

## IECC 2012 / IECC 2015

C408.2.2 Systems adjusting and balancing. **HVAC systems shall be balanced** in accordance with generally accepted engineering standards. Air and water flow rates shall be measured and adjusted to deliver final flow rates within the tolerances provided in the product specifications. Test and balance activities shall include air system and hydronic system balancing.

C408.2.3 Functional performance testing. **Functional performance testing** specified in Sections C408.2.3.1 through C408.2.3.3 **shall be conducted**.

C408.2.3.1 Equipment. Equipment functional 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 of the commissioned systems is confirmed**.



# INTERNATIONAL ENERGY CONSERVATION CODE

## IECC 2012 / IECC 2015

(Functional) Testing shall include all modes and sequence of operation, including under full-load, part-load and the following emergency conditions:

1. All modes as described in the sequence of operation.
2. Redundant or automatic back-up mode.
3. Performance of alarms.
4. Mode of operation upon a loss of power and restoration of power.
5. Exception: Unitary or packaged HVAC equipment listed in Tables C403.2.3(1) through C403.2.3(3) that do not require supply air economizers.

# INTERNATIONAL ENERGY CONSERVATION CODE

## IECC 2012

C408.2.3.2 Controls. HVAC 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.

Sequences of operation shall be functionally tested to document they operate in accordance with approved plans and specifications.

## IECC 2015

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.

Sequences of operation shall be functionally tested to document they operate in accordance with approved plans and specifications.

# INTERNATIONAL ENERGY CONSERVATION CODE

## IECC 2012

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 and provided to the building owner

## IECC 2015

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 and provided to the building owner **or owner's authorized agent. The report shall be organized with mechanical and service hot water findings in separate sections to allow independent review.**

# INTERNATIONAL ENERGY CONSERVATION CODE

## IECC 2012 / IECC 2015

The report shall be identified as “Preliminary Commissioning Report” and shall identify:

1. Itemization of deficiencies found during testing required by this section that have not been corrected at the time of report preparation.
2. Deferred tests that cannot be performed at the time of report preparation because of climatic conditions.
3. Climatic conditions required for performance of the deferred tests.

# INTERNATIONAL ENERGY CONSERVATION CODE

## IECC 2012 / IECC 2015

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.

# INTERNATIONAL ENERGY CONSERVATION CODE

## IECC 2012

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 include the following:

1. Results of functional performance tests.
2. Disposition of deficiencies found during testing, including details of corrective measures used or proposed.
3. Functional performance test procedures used during the commissioning process including measurable criteria for test acceptance, provided herein for repeatability.
4. Exception: Deferred tests that cannot be performed at the time of report preparation due to climatic conditions.

## IECC 2015

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 **or owner’s authorized agent. The report shall be organized with mechanical system and service hot water system findings in separate sections to allow independent review.** The report shall include the following:

1. Results of functional performance tests.
2. Disposition of deficiencies found during testing, including details of corrective measures used or proposed.
3. Functional performance test procedures used during the commissioning process including measurable criteria for test acceptance, provided herein for repeatability.
4. Exception: Deferred tests that cannot be performed at the time of report preparation due to climatic conditions.

# INTERNATIONAL ENERGY CONSERVATION CODE

## IECC 2012 / IECC 2015

*IECC contains detailed instructions for lighting system commissioning.*

C408.3 Lighting system functional testing. Controls for automatic lighting systems shall comply with this section.

## IECC 2012

C408.3.1 Functional testing. Testing shall ensure that control hardware and software are calibrated, adjusted, programmed and in proper working condition in accordance with the construction documents and manufacturer's installation instructions. **The construction documents shall state the party who will conduct the required functional testing. Where required by the code official, an approved party independent from the design or construction of the project shall be responsible for the functional testing and shall provide documentation to the code official certifying that the installed lighting controls meet the provisions of Section C405.**

## IECC 2015

C408.3.1 Functional testing. **Prior to passing final inspection, the registered design professional shall provide evidence that the lighting control systems have been tested** to ensure that control hardware and software are calibrated, adjusted, programmed and in proper working condition in accordance with the construction documents and manufacturer's instructions.

