# What is Commissioning?

Quality Assurance Process

#### System In Full Working Order

- Functionality
- Pressure Testing
- o Flow Regulation
- Work
- System Regulation
- Performance Testing
- User and Operator Training
- System Documentation



#### **Building Commission Process**



## **Steps of Commissioning**

- Stage 1 Preparation
- Stage 2 Design
- Stage 3 Pre-Construction
- Stage 4 Construction
- Stage 5 Commissioning of Engineering Services
- Stage 6 Pre-handover
- Stage 7 Initial Occupation
- Stage 8 Post-occupancy care

## **Phase of Commissioning**

- Pre-Design Phase: Preparation
- The Design Phase
- Construction Phase
- Post Construction Phase
- Continuous Commissioning
- Building Enclosure Commissioning Process
- Commissioning Authority Duties

# Pre-Design Phase

# **Pre-Design Phase: Preparation**

#### Form the Commissioning Team

#### • Project Manager (Team Leader)

- The contracting and managing authority for the Owner over the design and/or construction of the project.
- Construction Manager (CM)
  - × Owner's on-site representative or authority. The Contractor reports to the CM.

#### Construction Contractor and Subcontractors

**×** The general contractor for the project.

#### • Commissioning Agent (CxA)

An independent authority, not otherwise associated with the A/E team members or the Contractor though he/she may be hired as a subcontractor to them. The CA or the architect may coordinate the commissioning during design. The CA coordinates the commissioning during construction. The CA reports directly to the Owner's Project Manager during design.

#### • Architect/ Engineer (A/E)

 The prime consultant (architect) and sub-consultants who comprise the design team dealing with mechanical and electrical systems, generally the HVAC mechanical designer/engineer and the electrical designer/engineer.

# • Technical Experts (Structural, Mechanical, Electrical, Fire Protection, Seismic, LEED)

#### NOTE: SEE APPENDIX A

#### **Pre-Design Phase: Preparation**

- Review Lessons and Experiences from Similar Buildings and Projects
- Clearly Identify the Performance Outcomes Expected by Client and the End User
  - Prepare Basis of Design
    - $\star$  AND
  - o Owner's Project Requirements

### **Design Intent & Basis of Design**

#### Owner's Project Requirements

- Dynamic Document That Provides the Explanation of the Ideas, Concepts and Criteria that are Considered Important to the Owner
  - × Outcome of the Programming and Schematic Design Phase

#### Basis of Design/Design Intent

- Document That Processes Thought and Assumptions Behind Design Decisions That Were Made to Meet the Design Intent
  - Describes Systems, Components, Conditions and Methods Chosen to Meet the Intent

#### **Pre-Design Phase: Preparation**

- Help Produce the Design Brief that Correctly Represents the Required Performance
  - Scopes of Commissioning
    - × Heating, Cooling, Refrigeration, Ventilation Systems and Controls
    - Lighting and Day-lighting Controls
    - × Domestic Hot Water Systems
    - × Renewable Energy Systems



## **Plan Budget for Commissioning**

- Key Factors That Can Affect Commissioning
  - When the commissioning process starts
    - **×** (during design, construction, or post-construction)
  - The number and complexity of systems to be commissioned
  - Complexity of the systems
  - The level of detail required during the commissioning process (Does it include documenting and witnessing all equipment start-up, verification tests, spot checking the balancing report, etc.?)
  - Deliverables (design intent document, number of design reviews, commissioning plan, O&M manual review, final report, etc.)
  - Allocation of costs (Will the budget allow for increased design fee, increased contractor bids, training time for O&M personnel, the commissioning consultant's fee, etc.?)
  - Type of project (design-build, plan and spec, retrofit, etc.)

