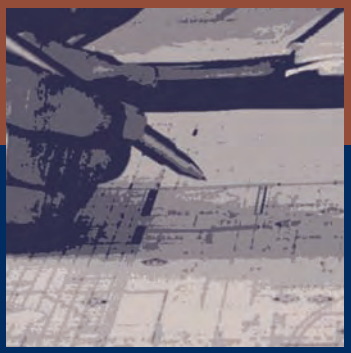
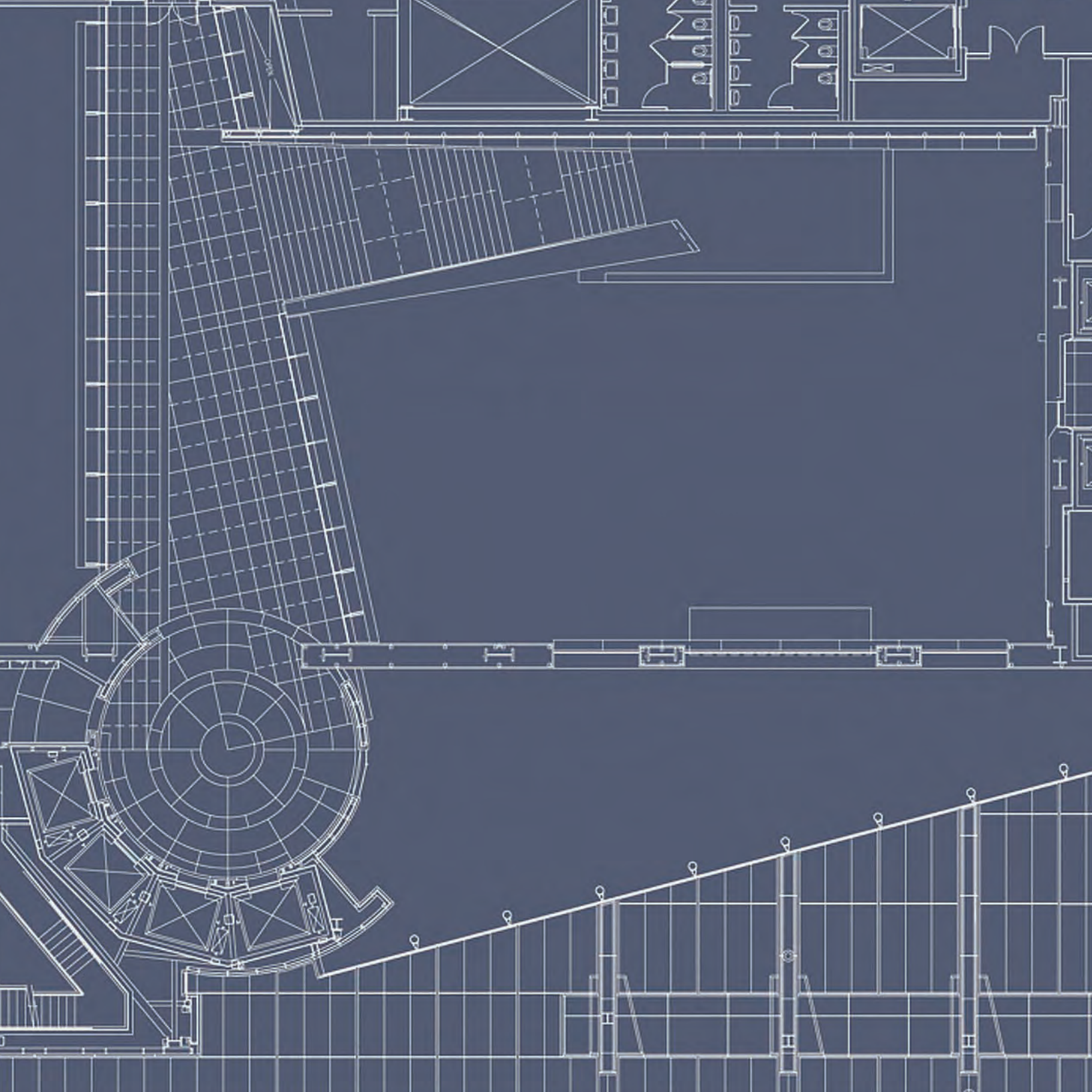
GSA Public Buildings Service

the building commissioning guide





the building commissioning guide

U.S. General Services Administration
Public Buildings Service
Office of the Chief Architect

April 2005

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foreword

The U.S. General Services Administration, through its Public Buildings Service (PBS), manages buildings that house over a million Federal associates and has an on-going planning, design and construction program to meet our federal customers housing needs. PBS' project delivery program is the vehicle for transforming our customer agencies' vision into reality. The built environment for our nation's public buildings, including courthouses, federal office buildings, laboratories, and border stations, in turn shapes the communities and landscape in which they reside.

