U.S. General Services Administration

GSA COMMISSIONING GUIDE

SEPTEMBER 2020

TABLE OF CONTENTS

FOREWORD

The U.S. General Services Administration (GSA) designs, constructs, and operates workplaces for 1.1 million Federal civilian employees through its Public Buildings Service (PBS). Comprising mostly courthouses, land ports of entry, and Federal office buildings, the PBS real estate inventory ranks among the largest in the United States.

For the tenants of Federal civilian buildings, existing conditions, maintenance, management, comfort, security, and design are criteria of workplace quality. PBS ensures it is delivering on all fronts through Total Building Commissioning.

As presented in this GSA Commissioning Guide, Total Building Commissioning, recommissioning, and ongoing commissioning translate expectations into documented and tangible facility results. Reduced operating costs, enhanced energy efficiency, elevated occupant safety, improved occupant comfort and health, increased asset longevity, and better maintainability, reliability, and operability are some of the proven results of commissioning.

In this guide, GSA specifically offers recommendations for navigating the commissioning process from its inclusion in project planning to its continued emphasis throughout the life of a facility. We hope the roadmap facilitates GSA associates, our customer agencies, and our consultants as they support our mission of providing a superior workplace for the Federal worker, and superior value for the American taxpayer.

Daniel W. Mathews
Commissioner of the Public Buildings Service
U.S. General Services Administration

INTRODUCTION

ABOUT THIS GUIDE

The primary audience for the GSA Commissioning Guide includes GSA's project managers (PMs) as well as their construction management advisors, the Commissioning Provider, and GSA's Office of Facilities Management (OFM). The commissioning process has many stakeholders, such as customer agencies, the balance of the project team, other members of government, and GSA's partners; these parties should consider interacting with the guide.

The GSA Commissioning Guide provides the overall framework for commissioning, from project planning through tenant occupancy. Further, it describes the mechanics of the commissioning process, by identifying the participation of each team member and other keys to success in each step along the way. While recognizing that every project is unique and that required activities will vary, this guide describes recommendations, minimum requirements, and best practices based upon industry guidance and GSA experience. Applying the GSA Commissioning Guide completely to projects not only addresses the facility needs of customer agencies, but also ensures national consistency in PBS practice.

The Guide is organized into the following sections:

- "Philosophy" provides GSA's definition and expectations for commissioning
- "Building Commissioning Process" details considerations, practices, and recommendations for commissioning during the project-initiation, design, construction, and occupancy and operations phases of a GSA project
- Appendices include templates and samples, tools, definitions, and links to further resources for additional information on commissioning

What's New

The 2005 version of the GSA Commissioning Guide has been updated to reflect current project-management process and tools, and this update features new processes for commissioning building enclosures. In addition, this most recent guide describes OFM recommissioning and ongoing-commissioning processes and describes commissioning roles and responsibilities for different construction delivery methods. Finally, it identifies the most current references and resources.

Beyond This Guide

As required by GSA's Facilities Standards for the Public Buildings Service (PBS-P100), all GSA capital construction projects employ the Total Building Commissioning practices recommended by the GSA Commissioning Guide. Commissioning requirements specific to each project should be detailed in the commissioning provider statement of work, A/E statement of work, and construction contractor commissioning specifications.

Development of this guide included a thorough review of myriad publications dedicated to the commissioning discipline. Total Building Commissioning further incorporates industry guidance and best practices suggested by leading organizations that include:

- ASHRAE
- ASTM International
- National Institute of Building Sciences (NIBS)
- U.S. Department of Energy

For a complete listing of resources and references, see Appendix C.

The GSA Commissioning Guide identifies many additional sources and experts for detailed support of the commissioning process, as well. GSA oversees a comprehensive body of these resources, which cover key topics in facilities ranging from site selection and historic preservation to sustainability and which also include pricing guides and facilities standards.

PHILOSOPHY

To assure a high standard of excellence for the American public, GSA utilizes Total Building Commissioning when serving the space requirements of Federal agencies. Total Building Commissioning is PBS's process of ensuring quality delivery of building functionality in new construction and major modernizations. It validates and documents that the performance of the total building and its systems meet the design intent and requirements of the owner. Ultimately, Total Building Commissions helps GSA achieve its intents and requirements and fulfill its duty to both customer agencies and the American taxpayer.

Defining Commissioning for GSA Buildings

Commissioning ensures the delivery of efficient, durable, and comfortable facilities. ASHRAE Guideline 0-2019 The Commissioning Process defines commissioning as follows:
"Commissioning Process (Cx): 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)".

Historically, the term *commissioning* has referred to the process by which a building's heating, ventilation, and air-conditioning (HVAC) systems were tested and balanced according to established standards prior to acceptance by the building owner. Today, the commissioning process views building performance as a holistic system whose impacts range from sustainability and workplace productivity to occupant safety and security: commissioning proves that all designed and constructed systems meet specified performance standards.

Depending on the project, separate commissioning efforts might be required for HVAC systems; fire protection and life safety systems; building enclosure systems that include roofing, facades, and below-grade waterproofing; and landscape systems. Such efforts are distinct and require different personnel, and project teams should develop separate commissioning plans for these efforts. PBS-P100 provides information on commissioning for fire protection and life safety systems, for example.

As reflected within the PBS-P100*,* GSA accepts building commissioning practices as described within this guide and by referenced standards. Since 2006, prospectus-level projects (new construction and major modernization) have adopted Total Building Commissioning practices beginning with project initiation

and concluding with the project's occupancy and operations phase. These projects should include provisions for Total Building Commissioning in their budgets. Where performance risk has been identified in the repair and alteration of existing buildings, project teams should consider incorporating commissioning requirements independent of project size and funding source.

Benefits of Commissioning for GSA Buildings

Because all building systems are integrated, a deficiency in one or more components can result in suboptimal operation and performance among other components. Remedying these deficiencies can result in a variety of benefits, such as:

- Improved building occupant productivity
- Lower utility bills through energy savings
- Increased occupant and owner satisfaction
- Enhanced environmental/health conditions and occupant comfort
- Improved system and equipment function
- Improved building operations and maintenance
- Increased occupant safety
- Better building documentation
- Shortened occupancy transition period
- Significant extension of equipment/systems' life cycle
- Increased building life-cycle durability

According to the U.S. Department of Energy 2018 Commissioning Cost/Benefit Study Findings, commissioning of existing buildings yields energy savings that range from 3 to 10 percent. New-construction commissioning results in 13 percent median whole-building energy savings. In utilizing commissioning, GSA aims to:

- Implementing solutions that manifest long-term energy efficiency and functionality in all PBS buildings
- Create safe, healthy, and reliable working environments that customers expect from GSA
- Improve facility operations' energy efficiency and reduce O&M costs
- Optimize the value received for each construction dollar spent
- Assure construction quality
- Improve Indoor Environmental Quality (IEQ) and decrease liability due to IEQ problems
- Improve PBS buildings systems documentation

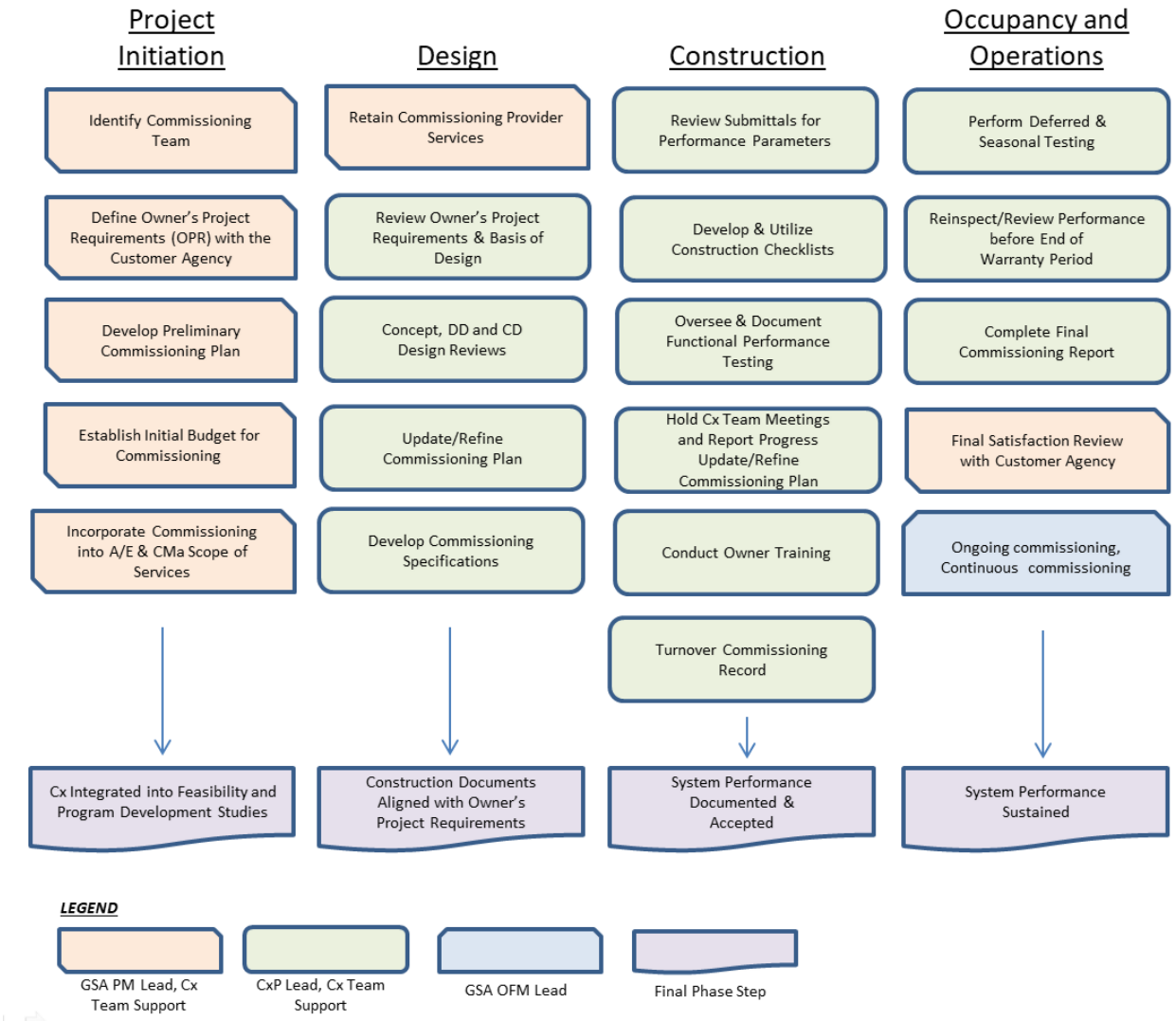
When properly coordinated with construction-phase work, commissioning enables the discovery of the sequence of activities required to achieve desired performance. GSA can be reasonably assured of the life-cycle cost effectiveness of the Federal Government's real estate investments, and it can establish workmanship standards for replication throughout its portfolio, in turn. Total Building Commissioning safeguards the interests of PBS.

BUILDING COMMISSIONING PROCESS

OVERVIEW

The building commissioning process is interwoven with the overall project delivery process. This Guide outlines only the key essential steps within the commissioning process, without detailing all of the capital program delivery process steps. Subsequent pages in this section provide more detail on the building commissioning process phases, deliverables and specific responsibilities of the entire Commissioning Team.

Building Commissioning Process



PROJECT INITIATION PHASE

For the purpose of this document, the Project Initiation Phase encompasses GSA's Pre-Planning, Feasibility Study and Program Development Study (PDS) activities per GSA PM Guide. Consideration for commissioning is critical even at the Project Initiation Phase of a project. During this phase, the GSA Project Manager (PM) should establish commissioning as an indelible piece of the overall delivery process. Adequate consideration for commissioning scope, budget and schedule should be included in the Feasibility Study and Program Development Study (PDS). Further, it is at this phase that the Owner's Project Requirements are developed in concert with the Customer Agency. These requirements establish the benchmarks for performance later in the commissioning process.

Identify Commissioning Team

The first step in the commissioning process is for the GSA PM to identify and layout the makeup of the Commissioning Team. The exact size and members of the commissioning team will vary depending on project type, size and complexity, however in general the team will consist of:

- GSA Project Manager (Team Leader)
- GSA Facilities Management/Operational Excellence representatives
- Customer Agency Representative(s)
- GSA Subject Matter Experts (SME) (i.e. Structural, Mechanical, Electrical, Fire Protection, Elevator, Seismic, Building Enclosure, LEED/Sustainability, Landscape Architecture, SITES, etc.)
- GSA Contracting Officer
- Construction Manager as Advisor (CMa)*
- Construction Contractor and Subcontractors
- Commissioning Provider (CxP)
- Architect/Engineer (A/E)
- Equipment Manufacturers and Vendors

*Note: Throughout this Guide there are references to Construction Manager and CM. Unless otherwise specified, this is assumed to mean Construction Management as Advisor (CMa) as opposed to Construction Management Contractor, CM at risk or General Contractor, which is consistently referenced as Construction Contractor.

The Commissioning Team is responsible for working as a cohesive unit to assure that all of the steps in the commissioning process are completed and the facility objectives are met. Even though it is likely that key team members (i.e. CMa, A/E, CxP) will not be on board at this phase of the project, completion of a project specific Roles and Responsibilities Matrix will help the GSA PM develop the A/E, CMa and CxP contract scopes for commissioning. The GSA PM should use a Roles and Responsibilities Matrix as a tool to develop the SOWs for the A/E, Construction, D-B, and CMa contracts depending on the project's selected delivery method and other project specific considerations. Using a Matrix will help ensure that the appropriate tasks are assigned to the right entities on the project team while also ensuring that no steps are unintentionally omitted. The initial roles and responsibilities matrix should be updated and confirmed during the design and construction phases once the team members are contracted. See appendix A for a draft commissioning roles and responsibilities matrix that should be edited to meet the project specific requirements.

Define Owner's Project Requirements with the Customer Agency

The objective of commissioning is to provide documented confirmation that a facility fulfills the functional and performance requirements of GSA, its occupants and operators. To attain this goal, it is necessary to establish and document owner project requirements and criteria for system function, performance and maintainability. The Owner's Project Requirements (OPR) forms the basis from which all design, construction, acceptance and operational decisions are made.

