



PRIMARYINTEGRATION

A Bureau Veritas Company

COMMISSIONING ROLES & RESPONSIBILITIES

Presented by:

Terry Rodgers, CPE, CPMP

Vice President, Commissioning Services

Primary Integration Solutions, Inc.

trodgers@primaryintegration.com



DISTINGUISHED LECTURER PROGRAM

This ASHRAE Distinguished Lecturer is brought to you by the ASHRAE Society Chapter Technology Transfer Committee

Please!

- Silence Phones
- Distinguished Lecturer Evaluation Forms are very important. Please complete at the end of the presentation and return to the CTTC or Program Chair.

More information on the DL program available at:

www.ashrae.org/distinguishedlecturers





LEADERSHIP WANTED

www.ashrae.org/volunteer

Become a future leader in ASHRAE & write the next chapter in your career.

ASHRAE Members who are active at their chapter and society become leaders and bring information and technology back to their job.

We need you for:

- Society Technical Committees
- Society Standard Committees
- Young Engineers in ASHRAE
- Chapter Membership Promotion
- Chapter Research Promotion
- Chapter Student Activities
- Chapter Technology Transfer

Find your place in ASHRAE & Volunteer!



AIA LEARNING OBJECTIVES

- List the various team members associated with executing the commissioning process.
- Define the meaning and content of an OPR (Owners Project Requirements) document, BOD (Basis-of-Design) document, and Commissioning Plan
- Describe and distinguish between the various commissioning team member roles and responsibilities
- Describe the various tasks and activities associated with the programming, design, construction, acceptance testing, and occupancy phases of a commissioned project.



AGENDA

01

THE COMMISSIONING
SCOPE

02

THE Cx STRATEGY

03

THE Cx TEAM

04

THE OWNERS' ROLE

05

THE A&E'S ROLE

06

THE CxA'S ROLE

07

THE GENERAL
CONTRACTOR'S ROLE

08

THE CONSTRUCTION
TEAM'S ROLE

09

THE FACILITIES
MANAGEMENT ROLE

10

Q&A



ASHRAE Cx STANDARDS & GUIDELINES

- Std 202-2018 Cx Process for Bldgs and Sys.s
- Gdl 0-2019 The Cx Process
- Gdl 0.2-2015* The Cx Process for Existing Sys.s and Assemblies
- Gdl 1.1-2007* HVAC&R Tech Requirements for the Cx Process
- Gdl 1.2-2019 Tech Requirements for the Cx Process for Existing HVAC&R Sys.s and Assemblies
- Gdl 1.3-2018 Bldg O&M Training for the HVAC&R Cx Process
- Gdl 1.4-2019 Preparing Systems Manuals for Facilities
- Gdl 1.5-2017 The Cx Process for Smoke Control Systems
- Gdl 1.6P (proposed) Cx of Data Centers

“*” = *guidelines in the process of being updated*





DEFINITION

ASHRAE Standard 202-2018 **Commissioning Process for Buildings and Systems** includes the following definition:

“Commissioning Process”: A quality-focused process for enhancing the delivery of a project. The process focuses on verifying and documenting that all of the commissioned systems and assemblies are planned, designed, installed, tested, operated, and maintained to meet the OPR (owner’s project requirements)”





FULL PROJECT LIFE CYCLE COMMISSIONING

- Programming Phase
 - OPR
- Design Phase
 - BOD, CDs & SOOs
- Construction Phase
 - Submittals
 - FATs & FWTs (L1)
 - Receiving, Storage, Install inspections(L2)
 - Startup and Pre-Functional Tests (L3)





FULL PROJECT LIFE CYCLE COMMISSIONING

- Acceptance Testing Phase
 - Functional Performance Testing (L4)
 - Integrated Systems Testing (L5)
- O&M Staff Training
 - Academics during construction
 - Hands-On during Functional Testing
- Close-Out Documentation
 - Record documents
 - Standard Operating Procedures (SOPs)
 - Sys Ops & Maint Manuals (SOMMs)
 - Final Cx Report
- Deferred Testing (Seasonal & Warranty)





THE Cx TEAM

- The Owner
- The Architectural & Engineering (A&E) Firm
- The Commissioning Agent (CxA)
- The General Contractor (GC)
 - Subcontractors (esp. MEP, FP&LS, and BMS)
 - Suppliers / Vendors
 - Select Manufacturers
- Facilities Management Firm
 - May be in-house or out-sourced