The comfort, productivity and job satisfaction of a million Federal associates in many ways rests with the quality of their immediate working environment. Critical to our management role is providing our customer agencies with the assurance that we are delivering to them facilities which meet or exceed their expectations for performance, efficiency, safety, sustainability, security and occupant satisfaction.

Integrating the process of Total Building Commissioning into project delivery is one way we can provide the occupants of our facilities with this level of assurance. Total Building Commissioning, as presented in this Guide, is GSA's quality delivery process which translates expectations into documented and tangible facility results. Reduction in operating costs, enhanced energy efficiency, improved occupant safety, comfort and health, and increased maintainability are only a few of the proven benefits of commissioning.

In this Guide, the U.S. General Services Administration offers a road map and recommendations for navigating the commissioning process from its necessary inclusion in project planning to its continued emphasis throughout the life of a facility. We hope that this Guide offers GSA associates, our customer agencies, and our consultants valuable assistance in support of our mission of providing a superior workplace for the federal worker, and superior value for the American taxpayer.

F. Joseph Moravec
Commissioner of the Public Buildings Service
U.S. General Services Administration

introduction

About This Guide

The primary audience for this ***Building Commissioning Guide*** is GSA's Project Managers, their construction management agents, and the Commissioning Agent. The secondary audience for this Guide includes the many stakeholders in the commissioning process including customer agencies, the balance of the project team, other members of government, as well as GSA's partners.

The Building Commissioning Guide provides the overall framework and process for building commissioning from project planning through tenant occupancy, keys to success within each step and the ways that each team member supports the process of commissioning. While recognizing that every project is unique and that the required activities will vary on every project, this Guide provides recommendations, minimum requirements and best practices based upon industry guidance and GSA experience. *The Building Commissioning Guide* encourages the use of these best practices to ensure completeness and consistency nationwide and to address the facility needs of the Customer Agency.

The Guide is organized into the following sections:

- **Philosophy** provides GSA's definition and expectations for commissioning
- **Building Commissioning Process** details the considerations, practices and recommendations for commissioning along the GSA project process including Planning, Design, Construction and Post-Construction Stages
- **Appendices** provide samples, tools, definitions and links to further resources for additional information on commissioning

Beyond This Guide

GSA's design criteria document, the ***Facilities Standards for the Public Buildings Service*** (P-100), requires all GSA capital construction projects to employ Total Building Commissioning practices, as addressed by this ***Building Commissioning Guide***. Also, GSA's Project Planning Tools (PPT) web site enables development of project specific commissioning plans, identifying commissioning tasks and

Commissioning Agent

The term Commissioning Agent is used synonymously with Commissioning Authority in this Guide. The term "Commisioning Agent" is not intended to carry any further legal interpretation beyond that of a "Commisioning Authority."

associated roles and responsibilities for the delivery team: This web site is available at: http://www.projectplanningtools.org.

Development of this Guide included a thorough review of the multitude of publications on commissioning, and the Building Commissioning Process in this Guide incorporates industry guidance and best practice suggested by such leading organizations as:

- American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE)
- Building Commissioning Association
- National Institute of Building Sciences (NIBS)
- Portland Energy Conservation, Inc. (PECI)
- U.S. Department of Energy
- U.S. Green Building Council

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

In addition, this Guide identifies many additional sources and experts for detailed support of the commissioning process. GSA has a comprehensive body of additional resources on key topics related to facilities projects including site selection and preservation handbooks, pricing guides, facilities standards and incorporation of sustainability concepts.

philosophy

GSA is responsible for meeting the space requirements of federal agencies. To assure a high standard of excellence for the American public, GSA utilizes a Total Building Commissioning Process. Total Building Commissioning is the Public Buildings Service's (PBS) process for quality delivery in new construction and facility modernization. It is the process for achieving, validating and documenting that the performance of the total building and its systems meet the design intent and requirements of the owner.

