HVAC Commissioning

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Commissioning (Cx)

- What it is
- Purpose
- Benefits
- How it is currently accomplished
- Where is appears to be going
- Roles and responsibilities
- Costs and resources
What Is Commissioning?

Commissioning is a systematic and documented process of assuring that specific building systems performs interactively in accordance with the design intent and the owner’s operational needs.
Cx Origins

- Cx is an outgrowth of the Total Quality Management (TQM) process
- Originally Cx focused on HVAC because:
  - Typically the most energy intensive element in commercial buildings
  - HVAC plays a major role in IAQ which has impacts on employee well-being, productivity, and absenteeism
- In recent years, it has been positioned as a service for engineering firms
Purpose Of Cx

- Collaborative effort to identify and address design, construction, and operational issues, an “extra pairs of eyes”
- Develop solutions that meet owners performance and operational needs
- Have the building operate as intended from day One!
Overall Benefits Of Cx

- Discover design problems early when they are less expensive to fix
- Reduce change orders
- Smoother transition at project handover
- Creates more effective O&M via documentation and facility staff training
- Improved IAQ, fewer occupant complaints
- Lower energy costs
Who Benefits From Commissioning?

- OWNERS
- DESIGNERS
- CONTRACTORS
Benefits To Owners

- Systems function as designed and as the owner intended
- Maximized efficiency minimizes energy, maintenance and operating costs
- Improved tenant comfort
- Improved tenant productivity and retention
Benefits To Designers

- Functional performance verification and acceptance tests of key systems
- Improved job specs and drawings which improves coordination among trades
- All the above provide direct design feedback – a learning experience
Benefits To Contractors

- Improved construction planning and coordination
- Fewer deficiencies at substantial completion
- Better documentation of system start-up and function = fewer call backs
**Current Use Of CX**

- Often used for buildings with complex or critical systems to reduce risks
  - Hospitals
  - Computer component fabricators
- Embraced by environmental proponents
  - Required for LEED Certification
- Required in some states for public buildings
  - Washington State < 50,000 sq. ft.
  - States and cities are integrating Cx into codes
How Does Cx “Get” Into Construction?

- Include Cx in the design/development
  - Identify systems appropriate for Cx
  - Define roles and responsibilities
- Include Cx specifications in the project documents
- Develop Cx operating procedures that covers all possible operational modes and conditions
Where Do Contractors Fit?

- Numerous Cx business models exist
- Most recommend third-party Cx contractors working directly for the owner
- HVAC Cx is basically TAB unless functional testing is required
- SMACNA contractors can provide third-party Cx services or TAB-like Cx testing
Functional Testing

- Functional testing – A functional testing program verifies that the building’s systems perform interactively in all modes of operation as intended.
  - HVAC controls shut down according to design intent on fire alarm, pressurize stairwells, close dampers, etc.
  - Systematic testing in all operational modes
Commissioning Authority

- Generally works for the owner
- Typically independent of design and construction contractors
- Witnesses performance tests
- Verifies acceptable performance
- Often a group of experienced specialists, especially at the “higher” commissioning levels, i.e. hospitals, knowledgeable about all systems and building operations
Foundation Of Cx

- **Design Intent--Fixed**
  - Original, underlying assumptions

- **Owner’s operational needs—Changing**
  - Building may initially be designed according to these needs but this is something that almost always changes over time.
  - Change-of-use building evolution presents re-commissioning opportunities
**Cx Impact On HVAC**

- **Identify design elements that prevent functional testing**
  - Duct design that causes turbulence could not be accurately tested under Cx protocols

- **Can increase contractor cost if installations are not done according to Cx documents**
  - Experts verifying duct installations

- **Has the potential to greatly reduce mechanical system interferences and changer orders**
Logical Cx Phases

- Pre-design*
- Design*
- Construction
- Acceptance
- Warranty
- Continuous Cx

*Often combined as Design
Design Cx Activities

- Design intent is created in response to owners expressed requirements
- Resolve confusing information
- Evaluate constructability
- Look for commissionability of systems
  - Identify designs that prevent or impede functional testing
- Identify value engineering opportunities
Cx Design Phase Benefits

