

Procuring Building Commissioning Services

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Synopsis

Due to the recent increased interest in building commissioning services, there is a growing need for accurate information and effective tools to help interested individuals choose the services of qualified Commissioning Authorities. Two approaches for executing Commissioning projects (Process and Technical Commissioning) have evolved in the commissioning industry. This paper discusses the differences between the two approaches to commissioning. It also provides tools for defining Building Commissioning work scope, as well for assigning tasks between all prospective members of the building commissioning team.

About the Author

Jerry Bauers, P.E., has managed and delivered Building and Process Commissioning Services since 1983. He is a NEBB Qualified Supervisor for Air & Hydronic Balancing and Building System Commissioning. Mr. Bauers currently serves as a member of the National Environmental Balancing Bureau's (NEBB) Building System Commissioning Committee. He speaks regularly on the subject of commissioning and retro-commissioning. Mr. Bauers has been the Principal Design and Commissioning Engineer for over \$1 billion dollars worth of building projects in the past 25 years. His work has included design, commissioning, and validation of pharmaceutical production and research facilities, research laboratories, corrections facilities, and support office facilities. He currently serves as Vice President of Commissioning Services for Olsson Associates in Kansas City, Missouri

Introduction

Building System Commissioning as an identified step in the building construction process has, in the past twenty years, taken on an increasingly important role in delivering buildings that work. In the past fifteen years, a number of organizations have attempted to define the commissioning process. Work on 'ASHRAE Guideline 1: The HVAC Commissioning Process', published in 1996, was begun in the late 1980's. The National Environmental Balancing Bureau (NEBB) published its first Procedural Standard for Building System Commissioning in 1993 and began providing training and certification for Commissioning Authorities in the same year. Portland Energy Conservation, Inc. (PECI) developed and published commissioning guideline documents in the mid-1990's that served as a model for early commissioning work. More recently, organizations like the Building Commissioning Association, the University of Wisconsin and AABC have begun developing commissioning guides.

As buildings have become more complex, the need for owner to understand, to effectively purchase, and to manage building commissioning services has become substantially more important to successful building delivery. With the adoption and acceptance of the United States Green Building Council's "Leadership in Energy and Environmental Design" (LEED) program in building construction, this need can only grow.

This paper is an attempt to provide a detailed and measurable definition of the building commissioning process. We have also provided information that allows an owner to distinguish between process and technical commissioning approaches. This information will allow owners to purchase the approach most suitable to his/her particular project.

Process versus Technical Commissioning

The building commissioning process consists of a combination of the following:

- *management* of the activities of a diverse group of parties to the design and construction process, and
- *execution* of highly technical inspections and tests designed to demonstrate compliance with the Design Intent of the Project.

In recent years, two fundamental approaches to commissioning have evolved. One approach, *Process Commissioning*, focuses on the management of a process executed by designers, contractors, and vendors. The second approach, *Technical Commissioning*, includes both the management tasks described above and a higher level of involvement in the detailed execution and documentation of inspections, test, and issue resolution associated with building delivery.

Process Commissioning is an approach that focuses on the management tasks associated with building commissioning. In this approach, the Commissioning Authority (C_A) is charged with the task of organizing and defining the inspections, start up tasks and integrated performance testing that is required to demonstrate compliance with the project Design Intent. Tasks include Design Phase Commissioning reviews and coordination and development of commissioning plans and specifications. Commissioning includes clarification for project bidders of both the systems to be commissioned and the tasks that each bidder must include in his scope to comply with the requirements of the Commissioning Plan.

During the Construction Phase, the Commissioning Authority continues to manage the commissioning process by assisting the contractors in tracking commissioning documents, reviewing project submittals, assisting in the integration of commissioning tasks into the overall project schedule and coordinating and verifying the inspections and start up testing performed by contractors, subcontractors, and vendors.

In the acceptance phase, the C_A again manages the work of the commissioning team and provides oversight for execution of integrated system performance tests. In general, these tests, defined by the C_A, are executed by contractors. Deficiencies are identified by the C_A and the performing contractors; resolution of the identified items is tracked by the C_A.

Technical Commissioning combines the management tasks of **Process Commissioning** described above with a greater involvement in execution of inspections, tests, and documentation of results. The technical commissioning process is driven by a high level of expertise in the construction, start up, and operation of building systems. It focuses on delivering this expertise to both designers and constructors in a ‘hands on’ way to shorten the start up period as well as to improve performance and building operator expertise.

Technical Commissioning providers fill the ‘systems expertise gap’ that exists for many contractors. Contractors, in general, provide their highest level of expertise in the procurement and installation of materials and systems. Technical commissioners supplement this expertise with intimate knowledge of building systems and their operation, maintenance tasks, expert test methodology, and documentation skills.