Defining Commissioning for GSA Buildings

The National Conference on Building Commissioning has established an official definition of 'Total Building Commissioning' as follows:

> **"Systematic process of assuring by verification and documentation, from the design phase to a minimum of one year after construction, that all facility systems perform interactively in accordance with the design documentation and intent, and in accordance with the owner's operational needs, including preparation of operation personnel"**

Historically, the term "commissioning" has referred to the process by which the heating, ventilation and air conditioning (HVAC) systems of a building were tested and balanced according to established standards prior to acceptance by the building owner. Today's use of commissioning recognizes the integrated nature of all building systems' performance, which impact sustainability, workplace productivity, occupant safety and security.

As reflected within the *Facilities Standards for the Public Buildings Service (P-100),* GSA accepts 'Building Commissioning' practices as described above and within this Guide. Prospectus level projects (new and modernization) planned for 2006 and thereafter shall adopt a Total Building Commissioning practice beginning with the project planning stage and concluding with the post occupancy evaluation phase. These projects shall include provisions for Total Building Commissioning cost in their budget.

Total Building Commissioning

To assure a high standard of excellence, GSA utilizes a Total Building Commissioning Process. Total Building Commissioning is the Public Buildings Service's (PBS) process for quality assurance in new construction and facility modernization. It is the process for achieving, validating and documenting that the performance of the total building and its systems meet the design intent and requirements of the owner.

For projects that have already received funding approval prior to 2005, a limited commissioning practice shall be adopted to meet project performance objectives.

- Repair & Alterations projects, where the scope of work is limited to HVAC upgrades, Commissioning for Start-up and Turnover practice shall be adopted.
- Repair & Alterations projects, where the scope of work is limited to re-skinning the building, or enclosing an atrium, or providing security and seismic upgrades, commissioning for functional performance testing (FPT) shall be adopted.
- All GSA new construction and modernization projects must achieve LEED Certification and must attempt a LEED Silver rating.

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 including:

- 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 operation and maintenance
- Increased occupant safety
- Better building documentation
- Shortened occupancy transition period
- Significant extension of equipment/systems life cycle

Industry sources indicate that on average the operating costs of a commissioned building range from 8% to 20% below that of a non-commissioned building. Certain available commissioning implementation tools, such as cost shared

USDOE Energy Contractors, may even result in a negative capital investment cost. GSA's goal in adopting building commissioning is:

- To safeguard PBS interest, by implementing solutions that best represent and meet the long term efficiency and functionality of all PBS buildings and meet the expectations of GSA's customers
- To improve facility operations
- To optimize the value received for each construction dollar spent
- To improve Indoor Environmental Quality (IEQ) and decrease liability due to IEQ problems

building commissioning process

overview

The building commissioning process is interwoven with the overall project delivery process. This Guide outlines only the necessary 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 steps, deliverables and specific responsibilities of the entire Commissioning Team. Additional support in defining GSA project delivery and commissioning processes can be found through the Project Planning Tools web site. (http://www.projectplanningtools.org)

Building Commission Process

PLANNING

- Identify Commissioning Team
- Define Owner's Project Requirements with the Customer Agency
- Develop Preliminary Commissioning Plan
- Establish Initial Budget for Commissioning

Cx Integrated into Feasibility and Program Development Studies

DESIGN

- Incorporate Commissioning into A/E & CM Scope of Services
- Retain Commissioning Agent Services
- Review Owner's Project Requirements & Basis of Design
- Concept, DD and CD Design Reviews
- Update/Refine Commissioning Plan
- Develop Commissioning Specifications

Contact Documents Aligned with Owner's Project Requirements

CONSTRUCTION

- Review Submittals for Performance Parameters
- Develop & Utilize Construction Checklists
- Oversee & Document Functional Performance Testing
- Hold Cx Team Meetings and Report Progress
- Conduct Owner Training
- Turnover Commissioning Record

System Performance Documented & Accepted

POST-CONSTRUCTION

- Perform Deferred & Seasonal Testing
- Reinspect/Review Performance before End of Warranty Period
- Complete Final Commissioning Report
- Final Satisfaction Review with Customer Agency