**Functional testing shall be in accordance with Sections C408.3.1.1 and C408.3.1.2 for the applicable control type.**

# COMMISSIONING PROCESS

- Based on the Cx Process defined in ASHRAE Guideline 0 and Standard 202.
- Requirements may be defined by rating systems (LEED, Green Globes, etc.)
- Requirements may be defined as Code in some jurisdictions (ASHRAE 90.1, IECC, local codes)



# COMMISSIONING PROCESS

- ASHRAE Guideline 0: Commissioning Process
- The Commissioning Process involves steps that are integrated into four distinct phases of the process:
  - Pre-Design Phase
  - Design Phase
  - Construction Phase
  - Occupancy and Operations Phase

# COMMISSIONING PROCESS

## Pre-Design Phase

- Roles and Responsibilities determined
- Owner develops Cx Scope
  - Which Systems and Equipment?
  - Sampling Verification approach?
  - Criticality, complexity, commodity
- Owner selects Cx Provider (or CxA)
  - An entity identified by the Owner who leads, plans, schedules, and coordinates the commissioning team to implement the Commissioning Process.
- Owner's Project Requirements (OPR) are determined and documented
  - Building scope and use
  - Performance
  - Training
  - Commissioning
  - Documentation
- Commissioning Plan is created

## ***Corresponding ASHRAE 202 Commissioning Requirements:***

- **5.2.1 Roles and Responsibilities**  
The owner shall include in the design and construction team's contracts, or roles and responsibilities, the Cx activities contained in this the project Cx Plan.
- **5.2.2 Commissioning Scope.**  
The owner shall determine the systems and assemblies to be included in the project team's scope.
- **5.2.3 Owner's Project Requirements.**  
For new construction or major renovations, the owner shall ensure development of the Owner's Project Requirements (OPR) prior to development of the architectural programming. The owner shall require a final updated and approved OPR at substantial completion.
- **5.2.4 The Commissioning Plan.**  
The owner shall require the development of the Cx Plan that define the project team's roles and responsibilities, communication protocols, Cx procedures, documentation, activities, and the schedule of those activities.

# COMMISSIONING PROCESS

More on Commissioning Scope

## **NFPA 99**

Heating, cooling, ventilating, and process systems serving spaces or providing health care functions covered by this code shall be commissioned in accordance with ASHRAE 90.1.

## **ASHRAE 90.1**

HVAC control systems and HVAC systems for projects larger than 50,000 ft<sup>2</sup> conditioned area, except warehouses and semi heated spaces.

# COMMISSIONING PROCESS

More on Commissioning Scope

## **IECC 2012 and 2015**

Commissioning of HVAC&R is required per IECC 2012 and later, per IECC 2015 it is required for systems in buildings where the total mechanical equipment capacity is 40 tons cooling capacity OR 600,000 Btu/h (combined space and service water) heating capacity and greater. Systems that serve dwelling units and sleeping units are exempt.