# **Establish Commissioning Plan**

- General Project Information
- Overview and Scope of the Project Commissioning
- Commissioning Protocols and Communications
- Commissioning Process, including Team Responsibilities
- Commissioning Schedule
- Commissioning Documentation
- Appendices
  - Testing and Inspection Plans
  - Pre-Functional and Functional Test Procedures
  - o Construction Checklists
  - Issues Logs

- Team and Contractors Work Together to Integrate Commissioning Activities Into Overall Construction Schedule
  - Keep Commissioning Activities Off Critical Path
  - Carry Out Site Inspections with Focus on Systems Operation and Maintenance
  - O Update Throughout Project
  - Maintain Project Milestones

Design Phase

### The Design Phase

- Systematic Process of Ensuring that all buildings Systems Perform Interactively According to:
  - Basis of Design; Design Intent
  - Owner's Project Requirements; Owner's Operational Needs
- Achieve by Documenting Design and Operation Intent at the Design Phase and Continuing Through Construction and Acceptance with Actual Verification of Performance
  - × Provide Commissioning Focused Design Review
  - Ensure that the Design and Operational Intent are Clearly Documented
  - Ensure that Commissioning for the Construction Phase is Adequately Reflected in the Bid Documents

#### **Design Intent & Basis of Design**

#### Mechanical

- Indoor and Outdoor Design Conditions, All Seasons
- Indoor "heat to" Temperatures, General and Specific
- Indoor "cool to" Temperatures, General and Specific
- Indoor Humidity, General and Specific
- Equipment Sizing Criteria and Calculations
- Diversity Used in Sizing
- Occupant Density and Function
- Air Quality Criteria
- Air Distribution Zoning Rationale
- Ventilation Requirements and Calculations
- Occupied and Unoccupied Operation Modes, All Seasons
- Steam Distribution and Condensate Recovery Rationale
- Chilled Water Distribution Rationale
- Life Safety Operation Modes
- For Individual Systems, Sequences of Operation, Set points and Dead Bands
- For Interactive Systems, Sequences of Operations
- Metering and Sub metering Requirements

#### **General Construction**

- Energy Performance
- Applicable Codes and Standards
- Glazing Fraction, U-Value and Shading Coefficient
- Objectives and Functional Use of the System, Equipment or Facility
- Occupancy, Usage, and Schedule Assumptions, All Seasons
- Building Envelope Assumptions
- Floor Load Assumptions and Calculations
- Vibration Assumptions and Calculations
- Noise Criteria and Acoustic Assumptions and Calculations
- Fire and Life Safety Considerations
- Fire Zoning Rationale
- Smoke Control Rationale
- Life Safety Operations Modes and Sequences
- LEED Goals
- Cost Considerations and Design Compromises
- Restrictions and Limitations of System or Facility

#### **Electrical**

- Lighting Requirements and Calculations
- Lighting Zone Assumptions
- Outdoor Lighting Control
- Fire and Life Safety Considerations
- Fire Alarm Zoning Rationale
- Equipment Load Assumptions and Calculations
- Energy Conservation Intentions and Calculations
- Life Safety Operation Modes
- Occupied and Unoccupied Operation Modes, All Seasons
- Equipment Sizing Criteria and Calculations
- Emergency Power and What Equipment is Connected
- Metering and Sub metering Assumptions

#### **Establish Testing & Inspection Plans**

- Testing Appropriate to a Facility Should be Designed Along Four Hierarchal Levels:
  - 1) Factory Device Testing
  - o 2) Field Component Start-up
  - 3) System Interface Testing
  - 4) Integrated System Testing
    - Tests the Overall Facility Resilience, Under all Probable Risk Scenarios, Including Failure Mode

#### **Commissioning Specifications**

#### The Construction Institute (CSI)

• Section Number 01 91 00

#### • Draft Set Included in Specification

- System Readiness Checklists (SRCs)
- **×** Verification Test Procedures (VTPs)

#### COMMISSIONING

#### **SECTION 01 91 00**

#### PART 1 - GENERAL

- 1.1 RELATED DOCUMENTS
- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

#### 1.2 SECTION INCLUDES

#### A. Equipment and system commissioning, including the following:

- Completion of commissioning procedures on specific equipment and systems as indicated under "Related Sections" below.
- Verification of operational and functional performance of specific equipment and systems for compliance with the "Design Intent" as described in the "Related Sections" indicated below.

#### 1.3 RELATED SECTIONS

- A. Section 01 33 00 Submittal Procedures: Procedures for submittal of product data and quality assurance submittals.
- B. Section 01 77 00 Closeout Procedures: General closeout requirements.
- C. Section 01 78 53 Sustainable Design Closeout Documentation: Closeout requirements relating to sustainable design certification.
- D. Appropriate Sections of Divisions 15 and 16 specify closeout and/or commissioning related requirements for specific pieces of equipment or building operating systems.