The commissioning process necessarily changes with the project delivery method. To ensure that a construction contract accounts for the full effort and cost of commissioning activities, the Owner's Project Requirements (OPR) must be developed prior to the construction contract award. For the Design-Bid-Build and Construction Manager as Constructor (CMc) delivery methods, the OPR can be developed concurrent with the design. Similarly, the OPR can be developed during the bridging phase of a design-build project. However, when the design-build delivery method is used, the OPR must be developed during project planning to ensure design-builders' technical and price proposals include all commissioning requirements. The OPR should establish requirements for all mock-ups and testing including testing types, quantities, and protocols for retesting.

The following suggested categories provide a framework for the types of requirements that should be considered.

Accessibility	Architectural Barriers Act Accessibility Standard (ABAAS)
Acoustics	Control of internal and external noise and intelligibility of sound
Comfort	Identify and document those comfort problems that have caused complaints in the past and which will be voided in this facility (i.e. glare, uneven air distribution, etc.)
Communications	Capacity to provide inter- and intra-telecommunications throughout the facility
Constructability	Feasibility of transportation to site, erection of components and assemblies, and health and safety during construction. Consider contractor means and methods and identifies risk in successful execution.
Design Coordination	Resolve all technical problems thoroughly and across disciplines to ensure durability and optimize facility life cycle performance.

Design Excellence	Concept development DE peer review process and incorporating peer guidance and adherence to approved design concept as design progresses
Durability	Retention of performance over required service life
Energy	Goals for energy efficiency (to the extent they are not called out in the Green Building Concepts)
Fire Protection and Life Safety	Fire protection and life safety systems. This includes active and passive fire protection and life safety systems and their interconnection with other building systems.
Flexibility	For future facility changes and expansions
Health and Hygiene	Protection from contamination from waste water, garbage and other wastes, emissions and toxic materials
Indoor Environment	Including hygrothermal, air temperature, humidity, condensation, indoor air quality and weather resistance
Installation evaluation, testing requirements, and sampling procedures.	Evaluation, testing, integrated system design and testing and sampling criteria quantity identified.
Light	Including natural and artificial (i.e. electric, solar, etc.) illumination
Maintenance Requirements	Varied level of knowledge of maintenance staff and the expected complexity of the proposed systems, maintainability, access and operational performance requirements.
Security	Protection against intrusion (physical, thermal, sound, etc.) and vandalism and chemical/biological/radiological threats
Site Development	Systematic process of verifying that the dynamic systems built beyond a building's skin, perform in accordance with design intent and the property owner's operational needs including stormwater management, site utilities, irrigation, filtration, water harvesting systems and dynamic site security systems.. (background report for reviewers on this subject can be found at: https://www.gsa.gov/real-estate/design-construction/landscape-architecture/landscape-analytics-and-commissioning)
Standards Integration	Integration of approved Federal, State and local as well as GSA and Customer Agency standards and requirements
Structural Safety	Resistance to static and dynamic forces, impact and progressive collapse
Sustainability	Sustainability concepts including LEED certification goals
Training	Training requirements for the Owner's staff

Obtaining the information and criteria for the Owner's Project Requirements (OPR) necessitates input from all key facility users and operators. The Owner's Project Requirements shall be developed in keeping with the processes detailed in GSA's PM Guide including conformance with the P100 standards, facility specific (i.e. courthouse, border station, etc.) design guidelines and project programming methodologies. In some cases the tenant is likely to have a prescribed set of project requirements typically identified as the Program of Requirements (POR). The OPR is the larger umbrella of requirements that includes the POR, the P100, exceptions, qualifications and all other requirements.

The Owner's Project Requirements should be reviewed by the CxP and approved by the Owner during pre-design phase. Updates during subsequent project activities should be formally accepted by the Owner. The OPR may evolve during the design phase of the project, but requirements should be firm at the completion of construction documentation and prior to soliciting a construction contract to control

the impacts of construction phase change. The OPR is the primary tool for assuring quality and will it ultimately become part of the systems manuals documentation.

GSA's P100 Facilities Standard establishes the minimum requirements for building enclosure commissioning (BECx). For some projects, P100 requirements are sufficient. For other project types, further development is required to address unique risks. Building types that require the development of more robust OPRs include, but are not limited to:

- Coastal buildings subject to extreme weather events
- NARA-certified storage facilities protecting valuable contents
- Laboratories with tightly controlled interior environments
- Tall buildings subject to stack effects
- Buildings, campuses and structures with security requirements

For BECx, the P100 Facilities Standard references ASTM E2813, Standard Practice for Building Enclosure Commissioning, and ASTM E2947, Standard Guide for Building Enclosure Commissioning. ASTM E2813 is the requirements document with enforceable contract language. ASTM E2813, Annex A1, provides an "OPR Development Guideline".

As noted above, the project delivery method has implications for the timing of commissioning planning. Commissioning experts must be retained and engaged to develop the OPR in advance of construction contract award. Doing so will help to mitigate the risks of scope changes and schedule delays during the construction phase.

GSA's P100 Facilities Standard establishes the minimum requirements for commissioning fire protection and life safety systems. In addition, commissioning of fire protection and life safety systems must meet the procedures, methods, and documentation for the commissioning of active and passive fire protection and life safety systems and their interconnections with other building systems in accordance with NFPA 3, Standard for Commissioning of Fire Protection and Life Safety Systems.

Develop Preliminary Commissioning Plan

The Commissioning Plan translates standards and requirements into an actionable approach by developing the sequence of activities required to prove system performance. The durations and costs of activities enable management of the processes. The Cx plan should include a discussion of the commissioning process, schedule, team and team member responsibilities, communication structures and a general description of the systems to be commissioned.

This preliminary version of the Cx Plan should be developed by members of the Commissioning Team. The CxP and/or BECxP should provide the requisite expertise and proactive leadership to properly represent GSA's and the Customer Agency's interests. Many CxPs and/or BECxPs make use of well-developed Cx Plan templates. However, a complete Cx Plan will adapt boiler plate language to address the project specific risks defined by the OPR.

It is prudent to develop the Preliminary Commissioning Plan prior to the award of the construction contract. Collectively, the OPR and Cx Plan will collectively describe the required efforts and their associated costs such that the Cx statement of work captures the full scope of mock-ups and functional performance testing. However, because commissioning activities require coordination with the construction contractor, the development of the Final Cx Plan necessarily occurs following construction contract award. Final Cx Plan development should occur as soon after construction contract award as possible so that the required activities can be incorporated into the construction schedule without risk of delay. Deleting Cx activities from the construction phase for convenience is unacceptable.

The suggested structure of the Commissioning Plan is as follows. All information in the Commissioning Plan should be project specific.

Introduction	Purpose and general summary of the Plan.
General Project Information	Overview of the project, emphasizing key project information and delivery method characteristics.
Commissioning Scope	The commissioning scope including which building assemblies, systems, subsystems and equipment will be commissioned on this project.
Team Contacts	Project specific Commissioning Team members and contact information
Communication Plan and Protocols	Documentation of the communication channels to be used throughout the project.
Commissioning Process	Detailed description of the project specific tasks to be accomplished during the Project Initiation, Design, Construction and Occupancy and Operations Phases with associated roles and responsibilities and the framework for procedures to follow when Cx evaluation does not meet the OPR.
Commissioning Documentation	List of commissioning documents required to identify expectations, track conditions and decisions and validate/certify performance.
Commissioning Schedule	Specific sequences of events and relative timeframes, dates and durations.

The Commissioning Provider will add to this preliminary Plan in the Design and Construction Phases by assembling and completing the Commissioning Plan Appendices as detailed below. The completed Appendices will form the Commissioning Record turned over at the end of the construction phase (see "Turnover Commissioning Record").

Commissioning Plan Appendices	Work completed during the commissioning process
A	Owner's Project Requirements
B	Basis of Design
C	Commissioning Specifications
D	Design Review
E	Submittal Review
F	Issues Log
G	Construction Checklists
H	Site Visit and Commissioning Meeting Minutes
I	O&M Manual Review
J	Training
K	Functional Performance Tests and Seasonal Testing
L	Warranty Review

Under the guidance of a qualified CxP and/or BECxP, and with the input of the Customer Agency, the GSA project team including GSA OFM personnel should derive the initial commissioning scope. In addition to incorporating established minimum requirements, the commissioning scope should address performance risks that are unique to a design. Innovative, custom designs represent a higher level of performance risk than other already proven systems. The Commissioning Systems Selection Matrix provided in Appendix B of this Guide is a useful tool in selecting systems to commission for a particular facility type. Exact systems should be determined on a project to project basis.

Commissioning for Certifications (LEED, Energy Star, SITES, etc.)

Development of the preliminary Commissioning Plan and initial commissioning scope should also include a discussion regarding project certifications and goal attainment (i.e. LEED, SITES, Energy Star, Energy Goals, Design Awards, etc.). The commissioning scope should include the activities needed to meet the project SITES or LEED prerequisite requirements for fundamental building commissioning and enhanced commissioning. For building enclosure commissioning, the GSA P100 Facilities Standard baseline requirements and Tier 1 requirements satisfy the corresponding LEED requirements for fundamental and enhanced commissioning, respectively

Establish Initial Budget for Commissioning

The GSA Project Manager develops commissioning related costs with assistance from GSA regional estimators and includes budgetary costs for commissioning in the Feasibility Study, Enhanced Feasibility Study and the Program Development Study. It is critical that the overall established budget which is submitted for funding approval contains necessary costs for commissioning.
Specifically, Feasibility Study, Enhanced Feasibility Study and Program Development Study deliverables per GSA's PM Guide call for estimated construction costs (ECC) and estimated total project costs (ETPC). These estimates must include line items for both commissioning services and testing.

Commissioning Provider Costs

Total building commissioning costs for Commissioning Provider services can range from $0.13 to $0.48 per square foot for existing buildings and from $0.40 to $1.35 per square foot for new construction (U.S. Department of Energy. 2018 Commissioning Cost/Benefit Study Findings).
GSA's total commissioning practice occurs during the entire life of a project and is based on a sliding scale. The larger the project, the lower the percentage, and the lower the unit cost (cost per GSF) paid for commissioning services. In addition, the building complexity has an impact on the expected commissioning cost. A Courthouse being more complex than a typical Office requires great due diligence in the commissioning services, hence a greater level of effort, and greater cost. The same is true for a complex Laboratory.

Other factors apart from building complexity that affect the cost of commissioning services are the overall size of the project, phasing 24/7 operations, the depth and breadth of commissioning services, the level of commissioning desired and the systems and assemblies chosen to be commissioned. The following chart shows benchmark costs (percent of construction costs and cost per GSF) for Commissioning Provider services by facility type.

Benchmark Cost of Total Building Commissioning				
Building Type	Percentage of Construction Cost (ECC)		Cost per GSF of Building Area	
	Minimum	Maximum	Minimum	Maximum
Office	0.5%	1.75%	$3.25	$5.00
Courthouse	0.75%	2.25%	$5.00	$8.00
Laboratory	0.90%	2.50%	$7.00	$10.00
Land Port of Entry	0.5%	2.00%	$3.00	$5.00

(Source: GSA Cost and Schedule Management Team, 2015 Development of Professional Services Fee Look-Up Table)

Additional Project Costs

The above costs only cover Commissioning Provider fees. There are also costs to the Construction Manager as Advisor, Construction Contractor, A/E and owner staff for their part in the commissioning process. The profile of these costs will vary depending on roles and responsibilities chosen. For a detailed estimate of professional service fees, an itemized level of effort needs to be performed based on unique project requirements.

DESIGN PHASE

Design Phase commissioning activities serve to assure that the Owner's Project Requirements for items such as energy efficiency, sustainability, indoor air environmental quality, fire protection and life safety, etc. are sufficiently defined and adequately and accurately reflected in the construction documents. The Design Phase is the Commissioning Team's opportunity to assure that building systems and assemblies as designed will function according to user expectations. Further, specific tests and procedures designed to verify the performance of systems and assemblies are developed and incorporated into the construction documents.

Incorporate Commissioning into A/E and CMa Scopes of Services

GSA Commissioning Guide recommended activities may be more rigorous than A/Es and CMas typically include in their scope of services. Project Initiation, Design, Construction, Occupancy and Operations phase commissioning activities should be defined and written into the Architect/Engineer and Construction Manager as Advisor scopes of work and executed contracts.

By the design phase of project development, the GSA Project Manager must have an awareness of how commissioning services will be delivered.

It is an industry best practice for commissioning services to be provided by an independent third-party. This eliminates the inherent conflicts of interest for construction contractors attempting to verify the performance of their own work. However, it has been GSA's practice to allow construction contractors to subcontract for testing services. This has been found to be beneficial because it allows the construction contractor to sequence the commissioning activities with other construction phase activities without risk of schedule delays caused by others. The roles and responsibilities of the various parties should be established by the Roles and Responsibilities Matrix and the Preliminary Cx Plan/BECx Plan.

It is also possible, and sometimes preferable, for GSA to contract for commissioning services independent of the construction contractor. Alternatives include procuring such services directly, tasking the Construction Manager as Advisor (CMa) to subcontract for services, or similarly tasking the Architect-Engineer of record. If GSA contracts for commissioning services independent of the construction contractor, it is incumbent upon the GSA project team and the CMa to coordinate the commissioning activities with the construction contractor's schedule so as to mitigate the possible risk of government caused delays.

When commissioning services are subcontracted by the construction contractor, GSA requires the representation of a CxP and/or BECxP to provide oversight, to ensure the integrity of the testing methods, and to report the outcomes. Again, alternatives include procuring such services directly, tasking the Construction Manager as Advisor (CMa), or tasking the Architect-Engineer of record. Should the project team determine that the CMa will contract the commissioning provider, this must be written into the CMa's scope of work.

In summary, the requirement for an independent commissioning provider may be satisfied by an independent third-party contracted by GSA, or by a firm subcontracted by the Construction Manager as Advisor (CMa), but not solely by the construction contractor itself.

