Commissioning – Defining Expectations

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Commissioning Defined

• (New Building) Commissioning
• Existing Building Commissioning (EBCx)
  – Recommissioning
  – Retro-Commissioning
• Continuous/Ongoing Commissioning

“...commissioning is a systematic, forensic approach to quality assurance, rather than a technology...”
Why Commissioning?

Better Buildings

• Energy, water and productivity savings achieved by Cx process can offset initial cost. Studies indicate 8 to 20% savings in operating costs vs. non-commissioned building.

Better People

• Enhances customer satisfaction by promoting proper training of operating personnel, which increases longevity and efficiency of systems.
Why Commissioning?

- Incomplete design.
- Rushed schedule.
- Contractor shortcuts.
- Poor coordination between the trades.
- Budgetary concerns.
Why Commissioning?

• Not to commission is to add a multitude of risks and an under-attainment of goals

• Prevention of:
  – Indoor air quality problems
  – Premature equipment failure
  – Warranty call-backs to contractor
  – Prevention against litigation

• Verification of:
  – Operator training
  – Equipment performance
    • Prior to warranty period
(New Building) Commissioning - LEED

**Fundamental Building Commissioning (EA P1)**
- Designate an individual as the CxA to lead, review and oversee the completion of the commissioning process activities.
- The CxA must review the OPR and BOD for clarity and completeness.
- Develop and incorporate commissioning requirements into the Construction Documents.
- Develop and implement a Commissioning Plan.
- Verify the installation and performance of the systems to be commissioned.
- Complete a summary Commissioning Report.

**Systems to be commissioned (minimum):**
- HVAC&R systems and associated controls
- Lighting and daylighting controls
- Domestic hot water systems
- Renewable energy systems (i.e., wind, solar)
Enhanced Commissioning (EA C3)

- Designate an independent CxA to lead, review and oversee the completion of all commissioning process activities.
- Conduct, at a minimum, one commissioning design review of the OPR, BOD and design documents prior to the Mid-Construction Phase.
- Review Contractor submittals for compliance with the OPR and BOD concurrently with the review of A/E.
- Develop a systems manual that provides to future operations staff the information needed to understand and operate systems.
- Verify that requirements for training operating personnel and building occupants have been completed.
- Review operation of building with operating personnel and occupants within 10 months of Substantial Completion.
(New Building) Commissioning - Definition

Defined by ASHRAE Guideline 0

“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.”
Owner’s Project Requirements

• Functional requirements
• Expectations as to how the building will be used and operated
• Goals and measurable performance criteria

Basis of Design

• Concepts, calculations, decisions and product selections to
  – meet the OPR
  – satisfy applicable regulatory requirements, standards and guidelines
• Narrative descriptions
• Lists of individual items that support the design process
(New Building) Commissioning – Not!

- Completing standard template forms
- Contractor QA/QC program
- Verification of the Contractor QA/QC program
- Construction inspection (EOR punchlisting)
- Construction Management substitute
(New Building) Commissioning – Objections!

• Designer (A/E) services typically do not include functional verification that the installed systems meet design intent.

• Construction Manager services typically do not include functional verification that the installed systems meet design intent.

“Haven’t I already paid for a quality building in my design and construction fees?”
Commissioning Authority

- Identified by the Owner who leads, plans, schedules and coordinates the commissioning team to implement the commissioning process.
- Can be independent third-party or from A/E, GC, CM or Owner’s personnel.
- For LEED Enhanced Commissioning, an independent third party must perform those tasks.

Commissioning Agent

- The individual or entity who performs the commissioning tasks in the field.
### (New Building) Commissioning – Typical Scope

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<td>• Security Systems</td>
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(New Building) Commissioning – Typical Process

- **FAT**
  - Factory Acceptance Testing

- **PFPC**
  - Pre-Functional Performance Checklist

- **STR**
  - Manufacturer’s Start-Up

- **BMS**
  - BMS Programming

- **TAB**
  - HVAC Testing, Adjusting and Balancing

- **FPT**
  - Functional Performance Test

- **IST**
  - Integrated System Test
(New Building) Commissioning - PFPC

• Typically performed by Subcontractors.

• Individual components, equipment and systems are installed in accordance with plans and specs.

• Confirms that the equipment is prepared for initial operation and Functional Performance Testing.