#### 1.4 REFERENCES

- A. [ASTM International (ASTM)]:
  - [ASTM X000-00, Title of Standard].
    [ASTM X000-00, Title of Standard].
- B. [Name of Organization (Organization Acronym)]:
  - [Acronym, Standard or Document Number and Date of Issue, Title of Standard or Document].

Project No

01 91 00-1

Project Name Project Name Project Location Date Commissioning



# EXAMPLE OF SPECIFICATION NOTE: SEE APPENDIX H

## **LEED and Commissioning**

# Leadership in Energy & Environmental Design

#### • Energy & Atmosphere Prerequisite 1

- Fundamental Building Systems Commissioning
  - Engage a Commissioning Authority
  - Review Design Intent and BOD
  - Include Commissioning Requirements in the Construction Documentation
  - Develop and Utilize a Commissioning Plan
  - Verify Installation, Functional Performance, Training and Documentation
  - Complete a Commissioning Report

#### • Energy & Atmosphere Credit 3

- Enhanced Building Systems Commissioning
  - Conduct a Focused Review of the Design Prior to the Construction Documents Phase
  - Conduct a Focused Review of the Construction Documents When Close to Completion
  - Conduct a Selective Review of Contractor Submittals of Commissioned Equipment
  - Develop a Re-commissioning Management Manual
  - Have a Contract in Place for a Near Warranty End or Post Occupancy Review



# Construction Phase

## **Construction Phase**

#### The Kick Off Meeting

o Submittal Review

#### **o** Pre-functional Checklist and Formal Startups

- Contractor Commissioning Meeting
- Startup Request Forms
- × A/E Site Inspections
- × PM, CA, FM, SSE Site Inspections
- Tracking of Deficiencies
- Commissioning Progress Reporting
- o O&M Manual
- o TAB
- Functional Performance Testing



• The Commissioning Authority Will Conduct a Selective Review of Contractor Submittals of Equipment to be Commissioned

• Any comments by the CA will be forwarded to A/E

 Need Both CA Submittal Review and A/E Submittal Review



### **Develop & Utilize Checklists**

- Pre-functional Checklists, Formal Startups, Construction Checklists
  - Ensures that the equipment and systems are hooked up and operational and functional performance testing may proceed without unnecessary delays.
    - Static Inspections and Procedures to Prepare the Equipment or System For Initial Operation
      - Oil Levels, Fan Belt Tensions, Labels Affixed, Gages in Place, Sensor Calibrations, etc.

D Disapproved

# **Formal Startup**

#### Contractor Commissioning Meeting

#### • CA Plans and Conducts Meeting

- Contractor will be given a generic pre-functional checklist template, contractor will remove any items that do not apply and add any items that were not included.
- Contractor then creates a form for each piece of equipment from the templates, with equipment specific information in filled in:
  - Equipment Tag
  - Location
  - Manufacturer
  - Model #
  - Serial Number
  - **o** Horsepower
  - Voltage
  - o GPM
  - CFM

# **Formal Startup**

#### Startup Request Forms

- Contractor will be given an electronic version of Equipment Startup Request Form along with the Pre-functional Checklists.
- Needs to submit a signed Startup Request Form a week before Equipment Startup.
- The signature on the Startup Request Form is to indicate that all of the pre-functional requirements for that equipment have been established.
- Equipment that requires an official scheduled startup will be designated in the "Equipment to be Commissioned" (SPEC 01810)
  - NOTE: SEE APPENDIX I

# **Formal Startup**

#### • A/E Site Inspections

- Applicable party on the A/E team will be notified when a startup request form has been submitted the first time for each different type of equipment.
- A/E will schedule a site visit with the CA to verify that all requirements specific to that type of equipment has been completed.

#### • CA, FM, SSE Site Inspections

• CA with schedule periodic site inspections with FM personnel that are on the commissioning team, focus of these inspections will be on equipment that is scheduled to be operating, as determined by the construction schedule.