Recommission Facility Every 3-5 Years

System Performance Sustained

GSA PM Lead
Cx Team Support

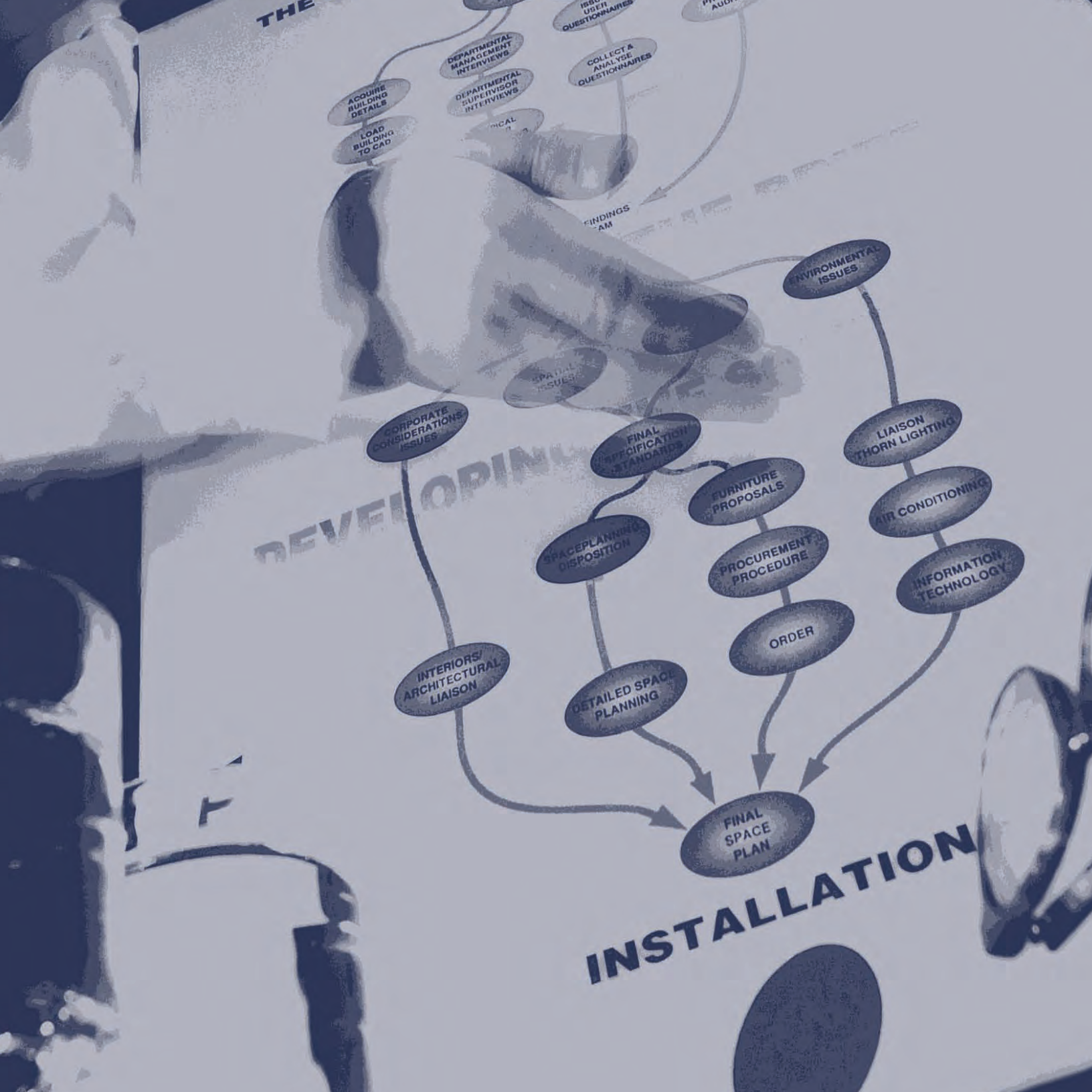
CxA Lead
Cx Team Support

Customer Agency Lead

Final Phase Step

building commissioning process

planning stage


ACQUIRE BUILDING DETAILS
LOAD BUILDING TO CAD
DEPARTMENTAL MANAGEMENT INTERVIEWS
DEPARTMENTAL SUPERVISOR INTERVIEWS
COLLECT & ANALYSE QUESTIONNAIRES
ENVIRONMENTAL ISSUES
CORPORATE CONSIDERATIONS ISSUES
FINAL SPECIFICATION STANDARDS
FURNITURE PROPOSALS
LIAISON THORN LIGHTING
AIR CONDITIONING
SPACEPLANNING DISPOSITION
PROCUREMENT PROCEDURE
INFORMATION TECHNOLOGY
ORDER
INTERIORS/ ARCHITECTURAL LIAISON
DETAILED SPACE PLANNING
FINAL SPACE PLAN
INSTALLATION