- Clarifies construction documents
- Reduces E&O claims
- Minimizes change orders
- Lessens likelihood of delays
- Gets everyone on the same “page”
Design Intent

- The building’s design benchmark
- Sometimes referred to as Owner’s Project Requirements
- A written document that details:
  - Functional requirements of the facility
  - Expectations of use and operation
- Precursor to the Program Document
Program Document

- Contains the Cx criteria as set by the owner
  - Scope – What will be commissioned
  - Roles and responsibilities – Matrix and sequence
  - Timing – When activities take place
  - Team – Generic identification of participants
  - Procedures – Acceptance/verification benchmarks, test protocols or code that applies
  - Operator training – Involvement/familiarization
  - Documentation – Plan content, checks and tests, training and final report format
Design Phase

- Alternate design solutions for Cx
- Cx Specifications
  - Cx agent qualifications list
  - Define roles and responsibilities
  - Generic list of Cx team members
  - List of systems subject to Cx
  - Acceptance and verification procedures
  - Coordination requirements and schedule
Construction Phase

- System readiness and start up
- Operation and functional performance checkout
- Functional performance verification by Cx Authority
- Demonstration and use and service instructions for handover to owner
Acceptance Phase

- Subset of Construction Phase
  - Completion of project as fully-operational facility with verification by Cx Authority
  - Functional test—individual systems
  - Functional test—between systems

- Instruction and handover to operators
  - Operation of each system
  - Startup and shut down procedures
  - Operational monitoring and maintenance
SMACNA-Defined Levels Of Cx

- Level 1 – Basic
- Level 2 – Comprehensive
- Level 3 – Critical Systems
- Re-commissioning
Level 1 Basic Cx

- Only during construction and acceptance
  - Schedule developed
  - Equipment and system pre-start and start-up
  - Functional performance tests
  - Operations, instruction and demonstration
- Embedded approach for competent contractors committed to quality
- The benefits of Cx typically offset the additional costs
Level 2 Comprehensive Cx

Takes place during all phases of the project

- Pre-design phase
  - Owner and Cx team assures that the owner’s operating goals can be met by the design
- Design intent/specifications
- Construction commissioning plan phase
- Equipment and system pre-start and start-up
- Functional performance tests and acceptance
- Instruction of and demonstrations to operating personnel
Level 3 Critical Systems Cx

- Similar to Level 2 Cx with additional details
- More detailed functional performance testing with step-by-step procedures
- Usually includes meeting very specific operational or environmental conditions
  - Labs, Fume Hood, Surgical Suites, etc
- Facilities staff may operate the systems during testing to verify performance of critical factors
- Usually applied to systems involving life safety, health risks, high-value processing or research
Re-commissioning

- Can apply to periodic Cx of a previously commissioned facility ~ every five years?
- A structured method to address O&M issues in an older building.
- Cx existing systems requires same steps except that design problems or shortcomings must be worked around
- Can accompany a building renovation
Roles & Responsibilities

- Owner
- Commissioning Authority
- Architect
- Engineer
- HVAC Contractor
Owner

- Define requirements
- Assigns commissioning responsibilities
- Assign a point of contact to the owner
  - Typically Cx Authority/Agent
- Develop contractual provisions
Commissioning Authority

- Review design plans and specifications
- Schedule commissioning
  - Training Sessions
  - Walk-Through Inspections
  - Review of Operations Manuals and final demonstration of systems
Architect

- Ensures shop drawing reviews are coordinated with the Commissioning Authority
Engineer

- Document design intent
- Coordinate O&M Manual Requirements
- HVAC O&M training sessions
- Shop drawing and submittal reviews
HVAC Contractor

- Coordinates testing with subcontractors and vendors
- Conduct walk-through inspections
- Demonstrate functional performance of equipment
- As-built mark-up drawings
HVAC/Electrical Cx Costs

- HVAC and controls
  2 – 3% of total mechanical costs

- Electrical systems
  1 – 2% of total electrical costs
Commissioning Resources

- www.smacna.org
- www.ashrae.org
- www.nibs.org