While each commissioning project will be defined by the owner and the nature of the construction project itself, the following table may serve to highlight some similarities and differences in the philosophies that drive each approach to commissioning.

<i>Process Commissioning</i>	<i>Technical Commissioning</i>
<i>Design Phase Commissioning Review</i>	
<i>“...Review... the design documents to facilitate commissioning during construction. Many of the features that facilitate commissioning will also enhance ease of building operation.”¹</i>	<i>“Design phase commissioning is the process of reviewing each system and element of the design as it relates to functionality, maintainability and industry accepted best practices.”²</i>
<i>Test Procedures</i>	
Define broad testing outline requirements. Details left to executing contractors. Witness contractor execution.	Define the detailed procedures and documentation requirements. Directly supervise and/or execute with contractor assistance inspections and integrated testing.
<i>Test Rigor</i>	
Utilize statistical sampling techniques at every phase of the commissioning process. Test ‘normal’ state operation for systems.	Provide rigorous testing of 100% of elements and devices deemed critical to achieving the project goals. Provide both ‘normal’ and ‘upset’ condition testing to demonstrated full functionality through all anticipated operating conditions.

The difference between technical commissioning versus process commissioning lies not in the cost of commissioning, but in where the costs for commissioning occur. In employing a technical commissioning approach for this work, an owner will be more in control of the professionals who will execute commissioning testing and inspections. Thus, more of the cost of commissioning will be borne by the commissioning contractor. In a process commissioning approach, more of the commissioning tasks are assigned to contractors and vendors. Thus, a more significant portion of the cost is shifted to the construction contract.

An owner, then, will benefit from an analysis of overall commissioning costs and a clear understanding of where the costs are to be borne so that a fair and reasonable comparison

¹ “Model Commissioning Plan, Design Phase,” *Portland Energy Conservation, Inc. (PECI)*, Portland, Oregon, Version 2.05, February 1998

² “Draft Design Phase Commissioning Handbook”, National Environmental Balancing Bureau, Washington, DC, Schedule for Spring, 2005, Publication

between these commissioning approaches can be made with an eye toward the quality of the final delivered building project.

Commissioning Scope of Work

Building system commissioning is an activity that is best executed by building professionals with a broad range of building design, construction, and operational expertise. In competitive solicitation for the services of a Commissioning Authority, an owner is best served by providing a detailed description of the work tasks requested of each competitor. By identifying the owner's desired approach and his division of commissioning labor between the Commissioning Authority and other members of the construction team, competitive proposals for the work can be more reasonably compared. By providing this level of detail in a solicitation for services, an owner can more effectively manage the total cost of building commissioning.

In order to manage the cost and result of the commissioning process, owners must consider the following three basic questions:

1. What systems should be included in the commissioning process?
2. What tasks should be completed in order to commission each system?
3. Who should be responsible for the execution of each task?

The answers to these questions will determine both the outcome of the process and its cost. Furthermore, the assignment of responsibilities determines the allocation of commissioning costs between your Commissioning Authority and the construction contracts.

Systems to be Commissioned

In considering which systems to include in a building commissioning contract, we have traditionally recommended that owners start with systems that include 'moving parts.' While a case is effectively made to include roofs, curtain walls, and other general construction elements in the commissioning process, it is the 'parts that move' that are the most difficult to construct and tune to operate properly. Furthermore, an effective commissioning process will also include consideration of the effects of general construction on the performance of the building.

To this end, the following table outlines the most commonly commissioned systems. Systems are listed in an order of priority that represents a non-scientific evaluation of our own experience in setting commissioning priorities with owners over the past 15 years:

<i>Typically Commissioned Systems</i>	
<i>System</i>	<i>Comments</i>
Building HVAC Systems	May include Air Conditioning & Distribution, Central Heating/Cooling Systems, Hydronic Systems, Exhaust and Pressure Management Systems, Variable Frequency Drives
Building Management Systems	Building Controls and the Interface of these systems with HVAC Systems, Fire Alarm and Security Systems
Emergency Power Systems	May include building generator systems, automatic transfer switches, UPS systems, egress lighting and emergency back up systems.
Electrical Distribution Systems	May include service entrance, normal and conditioned power distribution, short circuit and ground fault protection, lightning protection systems.
Fire Detection and Alarm Systems	Includes full or partial coverage fire detection and alarm systems, emergency communication systems and interface with building HVAC control systems, elevator controls and remote notification systems.
Fire Suppression Systems	Includes wet and dry sprinkler systems, specialty suppression systems and the interface between fire suppression systems and fire detection and alarm systems.
Plumbing Systems	Includes sanitary waste & vent, domestic hot and cold water systems, storm drainage. May include miscellaneous specialty waste or water handling and decontamination systems.
Voice/Data Distribution Systems	May include Voice & Data cabling, routers and switches.
Roof Systems	May include commissioning of the integrity of roof structures. Generally involves a specialty roofing consultant.
Curtain Wall Systems	May include integrity of curtain wall systems. Generally involves a specialty fenestration consultant