THE OWNER'S BASIC RESPONSIBILITY

- To define and communicate the facility's intent and performance requirements to the project team (Owner's Project Requirements (OPR) Document)
 - Must include all relevant stakeholders/business units/end-users
 - Should include long-term O&M/Fac Mgmt aspects
- To ensure the project delivers what is expected (Commitment to formal Cx)
- To define each participant's roles and responsibilities, and ensure accountability
 - Project Contracts and Scopes of Work should include Cx requirements and level of effort



THE OWNER'S PROGRAM REQUIREMENT DOC

Definition from ASHRAE Standard 202:

“A document that details the requirements of a project and the expectations for how it will be used and operated, including project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, training requirements, documentation requirements, and supporting information.



THE OWNER'S PROGRAM REQUIREMENT DOC

- Captures the facility's intent (the mission)
- Establishes the high-level performance requirements
- Should either cite or reference relevant Corporate Standards
- Should provide the basis for overarching acceptance criteria



THE A&E'S ROLE

- Support development of the OPR
- Develop the Basis-of-Design (BOD)
- Develop the Construction Documents (CDs)
 - Conceptual design phase, Design Development phase
 - 60%, 90% and 100% CDs
 - Develop detailed Sequences-of-Operations (SOOs)
- Construction “Administration”
 - Submittal reviews and approvals, RFI responses
 - Bulletins and Addendums
 - Progress inspections
- Support Acceptance Testing
- Deliver “Record” drawings



THE BASIS OF DESIGN DOCUMENT

ASHRAE Standard 202 Definition:

“A document that records the concepts, calculations, decisions, and product selections used to meet the OPR and to satisfy applicable regulatory requirements, standards, and guidelines. The document includes both narrative descriptions and lists of individual items that support the design process”



THE BASIS OF DESIGN DOCUMENT

- Captures the relevant physical aspects of the facility to achieve the performance requirements
- Aligns the design with the intent, or “mission”, that the facility is to perform
- Must reflect the proposed engineering and design strategies for satisfying the OPR requirements (that get further defined and embellished in the construction documents that follow)





THE CxA's ROLE

The CxA leads the Cx Team and manages and executes the Cx Process:

- Programming Phase
- Lead/facilitate development of the OPR
- Ensure all Stakeholders participate
- Represent the long-term, O&M perspective if the Facilities Management entity isn't assigned





THE CxA's ROLE

Design Phase

- Verify and ensure the BOD satisfies and complies with the OPR
- Verify the CDs reflect and comply with the OPR and BOD
 - Perform formal design reviews and track issues/comments to closure
 - Ensure design facilitates accessibility, ease-of-maintenance, energy efficiency
 - Ensure the specification manual includes relevant commissioning and testing requirements
- CxA documents and tracks to resolution all design review comments via a Design Review Log (DRL)
- Develop the Div 01 General Cx Specification (01 91 13)
- Develop a draft/initial Commissioning Plan



THE COMMISSIONING PLAN

ASHRAE Standard 202 Definition:

“A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning.”

THE COMMISSIONING PLAN

- Defines the verification and testing process that will ensure the project delivers what is expected
- Defines the Cx Team and respective Roles & Responsibilities
Includes training of the Owner's operations, maintenance, and management staff
Describes the documentation requirements that describe the completed facility





THE CxA ROLE (cont)

Construction Phase

- Review and verify submittals, RFI responses, SOOs, etc. comply with the CDs
- Review Factory Acceptance Tests/Attend Factory Witness Tests
- Perform site progress inspections
- Review/approve results of contractor's QA/QC reports
- Develop the O&M Staff Training plan and schedule
- Draft initial functional performance test scripts





THE CxA ROLE

Construction Phase

- Review and/or witness contractor/vendor/supplier installations and initial energizations/startup & checklists
 - Cleaning & Flushing, pressure tests, TAB, NETA, etc.
- Finalize functional performance test scripts
- Update and embellish the Commissioning Plan
- Track issues to resolution via a Cx Issues Log (CIL)
 - Different log than the Design Review Log
 - CIL should track issues from L1 through L5
 - Best practice is to resolve all previous level issues prior to proceeding with next level activities (exceptions handled on case-by-case basis)