#### **Track Deficiencies**

- Any Deviations From the Plan and Specifications Found During Commissioning Activities will be Forwarded to the PM for Tracking and Resolution.
   CA will log this and include in final Cx Report
- Other Issues Found During Cx That Are Not Considered Deviations from the Bid Documents But Still Affect the Performance of a System Will Be Championed by CA
  - Maintainability Issues
  - **o** Differences in Design Intent Interpretations
  - Systems Not Performing Up To Design Criteria

#### **Construction Phase**

- Commissioning Progress Reporting
  - At Beginning of Construction CA Should Provide Monthly Commission Progress Reports
    - **×** Memos, Progress Reports, and Commissioning Status Summary Sheets
  - 30 Days Before the Startup of Equipment CA Should Provide a Report Twice a Month Until Startup is Completed
- O&M
  - Operations and Maintenance Manual
- TAB
  - Testing & Balancing

#### Functional Performance Testing

- Systems Tested Under Various Modes
  - × Low Cooling or Heating Loads, High Loads, Component Failures, Unoccupied, Varying Outside Air Temperatures, Fire Alarm, Power Failure, etc.
- Dynamic Testing of Systems (Not Just Components) Under Full Operation
  - × Example: All Hot Water Pumps and Hot Water Converters Will Be Looked at Simultaneously For Temperature Controls

# Chapter 4

# Post Construction Phase

#### **Post Construction/Acceptance Phase**

#### O&M Documentation

- O&Ms will be reviewed by CA
- Turnover Meeting
  - Purpose: To Officially Transfer the Responsibility of Maintaining the Facilities From the Contracts and CM to FM (Attendees should include PM, CA, A/E and Appropriate FM Personnel)
    - × Agenda of Meeting
      - As-built Drawing Status
      - Turnover O&M Manuals
      - Turnover Remaining Attic Shock
      - Keys/Access
      - Contractor Contact Listing and the Work they Performed
      - Warranty Start/Finish Dates Consolidated Listing
      - Training What's Been Done, What's Left
      - Commissioning Status Remaining Functional Performance Testing Schedule
      - Open Punchlist/Commissioning Issues Review Create Action Plan and Assign a Champion For Any Open Items

#### **Post Construction/Acceptance Phase**

#### System Warranties

- Shall Take Affect After Successful Functional Testing is Complete and the System is Accepted by the CA, CM, CxPM and PM
  - Warranty Periods and Requirements During Such Shall Be Described in the Project Contract Specification

#### Off-Season Functional Testing

**o** HVAC Will Require Evaluation During Off Seasons As Well

#### Performance Monitoring

 During Warranty Period of the Building FM Personnel Will Evaluate the HVAC System Through Performance Monitoring Using the BAS System

### **BAS System**

#### Building Automation System

- Advanced Functionality Provided by the Control System of A Building
- BAS is an Example of a Distributed Control System

**×** Computerized, Intelligent Network of Electronic **Devices Designed to Monitor and** Control the Mechanical. Electronics. and Lighting Systems in a Building



#### **Post Construction/Acceptance Phase**

- Ten Month Final Walk-Thru and System Review
  - 10 Months into the Warrantee Period, the CA and FM will Meet and Discuss Any Remaining Outstanding Operational Issues and Review the Performance of Each System

#### Re-Commissioning Management Manual

- CA Will Provide FM Blank Functional Test Forms and Information On the Equipment Provided on the PFC by the Contractors
  - Will Use this Information and Forms for their Preventative Maintenance/ Re-commissioning Program for the Equipment Provided Under this Project
- Commissioning Report

#### **Post Construction/Acceptance Phase**

#### Commissioning Report

#### • CA Will Issue a Final Summary Report

- × Will Include:
  - Executive Summary
  - List of Participants
    - Roles
  - Brief Building Descriptions
  - Overview of Commissioning and Testing Scopes
  - General Description of Testing and Verification Methods
- Results of Commissioning Each System Should Include as Summary Identifying:
  - × 1. Equipment Met the Owner's Design Intent
  - × 2. Equipment Met the Specification Requirements
  - × 3. Equipment has been Installed Properly
  - × 4. Functional Performance Status of Each System
  - × 5. As-built Documentation
  - 6. Operator Training Was Completed