Many projects include specialty systems that bear a higher priority in commissioning work scopes. Laboratories, for example, will include primary containment systems (chemical fume hoods, biological safety cabinets, and specialty exhaust systems), laboratory and building pressure controls. Specialty plumbing systems will include deionized water systems, laboratory or hospital gases and waste containment/decontamination systems. System priorities are best established by identifying the systems that most directly affect the functionality and reliability of an operating building and the work that the building is intended to support.

Commissioning Work Tasks

In an effort to refine the definition of the Building System Commissioning process, the Building Systems Commissioning committee of the National Environmental Balancing Bureau (NEBB) developed a Commissioning Process Matrix. The matrix consists of two parts:

Table 1: Commissioning Process Matrix

Description of Tasks and Deliverables for each phase of commissioning

Table 2: Commissioning Responsibility Matrix

Assignment of Responsibilities for each Commissioning Team Member by Task

These matrices can be used by owners to both evaluate the work required in the commissioning process. Further, the matrices can be used to define an owner's expectation of his Commissioning Authority. By tailoring the matrix to your project and defining the basis for cost proposals for the work, competing proposals for the work will be directly comparable. Thus, the selection of a Commissioning Authority can be most easily reduced to an evaluation of qualifications and effectiveness.

Note also that the matrix can help owners to identify steps and deliverables in the design process that will promote an effective and timely building commissioning effort. When a designers work product at each project phase generally conforms to the requirements outlined in **Table 1**, both the design and commissioning process proceed more effectively.

Referring to **Tables 1 and 2**, owners can tailor these documents to their particular project and project delivery method to provide a detailed description of the work tasks required by the commissioning agent and the supporting tasks required by other members of the design and construction team. And, it is in **Table 2** where an owner can assign to each member of the Commissioning Team the tasks involved in inspection, start up and integrated system performance testing necessary to complete the process.

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Owners can utilize **Tables 1 and 2** to develop a scope of work for Commissioning Authorities that, in combination with a list of systems to be commissioned, will provide a detailed definition of work for competing CxA's.

We recommend that the following procedure be conducted to tailor the tables to your project:

1. **Review the tasks in Table 1** to confirm that they are consistent with the Building Delivery method you intend to use with your project. For example, in a design build project, design phase reviews may differ in quantity and content. For projects in which the CxA is engaged later in the project, some tasks may need to be modified to conform to progress on the project.

It is important to remember that a Design Review of some sort is an essential part of Building System Commissioning. While the nature of the review may change, the process of understanding the project and reaching an agreement with all parties regarding the 'final acceptable performance' of the built systems is the first necessary agreement to a successful commissioning project.

2. **Assign responsibility for each task**, utilizing the 'revised' definition of tasks from above, and subtask to specific members of the Commissioning Team. For example, a process commissioning process may assign responsibility for development of inspection, start up, and/or integrated performance testing protocols to contractors and suppliers. A technical commissioning approach assigns that same responsibility to the C_A.
3. **Attach to these tables your standard front-end language** for contracting with your organization.

Cost Impact of Commissioning Work Scope

One of the greatest challenges owners face in today's commissioning environment is evaluating competing cost proposals and work scopes. By utilizing the tables presented in this document, the owner can substantially improve the quality of competing proposals. They can also become more adept at understanding the total project cost of commissioning and at assigning both cost and responsibility for work tasks across the commissioning team. A professional relationship with your Commissioning Authority combined with the information provided here may give owner the best opportunity to effectively procure the commissioning services.

In terms of the cost of project commissioning, information in the literature has suggested costs should range from 0.5% up to 5.0% of building costs depending upon the complexity of the building type and the intensity of the commissioning effort. As noted

in the USGBC Reference Guide, actual cost of commissioning is dependent upon project “complexity, timing (number of site visits) and team cooperation...”³

In considering the process matrix presented above, the cost of a commissioning contract will also vary significantly with the assignment of work tasks. For example, assigning the task of completing and documenting Field Installation Verifications and Operational Performance Tests to the contractor can reduce the cost of the commissioning contract as much as 25%. Commissioning team meetings can represent as much as 12% of the commissioning contract value depending upon the construction duration of the contract.