THE CxA ROLE

Acceptance Phase

- Verify all significant construction phase discrepancies and issues are resolved prior to proceeding to functional performance testing
- Execute the functional performance test scripts
- Verify all significant functional test discrepancies and issues are resolved prior to proceeding to integrated systems testing
- Execute the integrated systems test scripts
- Update and embellish the Commissioning Plan
- Track issues to resolution via the Cx Issues Log (CIL)





THE CxA ROLE

Occupancy & Transition to Operations

- Deliver final Cx Report
- Ensure delivery of record documents (OPR, BOD, as-built dwgs, submittals, logs, etc.)
- Ensure adequate O&M staff training
- Ensure delivery of O&M documentation - best practice is to develop Sys.s Ops & Maintenance Manuals (SOMMs)
- Ensure delivery of Standard Operating Procedures (SOPs)
- Perform any deferred testing (typically seasonal) testing
- Perform a 11-month “pre-warranty expiration” site visit





GENERAL CONTRACTOR & SUB ROLES

- The GC should understand that they and their subcontractors are active participants to the commissioning process and members of the Cx Team
 - The GC must articulate this to all subs and ensure they understand their Cx related roles and include the associated levels-of-effort in their bids and pricing
- The GC and subs demonstrate compliance with the construction documents (contracts, dwgs and specs)
 - Submittals, FAT/FWT reports
 - Progress Inspections, NETA tests, TAB, pressure/leak tests, etc.
 - Vendor/Mfgr/Contractor equipment startup checklists and pre-functional tests
 - Executing L4 and L5 tests





GENERAL CONTRACTOR & SUB ROLES

- The GC should embed all Cx related activities (including predecessors and durations) into the master schedule
 - Should include all L1 – L5 activities, training, and closeout doc deliverables
- The GC and Subs must review and understand all testing requirements
 - Metering, technicians, load banks, etc.
 - Run times, allowable ranges, acceptance criteria
 - Coordinate and arrange for vendor/manufacture participation
 - Arrange for support and/or participation of external project entities (AHJ, Fire Marshall, 3rd-party inspectors, utilities, etc.)
- The GC and especially the Subs execute the acceptance tests





GENERAL CONTRACTOR & SUB ROLES

- The GC and subs provide much of the O&M staff training either directly or via vendor's/manufacturer's training
 - Best practice is to provide academics early (during construction) and reinforce via additional hands-on training during acceptance testing (requires having O&M staff on board early)
 - Should include site-specifics (vs generic only)
 - Should include formal training materials in an editable format so can be repeated and kept current
- The GC and subs resolve and report on status of issues via the CIL (note: The CxA owns the CIL and closes the issues after verifying completion)
- The GC and subs provide much of the record docs:
 - Redlines, approved submittals, inspection & test rpts, etc.





FACILITIES MANAGEMENT ROLE

- The Facilities Management (FM) can be direct employees of the owner or an in-house FM firm
- FM needs to participate as a stakeholder in the programming phase
 - Articulate and define requirements for long-term operations and maintenance:
 - Continuous staff coverage or “business hours” only
 - Jack-of-all Trades or specialists (mechanics, electricians, controls techs, etc.)
 - Combined operators and maintenance techs or separate staff
 - Self-performed maintenance or outsourced (or a hybrid)
 - Training needs (formal site-specific training program or generic)
 - Documentation formats, organization, content, media, doc controls, etc.
- FM should get permanent O&M staff involved as early in the project as possible
- FM should participate in progress inspections and witness acceptance testing (best training they will ever get)
- FM should be fully trained and provisioned before site goes “live”



THE COMMISSIONING LEVELS



Spans the spectrum from the testing of individual components prior to shipment, to simulating catastrophic events upon entire facilities and ensuring a myriad of integrated systems perform such that expected responses result in a predicted outcome



THE 5 (OR 6) COMMISSIONING LEVELS

L-1: Factory Acceptance Tests

- aka Factory Witness Tests when attended by Cx Team

L-2: Receiving/Storage & Installation

- Typically the realm of the GC and subcontractors
- Ensure what's received is what was ordered
- Ensure proper storage and protection until needed
- Verify installation is per the specified means & methods

L-3: Startup and Pre-Functional Testing

- Typically the realm of the GC and subcontractors
- Progress inspections best done by entire Cx Team
- Site-specific startup forms aka Pre-Functional Tests