Commissioning services for Design and Construction Management professionals should minimally include, but are not limited to the items listed below:

A/E and CMa Commissioning Scope Items

Design Professional

1. Participate and aid in the documentation of the Owner's Project Requirements.
2. Document revisions to Owner's Project Requirements and obtain GSA Approval.
3. Document the Basis of Design.
4. Review the P100 measurement and verification requirements and integrate Cx process requirements and activities into the construction documents.
5. Confirm the validity of the CX schedule and update as needed to coordinate with the construction schedule.
6. Integrate Cx process requirements and activities provided by the CxP into the construction documents.
7. Confirm qualified specialists, where required, perform commissioning activities.
8. Review submittals, plans and product data sheets, for conformance to the basis of design.
9. Document issues and changes to the project and update the commissioning plan.
10. Attend Commissioning Team meetings (Design Review Meetings and Construction Phase Cx Team meetings).
11. Specify and verify that the operation and maintenance of the systems and assemblies have been adequately detailed in the construction documents.
12. Review and incorporate as appropriate the CxP's comments into the construction documents.
13. Review integrated systems design for compatibility or communication problems.
14. Participate in the operations and maintenance personnel training as specified in the training program. Verify owner training took place.
15. Review test procedures submitted by the contractor. Document the testing activities.
16. Complete commissioning construction checklists.
17. Review and comment on the CxP's progress reports and issue logs.
18. Witness the functional testing of all commissioned systems and assemblies.

19. Review and accept record documents as required by the construction documents.
20. Verify that materials, construction, and installation conform to the basis of design.
21. Review and comment on the final Commissioning Record.
22. Recommend final acceptance of the systems to GSA.
23. Verify systems are installed as specified.

Construction Manager as Advisor

1. If appropriate, lead the RFQ process for commissioning services and award a contract to a Commissioning Provider directly under the Construction Manager as Advisor.
2. Include commissioning process activities and requirements into all General Contractor Bid Packages.
3. Work with the Commissioning Team to develop a schedule for commissioning activities and incorporate commissioning activities into the overall project schedule
4. Provide personnel with the means and authority to coordinate implementation of the commissioning process as detailed in the construction documents.
5. Attend Commissioning Team meetings (Design Review Meetings and Construction Phase Cx Team meetings).
6. Coordinate with the Commissioning Provider in development of a Commissioning Plan.
7. Perform quality assurance functions, particularly in the areas of design reviews for constructability and inspection.
8. Participate in and assist with the functional testing of all commissioned systems and assemblies.
9. Provide technical expertise such as testing, cost estimating and resolving disputes.
10. Ensure General Contractor coordinates and documents Owner/Operator training.
11. Issue a statement that certifies all work has been completed and the facility is operational, in accordance with the construction documents.
12. Coordinate General Contractor remedies for deficiencies identified by the Commissioning Provider during their verification of the installation or tests.
13. Review and comment on the final Commissioning Record.

Retain Commissioning Provider Services

GSA's suggested practice is to task the Construction Manager as Advisor (CMa) to hire a subcontractor to act as the Commissioning Provider (CxP). This results in no additional contract management responsibilities for GSA. In such a case, the CMa will lead the RFQ process for commissioning services. There will be exceptions to this suggested practice, and in these cases, GSA will lead the RFQ process for a CxP. Regardless of the contracting method, the CxP should be under contract by the beginning of Design Development.

For building enclosure commissioning, depending on the project delivery method, GSA should retain the services of the BECxP during the Pre-design phase and no later than Design Development. Projects using the design-build delivery method should retain the services of a CxP/BECxP during the planning phase to ensure the full scope of commissioning activities is solicited from the offerors.

Commissioning Provider Qualifications

The Commissioning Provider and the Construction Manager as Advisor generally have different skills. In general, the Construction Manager as Advisor provides management, technical and administrative expertise during the design and construction phases to ensure that the Customer Agency's goals relating to schedule, budget, scope and quality are met. A Commissioning Provider has technical background and in-depth expertise with the commissioning process including verification techniques, functional performance testing, system equipment, fabrication processes and O&M knowledge.

The Commissioning Provider must have significant commissioning experience, including technical and management expertise on projects of similar scope, size and type and meet the minimum commissioning qualifications required for LEED projects. Further the CxP should bring a total building commissioning perspective to the project and be knowledgeable in the interdependency of systems performance. Expertise should include knowledge of national building fire codes, as well as water-based extinguishing systems, detection systems, LEED and energy efficiency imperatives. A CxP/BECxP should further demonstrate experience with other Federal requirements (i.e. blast, progressive collapse, security, etc.).

GSA relies heavily on our Commissioning Providers (CxP/BECxP) to represent the interests of the government by assuring the quality of constructed systems. In addition to technical expertise and experience, CxP/BECxP qualifications should include strong leadership ability and a proactive approach to identifying and solving problems. GSA Project Managers should expect CxP/BECxPs to actively assert their expertise and identify risks before the project budget, schedule, and quality can be impacted. Especially when a CxP/BECxP is a subcontractor to a Construction Manager as Advisor, GSA PM's must ensure the Government's contracted expert representatives are empowered to advocate effectively.

Request for Qualifications (RFQ) for Commissioning Provider

The RFQ for Commissioning Provider services is based upon the Preliminary Commissioning Plan and the commissioning budget established in the Program Development Study (PDS). Depending on the CxP delivery method (i.e. CMa versus GSA contracts the CxP), this may be the responsibility of either GSA or the CMa. If the RFQ is performed by the CMa, this format may vary slightly.

Project Background	Building type, square footage, general program, overall project budget, milestone schedule dates, LEED and other certification pursuits, etc.
Objectives	GSA project objectives for commissioning
Scope of Work	Design, Construction and Occupancy and Operations Phase expectations for the Commissioning Provider
Systems and Assemblies	Preliminary identification of the systems and assemblies to be Commissioned. Once contracted, the CxP will further develop this matrix.
Qualifications	Desired qualification of the CxP Proposal Expectations for format and content of prospective CxP's proposal
Change in Personnel	Statement on GSA review of CxP changes in personnel for the project
Selection Criteria	A table indicating the selection criteria and scoring system for evaluating CxP proposals

Commissioning Provider Selection

This service should be acquired in the same manner as other professional services. The Commissioning Provider should be chosen on the primary basis of qualifications and not solely based on price. It is recommended that the CxP is contracted according to a two stage fee negotiation process. The first stage includes Project Initiation Phase, Pre-Design and Design Phase responsibilities and the second stage includes Construction Phase and Occupancy and Operations Phase. This two stage process allows for the negotiation of the initial fee to be based on known general factors, and negotiation of the Construction Phase and Occupancy and Operations Phase fee based upon a substantially completed design and the Final Cx/BECx Plan including the actual type and number of equipment, systems and assemblies to be inspected, started and tested. Within the Project Initiation Phase and Design Phase proposal, the CxP should be asked to provide budgetary numbers for the Construction Phase and Occupancy and Operations Phase.

Review Owner's Project Requirements and Basis of Design

As described in previous sections, the Owner's Project Requirements are developed as part of GSA's project planning processes and establish baseline criteria for facility function, performance and maintainability. The Basis of Design (BOD) is developed by the A/E early in the Design Phase based on Owner's Project Requirements. It is the primary document that translates GSA's and the Customer Agency's needs into building components such as HVAC systems, building enclosure systems, security systems, building automation system, etc. The BOD describes the technical approach planned for the project as well as the design parameters to be used. The BOD is typically developed by the A/E and written in technical terms, whereas the Owner's Project Requirements are developed by GSA in concert with the Customer Agency and expressed in layman's terms.

When the Commissioning Provider is brought on board early in the Project Initiation phase, one of their first tasks is to review the Owner's Project Requirements and the Basis of Design (BOD). The purpose of these reviews is to assure that the Customer Agency's needs are met as described in the Owner's Project Requirements and captured in the Basis of Design Document. The CxP's review ensures clarity and completeness with an eye toward commissioning process activities (benchmarks, standards, performance targets, etc.). The CxP may recommend changes to improve energy efficiency, operation and maintenance and equipment reliability. Making changes in the Design Phase, rather than after installation begins, saves money.

Through the design process, a key role for the Commissioning Provider is to facilitate a clear understanding of expectations by the design team. To do this, the practice of conducting program

review meetings is to be used to offer all stakeholders the opportunity to indicate what they want to see in the next design submission.

Concept, DD and CD Design Reviews

The Commissioning Provider should provide focused reviews of the design documents in a quantity that corresponds to project complexity. The GSA project team and the CxP and/or BECxP should collaborate to develop an approach and scope of services that promise to assure project quality. It is recommended that these reviews occur first at the end of Design Concepts, the second should occur during Design Development (50%) and the third toward the end of Construction Documents Phase (95%) (see P100 for definition of Concept, DD and CD design phases).

The CxP compares the design with the interests and needs of GSA as identified in the Owner's Project Requirements and Basis of Design (BOD). The CxP also compares the proposed design against GSA design standards as defined in the latest version of the PBS P100 Facilities Standards. The CxP identifies any improvements that can be made in areas such as energy efficiency, indoor environmental quality, operations and maintenance, etc. The CxP also identifies vulnerabilities in the design and/or challenges to constructability that represent possible risks of system failure and risks to life cycle durability. Though the CxP is responsible for reviewing the design from a commissioning perspective, the CxP is typically not responsible for design concepts and criteria or compliance with local, State and Federal Codes.

The CxP must coordinate all Fire Protection and Life Safety system commissioning with the GSA Regional Fire Protection Program Office. In certain jurisdictions, State and local government officials may elect to perform code compliance construction inspections of the building systems in addition to the GSA code compliance and testing of fire protection and life safety systems. Therefore, it is recommended that the A/E, CxP, CMa and each contractor's contract include provisions for each to handle the additional requirement of coordinating their work with State and local government officials.

Commissioning Provider Focused Design Review Scope

Certification Facilitation	Review construction documents to facilitate project certification goals (i.e. does design meet Energy Star requirements; does Cx meet LEED criteria, etc.).
Commissioning Facilitation	Review construction documents to facilitate effective commissioning (sufficient accessibility, test ports, monitoring points, etc.).
Commissioning Specifications	Verify that bid documents adequately specify building commissioning, including testing requirements by equipment type.
Control System and Control Strategies	Review HVAC, lighting, fire control, emergency power, security control system, strategies and sequences of operation for adequacy and efficiency.
Electrical	Review the electrical concepts/systems for enhancements.
Energy Efficiency	Review for adequacy of the effectiveness of building layout and efficiency of system types and components for building shell, HVAC systems and lighting systems.
Enclosure	Review enclosure design and assemblies to ensure the separation of outside and inside environmental conditions. Review for thermal, air, and water barrier continuity and integrity for all six sides of the building. Consider performance impacts on occupant

	comfort, interior finishes, and the performance of other interdependent systems including HVAC. Assure system life cycle durability.
Fire Protection and Life Safety	Review design and construction documents to facilitate effective Cx of fire protection and life safety systems and to aid in active fire protection systems being inspected and tested for proper installation and operation including witnessing the acceptance testing (e.g., sequence of operation and functional tests), and integrated system testing of these systems to obtain a GSA certificate of occupancy .
GSA Design Guidelines and Standards	Verify that the design complies with GSA P100 design guidelines and standards, Court Design Guide, Border Station Guide and Federal Facility Council requirements).
Functionality	Ensure the design maximizes the functional needs of the occupants.
Indoor Environmental Quality (IEQ)	Review to ensure that systems relating to thermal, visual acoustical, air quality comfort, air distribution maximize comfort and are in accordance with the OPR.
Life Cycle Costs	Review a life cycle assessment of the primary competing mechanical systems relative to energy efficiency, O&M, IEQ, functionality, sustainability.
Mechanical	Review for owner requirements that provide flexible and efficient operation as required in the P100, including off peak chiller heating/cooling AHU operations, after-hours operation, pressurization requirements and size and zoning of AHUs and thermostat zones.
Operations and Maintenance (O&M)	Review for effects of specified systems and layout toward facilitating O&M (equipment accessibility, system control, etc.).
O&M Documentation	Verify adequate building O&M documentation requirements.
Owner's Project Requirements	Verify that construction documents are in keeping with and will meet the Owner's Project Requirements.
Structural	Review the structural concepts/design for enhancements (i.e. blast and progressive collapse).
Sustainability	Review to ensure that the building materials, landscaping, water and waste management create less of an impact on the environment, contribute to creating a healthful and productive workspace, and are in accordance with Owner's Project Requirements. See also P100 LEED and SITES requirements.
Training	Verify adequate operator training requirements.

Issues Log

All comments and issues identified must be tracked in a formal Issues Log. The Issues Log must be sufficiently detailed so as to provide clarity and a point of future reference for the comments. The Issues log should contain at a minimum:

- Description of Issue
- Cause
- Recommendation
- Cost and Schedule Implications (on design, construction and facility operations)
- Priority
- Actions Taken
- Final Resolution

The Issues Log serves as a vehicle to track, critically review and resolve all commissioning related issues. The Log is maintained by the CxP and becomes part of the final Commissioning Record.

Design Review Meetings

The Cx Team should have Design Review Meetings (Kick-off, Concept/DD and CD) in number that corresponds to the project phases and CxP statement of work. Additional meetings may be required to resolve outstanding issues. The CxP is responsible to lead design review meetings and work collaboratively with the Commissioning Team toward presentation, discussion and resolution of design review comments. Upon resolution of the CxP's comments, the A/E is responsible to incorporate all approved changes into the design documents.

Update/Refine Commissioning Plan

Now that the Commissioning Provider is on board and has performed Pre-Design and Design Phase reviews, the team realigns and updates the Commissioning Plan in preparation for the Construction Phase consisting of the following:

- Commissioning team directory
- Commissioning process activities
- Roles and responsibilities
- Communication structures
- Commissioned systems and equipment
- Commissioning process schedule
- Appendices (Owner's Project Requirements, BOD, Design Review, Issues Log)

The Commissioning Team should formally accept the updated Commissioning Plan before moving into construction. Further, all outstanding comments and issues relative to the CxP's review of the design should be resolved, and accepted changes should be incorporated into the contract and construction bid documents.