So, for a process commissioning approach to your project a 1.5% fee for commissioning will result in an additional 0.5% cost for work completed by the construction team that may not be apparent from an analysis of project costs. Similarly, if an owner chooses to assign more of these tasks to his Commissioning Agent, the commissioning contract could rise to 1.8% to 2.0% of the work. This increase is not an increase in the project cost but only an assignment of costs to the CxA.

In developing commissioning request for qualifications/proposals, it is important for an owner to establish a quantity for the following items:

- **Project Duration**
- **Anticipated Design and Construction Review Meetings including: design phase review meetings, construction coordination meetings, and commissioning meetings.**
- **Assignment of Responsibility for both preparation and execution of FIV’s, OPT’s between the CxA and the Construction Team.**

By completing **Table 2** Commissioning Responsibility Matrix and assigning both responsibility and reasonable quantities to the items listed above, the owner can then evaluate qualifications and effectiveness of execution for similar work scopes for building commissioning projects.

³ “LEED NC Version 2.1 Reference Guide”, Energy & Atmosphere Section, US Green Building Council, November, 2002



BUILDING SYSTEMS COMMISSIONING COMMISSIONING MATRIX – TABLE 1

Task	Description	Documents	Comments
<i>Pre-Design Phase</i>			
a.	<i>Cx Agent Selection</i>	<ul style="list-style-type: none"> • RFP Format • Scope of Work Matrix • Scoring Matrix 	<ul style="list-style-type: none"> • Cx Agent selection should occur as early the Design process as possible. However, whenever the Cx Agent is selected, the selection should follow the proscribed process.
b.	<i>Cx Project Contract</i>	<ul style="list-style-type: none"> • Commissioning Contract 	
<i>Design Phase Commissioning</i>			
1.	Design Team Kickoff Meeting	<ul style="list-style-type: none"> • Design Development • Design Commissioning Plan • Meeting Agenda • Meeting Minutes 	<ul style="list-style-type: none"> • Identify Contacts and Responsibilities for Commissioning Team Members
2.	Owners Performance Requirements (OPR)	<ul style="list-style-type: none"> • Owners Performance Requirements (OPR) Summary 	<ul style="list-style-type: none"> • Establishes • Submittal Review & Acceptance
3.	Basis of Design	<ul style="list-style-type: none"> • Draft Basis of Design 	<ul style="list-style-type: none"> • Basis of design shall include, Engineering Calculations & load data, System selection, system rejection reasoning, Equipment Selection, equipment rejection, failure modes, and critical sequence of operations.



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Task	Description	Documents	Comments
4.	35% Plan Review	<ul style="list-style-type: none"> • Engineering Calcs. • Load Data • System Selection • Major Component Selections • Flow Sheets • Mechanical Room Layouts • Mechanical shaft Layouts • Ceiling cuts • Commissioning Review Log 	<ul style="list-style-type: none"> • Review Basis of Design submittal from the design team. • Resolution of any issues.
5.	65% Plan Review	<ul style="list-style-type: none"> • 65% Plans & Specifications • Updated Basis of Design • Preliminary Draft Commissioning Plan • Commissioning Specifications • Commissioning Review Log 	<ul style="list-style-type: none"> • Zoning requirements, typical room layouts, main ducts, piping mains, risers, standard details, equipment schedules, and coordination of disciplines.
6.	95% Plan Review	<ul style="list-style-type: none"> • 100% Plans & Specifications from design team. • Updated Basis of Design • Commissioning Specifications • Updated Draft Construction Commissioning Plan • Commissioning Review Log • Update/Finalize OPR 	<ul style="list-style-type: none"> • Submittal Review & Acceptance • Plans & Specifications are to be 100% complete