- A Continuation of the Commissioning Process Well Into the Occupancy and Operations Phase to Verify That a Project Continues To Meet Current and Evolving Owner's Project Requirements
  - On Going Process That Resolves Operating Problems, Improves Comfort, Optimize Energy Use, and Identify Retrofits for Existing Commercial and Institutional Buildings and Central Plant Facilities
- Continuous Commissioning Process Activities Are Ongoing For the Life of the Facility
  - Improves Overall Systems Control and Operations for the Building
    - **K** Goes Beyond Operations and Maintenance Program
- Ongoing Commissioning Process Activities Occur Throughout the Life of the Facility
  - Some of These Will Be Close to Continuous in Implementation, and Others Will Be Either Scheduled or Unscheduled (As Needed)
  - Does Not Ensure Systems Functions as Originally Designed But Ensures that the Building and Systems Operates Optimally to Meet the Current Requirements

#### • Key Activities

- Maintaining the Owner's Project Requirements to reflect changes in use and operation of the facility.
- Maintaining the Basis of Design to reflect changes in systems and assemblies due to renovations or in response to changes in the Owner's Project Requirements.
- Periodic evaluation of achieving the current Owner's Project Requirements and against previous benchmarks by appropriate tests.
- Maintaining the Systems Manual to reflect changes in
- Owner's Project Requirements, Basis of Design, and systems/assemblies.
- Ongoing training of operations and maintenance personnel and occupants on current Owner's Project Requirements and Basis of Design and changes in systems and assemblies.

#### • CCx Team Consists of

- Project Manager
  - **×** Coordinate Activities of Building Personnel and the Commissioning Team
  - Schedule Project Progress

#### • One or More CC Engineers

- Develop metering and field measurement plans
- Develop improved operational and control schedules and set points
- Make necessary programming changes to the building automation system
- Supervise technicians implementing mechanical systems changes
- Estimate potential performance changes and energy savings
- Conduct an engineering analysis of the system changes
- Write a project report
- One or More CC Technicians
  - Conduct Field Measurements
  - × Implement Mechanical, Electrical, and Control System Program Modifications and Changes Under the CC Engineer
- One or More Designated Member of the Facility Operating Team

#### Project Development Phase

- Identifies the Buildings and Facilities to be Included in the Project and Develops the Project Scope
- At End of this Phase, CC Scope is Defined and the CC Contract is Signed

#### Implementation and Verification Phase

- O Develop a Detailed Work Plan
- Identify the Entire Project
- Clarify the Duties of Each Team Member

# Building Enclosure Commissioning Process

# **Building Enclosure Commissioning Process**

#### BECx Ensures

- Appropriate Enclosure Systems
- Claddings
  - × AND
- Components Are Selected
- Appropriately Designed
- Constructed
- Tested to Perform



% of Air Leakage from Building/Home

 Minimal Differences Between the Building Development Process and the Commissioning Process









#### NOTE: SEE APPENDIX K

## **Building Enclosure Commissioning**

#### Typical Commissioning Objectives:

- Heat Flow
- Air Flow
- Noise
- Fire
- o Light
- Infrared
- Ultraviolet
- Rain Penetration
- Moisture
- Structural Performance
- Durability
- Security
- Reliability
- Aesthetics
- Value
- Constructability
- Maintainability
- Sustainability



Building Envelope Commissioning. A Key Component of Total Building Commissioning Source: Whole Building Design Guide

# **Common Air Leakage Sites**



### **Hidden Construction Details**

 Often the Largest and Most Important Air Leaks











# **US Army Corps of Engineers**

#### Air Leakage Test Protocol

#### • Air Leakage Specification

• *"The air leakage test must be performed in accordance with ASTM E -779 with the following additions and exceptions using either method one or method two.* 

**Method one**: The test consists of measuring the flow rates required to establish 12 positive and 12 negative building pressures from at least 25 Pa to at least 50 Pa. At least 12 bias pressure readings must be taken across the envelope and averaged over at least 5 seconds each before and after the test. None of the bias pressure readings must exceed 30% of the minimum test pressure.