Develop Commissioning Specifications

The commissioning tasks for the contractors will be identified in the commissioning specifications and will include:

- General commissioning requirements common to all systems and assemblies
- Detailed description of the responsibilities of all parties
- Details of the commissioning process (i.e. schedule and sequence of activities)
- Reporting and documentation requirements and formats
- Alerts to coordination issues
- Deficiency resolution
- Commissioning meetings

- Submittals
- O&M Manuals
- Construction checklists
- Functional testing process and specific functional test requirements including testing conditions and acceptance criteria
- Failure protocols and requirements for retests including responsibility for costs
- As-built drawings
- Training

Specifications must clearly indicate who is witnessing and documenting the startup of each commissioned system. Specifications must also clearly indicate who is writing, directing, conducting and documenting functional tests. The Commissioning Provider and the A/E must work together to ensure that commissioning requirements are fully integrated and coordinated in the project specifications.

While HVAC and building enclosure system performance is interdependent, the process of commissioning those systems requires independent efforts by different people. Because of this, requirements for building enclosure commissioning should be specified separately.

Written Test Procedures

Written functional test procedures define the means and methods to carry out system/intersystem tests during the construction phase. To the extent possible these test procedures should be defined by the Commissioning Team in the Design Phase and written into contractors' scopes of work. Test procedures will necessarily be refined early in the construction phase based on the submittal process. Tests procedures provide the following:

- Required parties for the test, which may include the CMa, Construction Contractor, specific subcontractor(s)), designer, GSA PM, GSA OFM, GSA Technical Experts and Customer Agency representatives. The roles of each required party must also be clearly defined.
- Prerequisites for performing the test including completion of specific systems and assemblies. Prerequisites are of critical importance when undertaking phased construction and/or phased occupancy. The CxP must coordinate tests with the CMa in terms of the overall construction schedule and the anticipated completion of given systems.
- List of instrumentation, tools and supplies required for the test.
- Step-by-step instructions to exercise the specific systems and assemblies during the test. This includes instructions for configuring the system to begin the test, and the procedure to return the system to normal operation at the conclusion of the test.
- Description of the observations and measurements which must be recorded and the range of acceptable results

Fire Protection Engineering and Life Safety

To ensure that no aspect of a building's design or operation presents an unacceptable risk, a fire protection engineering and life safety assessment is required in the Pre-Planning Phase (see GSA's PM

Guide). Please note that one of the CxP's roles in commissioning of fire protection and life safety systems is to also assist the GSA regional Fire Protection Program Office.

CONSTRUCTION PHASE

During the Construction Phase the Commissioning Team works to verify that systems and assemblies operate in a manner that will achieve the Owner's Project Requirements. The two overarching goals of the Construction Phase are to assure the level of quality desired and to assure the requirements of the contracts are met. The Construction Phase commissioning activities are a well-orchestrated quality process that includes installation, start-up, functional performance testing, and training to ensure documented system performance in accordance with the Owner's Project Requirements. This testing and documentation will also serve as an important benchmark and baseline for future recommissioning of the facility.

Review Submittals for Performance Parameters

As submittals for products and materials are received from contractors, copies of submittals critical to the commissioning process should be forwarded to the CxP. In general the CxP reviews the following types of submittals, shop drawings and test results:

- Coordination drawings
- Redline As-builts
- Submittals identified for review in the construction documents
- Product data and key operations data submittals
- Systems manuals
- Training program
- Shop drawings
- Reports of testing by others

Clearly, the CxP cannot review every project submittal. The CxP's review of submittals should be limited to those items identified in the commissioning plan and as described in the construction documents. This review allows the CxP to check the submittals for adherence to Owner's Project Requirements, Basis of Design and Project Specifications. The CxP should pay special attention to substitutions and proposed deviations from construction documents and the BOD. The CxP will only comment on submittals to the extent that there is a perceived deviation from the Owner's Project Requirements or Commissioning Plan. All CxP comments should be resolved by the GSA PM, CMa, A/E, construction contractor and CxP and documented.

Develop and Utilize Construction Checklists

Construction checklists are developed by Commissioning Provider, maintained by the Construction Manager as Advisor and used by the Construction Contractor and subcontractors. The intent of construction checklists is to convey pertinent information to the installers regarding the Customer Agency's concerns on installation and long-term operation of the facility and systems. The approach to the structure of the checklists is to keep it short and simple by focusing on key elements.

Checklists span the duration from when equipment is delivered to the job site until the point that the system/component is started up and operational. This includes testing, adjusting and balancing and control system tuning.

Construction checklists are tools for transferring the information contained in the construction documents (drawings and specifications) to the workers in the field. By completing the checklists, the workers are assured that requirements in the project documents are satisfied. Checklists generally fall into the following categories:

- Delivery and storage checks
    - Confirm unitized assemblies are fabricated within specified tolerances.
    - Document and track delivery of equipment and materials to site
    - Verify submittal information (avoid accepting and installing equipment which does not meet specifications)
    - Ensure equipment/materials remain free of contamination, moisture, etc.
    - For building enclosures, confirm unitized assemblies are fabricated within specified tolerances.
- Installation and start-up
    - Component-based checks
    - Systems-based checks

The development of the construction checklists takes close coordination amongst the GSA PM, GSA OFM, GSA Technical Experts, CxP, Construction Manager as Advisor, Construction Contractor, and in some cases, State and local government officials to maximize the benefits and tailor the checklists to the way the CMa and Construction Contractor will manage the project. Generally the checklists are developed as follows:

- CxP identifies components and systems for which checklists are required
- CxP reviews Owner's Project Requirements for key success criteria
- CxP reviews specifications and submittals for key requirements
- CxP develops sample checklists for GSA PM and CMa review
- CxP incorporates feedback and finalizes checklists for distribution

Once the checklists have been developed and provided to the Construction Contractor, the CxP will review the completion of the checklists periodically during site visits.

GSA PMs and Cx Teams are encouraged to reference the Construction Industry Institute's Planning for Start-up Education Module for more detail on startup processes and checklists.

Oversee and Document Functional Performance Testing

Functional performance testing takes over where the construction checklists end. The intent of functionally testing the system/building as a whole is to evaluate the ability of the components in a system to work together to achieve the Owner's Project Requirements. For functional testing to provide valid results, first the individual components and systems have to be verified to be operating properly (see Develop and Utilize Construction Checklists). This includes Start-up and Testing, Adjusting and Balancing (TAB).

The GSA PM must coordinate start-up and installation activities with the GSA Fire Protection Engineer's role in occupancy permitting to include testing for compliance with life safety and code requirements.

Test Data Records

Test data records capture outcomes of functional performance testing including test data, observations and measurements. Data may be recorded using photographs, forms or other means appropriate for the specific test. Test data records should include, but not limited to, the following information:

- Test reference (number, specific identifier, etc.)
- Date and time of test
- First test or retest following correction of an issue
- Identification of the systems, equipment and/or assemblies under test including location and construction document designation
- Conditions under which the test was conducted (i.e. ambient conditions, capacity/ occupancy, etc.). Tests should be performed under steady-state and stable conditions.
- Expected performance
- Observed performance including indication of whether or not this performance is acceptable
- Issues generated as a result of the test
- Dated signatures of those performing and witnessing the test

Test Issues and Follow-up

The functional performance tests are the heart of the commissioning process and they are also the most difficult and time consuming. As inspecting and testing proceed, despite the team's best efforts, the CxP will find a number of items that do not appear to work as intended. There will be a certain amount of system retesting that will be performed by the CxP because of system deficiencies during the initial testing. In order to assure success, the GSA PM should recognize project risks that may be caused by retesting and should develop a mitigation strategy that may include allowing some time in the schedule and money in the budget for retesting. The GSA PM should be apprised that issues resolution and associated financial implications are a common point of contention between parties. The Cx Plan should identify the responsibility for retesting costs and identify the protocols for retesting including the

required number of retests. To encourage construction quality control, the cost of retests and schedule delays caused by retesting should be the responsibility of the contractor.

For building enclosure commissioning (BECx), the costs of retests are typically the responsibility of the construction contractor. This incentivizes the contractor's own construction quality control. Protocols for retesting in the event of failures including the required number of retests must be specified. GSA's P100 Facilities Standard references ASTM E2813, Standard Practice for Building Enclosure Commissioning, which recommends a number of required retests for each testing type. While the recommended quantities are negotiable, they are generally followed as a best practice. ASTM E2813 is available to project teams through GSA's subscription to the IHS Engineering Workbench.

If equipment or systems are found to be malfunctioning, these problems should be documented and listed in the Issues Log for team resolution. The Issues Log must be very clear about the test, system(s) involved, and tracking of the problem as it is corrected. Both the amount of retesting paid for by GSA versus the amount paid by the contractor and/or designer, as well as the parameters for which parties are responsible for correcting deficiencies should be very clearly spelled out in the contracts.

Fire Protection Engineering and Life Safety

In accordance with the requirements within the P100, no new building or portion thereof shall be occupied until the GSA regional fire protection engineer has issued a certificate of occupancy to the GSA Project Manager. The certificate of occupancy will only be issued to the GSA Project Manager after the GSA regional fire protection engineer has ensured that all fire protection and life safety systems have been completed, inspected, successfully tested and approved and all outstanding fire and life safety deficiencies corrected to afford a reasonable degree of safety to the building occupants from fire and similar emergencies.

Hold Commissioning Team Meetings and Report Progress

Consistent, regular Commissioning Team meetings are essential to maintain the progress of the project and the momentum of the commissioning process. The schedule of meetings should be defined, documented and included in appropriate bid documents during the Design Phase (monthly construction phase Cx Team meetings are recommended). Team members at meetings must be authorized to make commitments and decisions for their respective parties. The typical agenda for construction phase Commissioning Team meetings should include items such as previous action items, outstanding issues, schedule review, new issues, etc.

In addition to regular meetings, the CxP is responsible for preparing monthly Commissioning Process Reports during the construction phase. These reports should include at a minimum the following information:

- Progress and status report along with look-ahead

- Identification of systems or assemblies that do not perform in accordance with Owner's Project Requirements
- Results from latest version of the Issues Log (importance, cost and measures for correction)
- Test procedures and data
- Deferred and seasonal tests (and reason for deferring)
- Suggestions for enhancements which will improve the commissioning process and/or the delivered facility

The Commissioning Progress Reports should be distributed to the entire Commissioning Team.

Conduct Owner Training

An important step in the commissioning process is ensuring that GSA OFM are properly trained in the required care, adjustment, maintenance and operations of the new facility equipment and systems (including active and passive fire protection and life safety systems). It is critical that operations and maintenance personnel have the knowledge and skills required to operate the facility to meet the Owner's Project Requirements. Training should specifically address:

- Step-by-step procedures required for normal day-to-day operation of the facility
- Adjustment instructions including information for maintaining operational parameters
- Troubleshooting procedures including instructions for diagnosing operating problems
- Maintenance and inspection procedures
- Repair procedures including disassembly, component removal, replacement and reassembly
- Upkeep of maintenance documentation and logs
- Emergency instructions for operating the facility during various nonstandard conditions and/or emergencies
- Key warranty requirements

Commissioning Provider Role in Training

Because of the Commissioning Provider's in-depth knowledge of the design intent and building systems, the CxP should review the contractors training plan. The contractor is responsible for facilitating the entire owner training process. This process begins in the Design Phase by assuring that appropriate levels of training are planned and included in the specifications. The contractor maintains a system-based as opposed to component-based focus in the training to ensure that GSA OFM understands the interrelationships of equipment, systems and assemblies. The CxP should review agendas and material developed by the contractors in advance of the training for quality, completeness and accuracy. The CxP should also attend a number of the key training sessions to evaluate effectiveness and suggest improvements in the delivery of the material.

Training Timing and Requirements

The majority of training should be done during the construction phase prior to substantial completion. Some systems and assemblies may require ongoing training during the occupancy and operation phase. The exact systems, subsystems, equipment and assemblies that require training as well as the required number of hours of training are spelled out in the project specifications. The CxP, GSA PM and GSA OFM should review the contractor training plan to ensure the appropriate amount of training hours are captured in the specification. The CMa should utilize attendee sign-in sheets to verify that the training was delivered to the intended staff.

The instruction should be given during regular work hours (for all shifts) on such dates and times that are selected by the GSA Project Manager. The instruction may be divided into two or more periods at the discretion of the GSA PM.

It is highly recommended that all training be video recorded. Video recording the training allows for future reference of the material and training of new employees down the road. The contractor should provide copies of the video recording in DVD or USB storage device format and should index the training recording by subject, equipment or system type so users can go directly to a specific subject, equipment or system to view the training. The Contractor should provide the GSA PM with an edited draft version of the recorded training sessions (generally within seven days), which include all aspects of the operation, inspection, testing and maintenance of the systems. The CMa, CxP, GSA OFM and GSA Technical Experts should review the draft training recordings and provide the Contractor with comments. The Contractor should then resubmit an edited final version of the training recordings (generally within seven days of receipt of comments).

Instructor(s) Qualifications

The instructor(s) qualification should include leadership ability and demonstrate a proactive approach to advocating for the interests of the Federal Government. The instructor(s) should have received specific training from the manufacturer regarding the inspection, testing and maintenance of the system provided. The instructor(s) should train the Government employees designated by the Contracting Officer in the care, adjustment, maintenance and operation of the new facility equipment and systems. Each instructor should be thoroughly familiar with all parts of the installation. The instructor(s) should be trained in operating theory as well as practical operation and maintenance work.

Turnover Commissioning Record

It is critical to understand that commissioning documentation is developed throughout the project and turned over before substantial completion. Commissioning documentation turned over at this phase of the project is a result of a well thought out documentation plan and collection of information throughout all of the project phases. The following matrix outlines necessary documentation of the commissioning process by project phase in order to complete the Commissioning Record.

Commissioning Record Document

Document	Phase Started	Developed/Provided By
Commissioning Plan	Project Initiation	CxP, GSA PM/CxP
Commissioning Plan Appendices		
A. Owner's Project Requirements	Project Initiation	GSA PM
B. Basis of Design	Project Initiation	A/E
C. Commissioning Specifications	Design	A/E/CxP
D. Design Review	Design	CxP
E. Submittal Review	Design	CxP
F. Test Procedures	Design	CxP
G. Issues Log	Construction	CxP
H. Construction Checklists	Construction	CxP/Construction Contractor
I. CxP Site Visit and Cx Team Mtg. Minutes	Construction	CxP
J. O&M Review	Construction	CxP
K. Training Documentation	Construction	CxP/Construction Contractor
L. Warranty Review	Construction	CxP
M. Test Data Reports	Construction	CxP/Construction Contractor
Summary Report	Construction	CxP
Verification modifications to design intent accurately reflected in as-built documents	Construction	CxP
Final COBie and BIM electronic files and completion and sign-off of COBie Information Delivery Plan	Design	AE

The Commissioning Record should include a brief summary report that includes a list of participants and roles, brief building description, overview of commissioning and testing scope, and a general description of testing and verification methods. For each piece of commissioned equipment, the report should contain the disposition of the Commissioning Provider regarding the adequacy of the equipment, documentation and training meeting the construction documents in the following areas:

1. Equipment meeting the equipment specifications,
2. Equipment installation,
3. Functional performance and efficiency,
4. Equipment documentation, and
5. Operator training.