BUILDING SYSTEMS COMMISSIONING COMMISSIONING MATRIX – TABLE 1

Task	Description	Documents	Comments
7. Pre-bid Meeting and Assistance During Bidding process.	<ul style="list-style-type: none"> Pre-bid meeting to assist contractors in answering any questions about the systems or the commissioning process or work that may come up at that time. Provide assistance in answering written questions (in the form of clarifications or addendum recommendations) during the bidding process. 	<ul style="list-style-type: none"> Written Responses or Recommendations 	
<ul style="list-style-type: none"> Construction Phase Commissioning 			
8. Construction Commissioning Kick Off meeting	<ul style="list-style-type: none"> Conduct an initial commissioning meeting with all contractors and commissioning team members. The purpose of the meeting will be to establish the purpose and proposed process for commissioning this facility in the construction, acceptance and warranties phases of the project. Review the individual roles and responsibilities of each participating commissioning team member as specified in the Construction Documents. 	<ul style="list-style-type: none"> Meeting Minutes Final Commissioning Plan with specific with specific individual responsibilities identified. 	
9. Prepare Duration Schedule for Commissioning Activities	<ul style="list-style-type: none"> Based on the final commissioning plan, Prepare a duration schedule for the contractors for the commissioning activities required by the commissioning plan. This duration schedule should be incorporated into the contractor's project schedule to track all commissioning activities of the commissioning team. 	<ul style="list-style-type: none"> Duration Schedule 	<ul style="list-style-type: none"> Facilitate Schedule Coordination and Approve Construction Schedule



BUILDING SYSTEMS COMMISSIONING COMMISSIONING MATRIX – TABLE 1

Task		Description	Documents	Comments
10.	Submittal & Shop Drawing Review	<ul style="list-style-type: none"> Review all pertinent approved shop drawings to support the Commissioning Process. Review of the shop drawings is for the purpose of developing appropriate FIV, OPT and FPT documents. Submittals & Shop drawings shall be reviewed for commissionability, maintainability and for compliance to the OPR. Note any issues identified in the Shop Drawing Review that might compromise the final commissioned system on the 'Commissioning Review Log' and submit comment to the Design Team for resolution. 	<ul style="list-style-type: none"> Commissioning Review Log 	<ul style="list-style-type: none"> Cx reviews submittals & shop drawings that have already been reviewed/approved by the design team.
11.	Finalize Construction Commissioning Plan	<ul style="list-style-type: none"> Based on the work completed in the items above, we will finalize the Commissioning Plan for this project. The final commissioning plan will incorporate all changes established by review with your staff and the design team members. The final commissioning plan will also include complete FIV, OPT and FPT protocols for each system. 	<ul style="list-style-type: none"> Final Construction Commissioning Plan Create all FIV, OPT and FPT documents. Design FPT protocols. 	
12.	Field Inspection Verifications (FIV)	<ul style="list-style-type: none"> During the course of construction, visit the site to inspect the progress of construction with respect to the systems being commissioned. The purpose of the inspections is to verify that the construction complies with the plans & specifications and standard construction quality practices. 	<ul style="list-style-type: none"> FIV Check Sheets Daily Log Commissioning Issues Log 	
13.	Commissioning Team Meetings	<ul style="list-style-type: none"> Hold commissioning meetings on a regular basis with the commissioning team to review progress of the commissioning effort and reinforce individual responsibilities. Review completed work and agree upon the acceptability of the delivered product. 	<ul style="list-style-type: none"> Meeting Minutes Commissioning Issues Log 	



BUILDING SYSTEMS COMMISSIONING COMMISSIONING MATRIX – TABLE 1

Task	Description	Documents	Comments
14. Complete all FIV's	<ul style="list-style-type: none"> Complete all field inspection verifications. A completed FIV indicates the system or piece of equipment is ready to be started and OPT's performed. 	<ul style="list-style-type: none"> Completed FIV check sheets. Commissioning Issues Log 	
15. Operational Performance Tests (OPT)	<ul style="list-style-type: none"> Observe or facilitate all equipment and system start up procedures. The Contractor will execute all start up and point-to-point tests and the Cx will witness execution of all OPT's. 	<ul style="list-style-type: none"> Completed OPT's. Commissioning Issues Log 	
<ul style="list-style-type: none"> Acceptance Phase Commissioning 			
16. Functional Performance Tests (FPT)	<ul style="list-style-type: none"> Observe and facilitate all FPT testing. FPT's shall be designed by the Cx and performed by the contractors. 	<ul style="list-style-type: none"> FPT Check Sheets Commissioning Issues Log 	
17. Operator Training	<ul style="list-style-type: none"> Work with the contractor and owner to schedule and plan training activities so that training occurs in a coordinated and coherent fashion. Assist in the development of training schedules and agendas, encourage the use of a combination of "classroom" and field training, and assist the contractors in the development of training agendas for each system or component installed in the project. Contractors and vendors provide all training. Additional skill training can be provided as an additional scope item if desired by the owner. 	<ul style="list-style-type: none"> Coordinated Training Agendas 	
18. Prepare Final Commissioning Report	<ul style="list-style-type: none"> Based on the accumulated commissioning work completed as described above, we will assemble the data into a final commissioning report. The final report will incorporate the final record documents for each system, as appropriate. The report will also include a summary of commissioning that will highlight the final condition of each system commissioned. 	<ul style="list-style-type: none"> Final Commissioning Report 	<ul style="list-style-type: none"> If Warranty Phase commissioning or deferred testing (off season) is included in the scope of work, this report can be submitted as a draft report pending completion of final testing and inspections.