• Includes baseline tests that must be performed prior to placing equipment online.
  • Example: Electrical resistance testing
(New Building) Commissioning - PFPC
**Energy Exchange: Federal Sustainability for the Next Decade**

(New Building) Commissioning – Start-Up

- Field programming, customization and calibration
- Preparation for Functional Performance Test
- Defines minimum requirements of manufacturer start-up process.
Can include (job-specific):

- BATC: building automation and temperature control
- EPMS: electrical power monitoring system
- SCADA: supervisory control and data acquisition
- BCMS: branch circuit monitoring system

Contractor certifies that equipment is ready for functional testing:

- Tested via local data-gathering panel
- Tested via DGP with full graphics
- Tested via facilities head end
• Testing, Adjusting and Balancing (TAB)

  – Must be completed prior to FPT.

  – TAB Subcontractor to submit an outline of the TAB plan and approach for air and water systems.

  – TAB Subcontractor to provide a signed schedule sheet listing equipment that has been completed.
• Performed by CxA.

• Test of the dynamic function and operation of equipment and systems using manual or monitoring methods.

• Systems are tested under various modes, such as normal mode, start-up, shutdown, simulation of safeties, component failures, fire alarm, power failure and interlocks to other equipment.
• Performed by CxA

• Conducted under various modes, such as cooling season, heating season, life safety conditions, power failure, etc.

• Systems are operated through all specified control sequences of operation

• Executed after Functional Performance Tests are complete and prior to Substantial Completion
Existing-Building Commissioning (Retro)
Typical Project Timeline – Why EBCx?

- Pre-Design Phase
- Design Phase
- Construction Phase
- Occupancy and Operation Phase

Diagram showing the typical life-cycle for commercial buildings, with phases labeled as Planning & Design, Construction & Commission, Operations, Maintenance, and Renewal, and Decommission & Disposal. The timeline indicates durations of 1-2 years, 1-3 years, 30-50 years, and 1-2 years.
Existing-Building Commissioning - Defined

- EBCx/Retro-/Recommissioning commonly used interchangeably

When is Existing-Building Commissioning used?
- Scheduled recommissioning developed as part of an ongoing commissioning process
- Triggered by facility use change
- Operational problems
- Other Owner’s needs
- Loss of energy savings
Existing-Building Commissioning

- Required in New York, California and other cities and states on commercial buildings
  - over 50,000 square feet every 10 years (NYC - LL87)
- Helps to aid in occupant complaints due to changing occupancy and space uses over time
  - Changes operators make to satisfy complaints can take the building “out of tune”
- Helps to take inevitable drift from where things should be to help put back on course, and hopefully exceed original energy expectations
  - Why do we tune up our bodies, cars, etc., but not far more complex buildings
New vs. EBCx Processes

Commissioning Process Overview
- Pre-Design Phase
  - Select a commissioning lead
  - Pre-Design Phase commissioning meeting
  - Begin developing Owner's Project Requirements
  - Develop Initial Commissioning Plan outline
- Design Phase
  - Design Phase commissioning meeting (if Pre-Design meeting didn't occur)
  - Perform commissioning-focused design review
  - Update Commissioning Plan
  - Develop commissioning requirements for the specification
  - Begin planning for verification checklists, functional tests, Systems Manual, and training requirements
  - Construction Phase kick-off meeting
  - Review submittals, monitor development of Shop and Coordination Drawings
  - Review O&M Manuals
  - Perform ongoing construction observation
  - Perform verification checks
  - Perform diagnostic monitoring
  - Perform functional testing
  - Develop Commissioning Report and Systems Manual
  - Develop Recommissioning Plan
  - Verify and review training of owner's staff
  - Resolve outstanding commissioning issues
  - Perform seasonal/deferred testing
  - Perform near warranty-end review
- Construction Phase
- Occupancy and Operations Phase

Retrocommissioning Process Overview
- Planning Phase
  - Select the project
  - Set project objectives and obtain support
  - Select a commissioning lead
  - Document the current operating requirements
  - Perform an initial site walk-through
  - Develop the Retrocommissioning Plan
  - Assemble the retrocommissioning team
  - Hold a project kick-off meeting
- Investigation Phase
  - Review facility documentation
  - Perform diagnostic monitoring
  - Perform functional tests
  - Perform simple repairs
  - Develop Master List of Findings
  - Prioritize and select operational improvements
- Implementation Phase
  - Develop Implementation Plan
  - Implement selected operational improvements
  - Verify results
- Hand-Off Phase
  - Develop Final Report
  - Compile a Systems Manual
  - Develop Recommissioning Plan
  - Provide training
  - Hold close-out meeting
  - Implement persistence strategies
Existing-Building Commissioning - Phases

• Assessment
• Investigation
• Implementation
• Hand-Off
• Ongoing Commissioning
Existing-Building Commissioning - Assessment

**Assessment Phase**
- Define Owner’s goals and objectives
- Establish systems manual outline
- A cursory data-gathering and brief walk-through
- Determine availability of existing documents
- Understand how the building operates
- Identify existing issues
- Identify training needs