Building enclosure systems are sometimes modified during the course of testing to achieve the required performance. In such a case, the Commissioning Record should document modifications to systems that deviate from the original design intent in the as-built drawings prior to closing out the project.

OCCUPANCY AND OPERATIONS PHASE

Systems, assemblies, equipment and components will tend to shift from their as-installed conditions over time. In addition, the needs and demands of facility users typically change as a facility is used. The Occupancy and Operations Phase allows for the continued adjustment, optimization and modification of building systems to meet specified requirements.

The objective of the Occupancy and Operations phase is to maintain building performance throughout the useful life of the facility. The active involvement of the Commissioning Provider and the Commissioning Team during initial facility operations is an integral aspect of the commissioning process. Commissioning activities during Occupancy and Operations include issues resolution, seasonal testing, delivery of the Final Commissioning Report and performing a post-occupancy review with the Customer Agency.

Perform Deferred and Seasonal Testing

Due to weather conditions, not all systems can be tested at or near full load during the Construction Phase. For instance, testing of a boiler system might be difficult in the summer and testing of a chiller and cooling tower might be difficult in the winter. For these reasons commissioning plans should include offseason testing to allow for testing of certain equipment under the best possible conditions. In addition to seasonal testing, several systems may have been deferred during the initial testing for a number of reasons including prerequisite activities not complete, phased occupancy issues and improper testing conditions. The commissioning team must use the Issues Log as a guide during Occupancy and Operations Phase to complete all deferred testing. Requirements for deferred and seasonal testing must be clearly defined in the construction documents as it will require some contractor personnel to return to the site after the project is completed. It may also be necessary to withhold money for this activity in addition to the traditionally withheld warranty items.

Reinspect/Review Performance before End of Warranty Period

During the first year of the building's operation it is important to assure that the performance of the facility is maintained, particularly before the warranty period expires. At 10 months into a 12 month warranty period, operation of system and components is critically reviewed by CxP, GSA OFM and CMa to identify any items that must be repaired or replaced under warranty. This review is based on

warranty items and continued performance in accordance with the Owner's Project Requirements. Discrepancies between predicted performance and actual performance and/or an analysis of any complaints received may indicate a need for minor system modifications. The CxP documents the results and forwards recommendations to the Owner, CMa and construction contractor for resolution. The GSA PM should be cognizant of the impacts of a phased occupancy, if applicable, on the warranty period and make necessary adjustments for review and inspection.

Proper maintenance programs, training and familiarization of the systems by the new operating staff are important to support occupancy and operations commissioning. For example, a standard method of recording and responding to complaints must be in place and used consistently. As equipment and controls are replaced throughout the maintenance program, calibration and performance must be checked, documents revised and any changes or new equipment data sheets included in the operations and maintenance manuals.

Ongoing training includes refresher training of existing personnel, training of new personnel and training of all personnel on newly installed equipment or revised operating procedures.

Complete Final Commissioning Report

During Occupancy and Operations, the Commissioning Provider is responsible for delivering a Final Commissioning Report. This document is additive to those items detailed in the "Turnover Commissioning Record" section. The Final Commissioning Report should include at a minimum:

- A statement that systems have been completed in accordance with the construction documents and that the systems are performing in accordance with the final Owner's Project Requirements document
- Identification and discussion of any substitutions, compromises or variances between the final design intent, construction documents and as-built conditions
- Description of components and systems that exceed Owner's Project Requirements and those which do not meet the requirements and why
- Summary of all issues resolved and unresolved and any recommendations for resolution
- Post-Construction activities and results including deferred and seasonal testing results, test data reports and additional training documentation
- Lessons learned for future commissioning project efforts
- Recommendations for changes to GSA standard test protocols and/or facility design standards (i.e. GSA P100, etc.)

The Final Commissioning Report will serve as a critical reference and benchmark document for future recommissioning of the facility. The CMa is responsible at this phase to assure the A/E's update to the CAD As-Built drawings is completed. The CxP should review the as-built drawings to verify all deviations from the design intent are included in the as-built drawings and provide a report to the CMa.

Recommission Facility as Needed or Employ Continuous Commissioning

At this phase of operation a considerable investment has been put into assuring the facility operates as intended. Understanding that systems tend to shift from their as-installed conditions over time due to normal wear, user requests and facility modifications, it is strongly recommended to consider recommissioning facilities or employ a continuous commissioning program. Where continuous commissioning is not in place, recommissioning should be considered when periodic reviews suggest it, such as MARS, BAT, Energy Audits, E4 BAS re-tunings, Post Occupancy Evaluations (POE), and others. A facility recommissioning program serves to assure operational efficiency and continued user satisfaction. Maintaining good O&M and occupant complaint records is key to continued recommissioning efforts. This can be accomplished with robust use of NCMMS.

Recommissioning should generally include:

Establishing that original basis of design and operation is still appropriate for use, occupancy, tenant agencies and GSA goals, and modify the operations/controls sequencing as appropriate for optimum operations;

- Reviewing and benchmarking key systems operations/performance against the Basis of Design
- Evaluating envelope tightness/pressurization by infrared thermography or other methods
- Performing energy analysis
- Recommending and completing repairs/modifications to optimize building performance
- It is important to recognize that several years after occupancy, the GSA PM will not be involved with a particular project. Therefore, OFM will take the lead on facility recommissioning activities. Recommissioning can include CxP services. There may be some benefit to bringing back the original project CxP due to their familiarity with the original design where the building has not undergone significant changes. Recommissioning is not part of the original CxP contract, and therefore the services must be procured through a RFQ/RFP process at the time of recommissioning.

Building Automation System (BAS) Re-tuning:

The Targeted E4 BAS Retuning program is an Office of Facilities Management (OFM) program implemented through an interagency agreement with the Department of Energy and the Pacific Northwest National Lab. E4 BAS Re-tunings accomplish an important portion of recommissioning. These remote or onsite efforts evaluate and retune BAS operations to maximize energy efficiency, tenant comfort, and equipment longevity. In order to maintain cost and time efficiencies, field verifying of equipment and air balancing is not part of a Targeted E4 BAS Re-tuning. Where full recommissioning is necessary it will be the responsibility of the regions to budget for the process. OFM funds a limited number of Targeted E4 BAS Re-tunings annually. Regions may fund additional re-tunings as they have the need and funding availability.

The Targeted E4 BAS Retuning program focuses on implementation of measures rather than only identifying measures. Measures are developed around 4 major principles - Turn it Off, Turn it down, Mitigate Simultaneous Heating and Cooling, and Reduce Infiltration and Outside Air. These efforts are proven over an 8 year running program which includes tracking based on actual metered energy consumption. As of the end of FY 2019, PNNL has conducted Targeted E4 re-tuning site visits at 83 federally owned buildings in GSA's inventory, encompassing over 35 million square feet of floor space in all of GSA's 11 regions. On aggregate, this process has yielded approximately 9% annual building energy savings in the first year following the initial site visit and 13% savings in the second year. Where data was available for 1 year of tracking, FY18 re-tunings have yielded $363,000 worth of energy savings with an additional 10 re-tunings performed in FY18 and FY19 predicted to save an average of 7.7% in energy consumption at each site.

Ongoing and Continuous Commissioning:

Ongoing commissioning (OCx) is a process that includes planning, point monitoring, system testing, performance verification, corrective action response, ongoing measurement, and documentation to proactively address operating problems in the systems being commissioned. Several currently practiced OCx approaches are available, including continuous commissioning (CCx) and monitoring-based commissioning (MBCx) / real-time commissioning. Each has its own approach and methodology.

This ongoing process is designed to resolve operating problems, improve comfort, optimize energy use, and identify retrofits for existing buildings. Although it is ideal for large complex buildings with automation and advanced metering systems, ongoing commissioning is the most costly approach for existing buildings because of staff and equipment allocations. However, the process can identify equipment inefficiencies as they occur and allow for quick remediation and greater energy and cost savings. Random sampling is a technique frequently used to manually commission large buildings or complex systems. As a result, not all equipment or components are verified and some are completely skipped.

GSA has implemented an in-house MBCx called GSAlink. GSAlink is a nationwide GSA platform with over 46 billion time series points representing more than 57 million square feet of building space in 105 buildings as of May 2020. GSAlink is a useful tool that supports Commissioning (Cx), Retro-Commissioning (RCx), and CC efforts by identifying operational issues, tracking tenant comfort, and optimizing energy consumption.

This MBCx approach is an ongoing solution that commissioning providers and building operators can use to evaluate building performance and highlight any degradations. When continually evaluating data, as is done with GSAlink-connected facilities, operational strategies can be improved. Building conditions change over the course of time and operation drifts from peak efficiency. PID loops need tuning, sensors need recalibration, coils need routine cleaning, and filters need to be replaced. Building automation systems learn to start earlier to overcome these system inefficiencies, which equates to longer run times. The commissioning process catches these issues. By automating the process, GSAlink facilitates MBCx and works to mitigate these problems by detecting patterns and visualizing the data. Analytics

within GSAlink are continuously monitoring all connected equipment and alert to equipment that is "sparking" or varying from expected operation. GSAlink can also be used to verify or update a building's Testing Adjusting Balancing (TAB) report even after a change of use occurs, throwing systems out of balance. Not enough airflow or excessive airflow created by incorrect TAB results in significant energy waste. Airflow monitoring stations and fluid flow monitoring stations in GSAlink-connected buildings are pulled into GSAlink and may be used to verify accuracy of TAB reports. BAS components such as airflow monitoring stations, fluid flow monitoring stations, sensors, meters, etc. are essential to provide GSAlink with the data needed to perform MBCx and should not be eliminated from a project through a Value Engineering exercise.

GSAlink can assist in the assessment, investigation and implementation phases of RCx and MBCx. If the building has been connected to GSAlink for at least a year, it can be used to baseline the building before commissioning is conducted. GSAlink pulls in information from the BAS and displays it in multiple interfaces that provide the following utility:

- Historical data trending
- Comparison to prior year's energy consumption
- Alerts or sparks indicating departure from normal equipment operations
- Diagnostic monitoring of energy systems
- Equipment on/off status
- Ability to customize information, graphs and displays

Additionally, when a building is added to GSAlink, the implementation process provides the following commissioning benefits:

- Documentation of design intent and current documentation
- Perform trend analysis
- Document master list of findings
- Estimate energy cost savings for findings
- Present a findings and recommendations report / email / summary
- Request of update to control sequences and system documentation
- Document issues tracked by the property teams

APPENDICES

Appendix A – Commissioning Roles and Responsibility Matrix Template

Delivery Method – CMc

COMMISSIONING ROLES AND RESPONSIBILITIES MATRIX TEMPLATE

The following matrices reflect the recommended assignment of responsibility for performing Cx-related tasks on a typical GSA-owned new construction or major modernization project. The Project Manager, in consultation with appropriate Subject Matter Experts, may need to make different assignments on their particular project due to unique project types and schedules. For Design-Build and Bridging delivery methods, the order and timing of tasks in the Design and Construction Phases will vary depending on the execution schedule of the project and to what extent work is fast-tracked.

LEGEND		Owner and Owner's Representative						Delivery Method - CMc		
L	LEAD Cx	GSA CO / PM	GSA OFM	Tenant Agncy Reps	GSA SMEs	Program Dev. Study A/E	CMa / CxP	A/E Design Team	GC pre construction services	GC as Constructor
P	SUGGESTED Cx PARTICIPANT									
		Project Phase								
ACTIVITY		PROJECT INITIATION - PDS Begins								
A1	Include CxP services in feasibility, enhanced feasibility, PDS studies	L	P		P					
A2	Develop Project Program of Requirements (POR)	P	P	P		L				
A3	Develop Owner's Project Requirements (OPR)	P	P	P	P	L				
A4	P-100 Performance Matrix - baseline development	P	P	P	P	L				
A5	Identify Project Goals & Objectives and Charter	L	P	P	P	P				
A6	Include commissioning services into project budget for the CILP submission	L			P	P				
A7	Coordinate CxP responsibilities in CMa, A/E, CMc SOWs	L	P		P					
A8	Develop Initial Cx Plan and incorporate into CapPMP	L	P							
ACTIVITY		DESIGN - Design Begins, CMc Preconstruction Services Begins								
B1	Develop the Cx Plan	P			P		L	P		
B2	Conduct Design phase Cx meetings	P	P	P			L	P		
B3	Review Owner's Project Requirements (OPR) for completeness & clarity	P					L	P		
B4	Prepare and submit design submissions, including Basis of Design (BOD), in conformance with OPR							L		

LEGEND		Owner and Owner's Representative						Delivery Method - CMc		
L	LEAD Cx	GSA CO / PM	GSA OFM	Tenant Agncy Reps	GSA SMEs	Program Dev. Study A/E	CMa / CxP	A/E Design Team	GC pre construction services	GC as Constructor
P	SUGGESTED Cx PARTICIPANT	Project Phase								
ACTIVITY		DESIGN - Design Begins, CMc Preconstruction Services Begins *(continued)*								
B5	Review Design Submissions and provide written comments	P	P	P	P		L		P	
B6	Perform project constructability reviews and provide written comments	P			P		P	P	L	
B7	Manage Written Design Review Comments	P					L		P	
B8	Respond to Written Design Review Comments							L		
B9	Refine Owner's Project Requirements based upon Design phase Decisions	P	P	P	P		P	L	P	
B10	Create Cx specifications including testing protocols for all commissioned equip./systems				P		P	L		
B11	Integrate Cx activities into project schedule	P					P		L	
B12	Define Building Enclosure Commissioning (BECx) testing, inspection, and mockups.	P			P		L	P	P	
B13	Define Functional Tests, excluding manufacturer instructions				P		P	L		
B14	Define training requirements for GSA Operating Personnel		P				L	P		
B15	Incorporate commissioning requirements into Construction Documents	P					P	L	P	
B16	Incorporate training requirements for GSA Operating Personnel into Construction Documents	P	P		P		P	L		