BUILDING SYSTEMS COMMISSIONING COMMISSIONING MATRIX – TABLE 1

Task	Description	Documents	Comments	
• Warranty Phase Commissioning				
19.	Deferred (Off season) Testing	<ul style="list-style-type: none">Conduct any testing required by the commissioning plan that was deferred from the acceptance period.	<ul style="list-style-type: none">Warranty Commissioning PlanFPT Test check sheets	
20.	Ten Month Warranty Visit	<ul style="list-style-type: none">Cx will inspect the site and interview building operating personnel to identify any outstanding warranty failures and to identify any persistent equipment failure issues that should be handled within the warranty period.	<ul style="list-style-type: none">Commissioning Warranty Issues LogCommissioning report addenda.	



BUILDING SYSTEMS COMMISSIONING COMMISSIONING MATRIX – TABLE 1

Task	Description	Owner	Cx	Design Team	Contractor
<i>Pre-Design Phase</i>					
a.	<i>Cx Agent Selection</i>	<ul style="list-style-type: none"> Develop an RFP for commissioning services. RFP should follow the NEBB format for qualifications based selection. If interviews are conducted, the recommended scoring system should be used to evaluate qualifications of proposing firms. 	<ul style="list-style-type: none"> RFP Define Scope of Work Score Matrix 	<ul style="list-style-type: none"> Format RFP If requested. Provide Scope of Work Matrix and scoring criteria matrix if requested 	
b.	<i>Cx Project Contract</i>	<ul style="list-style-type: none"> Negotiate, prepare and execute a commissioning contract. 	<ul style="list-style-type: none"> Commissioning Contract 	<ul style="list-style-type: none"> Provide sample Commissioning contract if requested. 	
<i>Design Phase Commissioning</i>					
21.	Design Team Kickoff Meeting	<ul style="list-style-type: none"> Conduct an initial “Kickoff Meeting” with the Design Team. The purpose of the meeting will be to establish the purpose and proposed process for commissioning this facility and to establish the individual roles of each participating commissioning team member. 	<ul style="list-style-type: none"> Facilitate Kickoff Meeting 	<ul style="list-style-type: none"> Meeting Agenda Meeting Minutes 	<ul style="list-style-type: none"> Identify design team members and their Responsibilities
22.	Owners Performance Requirements (OPR)	<ul style="list-style-type: none"> In cooperation with the Owner and, if available, the Owner’s Design Team, the Cx Agent shall prepare a design intent summary document. This document will serve as the basis for all design, inspection, commissioning and acceptance testing for the project. 	<ul style="list-style-type: none"> Provide input for performance requirements. 	<ul style="list-style-type: none"> Design Intent Summary containing all OPR’s. 	<ul style="list-style-type: none"> Provide input for performance requirements.
23.	Basis of Design	<ul style="list-style-type: none"> The design team shall prepare a Basis of Design document in response to the OPR previously established. 		<ul style="list-style-type: none"> Review Basis of design document 	<ul style="list-style-type: none"> Create Basis of Design document



BUILDING SYSTEMS COMMISSIONING COMMISSIONING MATRIX – TABLE 1

Task		Description	Owner	Cx	Design Team	Contractor
24.	35% Plan Review	<ul style="list-style-type: none"> Complete a thorough review of the 35% plan documents and submitted criteria to establish the systems to be designed and installed in compliance with the OPR. 35% documents shall include, Engineering Calculations, System selection and major Component selection. 	<ul style="list-style-type: none"> Review Basis of Design submittal from the design team. Resolution of any issues. 	<ul style="list-style-type: none"> Review and comment on 35% Design Review Log, issue resolution and Preliminary Commissioning Plan 	<ul style="list-style-type: none"> Basis of Design Document Engineering Calculations Major Component Selections Design Review Log Responses 	
25.	65% Plan Review	<ul style="list-style-type: none"> Review 65% Design Documents Draft Preliminary Construction Commissioning Plan, Commissioning Specifications and Supplemental Commissioning Language for other specification sections. 65% documents shall include zoning requirements, specifications, typical room layouts, system main layouts, riser layouts, standard details, schedules and coordination requirements. 	<ul style="list-style-type: none"> Owner will review all project submittal documents, assist in resolution of project issues and accept complete submittal. 	<ul style="list-style-type: none"> Preliminary Commissioning Plan Commissioning Specifications Design Review Log 	<ul style="list-style-type: none"> 65% Plans & Specifications Design Review Log Responses Update Basis of Design 	
26.	95% Plan Review	<ul style="list-style-type: none"> Review 95% Design Documents Updated Commissioning Plan, Final Commissioning Specifications and Supplemental Commissioning Language for other specification sections. 95% plans shall be essentially 100% complete except for coordination and review issues. 	<ul style="list-style-type: none"> Owner will review all project documents and assist in resolution of project issues and accept completed documents. 	<ul style="list-style-type: none"> Final Commissioning Specifications Updated Commissioning Plan Design Review Log 	<ul style="list-style-type: none"> 95% Plans & Specifications Update Basis of Design 	