**Method two**: The test consists of measuring the flow rates required to establish 12 positive building pressures from at least 50 Pa to at least 75 Pa. At least 12 bias pressure readings must be taken across the envelope and averaged over at least 5 seconds before and after the test. None of the bias pressure readings must exceed 20% of the minimum test pressure. The flow rate must not exceed 0.25 CFM at 75 Pa per square foot of envelope area as given by the architect of record."

#### o Scope

 Apply to Exterior Envelopes (Buildings over 500,000 sq.ft of Envelope May Require Special Test Techniques Using Building HVAC or Large Truck Mounted Fans)

• Air Leakage Tester Form Guide

• NOTE: SEE APPENDIX D



US Army Corps of Engineers®

# **US Army Corps of Engineers**

#### Balancing Energy and Air Quality

- No Such Thing as a "Too Tight" Building
- o Build Tight and Ventilate Right!

#### Air Leakage Reduction

- o Starts With a Good Design
- Timely Measurement and Sealing is Essential
- Measure Leakage with a Door Fan
  - NOTE: SEE APPENDIX E







US Army Corps of Engineers®

# **US Army Corps of Engineers**

- US Army Corps of Engineers (USACE) Standard For Air Leakage
  - The USACE requires all new buildings to pass an air leakage test where the results are less than or equal to 0.25 cfm per square foot of exterior envelope at 75 Pa pressure. The test is to be performed according to the protocol outlined in this procedure along with the attachments
    - Appendix F
- "<u>Stack</u>" Effect of Warm Air Rising or Cool Air Falling is Called in a Building, Often the Most Constant Force Pulling Air Through Buildings
  - Stack and Wind Form the Basis of Unintentional Exfiltration and Infiltration in Buildings
- Where Buildings Leak?
  - Stack Pressures Greatest at the Top and Bottom of the Buildings
- Air Barriers
  - Every Building Must Have Continuous Air Barrier to Contain Air Leakage
  - Insulation Does Not Work Without Air Barrier



US Army Corps of Engineers®

#### **Blower Door Test**

- Document the Relative Air tightness of Buildings
  - Are they Leaky? Tight? Or Somewhere in between?
- Investigate Duct Leakage Problems
- Help Estimate Need For Mechanical Ventilation
- Used to Blow Air Out Of Or Into The Building



#### **Multi-Fan Blower Door Systems**

- Airtightness of a Building Requires More Fan Flow
  - 2 or 3 Fans in a Single Doorway Can Make it
     Possible to Measure the Air tightness of Almost Any Size
     Room or Building





NOTE: SEE APPENDIX G

# Index

Appendix A – *Roles and Duties* 

Appendix B – Owner's Project Requirement

Appendix C – Basis of Design

Appendix D – Air Leakage Tester Form Guide

Appendix E – International Protocol

Appendix F – USACE Standard for Air Leakage

Appendix G – Blower Door Test Building Airtightness Testing Systems

Appendix H – Specification Commissioning 01 91 00

Appendix I – Specification Testing for Indoor Air Quality 01 81 09

Appendix J – ASHRAE Guideline, The Commissioning Process

Appendix K – NIBCS Guideline 3-2012, Building Enclosure Commissioning Process BECx

# **Roles and Duties**

# **Commissioning Authority Duties**

- 1. Coordinate and Direct the Commissioning Activities in a Logical, Sequential and Efficient Manner
- 2. Coordinate the Commissioning Work
- 3. Revise, Commissioning Plan-Construction Phase
- 4. Plan and Conduct a Commissioning Scoping Meeting
- 5. Request and Review Additional Info. Required to Perform Commissioning Tasks, Including O&M Materials, Contractor Start-Up and Checkout Procedures
- 6. Review and Approve Normal Contractor Submittals
- 7. Write and Distribute Pre-functional Tests and Checklists
- 8. Develop Enhanced Start-up and Initial Systems Checkout Plan with Subcontractors
- 9. Perform Site Visits, As Necessary
- 10. Witness All or Part of the HVAC Piping Test and Flushing Procedure
- 11. Witness All or Part of Any Ductwork Testing and Cleaning Procedures
- 12. Approve Pre-functional Tests and Checklist Completion by Reviewing Pre-fucntional Checklist Reports or by Direct Site Observation
- 13. Approve Systems Startup by Reviewing Start-up Reports and by Selected Site Observation
- 14. Review Testing, Adjusting, and Balancing Execution Plan-Oversee Sufficient Functional Testing of the Control System and Approve it for use by TAB, Before TAB Is Executed
- 15. Approve Air and Water Systems Balancing by Spot Testing and by Reviewing Completed Reports and by Selected Site Observation