LEGEND		Owner and Owner's Representative						Delivery Method - CMc		
L	LEAD Cx	GSA CO / PM	GSA OFM	Tenant Agncy Reps	GSA SMEs	Program Dev. Study A/E	CMa / CxP	A/E Design Team	GC pre construction services	GC as Constructor
P	SUGGESTED Cx PARTICIPANT	Project Phase								
ACTIVITY		DESIGN - Design Begins, CMc Preconstruction Services Begins *(continued)*								
B17	Incorporate commissioning requirements into CMc's Scope of Work	L					P	P	P	
B18	Develop Division 1 Specs for CMc contract	L	P	P			P	P		
ACTIVITY		CONSTRUCTION - Design Phase complete, CMc Precon Ends, Construction Begins								
C1	Revise Commissioning Plan as necessary				P		L	P		P
C2	Preconstruction Cx Meeting	P					L	P		P
C3	Review submittals indicated in the Commissioning Plan						L	P		
C4	Review all submittals for construction quality control & specification conformance							P		L
C5	Submit functional testing procedures that include manufacturer requirements				P		P	P		L
C6	Develop functional test procedures and documentation formats for all commissioned equipment & assemblies				P		L	P		P
C7	Install components & systems									L
C8	Complete construction checklists as the work is accomplished						L			
C9	Review RFIs and changes for impacts on Cx						L			
C10	Coordinate functional testing for all commissioned systems & assemblies						L	P		P

LEGEND		Owner and Owner's Representative						Delivery Method - CMc		
L	LEAD Cx	GSA CO / PM	GSA OFM	Tenant Agncy Reps	GSA SMEs	Program Dev. Study A/E	CMa / CxP	A/E Design Team	GC pre construction services	GC as Constructor
P	SUGGESTED Cx PARTICIPANT	Project Phase								
ACTIVITY		CONSTRUCTION - Design Phase complete, CMc Precon Ends, Construction Begins *(continued)*								
C11	Perform Functional Testing and Demonstrate operation of systems		P							L
C12	Witness and Maintain record of functional testing						L			P
C13	Continuously maintain the as-built drawings and submit as detailed in the contract documents	P						P		L
C14	Maintain Record Drawings and update the BOD	P						L		
C15	Perform quality control inspections	P					P	P		L
C16	Prepare Cx Progress Reports						L			P
C17	Hold Construction Phase Cx meetings	P	P	P	P		L	P		P
C18	Maintain master Issues Log		P		P		L	P		P
C19	Review Warranties for conformance with contract documents	P	P				L			
C20	Provide training for GSA Operating Personnel		P				P			L
C21	Verify effectiveness of training by evaluating attendees		P				L			
C22	Compile and deliver Construction Turnover Package									L
C23	Prepare and deliver Commissioning Report/Record	P	P		P		L	P		P
C24	Determination of Substantial Completion	L			P		P	P		P

LEGEND		Owner and Owner's Representative						Delivery Method - CMc		
L	LEAD Cx	GSA CO / PM	GSA OFM	Tenant Agncy Reps	GSA SMEs	Program Dev. Study A/E	CMa / CxP	A/E Design Team	GC pre construction services	GC as Constructor
P	SUGGESTED Cx PARTICIPANT	Project Phase								
ACTIVITY		OCCUPANCY AND OPERATIONS - Construction Ends, Cx Continues								
D1	Identify new issues that occur following substantial completion		L							
D2	Coordinate & perform deficiency corrections	P	P		P		P	P		L
D3	Coordinate & perform deferred & seasonal testing	P	P				L			P
D4	Review current building operation at 10 months into 12 month warranty period & develop action plan to correct deficiencies	P	P		P		L			
D5	Perform IPMVP Measurement & Verification Services to understand building energy and water performance compared to the BOD	P	P		P		L	P		
D6	Complete Final Commissioning Report						L			
D7	Develop Re-commissioning plan		P				L			
D8	Re-commission the facility at 3-5 years after turnover to reset optimal performance		L							

Delivery Method – Design Bid Build

COMMISSIONING ROLES AND RESPONSIBILITIES MATRIX TEMPLATE										
The following matrices reflect the recommended assignment of responsibility for performing Cx-related tasks on a typical GSA-owned new construction or major modernization project. The Project Manager, in consultation with appropriate Subject Matter Experts, may need to make different assignments on their particular project due to unique project types and schedules. For Design-Build and Bridging delivery methods, the order and timing of tasks in the Design and Construction Phases will vary depending on the execution schedule of the project and to what extent work is fast-tracked.										
LEGEND		**Owner and Owner's Representative**						**Delivery Method Design - Bid - Build**	
L	LEAD Cx	**GSA CO / PM**	**GSA OFM**	**Tenant Agncy Reps**	**GSA SMEs**	**Program Dev. Study A/E**	**CMa / CxP**	**A/E Design Team**	**GC**
P	SUGGESTED Cx PARTICIPANT								
		Project Phase							
ACTIVITY		**PROJECT INITIATION - PDS Begins**							
A1	Include CxP services in feasibility, enhanced feasibility, PDS studies	L	P		P				
A2	Develop Project Program of Requirements (POR)	P	P	P		L			
A3	Develop Owner's Project Requirements (OPR)	P	P	P	P	L			
A4	P-100 Performance Matrix - baseline development	P	P	P	P	L			
A5	Identify Project Goals & Objectives and Charter	L	P	P	P	P			
A6	Include commissioning services into project budget for the CILP submission	L			P	P			
A7	Coordinate CxP responsibilities in CMa, A/E, GC SOWs	L	P		P				
A8	Develop Initial Cx Plan and incorporate into CapPMP	L	P						
ACTIVITY		**DESIGN - Design Begins**							
B1	Develop the Cx Plan	P			P		L	P	
B2	Conduct Design phase Cx meetings	P	P	P			L	P	
B3	Review Owner's Project Requirements (OPR) for completeness & clarity	P					L	P	
B4	Prepare and submit design submissions, including Basis of Design (BOD), in conformance with OPR							L	
B5	Review Design Submissions and provide written comments	P	P	P	P		L		
B6	Perform project constructability reviews and provide written comments	P			P		L	P	

LEGEND		Owner and Owner's Representative						Delivery Method Design - Bid - Build	
L	LEAD Cx	GSA CO / PM	GSA OFM	Tenant Agncy Reps	GSA SMEs	Program Dev. Study A/E	CMa / CxP	A/E Design Team	GC
P	SUGGESTED Cx PARTICIPANT								
		Project Phase							
ACTIVITY		DESIGN - Design Begins *(continued)*							
B7	Manage Written Design Review Comments	P					L		
B8	Respond to Written Design Review Comments							L	
B9	Refine Owner's Project Requirements based upon Design phase Decisions	P	P	P	P		P	L	
B10	Create Cx specifications including testing protocols for all commissioned equip./systems				P		P	L	
B11	Integrate Cx activities into project schedule	P					P	L	
B12	Define Building Enclosure Commissioning (BECx) testing, inspection, and mockups.	P			P		L	P	
B13	Define Functional Tests, excluding manufacturer instructions				P		P	L	
B14	Define training requirements for GSA Operating Personnel		P				L	P	
B15	Incorporate commissioning requirements into Construction Documents	P					P	L	
B16	Incorporate training requirements for GSA Operating Personnel into Construction Documents	P	P		P		P	L	
B17	Incorporate commissioning requirements into GC's Scope of Work	L						P	
B18	Develop Division 1 Specs for GC contract	L	P	P			P	P	
ACTIVITY		CONSTRUCTION - Construction Begins							
C1	Revise Commissioning Plan as necessary				P		L	P	P
C2	Preconstruction Cx Meeting	P					L	P	P
C3	Review submittals indicated in the Commissioning Plan						L	P	

LEGEND		Owner and Owner's Representative						Delivery Method Design - Bid - Build	
L	LEAD Cx	GSA CO / PM	GSA OFM	Tenant Agncy Reps	GSA SMEs	Program Dev. Study A/E	CMa / CxP	A/E Design Team	GC
P	SUGGESTED Cx PARTICIPANT								
		Project Phase							
ACTIVITY		CONSTRUCTION - Construction Begins *(continued)*							
C4	Review all submittals for construction quality control & specification conformance							P	L
C5	Submit functional testing procedures that include manufacturer requirements				P		P	P	L
C6	Develop functional test procedures and documentation formats for all commissioned equipment & assemblies				P		L	P	P
C7	Install components & systems								L
C8	Complete construction checklists as the work is accomplished						L		
C9	Review RFIs and changes for impacts on Cx						L		
C10	Coordinate functional testing for all commissioned systems & assemblies						L	P	P
C11	Perform Functional Testing and Demonstrate operation of systems		P						L
C12	Witness and Maintain record of functional testing						L		P
C13	Continuously maintain the as-built drawings and submit as detailed in the contract documents	P					P	P	L
C14	Maintain Record Drawings and update the BOD	P					P	L	
C15	Perform quality control inspections	P					P	P	L
C16	Prepare Cx Progress Reports						L		P
C17	Hold Construction Phase Cx meetings	P	P	P	P		L	P	P
C18	Maintain master Issues Log		P		P		L	P	P

LEGEND		Owner and Owner's Representative						Delivery Method Design - Bid - Build	
L	LEAD Cx	GSA CO / PM	GSA OFM	Tenant Agncy Reps	GSA SMEs	Program Dev. Study A/E	CMa / CxP	A/E Design Team	GC
P	SUGGESTED Cx PARTICIPANT								
		Project Phase							
ACTIVITY		CONSTRUCTION - Construction Begins *(continued)*							
C19	Review Warranties for conformance with contract documents	P	P				L		
C20	Provide training for GSA Operating Personnel		P				P		L
C21	Verify effectiveness of training by evaluating attendees		P				L		
C22	Compile and deliver Construction Turnover Package								L
C23	Prepare and deliver Commissioning Report/Record	P	P		P		L	P	P
C24	Determination of Substantial Completion	L			P		P	P	P
ACTIVITY		OCCUPANCY AND OPERATIONS - Construction Ends, Cx Continues							
D1	Identify new issues that occur following substantial completion		L						
D2	Coordinate & perform deficiency corrections	P	P		P		P	P	L
D3	Coordinate & perform deferred & seasonal testing	P	P				L		P
D4	Review current building operation at 10 months into 12 month warranty period & develop action plan to correct deficiencies	P	P		P		L		
D5	Perform IPMVP Measurement & Verification Services to understand building energy and water performance compared to the BOD	P	P		P		L	P	
D6	Complete Final Commissioning Report						L		
D7	Develop Re-commissioning plan		P				L		
D8	Re-commission the facility at 3-5 years after turnover to reset optimal performance		L						

Delivery Method – Design Build-Bridging

COMMISSIONING ROLES AND RESPONSIBILITIES MATRIX TEMPLATE									
The following matrices reflect the recommended assignment of responsibility for performing Cx-related tasks on a typical GSA-owned new construction or major modernization project. The Project Manager, in consultation with appropriate Subject Matter Experts, may need to make different assignments on their particular project due to unique project types and schedules. For Design-Build and Bridging delivery methods, the order and timing of tasks in the Design and Construction Phases will vary depending on the execution schedule of the project and to what extent work is fast-tracked.									
LEGEND		**Owner and Owner's Representative**						**Delivery Method - DB-Bridging**	
L	LEAD Cx	**GSA CO / PM**	**GSA OFM**	**Tenant Agncy Reps**	**GSA SMEs**	**Program Dev. Study A/E**	**CMa / CxP**	**Bridging A/E Design Team**	**DB**
P	SUGGESTED Cx PARTICIPANT								
		Project Phase							
ACTIVITY		**PROJECT INITIATION - PDS Begins**							
A1	Include CxP services in feasibility, enhanced feasibility, PDS studies	L	P		P				
A2	Develop Project Program of Requirements (POR)	P	P	P		L			
A3	Develop Owner's Project Requirements (OPR)	P	P	P	P	L			
A4	P-100 Performance Matrix - baseline development	P	P	P	P	L			
A5	Identify Project Goals & Objectives and Charter	L	P	P	P	P			
A6	Include commissioning services into project budget for the CILP submission	L			P	P			
A7	Coordinate CxP responsibilities in CMa, Bridging A/E, DB SOWs	L	P		P				
A8	Develop Initial Cx Plan and incorporate into CapPMP	L	P						
ACTIVITY		**BRIDGING DESIGN - Bridging Design Begins**							
B1	Develop the Cx Plan	P			P		L	P	
B2	Conduct Design phase Cx meetings	P	P	P			L	P	
B3	Review Owner's Project Requirements (OPR) for completeness & clarity	P					L	P	
B4	Prepare and submit design submissions, including Basis of Design (BOD), in conformance with OPR							L	
B5	Review Design Submissions and provide written comments	P	P	P	P		L		

LEGEND		Owner and Owner's Representative						Delivery Method - DB-Bridging	
L	LEAD Cx	GSA CO / PM	GSA OFM	Tenant Agncy Reps	GSA SMEs	Program Dev. Study A/E	CMa / CxP	Bridging A/E Design Team	DB
P	SUGGESTED Cx PARTICIPANT	Project Phase							
ACTIVITY		BRIDGING DESIGN - Bridging Design Begins *(continued)*							
B6	Perform project constructability reviews and provide written comments	P			P		L	P	
B7	Manage Written Design Review Comments	P					L		
B8	Respond to Written Design Review Comments							L	
B9	Refine Owner's Project Requirements based upon Design Phase Decisions	P	P	P	P		P	L	
B10	Create Cx specifications including testing protocols for all commissioned equip./systems				P		P	L	
B11	Integrate Cx activities into project schedule	P					P	L	
B12	Define Building Enclosure Commissioning (BECx) testing, inspection, and mockups.	P			P		L	P	
B13	Define Functional Tests, excluding manufacturer instructions				P		P	L	
B14	Define training requirements for GSA Operating Personnel		P				L	P	
B15	Incorporate commissioning requirements into Bridging Documents	P					P	L	
B16	Incorporate training requirements for GSA Operating Personnel into Bridging Documents	P	P		P		P	L	
B17	Incorporate commissioning requirements into DB's Scope of Work	L					P	P	
B18	Develop Division 1 Specs for DB contract	L	P	P			P	P	