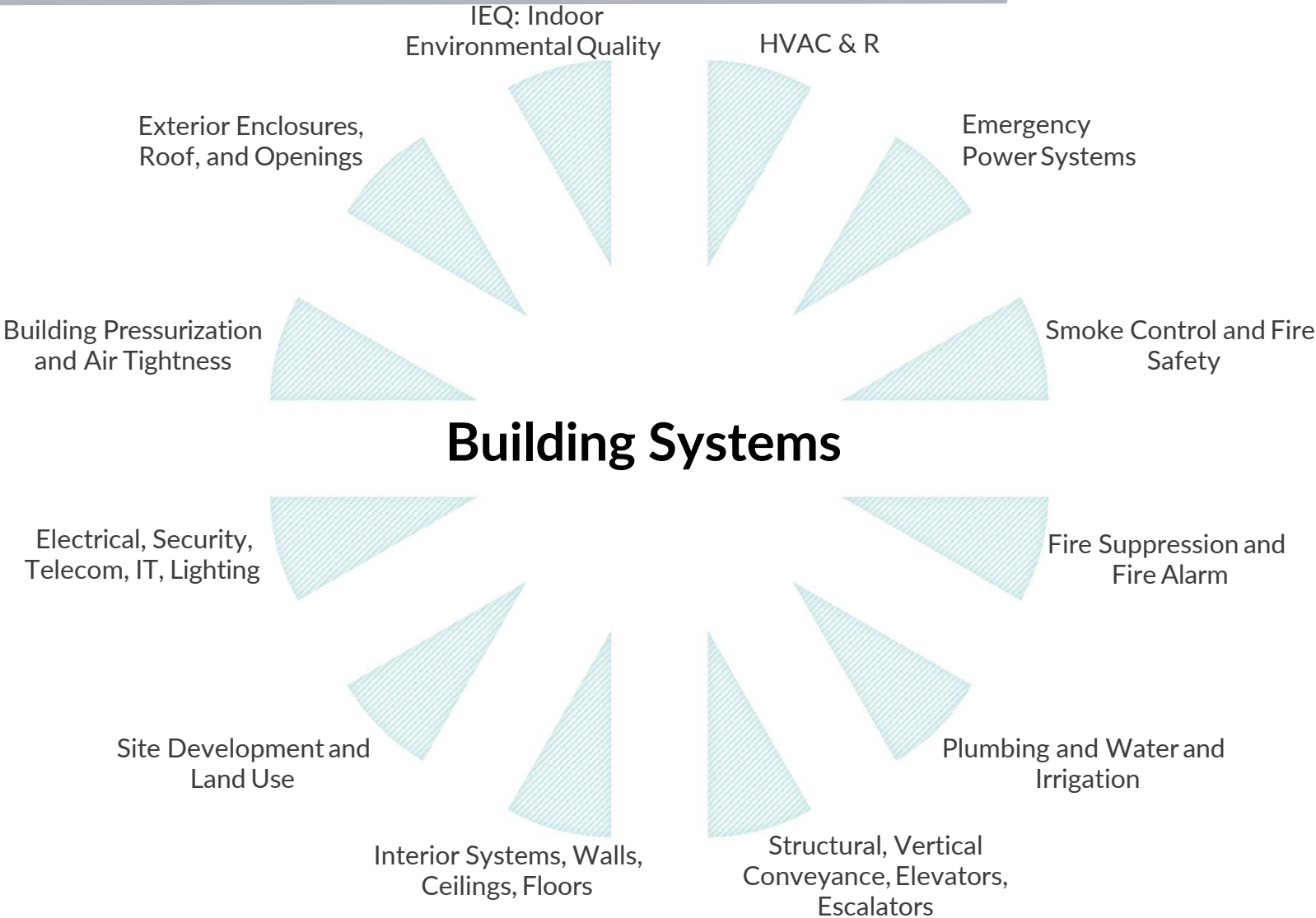
All HVAC equipment listed in IECC C403.2.3 Tables 1-10 are to be included, except small packaged or unitary equipment listed in Tables 1-3 which do not require an economizer. This includes but is not limited to air conditioners and condensing units, heat pumps, PTACs, PTHPs, gas and oil fired furnaces and unit heaters, boilers, chillers, heat rejection equipment, CRACs, and heat exchangers

Commissioning of Lighting Controls is required per IECC 2012 and later.

Commissioning of Service Water heating equipment is required per IECC 2015 and later.

# COMMISSIONING PROCESS

Process Overview



# COMMISSIONING PROCESS

## Design Phase

- Design team determines approach to meet OPR, documented in Basis of Design (BoD)
- Cx Requirements incorporated into project specs
- BoD reviewed by Cx Provider for conformance to OPR
- Cx Design Review(s) completed, for conformance to OPR, and report provided

## *Corresponding ASHRAE 202 Commissioning Requirements:*

- **5.2.6 Basis of Design Documentation.**  
For construction or renovation projects requiring design, the owner shall require, by agreement, the development and updating of the Basis of Design by the designers.
- **5.2.7 Commissioning Specifications.**  
For construction or renovation projects requiring contract documents, the owner shall require, by agreement, the design / construction team to include Cx specifications in the project contract documents. The Cx specification shall include the meeting of all requirements defined in the OPR applicable to the contracted parties and follow the Cx Process contained in the project's Cx Plan.
- **5.2.8 Commissioning Design Reviews.**  
For construction or renovation projects requiring design, the owner shall require, by agreement, the design team to review, respond to, and participate in an issue resolution process to resolve issues identified during the Cx design review process. The owner or designated representative shall review the Cx Process design review comments, participate in an issue resolution process, and provide direction to the team when needed to meet the OPR.

# COMMISSIONING PROCESS

## Construction Phase

- Submittals are reviewed, concurrent with design team reviews, for conformance to OPR and contract documents
- Construction is observed and verified including installation, equipment start-up and initial testing / checkout
- Contractor documents on Cx Provider provided checklists

## *Corresponding ASHRAE 202 Commissioning Requirements:*

- **5.2.9 Construction Submittals Review.** For construction or renovation projects requiring design and/or submittals, the owner shall require, by agreement, that the construction submittals for systems and assemblies being commissioned be reviewed.
- **5.2.5 Checklists.** The owner shall require, by agreement, the Cx Team including the Cx Provider and design and construction service providers to develop, use, and complete Cx procedures and written Cx observation and testing checklists in accordance with the Cx Plan.