THE 5 (OR 6) COMMISSIONING LEVELS

L-4: Site Acceptance Testing

- Scripts developed by the CxA and approved by the Cx Team
- Testing executed by the GC & Subs under direction and oversight of CxA
- Start at component/equipment level and progress to assemblies and system level

L-5: Integrated Systems Testing

- Scripts developed by CxA, approved by Cx Team and executed by GC and subs
- Should be essentially “hands-off” and demonstrates the facilities expected response to anomalies and utility outages

L-6: Integrated Building/Campus Testing

- Would encompass bldg-to-bldg fail-over testing



L5: INTEGRATED SYSTEMS TEST

- Where redundant and backup components, systems, and groups of interrelated systems are tested for their response to expected and unexpected anomalies
- The Challenge – to ensure all methods of failure are considered in advance and appropriately tested to demonstrate the response meets the original program intent





CX INSPECTION & TESTING STRATEGY

Identify and resolve issues as early as possible when least impactful (schedule, cost and quality)

- Identify faulty components prior to shipping (L1)
- Identify damaged deliveries prior to install (L2)
- Identify installation errors prior to startup (L3)
- Identify system level issues prior to integrated systems testing (L4)
- Identify facility performance & reliability issues prior to beginning facility occupancy & operations (L5)



THE VITAL ROLE OF BAS

- The Building Automation System (BAS) can play a vital role esp. during L-4 and L-5
 - Data collection tool
 - Automation for executing various Sequences-of-Operations
- Commission the BAS first to ensure valid and accurate data collection prior to use as a commissioning tool for other systems!





THE CRITICAL PATH BAS CHALLENGE

- BAS system design and install typically lags other system's design & installation
- BAS design is contingent on selection & design of the critical infrastructure
- BAS installation is contingent on completing the installation of infrastructure & equipment
- Yet you need to startup & commission the BAS first!



MISSION CRITICAL FACILITIES (MCF)

- Typically have more demanding performance requirements regarding how they respond to anomalies without impacting “critical” operations
- Include redundancies, backup equip. & systems, and excess capacities
- Requires a high degree of automation, interrelatedness, and complexity





MCF COMMISSIONING

- More equipment and systems
- More complexity
- More scenarios
- Demonstrate concurrent-maintenance & fault-tolerance
- Result on Commissioning:
 - *More Time, More Money, More Issues*



MCF & L5

- Where the science of commissioning approaches art in that creativity, insight, and innovation can determine the level of success
- L-5 from an Owner's perspective is frequently the most important aspect of commissioning
- The facility is shown to be capable of meeting the design intent and program requirements.



THE TEAM APPROACH

- Commissioning requires the combined insight and expertise of all project participants
 - Design Engineers for design intent
 - Mfgs for failure modes & responses of equipment
 - Installing Contractor for system interfaces
 - Owner/O&M staff for long-term considerations
 - CxA to lead, manage and implement the Cx Process



PRACTICAL LIMITATIONS & CONFLICTS

- The comprehensiveness of tests to encompass all conceivable means of failure
- Potential for conflict among participants esp. in resolving identified discrepancies
- The best means to minimize and avoid conflict and ensure success is for all stakeholders to participate during the entire commissioning process from programming through final acceptance testing



COMMISSIONING COSTS

- L-1: Typically included in equip. pricing
- L-2: Relatively small increase due to additional effort and paperwork over typical “receiving”
- L-3: Incremental increases in time & money, and level of effort should be clearly defined





COMMISSIONING COSTS

- L-4: Significantly more than conventional startup & testing.
- Include contingencies (time & money) to address & resolve discrepancies & unexpected re-work
- L-5: Proportional to quantity of equip., system interrelationships, and complexity of scenarios



THE OWNER'S INTANGIBLE RISK OR THE COST OF *NOT* COMMISSIONING

- Regardless of who is contractually responsible for schedule delays, the Owner incurs intangible “lost business” costs beyond those directly attributed to the design and construction project
- The Owner needs the facility in order to accomplish the “mission” which in most cases, equates to cash-flow and profit



***DON'T FORGET
TO COMPLETE &
RETURN THE
EVALUATION
FORM***

Terry Rodgers, CPE, CPMP
ASHRAE Distinguished Lecturer
**Vice President, Commissioning
Services**

Primary Integration Solutions, Inc.
trodgers@primaryintegration.com

704-765-4407