BUILDING SYSTEMS COMMISSIONING COMMISSIONING MATRIX – TABLE 1

Task		Description	Owner	Cx	Design Team	Contractor
27.	Pre-bid Meeting and Assistance During Bidding process.	<ul style="list-style-type: none"> Pre-bid meeting to assist contractors in answering any questions about the systems or the commissioning process or work that may come up at that time. Provide assistance in answering written questions (in the form of clarifications or addendum recommendations) during the bidding process. 	<ul style="list-style-type: none"> Hold pre-bid meeting. 	<ul style="list-style-type: none"> Attend pre-bid meeting to answer commissioning questions. 	<ul style="list-style-type: none"> Attend pre-bid meeting to answer system questions. 	<ul style="list-style-type: none"> Attend pre-bid meeting.
<ul style="list-style-type: none"> Construction Phase Commissioning 						
28.	Construction Commissioning Kick Off meeting	<ul style="list-style-type: none"> Conduct an initial commissioning meeting with all contractors and commissioning team members. The purpose of the meeting will be to establish the purpose and proposed process for commissioning this facility in the construction, acceptance and warranties phases of the project. Review the individual roles and responsibilities of each participating commissioning team member as specified in the Construction Documents. 	<ul style="list-style-type: none"> Facilitate commissioning kick off meeting. 	<ul style="list-style-type: none"> Conduct initial commissioning kick off meeting. Meeting Minutes Updated Commissioning Plan 		<ul style="list-style-type: none"> Identify Contacts and Responsibilities for Commissioning Team Members
29.	Prepare Duration Schedule for Commissioning Activities	<ul style="list-style-type: none"> Based on the final commissioning plan, Prepare a duration schedule for the contractors for the commissioning activities required by the commissioning plan. This duration schedule should be incorporated into the contractor's project schedule to track all commissioning activities of the commissioning team. 		<ul style="list-style-type: none"> Create and coordinate duration schedule 		<ul style="list-style-type: none"> Provide construction schedule for coordination with commissioning schedule. Incorporate Commissioning Activities into CPM Project Schedule



BUILDING SYSTEMS COMMISSIONING COMMISSIONING MATRIX – TABLE 1

Task		Description	Owner	Cx	Design Team	Contractor
30.	Submittal & Shop Drawing Review	<ul style="list-style-type: none"> Review all pertinent approved shop drawings to support the Commissioning Process. Review of the shop drawings is for the purpose of developing appropriate FIV, OPT and FPT documents. Submittals & Shop drawings shall be reviewed for commissionability, maintainability and for compliance to the OPR. Note any issues identified in the Shop Drawing Review that might compromise the final commissioned system on the 'Commissioning Review Log' and submit comment to the Design Team for resolution. 	<ul style="list-style-type: none"> Assist in resolution of project issues if required. 	<ul style="list-style-type: none"> Review approved shop drawings. Create Design Review Log 	<ul style="list-style-type: none"> Design Review Log Responses 	<ul style="list-style-type: none"> Incorporate shop drawing and submittal changes as directed by the design team.
31.	Finalize Construction Commissioning Plan	<ul style="list-style-type: none"> Based on the work completed in the items above, finalize the Commissioning Plan for this project. The final commissioning plan will incorporate all changes established by review with your staff and the design team members. The final commissioning plan will also include complete FIV, OPT and FPT protocols for each system. 		<ul style="list-style-type: none"> Final commissioning plan 		
32.	Field Inspection Verifications (FIV)	<ul style="list-style-type: none"> During the course of construction, visit the site to inspect the progress of construction with respect to the systems being commissioned. The purpose of the inspections is to verify that the construction complies with the plans & specifications and standard construction quality practices. 	<ul style="list-style-type: none"> Review submitted documents. Provide Response to any Owner Related Commissioning Issue 	<ul style="list-style-type: none"> FIV Check Sheets. Site Inspection Reports. Daily Logs Commissioning Issues Log 	<ul style="list-style-type: none"> Review submitted commissioning issue logs. Provide Response to any Design Related issues. 	<ul style="list-style-type: none"> Review issues logs. Provide Response to any issues.