# COMMISSIONING PROCESS

Construction Checklists provided by Cx Provider

## Construction Checklists

- Completed by the Contractor
- Checklists do not take the place of the manufacturer's recommended checkout and startup procedures
- Contractor's checklist of similar rigor can be used
- Confirms required documentation is provided
- Document basic equipment info
- Documents a physical inspection of equipment
- Construction Checks, by trade – installation against details, start-up, TAB, controls checkout
- Comments, Participant Signature and Date, Approval
- Cx Provider verifies a portion of the Checks

**CLIENT**  
**BUILDING**  
**Project**  
**Construction Checklist**  
**EQUIPMENT NAME AND ID**

**BSA LifeStructures**  
Creating inspired solutions that improve lives

Construction checklist items are to be completed as part of startup & initial checkout, prior to functional testing.  
This checklist does not take the place of the manufacturer's recommended checkout and startup procedures or report.  
Items that do not apply shall be noted with the reasons on this form (N/A = not applicable, BO = by others).  
If this form is not used for documenting, one of similar rigor shall be used.  
Contractor assigned responsibility for sections of the checklist shall be responsible to see that checklist items by their subcontractors are completed and checked off.  
"Contr." column or abbreviations in brackets to the right of an item refer to the contractor responsible to verify completion of this item. A/E = architect/engineer, All = all contractors, CA = commissioning authority, CC = controls contractor, EC = electrical contractor, GC = general contractor, MC = mechanical contractor, SC = sheet metal contractor, TAB = test and balance contractor

**1 Requested Documentation Submitted**

Check if Okay. Enter comment if deficient

Document	EF-1	EF-2
Manufacturer's cut sheets		
Start-up Report		
Operation and Maintenance Manual		
Balance Report		
Above complete per contract documents? Yes/No		SC

**2 Model Verification**

Manu.	Field		EF-1	EF-2
	submitted	SC		
	delivered	SC		
Model	submitted	SC		
	delivered	SC		
Serial #	delivered	SC		
Fan Type	submitted	SC		
	delivered	SC		
Capacity/Static (cfm/wg)	submitted	SC		
	delivered	SC		
Motor speed/hp (rpm/hp)	submitted	SC		
	delivered	SC		
Motor V / Phase/ Freq Hz	submitted	SC		
	delivered	SC		

Installed equipment matches the spec? Yes/No  SC

CLIENT BUILDING PROJECT  
construction checklist  
BSALS # XXXXXXX

Page 1 of 4

EXHAUST FAN



# COMMISSIONING PROCESS

## Prerequisites To HVAC Functional Testing

- Construction Checklists
- Mechanical systems checkout
  - Installation and start-up checks
  - Cleaning and flushing
  - Duct leakage and piping pressure testing
  - Equipment alignment
- Electrical systems proof of performance
- Test, Adjust, & Balance work complete
  - Waterside
  - Airside
  - Setpoint initialization
- Controls checkout including
  - Point to Point checks
  - Initial Calibrations
  - Required alarms in place
  - Loop tuning complete
  - All sequences of operation in place and tested
  - Properly dressed and labeled panels, etc.
  - May require pre-test trend reports
  - May require complete graphics and alarms

# COMMISSIONING PROCESS

## Construction Phase (substantial completion)

- Checklists and Proof of performance are reviewed
- Functional testing is performed by the Cx team to verify OPR as well as sequences, failure modes, etc.

## *Corresponding ASHRAE 202 Commissioning Requirements:*

- **5.2.10 Observation and Testing.** The owner shall require, by agreement, that project observation and testing be performed and documented as required in the Cx Plan.

# COMMISSIONING PROCESS

## HVAC Functional Testing Example

### **Typical Variable Volume Air Handling System (can be applied to other equipment and systems)**

- Document initial conditions, and initial set points and resets against specs
- Test all safeties first – pressure, temperature, etc.
- Test critical and specified alarms
- Document instrument locations, perform calibrations
- Point to point / component level testing
- Step by step test scripts based on sequence of operations
- Focus on energy - Validate and optimize economizer operation, resets, heating/cooling interlocks, scheduling, setbacks, setpoints, etc.
- Healthcare Focus – Reliability, Life Safety, Infection Control
- Test all modes – normal, failure, emergency power
- Test OPRs
- Tests to verify integration with other systems (chillers, boilers, pumps, terminals, fire alarm)
- Return all setpoints and overrides