LEGEND		Owner and Owner's Representative						Delivery Method - DB-Bridging	
L	LEAD Cx	GSA CO / PM	GSA OFM	Tenant Agncy Reps	GSA SMEs	Program Dev. Study A/E	CMa / CxP	Bridging A/E Design Team	DB
P	SUGGESTED Cx PARTICIPANT	Project Phase							
ACTIVITY		DESIGN-BUILD - Bridging Documents Complete, DB Contract Begins							
C1	Revise Commissioning Plan as necessary				P		L	P	P
C2	Prepare and submit design submissions, including Basis of Design (BOD), in conformance with Bridging Documents and OPR								L
C3	Review Design Submissions and provide written comments	P	P	P	P		L	P	
C4	Manage Written Design Review Comments	P					L	P	
C5	Respond to Written Design Review Comments								L
C6	Prepare and submit DB BOD based upon Design-Build Phase Decisions	P	P	P	P		P		L
C7	Create Cx specifications including testing protocols for all commissioned equip./systems				P		P	P	L
C8	Integrate Cx activities into project schedule	P					P		L
C9	Preconstruction Cx Meeting	P					L	P	P
C10	Review submittals indicated in the Commissioning Plan						L	P	
C11	Review all submittals for construction quality control & specification conformance						P	P	L
C12	Submit functional testing procedures that include manufacturer requirements				P		P	P	L
C13	Develop functional test procedures and documentation formats for all commissioned equipment & assemblies				P		L	P	P
C14	Install components & systems								L

LEGEND		Owner and Owner's Representative						Delivery Method - DB-Bridging	
L	LEAD Cx	GSA CO / PM	GSA OFM	Tenant Agncy Reps	GSA SMEs	Program Dev. Study A/E	CMa / CxP	Bridging A/E Design Team	DB
P	SUGGESTED Cx PARTICIPANT	Project Phase							
ACTIVITY		DESIGN-BUILD - Bridging Documents Complete, DB Contract Begins *(continued)*							
C15	Complete construction checklists as the work is accomplished						L		
C16	Review RFIs and changes for impacts on Cx						L		
C17	Coordinate functional testing for all commissioned systems & assemblies						L	P	P
C18	Perform Functional Testing and Demonstrate operation of systems		P						L
C19	Witness and Maintain record of functional testing						L		P
C20	Continuously maintain the as-built drawings and submit as detailed in the contract documents	P						P	L
C21	Maintain Record Drawings and update the BOD	P							L
C22	Perform quality control inspections	P					P	P	L
C23	Prepare Cx Progress Reports						L		P
C24	Hold Construction Phase Cx meetings	P	P	P	P		L	P	P
C25	Maintain master Issues Log		P		P		L	P	P
C26	Review Warranties for conformance with contract documents	P	P				L		
C27	Provide training for GSA Operating Personnel		P				P		L
C28	Verify effectiveness of training by evaluating attendees		P				L		

LEGEND		Owner and Owner's Representative						Delivery Method - DB-Bridging	
L	LEAD Cx	GSA CO / PM	GSA OFM	Tenant Agncy Reps	GSA SMEs	Program Dev. Study A/E	CMa / CxP	Bridging A/E Design Team	DB
P	SUGGESTED Cx PARTICIPANT	Project Phase							
ACTIVITY		DESIGN-BUILD - Bridging Documents Complete, DB Contract Begins *(continued)*							
C29	Compile and deliver Construction Turnover Package								L
C30	Prepare and deliver Commissioning Report/Record	P	P		P		L	P	P
C31	Determination of Substantial Completion	L			P		P	P	P
ACTIVITY		OCCUPANCY AND OPERATIONS - Construction Ends, Cx Continues							
D1	Identify new issues that occur following substantial completion		L						
D2	Coordinate & perform deficiency corrections	P	P		P		P	P	L
D3	Coordinate & perform deferred & seasonal testing	P	P				L		P
D4	Review current building operation at 10 months into 12 month warranty period & develop action plan to correct deficiencies	P	P		P		L		
D5	Perform IPMVP Measurement & Verification Services to understand building energy and water performance compared to the BOD	P	P		P		L	P	
D6	Complete Final Commissioning Report						L		
D7	Develop Re-commissioning plan		P				L		
D8	Re-commission the facility at 3-5 years after turnover to reset optimal performance		L						

Delivery Method – Design Build

COMMISSIONING ROLES AND RESPONSIBILITIES MATRIX TEMPLATE								
The following matrices reflect the recommended assignment of responsibility for performing Cx-related tasks on a typical GSA-owned new construction or major modernization project. The Project Manager, in consultation with appropriate Subject Matter Experts, may need to make different assignments on their particular project due to unique project types and schedules. For Design-Build and Bridging delivery methods, the order and timing of tasks in the Design and Construction Phases will vary depending on the execution schedule of the project and to what extent work is fast-tracked.								
LEGEND		**Owner and Owner's Representative**						**Delivery Method - Design Build**
L	LEAD Cx	**GSA CO / PM**	**GSA OFM**	**Tenant Agncy Reps**	**GSA SMEs**	**Program Dev. Study A/E**	**CMa / CxP**	**DB**
P	SUGGESTED Cx PARTICIPANT							
		Project Phase						
ACTIVITY		**PROJECT INITIATION - PDS Begins**						
A1	Include CxP services in feasibility, enhanced feasibility, PDS studies	L	P		P			
A2	Develop Project Program of Requirements (POR)	P	P	P		L		
A3	Develop Owner's Project Requirements (OPR)	P	P	P	P	L		
A4	P-100 Performance Matrix - baseline development	P	P	P	P	L		
A5	Identify Project Goals & Objectives and Charter	L	P	P	P	P		
A6	Include commissioning services into project budget for the CILP submission	L			P	P		
A7	Coordinate CxP responsibilities in CMa and DB SOWs	L	P		P			
A8	Develop Initial Cx Plan and incorporate into CapPMP	L	P					
A9	Define Building Enclosure Commissioning (BECx) testing, inspection, and mockups.	P			P	L		
A10	Incorporate commissioning requirements into DB's Scope of Work	L						
A11	Develop Division 1 Specs for DB contract	L	P	P				

LEGEND		Owner and Owner's Representative						Delivery Method - Design Build
L	LEAD Cx	GSA CO / PM	GSA OFM	Tenant Agncy Reps	GSA SMEs	Program Dev. Study A/E	CMa / CxP	DB
P	SUGGESTED Cx PARTICIPANT	Project Phase						
ACTIVITY		DB DESIGN PHASE - Design Phase Begins						
B1	Develop the Cx Plan	P			P		L	P
B2	Conduct Design phase Cx meetings	P	P	P			L	P
B3	Review Owner's Project Requirements (OPR) for completeness & clarity	P					L	P
B4	Prepare and submit design submissions, including Basis of Design (BOD), in conformance with OPR							L
B5	Review Design Submissions and provide written comments	P	P	P	P		L	
B6	Perform project constructability reviews and provide written comments	P			P		L	P
B7	Manage Written Design Review Comments	P					L	
B8	Respond to Written Design Review Comments							L
B9	Refine Owner's Project Requirements based upon Design Phase Decisions	P	P	P	P		P	L
B10	Create Cx specifications including testing protocols for all commissioned equip./systems				P		P	L
B11	Integrate Cx activities into project schedule	P					P	L
B12	Define Functional Tests, excluding manufacturer instructions				P		P	L
B13	Define training requirements for GSA Operating Personnel		P				L	P

LEGEND		Owner and Owner's Representative						Delivery Method - Design Build
L	LEAD Cx	GSA CO / PM	GSA OFM	Tenant Agncy Reps	GSA SMEs	Program Dev. Study A/E	CMa / CxP	DB
P	SUGGESTED Cx PARTICIPANT	Project Phase						
ACTIVITY		DB DESIGN PHASE - Design Phase Begins *(continued)*						
B14	Incorporate commissioning requirements into Construction Documents	P					P	L
B15	Incorporate training requirements for GSA Operating Personnel into Construction Documents	P	P		P		P	L
ACTIVITY		DB CONSTRUCTION PHASE - Construction Phase begins						
C1	Construction Activities Begin	P					P	L
C2	Revise Commissioning Plan as necessary				P		L	P
C3	Preconstruction Cx Meeting	P					L	P
C4	Review submittals indicated in the Commissioning Plan						L	P
C5	Review all submittals for construction quality control & specification conformance						P	L
C6	Submit functional testing procedures that include manufacturer requirements				P		P	L
C7	Develop functional test procedures and documentation formats for all commissioned equipment & assemblies				P		L	P
C8	Install components & systems							L
C9	Complete construction checklists as the work is accomplished						L	
C10	Review RFIs and changes for impacts on Cx						L	

LEGEND		Owner and Owner's Representative						Delivery Method - Design Build
L	LEAD Cx	GSA CO / PM	GSA OFM	Tenant Agncy Reps	GSA SMEs	Program Dev. Study A/E	CMa / CxP	DB
P	SUGGESTED Cx PARTICIPANT	Project Phase						
ACTIVITY		DB CONSTRUCTION PHASE - Construction Phase begins *(continued)*						
C11	Coordinate functional testing for all commissioned systems & assemblies						L	P
C12	Perform Functional Testing and Demonstrate operation of systems		P					L
C13	Witness and Maintain record of functional testing						L	P
C14	Continuously maintain the as-built drawings and submit as detailed in the contract documents	P					P	L
C15	Maintain Record Drawings and update the BOD	P					P	L
C16	Perform quality control inspections	P					P	L
C17	Prepare Cx Progress Reports						L	P
C18	Hold Construction Phase Cx meetings	P	P	P	P		L	P
C19	Maintain master Issues Log		P		P		L	P
C20	Review Warranties for conformance with contract documents	P	P				L	
C21	Provide training for GSA Operating Personnel		P				P	L
C22	Verify effectiveness of training by evaluating attendees		P				L	
C23	Compile and deliver Construction Turnover Package							L
C24	Prepare and deliver Commissioning Report/Record	P	P		P		L	P
C25	Determination of Substantial Completion	L			P		P	P

LEGEND		Owner and Owner's Representative						Delivery Method - Design Build
L	LEAD Cx	GSA CO / PM	GSA OFM	Tenant Agncy Reps	GSA SMEs	Program Dev. Study A/E	CMa / CxP	DB
P	SUGGESTED Cx PARTICIPANT	Project Phase						
ACTIVITY		OCCUPANCY AND OPERATIONS - DB Contract Ends, CxP Continues						
D1	Identify new issues that occur following substantial completion		L					
D2	Coordinate & perform deficiency corrections	P	P		P		P	L
D3	Coordinate & perform deferred & seasonal testing	P	P				L	P
D4	Review current building operation at 10 months into 12 month warranty period & develop action plan to correct deficiencies	P	P		P		L	
D5	Perform IPMVP Measurement & Verification Services to understand building energy and water performance compared to the BOD	P	P		P		L	P
D6	Complete Final Commissioning Report						L	
D7	Develop Re-commissioning plan		P				L	
D8	Re-commission the facility at 3-5 years after turnover to reset optimal performance		L					

Appendix B - Commissioning Systems Selection Matrix

Commissioned System	Items Included	Federal Office Building (FOB)	Land Port of Entry	Courthouse	Laboratory	Data Center
Building Enclosure	Air and Moisture Barriers	✓	✓	✓	✓	✓
	Facades	✓	✓	✓	✓	✓
	Windows	✓	✓	✓	✓	✓
	Roofing	✓	✓	✓	✓	✓
	Below-grade Waterproofing	✓	✓	✓	✓	✓
	Skylights	✓	✓	✓	✓	✓
Plumbing Systems	Cleaning/flushing water systems	✓	✓	✓	✓	✓
	Cleaning/flushing storm drainage systems	✓	✓	✓	✓	✓
	Cleaning/flushing sanitary sewage systems	✓	✓	✓	✓	✓
	Cleaning/flushing lab drainage systems				✓	
	Thermometers and gauges	✓	✓	✓	✓	✓
	Sump pumps and ejectors	✓	✓		✓	✓
	Trap primers	✓	✓	✓	✓	✓
	Backflow preventers/relief valves	✓	✓		✓	✓
	Water heaters, water coolers	✓	✓	✓	✓	✓
	Domestic water booster pumps	✓	✓	✓	✓	✓
	Vibration isolation	✓	✓	✓	✓	✓
	Lab waste neutralization				✓	
	High purity water system				✓	
	Special gas manifolds				✓	
	Vacuum air system				✓	
	Compressed air systems				✓	
	Emergency shower/eyewashes	✓	✓	✓	✓	✓
	Deionized water system				✓	
	Fuel oil/gas systems	✓	✓	✓	✓	✓
	Irrigation systems	✓	✓	✓	✓	✓
	Water filtration (General Use)				✓	✓
	Showers/Lavatories/Toilets	✓	✓	✓	✓	✓
	Thermostatic mixing valves	✓	✓	✓	✓	✓
	Heating water recirculating pumps and aquastats	✓	✓	✓	✓	✓
	Water softener systems	✓	✓	✓	✓	✓
Heating, Ventilating and Air Conditioning (HVAC)	Thermometers and gauges	✓	✓	✓	✓	✓
	Vibration isolation	✓	✓	✓	✓	✓
	Steam condensate systems	✓	✓	✓	✓	✓
	Hot water heating systems	✓	✓	✓	✓	✓
	Computer room air conditioning units	✓	✓	✓	✓	✓
	Chemical water treatment systems	✓	✓	✓	✓	✓
	Liquid chillers	✓	✓	✓	✓	✓