BUILDING SYSTEMS COMMISSIONING COMMISSIONING MATRIX – TABLE 1

Task		Description	Owner	Cx	Design Team	Contractor
33.	Commissioning Team Meetings	<ul style="list-style-type: none"> Hold commissioning meetings on a regular basis with the commissioning team to review progress of the commissioning effort and reinforce individual responsibilities. Review completed work and agree upon the acceptability of the delivered product. 	<ul style="list-style-type: none"> Attend meetings Assist in resolution of project issues if required. 	<ul style="list-style-type: none"> Hold commissioning meetings Keep commissioning issues log current. 	<ul style="list-style-type: none"> Attend meetings Assist in resolution of design issues if required. 	<ul style="list-style-type: none"> Attend meetings Assist in resolution of project issues
34.	Complete all FIV's	<ul style="list-style-type: none"> Complete all field inspection verifications. A completed FIV indicates the system or piece of equipment is ready to be started and OPT's performed. 	<ul style="list-style-type: none"> Assist in resolution of project issues if required. 	<ul style="list-style-type: none"> Complete FIV check sheets. 	<ul style="list-style-type: none"> Assist in resolution of design issues if required. 	<ul style="list-style-type: none"> Resolve any FIV check sheet issues.
35.	Operational Performance Tests (OPT)	<ul style="list-style-type: none"> Observe or facilitate all equipment and system start up procedures. The Contractor will execute all start up and point-to-point tests and the Cx will witness execution of all OPT's. . 	<ul style="list-style-type: none"> Assist in resolution of project issues if required. 	<ul style="list-style-type: none"> Observe all OPT tests. 	<ul style="list-style-type: none"> Assist in resolution of design issues if required. 	<ul style="list-style-type: none"> Complete all startup and OPT tests.
<ul style="list-style-type: none"> Acceptance Phase Commissioning 						
36.	Functional Performance Tests (FPT)	<ul style="list-style-type: none"> Observe and facilitate all FPT testing. FPT's shall be designed by the Cx and performed by the contractors. 	<ul style="list-style-type: none"> Assist in resolution of project issues if required. 	<ul style="list-style-type: none"> Observe FPT tests. Keep commissioning Issues Log current. 	<ul style="list-style-type: none"> Provide Response to any Design issues if required. 	<ul style="list-style-type: none"> Perform FPT tests. Resolve any FPT check sheet issues.



BUILDING SYSTEMS COMMISSIONING COMMISSIONING MATRIX – TABLE 1

Task	Description	Owner	Cx	Design Team	Contractor
37. Operator Training	<ul style="list-style-type: none"> Work with the contractor and owner to schedule and plan training activities so that training occurs in a coordinated and coherent fashion. Assist in the development of training schedules and agendas, encourage the use of a combination of “classroom” and field training, and assist the contractors in the development of training agendas for each system or component installed in the project. Contractors and vendors provide all training. Additional skill training can be provided as an additional scope item if desired by the owner. 	<ul style="list-style-type: none"> Schedule operators to attend training 	<ul style="list-style-type: none"> Schedule and coordinate training. 	<ul style="list-style-type: none"> Participate as required by the owner. 	<ul style="list-style-type: none"> Provide training as required.
38. Prepare Final Commissioning Report	<ul style="list-style-type: none"> Based on the accumulated commissioning work completed as described above, assemble all data into a final commissioning report. The final report will incorporate the final record documents for each system, as appropriate. The report will also include a summary of commissioning that will highlight the final condition of each system commissioned. 	<ul style="list-style-type: none"> Review final report 	<ul style="list-style-type: none"> Create report 		
• Warranty Phase Commissioning					
39. Deferred (Off season) Testing	<ul style="list-style-type: none"> Conduct any testing required by the commissioning plan that was deferred from the acceptance period. 	<ul style="list-style-type: none"> Review report addenda. 	<ul style="list-style-type: none"> Observe off season tests. 		<ul style="list-style-type: none"> Conduct off season FPT tests. Resolve any FPT check sheet issues.
40. Ten Month Warranty Visit	<ul style="list-style-type: none"> Cx will inspect the site and interview building operating personnel to identify any outstanding warranty failures and to identify any persistent equipment failure issues that should be handled within the warranty period. 	<ul style="list-style-type: none"> Review report addenda. Review final issues log. 	<ul style="list-style-type: none"> Conduct warranty visit. Follow up on any warranty repair issues. 		<ul style="list-style-type: none"> Resolve any warranty issues.