# COMMISSIONING PROCESS

## Construction Phase (substantial completion)

- Issues are documented and tracked to resolution
- As-built documents, warranties and O&M Manuals are reviewed, Systems Manual
- Training of the O&M staff is verified to be conducted in accordance with the project documents

## *Corresponding ASHRAE 202 Commissioning Requirements:*

- **5.2.11 Issues and Resolution Log and Cx Progress Reports.**  
The owner shall require the development and use of Cx Progress Report and issue and resolution logs as required in the OPR. The owner shall review Cx issues log and Cx Progress Reports, participate in collaborative team resolution, and provide direction when needed.
- **5.2.12 Systems Manual.**  
The owner shall require, by agreement, the development and delivery of a project systems manual and that deliverables be provided for the systems manual. The owner shall ensure that specific entities are designated for the development and assembly of the systems manual and the facility guide.
- **5.2.13 Training.**  
The owner shall require, by agreement, that the Cx Team, including the design and construction parties as applicable, perform training defined in the OPR or Cx Plan

# COMMISSIONING PROCESS

## Occupancy and Operations Phase

- This phase begins at substantial completion and focuses on finalizing all incomplete functional testing, training, and project documentation while fine tuning system performance
- Seasonal and deferred testing is completed
- Monitoring based Cx
- Commissioning Report is finalized.

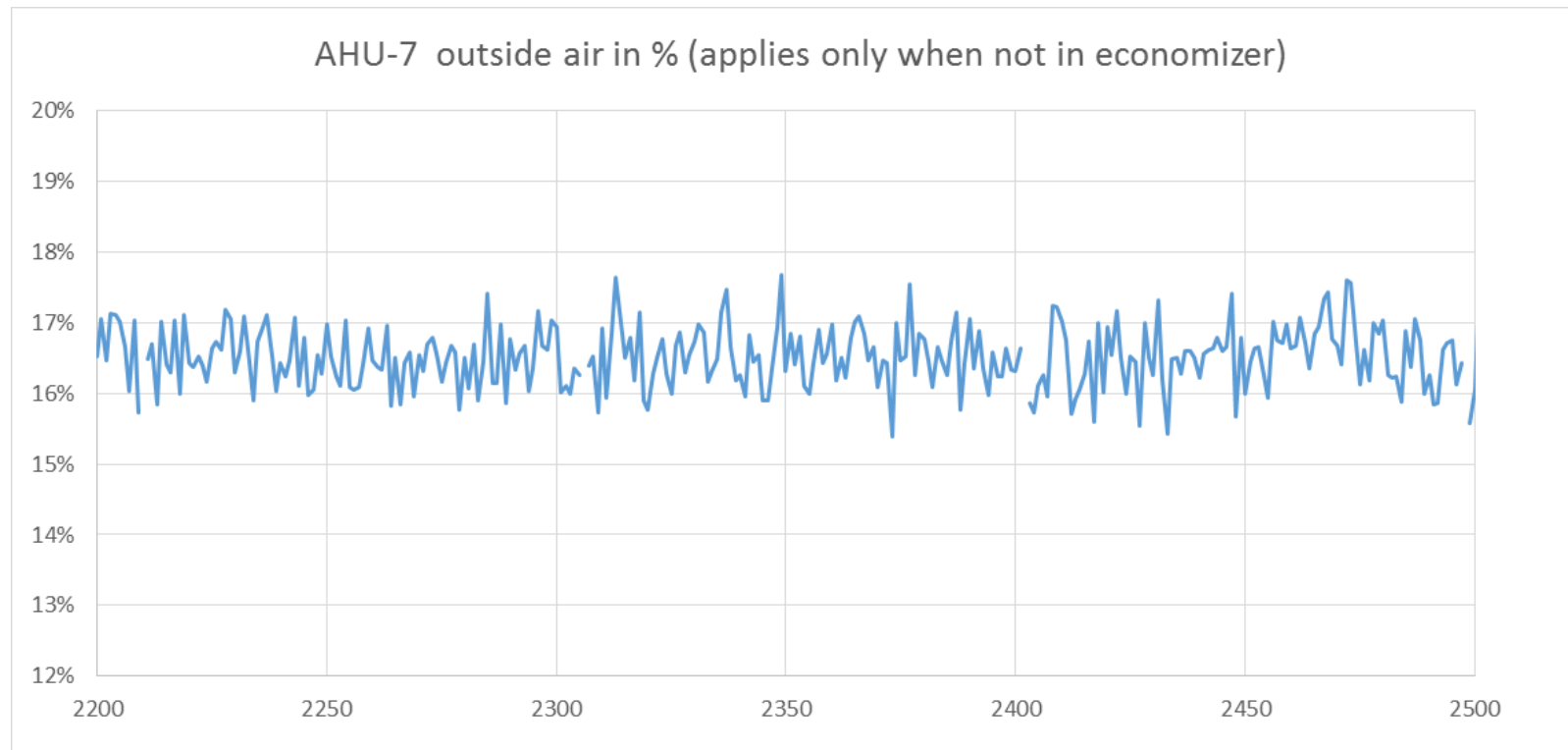
## ***Corresponding ASHRAE 202 Commissioning Requirements:***