Commissioned System	Items Included	Federal Office Building (FOB)	Land Port of Entry	Courthouse	Laboratory	Data Center
	Cooling towers	✓	✓	✓	✓	✓
	Condenser water system	✓	✓	✓	✓	✓
	Chilled water system	✓	✓	✓	✓	✓
	Air terminal unit system/VAV units	✓	✓	✓	✓	✓
	Humidifiers	✓	✓	✓	✓	✓
	Duct silencers	✓	✓	✓	✓	✓
	Fire and smoke/fire dampers	✓	✓	✓	✓	✓
	Variable speed drives	✓	✓	✓	✓	✓
	Air distribution systems	✓	✓	✓	✓	✓
	Exhaust air systems	✓	✓	✓	✓	✓
	Laboratory fume hoods				✓	
Building Automation System (BAS)	Component FPT and calibration	✓	✓	✓	✓	✓
	Control air supply	✓	✓	✓	✓	✓
	Air terminal units, non-lab	✓	✓	✓	✓	✓
	Air terminal units, lab supply/fume exhaust				✓	
	Sequence control, AHU, 100% OSA	✓	✓	✓	✓	✓
	Sequence control, EAHU	✓	✓	✓	✓	✓
	Sequence control, AHU, H&V	✓	✓	✓	✓	✓
	Sequence control, exhaust air fans	✓	✓	✓	✓	✓
	Sequence control, differential bypass valve	✓	✓	✓	✓	✓
	Sequence control, air terminal units, CV	✓	✓	✓	✓	✓
	Sequence control, air terminal units, VAV/CV	✓	✓	✓	✓	✓
	Sequence control, air terminal units, VAV	✓	✓	✓	✓	✓
	Sequence control heat exchanger	✓	✓	✓	✓	✓
	Sequence control, variable speed pumps	✓	✓	✓	✓	✓
	Sequence control, cabinet unit heaters	✓	✓	✓	✓	✓
	Sequence control, condenser water system	✓	✓	✓	✓	✓
	Sequence control, steam humidifiers	✓		✓	✓	✓
	Sequence control, water heaters	✓	✓	✓	✓	✓
	Sequence control, heating coils/radiant panels	✓	✓	✓	✓	✓
	Sequence control, labs with VAV fume hoods				✓	
	Sequence control, condenser water filters	✓	✓	✓	✓	✓
	Sequence control, steam generator	✓	✓	✓	✓	✓
	Graphic display	✓	✓	✓	✓	✓
	Trend logs	✓	✓	✓	✓	✓
	Status review screens, checks and alarming	✓	✓	✓	✓	✓
	Network communication	✓	✓	✓	✓	✓
Electrical Systems	Electrical primary voltage system	✓	✓	✓	✓	✓
	Service switchgear	✓	✓	✓	✓	✓
	Emergency power system	✓	✓	✓	✓	✓

Commissioned System	Items Included	Federal Office Building (FOB)	Land Port of Entry	Courthouse	Laboratory	Data Center
	Generators	✓	✓	✓	✓	✓
	Lighting controls (scheduled/occupancy sensors)	✓	✓	✓	✓	
	Daylight dimming controls	✓	✓	✓	✓	
	Switchboards	✓	✓	✓	✓	✓
	Distribution panel boards		✓		✓	
	Transformers		✓		✓	
	Motor control centers		✓		✓	✓
	Power monitoring and metering	✓	✓	✓	✓	✓
	Transient voltage surge suppressors	✓	✓		✓	✓
	Variable speed drives	✓	✓	✓	✓	✓
	Grounding and ground fault systems		✓		✓	✓
	Overcurrent protective devices		✓		✓	✓
	Low voltage busway		✓		✓	✓
	Thermographic Survey	✓	✓	✓	✓	✓
	Electronic calendaring or directory				✓	
	White sound system	✓			✓	
	Data and communication system	✓	✓	✓	✓	✓
	Paging system	✓	✓		✓	
	Local devices (switches and outlets)	✓	✓	✓	✓	✓
	Photovoltaics (panels, wiring, connections, meters, switches)	✓	✓	✓	✓	✓
Fire Protection and Life Safety Systems	Water supply systems (e.g., fire mains and hydrants, water tanks, fire pumps, etc.)	✓	✓	✓	✓	✓
	Water-based sprinkler systems	✓	✓	✓	✓	✓
	Standpipe systems	✓	✓	✓	✓	✓
	Fire alarm and signaling systems	✓	✓	✓	✓	✓
	Fire extinguishing systems (e.g., clean agent, water mist, etc.)	✓	✓	✓	✓	✓
	Smoke control/management systems (e.g., smoke exhaust, exit stair pressurization, etc.)	✓	✓	✓	✓	✓
	Commercial cooking equipment and exhaust systems fire suppression system(s) (e.g., wet chemical, automatic sprinklers, etc.)	✓	✓	✓	✓	✓
	Emergency power systems applicable to fire protection and life safety systems	✓	✓	✓	✓	✓
	Elevator systems applicable to FP and life safety systems	✓	✓	✓	✓	✓
	Security systems applicable to means of egress and fire protection and life safety systems	✓	✓	✓	✓	✓
	Passive systems (e.g., doors, walls, floors, ceilings, roof decks, etc.)	✓	✓	✓	✓	✓
	Hazardous material protection	✓	✓	✓	✓	✓

Commissioned System	Items Included	Federal Office Building (FOB)	Land Port of Entry	Courthouse	Laboratory	Data Center
Security	Access control	✓	✓	✓	✓	✓
	Alarm monitoring	✓	✓	✓	✓	✓
	Surveillance	✓	✓	✓	✓	✓
Specialties	Elevators	✓	✓	✓	✓	✓
	Escalators	✓		✓	✓	
	Cold rooms				✓	
	Kitchen/food service	✓		✓	✓	
	Mechanized solar shading systems	✓	✓	✓	✓	✓
	Audio visual systems	✓		✓	✓	
	Automatic doors	✓	✓	✓	✓	✓
	Dark rooms	✓			✓	
	Oil/water separators	✓	✓	✓	✓	✓
	Detention mains		✓		✓	
Site Systems	Irrigation systems	✓	✓	✓	✓	✓
	Wastewater Collection	✓	✓	✓	✓	✓
	Wastewater Storage	✓	✓	✓	✓	✓
	Site Plumbing/Reuse Systems	✓	✓	✓	✓	✓
	Porous Pavement Water Infiltration	✓	✓	✓	✓	✓
	Dynamic Site Security Systems	✓	✓	✓	✓	✓
	Site lighting	✓	✓	✓	✓	✓
	Active vehicle barrier systems	✓	✓	✓	✓	✓
	Dual Use Pavement Structural Stability	✓	✓	✓	✓	✓
Green Roofs	Growing media	✓	✓	✓	✓	✓
	Plant materials	✓	✓	✓	✓	✓
	Irrigation system	✓	✓	✓	✓	✓
	Rain water collection system	✓	✓	✓	✓	✓
	Drainage system	✓	✓	✓	✓	✓
	Waterproofing membrane assemblies	✓	✓	✓	✓	✓

Appendix C – Resources and References

Resources

ASHRAE
1791 Tullie Circle, NE, Atlanta, GA 30329
404.636.8400 • www.ashrae.org

ASTM International
100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428
1-877-909-2786 • www.astm.org

National Institute of Building Sciences (NIBS)
1090 Vermont Avenue, NW, Suite 700, Washington, DC 20005-4905
202.289.7800 • www.nibs.org
Whole Building Design Guide: www.wbdg.org
Envelope Design Guide and Envelope Commissioning Guide
Building Commissioning

U.S. Environmental Protection Agency Energy Star Program
Environmental Protection Agency
Ariel Rios Building
1200 Pennsylvania Avenue, NW, Washington, DC 20460
202.272.0167 • www.energystar.gov

U.S. Department of Energy Federal Energy Management Program
1000 Independence Avenue, SW, Washington, DC 20585
1.800.dial.DOE • www.doe.gov

References

The U.S. General Services Administration recognizes the wealth of information various organizations (including those on the previous pages) have contributed to the field of commissioning. Reviewing and incorporating industry best practice was a critical step in preparing this *GSA Commissioning Guide*, and GSA would like to recognize the following sources that were instrumental in preparing this Guide.

- ASHRAE
- ASTM International
- ASTM E2813, Standard Practice for Building Enclosure Commissioning
- ASTM E2947, Standard Guide for Building Enclosure Commissioning
- International Organization for Standardization, ISO Central Secretariat, Chemin de Blandonnet 8 CP 401 - 1214 Vernier, Geneva, Switzerland
- ISO 21105 - Performance of Buildings - Building Enclosure Thermal Performance Verification and Commissioning
- National Fire Protection Association (NFPA); NFPA 3, Standard for Commissioning Fire Protection and Life Safety Systems
- National Institute of Building Sciences. Whole Building Design Guide, Building Commissioning, 11/12/2016. 1090 Vermont Avenue, NW, Suite 700, Washington, DC 20005.
- National Institute of Building Sciences, NIBS Guideline 3, Building Enclosure Commissioning Process BECx
- U.S. Department of Energy. Building Commissioning: A Golden Opportunity for Reducing Energy Costs and Greenhouse Gas Emissions, July 21, 2009
- U.S. Department of Energy. 2018 Commissioning Cost/Benefit Study Findings

Appendix D – Glossary

Acronyms

A/E	Architect/Engineer
BAS	Building Automation System
BAT	Building Assessment Tool
BOD	Basis of Design
CAD	Computer Aided Design
CCx	Continuous Commissioning
CMa	Construction Manager as Advisor
Cx	Commissioning
CxP	Commissioning Provider
CxP Team	Commissioning Provider Team
FPT	Functional Performance Test
HVAC	Heating Ventilating and Air Conditioning
IEQ	Indoor Environmental Quality
LEED	Leadership in Energy and Environmental Design
IPMVP	International Performance Measurement and Verification Protocol
MARS	Management Analysis Review System
MBCx	Monitoring Based Commissioning
NCMMS	National Computerized Maintenance Management System
OCx	Ongoing Commissioning
O&M	Operations and Maintenance
P100	*Facilities Standards for the Public Buildings Service*
PDS	Program Development Study
PM	Project Manager (in this Guide the GSA PM)
RFP	Request for Proposal
RFQ	Request for Qualifications
TAB	Testing, Adjusting and Balancing

Definitions

Basis of Design (BOD): The documentation by the design team of the primary thought processes and assumptions behind design decisions that are made to meet the Owner's Project Requirements. The BOD describes the assumptions used for sizing and selection of systems (i.e. codes, standards, operating conditions, design conditions, weather data, interior environmental criteria, other pertinent design assumptions, etc.).

Building Assessment Tool (BAT): The purpose of the BAT system is to help PBS estimate the total future costs for repairing and maintaining each building in order to facilitate development of an appropriate asset strategy. The BAT system will be used to manage the data for two types of surveys, BAT (previously called PCS) and BER (aka WebBER).

Building Enclosure Commissioning (BECx): ASTM E2947: architecture or engineering-related technical services or both, performed on behalf of the Owner that implements a quality-focused process for enhancing the delivery of a project by focusing on validating during the design phase and verifying during the construction phase that the performance of building enclosure materials, components, assemblies and systems are designed and installed to meet the Owner's Project Requirements

Building Enclosure Commissioning Plan (BECx plan): ASTM E2947: a document that outlines the scope, organization, schedule, allocation of resources, responsibilities, testing and documentation requirements of the building enclosure commissioning process to meet the OPR. The BECx plan may be a portion of the whole building Cx plan.

Building Enclosure Commissioning Provider (BECxP): ASTM E2947- a duly authorized person or firm in the jurisdiction of the project retained by the Owner to develop, manage, and be in responsible charge of the BECx process.

Commissioning Process (Cx): ASHRAE Standard 202-2018: 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.

Commissioning Provider (CxP): an entity, identified by the Owner, who leads, plans, schedules, and coordinates the CxP Team to implement the Cx.

Commissioning Provider Team (CxP Team): the team of specialists and related support staff who are responsible for the management of actions and the generation of deliverables by the CxP as outlined in the contract between the Owner and the CxP and in the Cx Plan. The CxP Team may consist of several companies, including subcontractors to the CxP who acts as the contact to the Owner.

Commissioning Plan: The document prepared for each project that outlines the organization, schedule, allocation of resources, and documentation requirements of the whole building commissioning process

Commissioning Oversight Authority (CxOA): GSA's representative providing planning and oversight services of Cx testing services.

Cx testing: the evaluation and documentation of the equipment and assemblies, delivery and condition, installation, proper function according to the manufacturer's specifications, and project documentation to meet the criteria in the OPR.

Commissioning Record: The complete set of commissioning documentation for the project which is turned over to GSA at the end of the construction phase.

Construction Checklist: A checklist to ensure that the specified equipment has been provided, is properly installed and initially started and checked out adequately in preparation for full operation and functional testing.

Functional Tests: Tests that evaluate the dynamic function and operation of equipment and systems using direct observation or other monitoring methods. Functional testing is the assessment of the system's (rather than just component's) ability to perform within the parameters set up within the Owner's Project Requirements and Basis of Design. Functional tests are performed after construction checklists are complete.

Indoor Environmental Quality (IEQ): The artificial environment that exists in a building that includes the factors of thermal comfort, illumination, noise, ventilation and level of indoor air pollutants.

Issues Log: A formal and ongoing record of problems or concerns, as well as associated priorities, implications and resolutions.

Management Analysis Review System (MARS) Review: A tool for the GSA managers to monitor, assess and improve regional property management operations. A self-audit, conducted every two years, in response to the Office of Management and Budget Circular A-123. The review checklists focuses on: Administrative, Childcare, Concessions, Custodial, Security, Energy, Occupancy Administration, Lease Management, Maintenance, Measures, Procurement, Repair and Alteration, Fire Protection and Life Safety Program Management, and Environmental, Health and Safety (EH&S).

National Computerized Maintenance Management System (NCMMS): A "computerized maintenance management system" is a database and application software package that auto-mates the O&M and repairs record keeping requirements. GSA's National Computerized Maintenance System (NCMMS) is designed to enhance efficiency and effectiveness of maintenance activities. Typical features include planning, scheduling and monitoring of work orders and maintenance needs.

- The National NCMMS (NCMMS) is a central repository (Database) for all maintainable GSA Assets. The NCMMS provides a mandatory, Agency-Wide means and method for processing and reporting all maintenance work done for GSA regardless of Region or Contractor.

Owner’s Project Requirements: The documentation that provides the Owner’s vision for the planned facility, functional performance requirements and expectations for how it will be used and operated. It also provides benchmarks and criteria for performance.

Recommissioning: The process of commissioning a facility beyond the construction, occupancy and warranty phases. The purpose of recommissioning is to assure the facility performs as expected over its useful life.