### **Commissioning Authority Duties**

- 16. Analyze Any Functional Performance Trend Logs and Monitoring Data to Verify Performance
- 17. Coordinate, witness and approve manual functional performance tests performed by installing Contractors, retest as necessary
- 18. Maintain a master deficiency and resolution log and a separate testing record
- 19. Witness Performance Testing of Smoke Control Systems, Document
- 20. Review Equipment Warranties to Ensure that the Owner's Responsibilities are Clearly Defined
- 21. Oversee and Approve the Training of the Owner's Operating Personnel
- 22. Compile and Maintain a Commissioning Record and Building Systems Books
- 23. Review and approve the preparation of the O&M Manuals
- 24. Provide a final commissioning report
  - Include executive summary,
  - List of Participants and Roles, Brief Building Description,
  - Overview of Commissioning and Testing Scope and a General Description of Testing and Verification Methods
  - Commissioned Equipment, Report Containing the Adequacy of the Equipment, Documentation and Training Meeting the Contract Documents in the Following Areas:
    - × 1) Equipment meeting the equipment specifications
    - × 2) Equipment installation
    - × 3) Functional performance and efficiency
    - × 4) Equipment documentation and design intent
    - 5) Operator training.

## Matrix

Definitions to the Roles & Responsibilities Matrix **Pre-Design/ Design Stage** 

- Lead (L) = Direct and take overall responsibility for accomplishment
- Support (S) = Provide assistance
- Approve (A) = Formally accept—either written or verbal depending on the situation
- Participate (P) = Take part in the activity (i.e. attend the meeting, etc.)
- Inform (I) = Make this party aware of the activity or result or provide a copy of the deliverable
- Verify (V) = Confirm the accuracy or completeness of the task

Commissioning Roles & Responsibilities M	Aatrix							
Legend $L = Lead$ $P = Participate$ $S = Support$ $I = Inform$ $A = Approve$ $V = Verify$	Project Manager	Operating Personnel	Customer Agency	Technical Experts	Construction Manager	Construction Contractor	Commissioning Agent	Architect/ Engineer
Planning Stage								
Identify Commissioning Team	L/A	S	S	P/S				
Develop Owner's Project Requirements	L/A	S	S	S				
Develop preliminary commissioning scope	L	S	S	P/S				
Develop Preliminary Commissioning Plan	L	S	S	S				
Establish budget for all Cx work & integrate costs for com- missioning into project budget	L	s	s	s				
Include time for Cx in initial project schedule	L	Ι	Ι	Ι				
Include Cx responsibilities in A/E & CM scope of services	L/A	S		S				
Design Stage								
Contract fro Commissioning Agent Services	L/A	Р	Р	Р	L			
Hold Design Stage Cx meetings	Р	Р	Р	Р	Р		L	Р
Identify project specific responsibilities	L	Р	Р	S	S		Р	Р
Review Owner's Project Requirements documentation for completeness & clarity	s	s	Ι		Ι		L	Ι
Develop Basis of Design	А	Р	Р	S/A	Ι		Ι	L
Perform focused Cx reviews of design drawings & specifica- tions	Р	Р		Р	s		L	S
Per form project constructability reviews	Р			I/P	L		I/S	S
Incorporate appropriate changes to contract documents based upon design reviews	А	Р	Р	Ι	Ι		Ι	L
Refine Owner's Project Requirements based upon Design Stage Decisions	А	Р	Р	s	Ι		L	S
Create Cx specifications including testing protocols for all commissioned equip./systems	Ι	Ι	Ι	P/S	S		L	S
Integrate Cx activities into project schedule	А	Ι	Ι	Ι	L		S	Ι
Coordinate integration issues & responsibilities between equipment, systems & disciplines	А	Ι	Ι	P/S	S		V	L

# Matrix

#### Definitions to the Roles & Responsibilities Matrix **Pre-Design/ Design Stage**

- Lead (L) = Direct and take overall responsibility for accomplishment
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- Verify (V) = Confirm the accuracy or completeness of the task