- **5.2.14 Post Occupancy and Initial Operations.**  
The owner shall require, by agreement, that the Cx Process Activities be performed. This shall include additional training, seasonal tests, problem resolution, site visits, updating drawings and specifications, or other requirements performed during the post occupancy and initial operations period defined for the project in the OPR and Cx Plan.
- **5.2.15 Warranty Period Commissioning.**  
The owner shall require, by agreement,
  - a. Cx Provider performance of Cx during the warranty period,
  - b. updating the systems manual based on modifications to operations to meet the OPR, and
  - c. updating the OPR to meet changes in the owner's objectives and criteria.
- **5.2.16 Commissioning Progress Report.**  
The owner shall require, by agreement, the development and delivery of a Cx Progress Report and that deliverables be provided. The owner shall ensure that specific entities are designated for the development and assembly of the Cx Progress Report.

# COMMISSIONING PROCESS

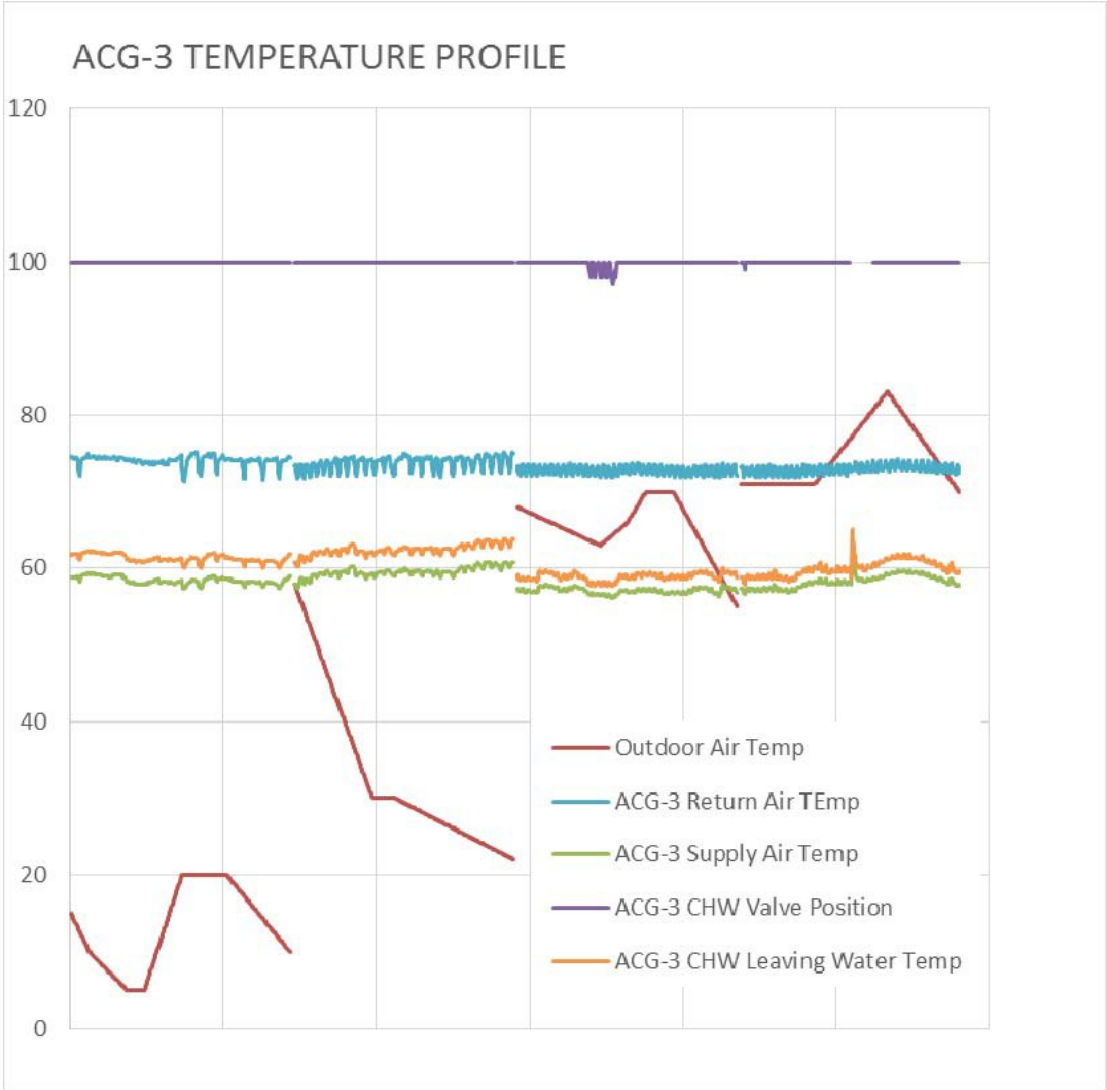
## HVAC MBCx Example

- You must first validate the control system – trust but verify
- Demonstrates system control not just response to change in input
- Focus is on energy efficient operation