**Deliverables**
- Current Facility Requirements (CFR)
- EBCx Plan and Report
Current Facility Requirements

- User/Occupant requirements
- Owner-directed requirements
- Training requirements
- Sustainability requirements
- Maintainability requirements
- OCx requirements
- Benchmark requirements
- Financial requirements
Existing-Building Commissioning - Investigation

**Investigation Phase**
- Review existing system records
- Perform site investigation and testing
- List and analyze costs and benefits of recommendations
- Implement and document immediate improvements

**Deliverables**
- Condition evaluations and performance evaluations
- Iterative process

**Investigation report for EBCx report**
Existing-Building Commissioning - Implementation

Implementation Phase
- Select recommendations to implement (Owner)
- Implement capital projects (Owner)
- Informal training (CxA during testing)
- Implement recommendations (Owner)
- Verify completed recommendations (CxA)

Deliverables
- EBCx report
Existing-Building Commissioning - Hand-Off

Hand-Off Phase
• Develop ongoing Cx plan
• Assemble systems manual
• Formal facility personnel training
• Verify training effectiveness
• Conduct lessons-learned workshop
• Finalize EBCx report

Deliverables
• EBCx report
Existing-Building Commissioning - Unique Challenges

- No documentation
- Outdated documentation
- Lack of organization
Existing-Building Commissioning - Unique Challenges

Equipment degradation adds another dimension to the process.

- Equipment must be more heavily scrutinized to determine if it can handle existing building load.
- Recommendation for equipment repair/overhaul/replacement becomes another layer of the process.

Existing-Building Commissioning - Unique Challenges
Operations and Maintenance Staff

• Preventing O&M staff from becoming defensive/guarded by critiquing their plant

• They have the most incentive to improve the operation of the plant

• They understand how the plant is operated

• Knowledge of equipment that is underperforming
Existing-Building Commissioning - Info Sources

- Location of equipment, documentation, logs
- Tenant complaints (trouble areas)
- Identifying deviations from approved sequence of operation
- Building management system trending data
- Operations logs
- Building energy bills
Documentation

- Existing systems manual
- Equipment schedules
- Construction Documents
- Motor lists
- Maintenance documents
- Operations logs
Ongoing Commissioning - Defined
Ongoing Commissioning - Defined

- Synonymous with continuous commissioning
- Continuation of Cx process well into Occupancy and Operation Phase
- O&M staff continued training
- Systems manual continuously updated
- Lessons-learned workshops
- Periodic system performance evaluations (if contracted)
Ongoing Commissioning - Phase

- Verify achievement of CFR
- Investigate unacceptable performance
- Implement corrective actions
- Write/deliver OCx report
Ongoing Commissioning - Monitoring

- Use of BMS/EMS to
  - Collect and log hundreds or thousands of DDC points
  - Conduct energy use and performance metrics
  - Conduct statistical analysis
  - Compare actual to predicted energy use via trend logs, charts, etc.

- CxA can easily compare actual to predicted energy use in various forms (trend logs, tables, charts).

- Details of systems operation are readily available and the source of performance discrepancies can be identified.
Commissioning to Save Energy
Prescriptive to Performance

• Energy savings handily eclipse the cost of the commissioning process
• Obstacles to expected performance with New Building Commissioning:
  – Fine-tuning a building could take years after final occupancy
  – Systems may perform adequately in terms of meeting space comfort conditions, but may fall short of predicted energy performance
  – Construction schedules may dictate testing systems sequentially in order for turnover without returning prior to acceptance
Not Meeting Predicted Energy Performance

- Lack of coordination and accountability among project team members
- Deviations in the installed equipment that differ from those in the design documents
  - Changes in the physical installation/layout of equipment or operating the systems differently than originally intended
  - Differs from what previous project team members were involved in (“not how we typically do it”)
Not Meeting Predicted Energy Performance

- Equipment not installed per manufacturer’s recommendations
- Commissioning not performed to Owner’s expectations
- Equipment not left in “auto”
- Schedules not properly set to match occupancy, or not set at all
- Simultaneous heating and cooling
Not Meeting Predicted Energy Performance

- Occupancy sensors on lighting system
- Insulation damaged or missing
- “Band-aids” over time that add up
- Changes in architectural layout without regard for MEP systems
- Ductwork leaks that reappear
Wrap-Up/Lessons Learned

• New Building Commissioning confirms that systems are operating per their original intent
• EBCx and Monitoring-Based Cx can be performed to bring building back to predicted measures by Cx providers or Building Operators

*Building Owners and Operators have resources at their disposal to bring the building’s performance right back to where it should be, and occasionally...it’s even required!*
Questions?

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