Commissioning Roles & Responsibilities Matrix								
Leg end L= Lead P = Participate S = Support I = Inform A = Approve V = Verify	Project Manag <i>e</i> r	Operating Personnel	Customer Agency Reps	Te chuical Expert s	Construction Manager	Construction Contractor	Commissioning Agent	Architect/ Ergineer
Update Commissioning Plan	А	Ι	Ι	Ι	S		L	Ι
In corporate commissioning requirements into Construction Contractor's Scope of Work	Α			Ι	L		s	s
Construction Stage								
Revise Commissioning Plan as necessary	А	Ι	Ι	Ι	Ι	S	Ι	L
Review submittals applicable to equipment/systems being commissioned	Ι			Р	А	s	S	L
Review project submittals for construction quality control & specification conformance	Ι			I/P	А	L	S	V
Develop functional test procedures and documentation for- mats for all commissioned equipment & assemblies	А	Ι	Ι	S/A	S	S	Ι	L
Include Cx requirements and activities in each purchase order and subcontract written	А					Α	L	V
Develop construction checklists for equipment/systems to be commissioned	А			Р	Ι	Ι	Ι	L
In stall components & systems	Ι	Ι	Ι		А	А	L	V
Review RFIs and changes for impacts on Cx	A	Ι	Ι	I/S	S	L	S	V
Demonstrate operation of systems	Ι		Р/І		Ι	Р	L	V
Complete construction checklists as the work is accomplished	Ι	Ι		Ι	Ι	s	L	А
Continuously maintain the record drawings and submit as detailed in the contract documents	А	S			Ι	S	L	V
Coordinate functional testing for all commissioned systems $\&$ assemblies	Ι	Ι	Ι	P/A	Ι	S	S	L/A
Perform quality control in spection s	Ι			I/P		L	S	P/I
Maintain record of functional testing	Ι	Ι	Ι	I/P	Ι	S	S	L

# Matrix

#### Definitions to the Roles & Responsibilities Matrix Design Stage/Post Construction Stage

- Lead (L) = Direct and take overall responsibility for accomplishment
- Support (S) = Provide assistance
- Approve (A) = Formally accept–either written or verbal depending on the situation
- Participate (P) = Take part in the activity (i.e. attend the meeting, etc.)
- Inform (I) = Make this party aware of the activity or result or provide a copy of the deliverable
- Verify (V) = Confirm the accuracy or completeness of the task

Commissioning Roles & Responsibilities Matrix									
Legend L = Lead P = Participate S = Support I = Inform A = Approve V = Verify	Project Manager	Operating Personnel	Customer Agency Reps	Technical Experts	Construction Manager	Construction Contractor	Commissioning Agent	Architect/ Engineer	
Prepare Cx Progress Reports	А	Ι	Ι	I/P	Ι	Р	s	L	
Hold Construction Phase Cx meetings	Р	Р	Р	Р	Р	Р	Р	L	
Maintain master Issues Log	Ι	Ι	Ι	Ι	Ι	S	Ι	L	
Review equipment warranties to ensure GSA responsibilities are clearly defined	Ι	Ι				s	S	L	
Implement training program for GSA Operating Personnel	Ι	Р	Р	I/S	Р	S	S	L	
Compile and deliver Turnover Package	А	А			S	S	L	S/V	
Deliver Commissioning Record (see page 48	А	Р	Р	Ι	S	s	S	L	
Post-Construction Stage									
Coordinate & supervise deficiency corrections	А	Р		Ι	I/S	L	S	Ι	
Coordinate & supervise deferred & seasonal testing	А	Р		Ι		S		Ι	
Review & address outstanding issues	А	Р		Ι	I/S	s	s	Ι	
Review current building operation at 10 months into 12 month warranty period	А	Р		Ι	s	s		Ι	
Address concerns with operating facility as intended	А	Р		Ι	s	s	s	s	
Complete Final Commissioning Report	А	Р			I/P	Ι		Ι	
Perform Final Satisfaction Review with Customer Agency 12 months after occupancy	A	s		s		s		s	
Recommission the facility at 3-5 years after turnover to reset optimal performance	L	Р		L	Р				