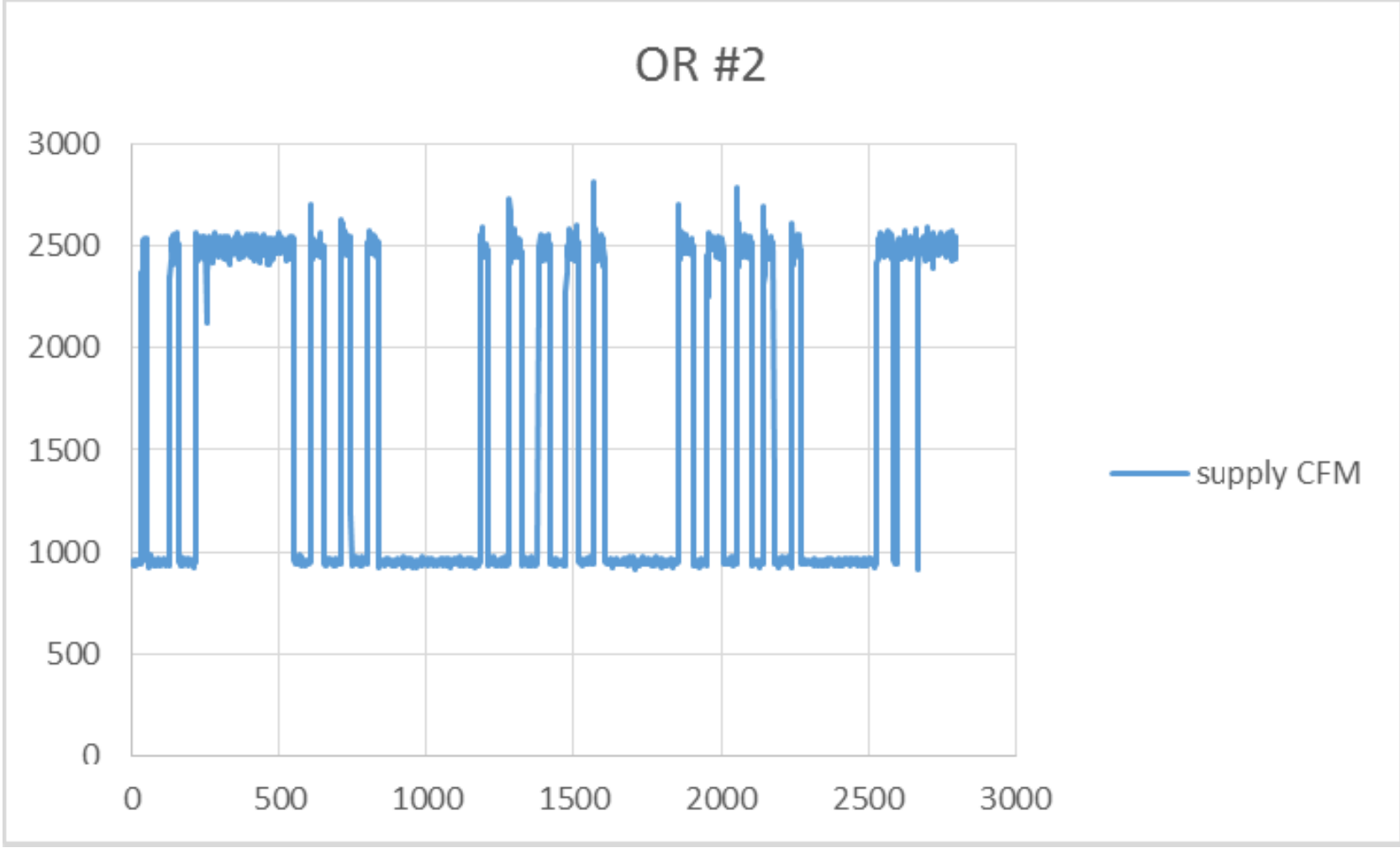
# COMMISSIONING PROCESS

HVAC MBCx Example



# COMMISSIONING PROCESS

HVAC MBCx Example





# COMMISSIONING PROCESS

## HVAC Functional Testing Example

- Shoulder season testing verifies system performance at part load, economizer operation
- Cooling season testing
  - Carryover
  - Overcooling then reheating
  - Condensate drainage
  - Dehumidification
  - Minimum ventilation requirements
- Heating season testing
  - Stratification
  - Overheating then cooling
  - Steam condensate drainage
  - Humidification
  - Free cooling
  - Minimum Ventilation requirements

# COMMISSIONING PROCESS

## Occupancy and Operations Phase (continued)

- Lessons learned
- Site visit 8-10 months after substantial completion, includes discussion with owner.
- Final report provided to owner

## *Corresponding ASHRAE 202 Commissioning Requirements:*

- **5.2.16 Commissioning Progress Report.**  
The owner shall require, by agreement, the development and delivery of a Cx Progress Report and that deliverables be provided.

The owner shall ensure that specific entities are designated for the development and assembly of the Cx Progress Report.

# BENEFITS TO OWNERS

## Why Commissioning

- Cx Provider is an Owner Advocate
- Design and Submittal Review can reduce change orders
- Design Professional Site Visits and Punch lists don't allow for quality control beyond field observations.
- Identifies issues & corrects deficiencies prior to occupancy
  - Design errors
  - Failed equipment
  - Improper installation
  - Poorly tuned controls / improper sequences
  - \$\$ Energy performance \$\$
- Reduced project budgets and shorter project timelines
- Fills gaps in project coordination
- Demonstrate performance of complex systems prior to turnover

# BENEFITS TO OWNERS

## What is the value added?

- Intent is reduced project capital cost through the warranty period
- Reduced life-cycle cost
  - Reduced utility cost
  - Increased equipment life / Maintainability
- Fully functional, fine-tuned facility
- Better control – improved occupant comfort / productivity
- Complete facility documentation
- Facility staff preparedness
- Reduced break-in period – Fewer call-backs

# KEYS TO SUCCESSFUL IMPLEMENTATION

When...

- the Cx Provider is a qualified, impartial owner advocate
- the process is initiated early to maximize benefits
- issues are communicated clearly and timely (and response to issues is timely) to avoid schedule delays
- the entire Cx team (includes A/E and contractors) is accountable and qualified and buys in to the process
- **The Process is integrated into the project schedule**

...commissioning is a valuable process to improve the delivered quality of a project

# SUMMARY

- The recent adoption by the Centers for Medicaid and Medicare Services (CMS) of NFPA 99: Health Care Facilities Code, 2012 brings with it commissioning requirements for projects which are subject to a CMS survey.
- This follows the adoption by other jurisdictions in the Midwest of the International Energy Conservation Code (IECC), which also includes requirements for commissioning.
- The Commissioning Process is a quality focused process for enhancing the delivery of a project.

# REFERENCES

- ASHRAE Standard 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings, 2007, 2010, 2013.
- ASHRAE Standard 202 Commissioning Process for Buildings and Systems, 2013
- ASHRAE Guideline 0, The Commissioning Process, 2005, 2013.
- ASHRAE Guideline 1.1, HVAC&R Technical Requirements for The Commissioning Process, 2007.
- ASHRAE Strategic Guide to Commissioning, 2014
- <https://bcapcodes.org/>
- BCxA, The Building Commissioning Handbook, Third Edition 2017
- BCxA Presentation, The Commissioning Process - Application in Codes, Standards, Guidelines and Programs, 2017
- <https://www.federalregister.gov/documents/2016/05/04/2016-10043/medicare-and-medicaid-programs-fire-safety-requirements-for-certain-health-care-facilities>
- International Energy Conservation Code, 2009, 2012, 2015
- NFPA 101, Life Safety Code (LSC), 2012.
- NFPA 99, Health Care Facilities Code (HCFC), 2012.
- USGBC LEED Rating System, V4