planning stage

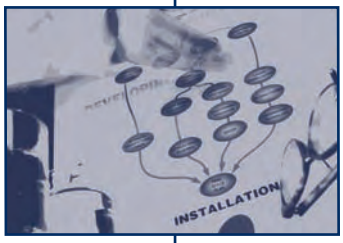
For the purpose of this document, the Planning Phase encompasses GSA's Pre-Planning, Feasibility Study and Program Development Study (PDS) activities per *The Project Planning Guide*.

Consideration for commissioning is critical even at the Planning Stage of a project. During this stage, the GSA Project Manager (PM) must establish commissioning as an indelible piece of the overall delivery process. Adequate consideration for commissioning scope, budget and schedule shall be included in the Feasibility Study and Program Development Study (PDS). Further, it is at this stage 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 Operating Personnel
- Customer Agency Representative(s)
- GSA Technical Experts (i.e. Structural, Mechanical, Electrical, Fire Protection, Elevator, Seismic, LEED/Sustainability, etc.)
- Construction Manager (CM)*
- Construction Contractor and Subcontractors
- Commissioning Agent (CxA)
- Architect/Engineer (A/E)



Identify Commissioning Team

Define Owner's Project Requirements with the Customer Agency

Develop Preliminary Commissioning Plan

Establish Initial Budget for Commissioning

Cx Integrated into Feasibility and Program Development Studies

GSA PM Lead
Cx Team Support

CxA Lead
Cx Team Support

Customer Agency Lead

Final Phase Step

*Note: Throughout this Guide there are references to Construction Manager and CM. Unless otherwise specified, this is assumed to mean Construction Management Agent (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. The Commissioning Roles & Responsibilities Matrix on the following pages is a summary interpretation of individual roles of team members. The Project Planning Tools' Commissioning Tool offers an expanded Roles & Responsibilities Matrix to address project delivery/commissioning tasks, all of which can be edited to suit unique project requirements.

Even though it is likely that key team members (i.e. CM, A/E, CxA) will not be on board at this stage of the project, completion of a project specific roles & responsibilities matrix will help the GSA PM develop the A/E, CM and CxA contract scope for commissioning. This initial roles & responsibilities matrix will be updated and confirmed during the design and construction stages once these team members are contracted.

The following definitions apply to the Roles & Responsibilities Matrix:

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

Roles & Responsibilities Matrix Template

Appendix A of the Building Commissioning Guide provides a blank template roles & responsibilities matrix for tailoring and customization by project teams.

Commissioning Roles & Responsibilities Matrix

Legend

L = Lead P = Participate
S = Support I = Inform
A = Approve V = Verify

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

Commissioning Roles & Responsibilities Matrix

Legend
L = Lead P = Participate
S = Support I = Inform
A = Approve V = Verify

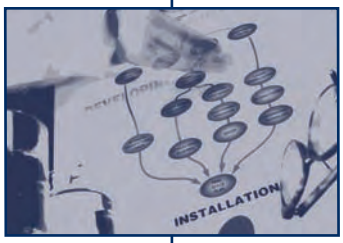
	GSA Project Manager	GSA Operating Personnel	Customer Agency Reps	GSA Technical Experts	Construction Manager	Construction Contractor	Commissioning Agent	Architect/ Engineer
Update Commissioning Plan	A	I	I	I	S		L	I
Incorporate commissioning requirements into Construction Contractor's Scope of Work	A			I	L		S	S
Construction Stage								
Revise Commissioning Plan as necessary	A	I	I	I	I	S	I	L
Review submittals applicable to equipment/systems being commissioned	I			P	A	S	S	L
Review project submittals for construction quality control & specification conformance	I			I/P	A	L	S	V
Develop functional test procedures and documentation formats for all commissioned equipment & assemblies	A	I	I	S/A	S	S	I	L
Include Cx requirements and activities in each purchase order and subcontract written	A					A	L	V
Develop construction checklists for equipment/systems to be commissioned	A			P	I	I	I	L
Install components & systems	I	I	I		A	A	L	V
Review RFIs and changes for impacts on Cx	A	I	I	I/S	S	L	S	V
Demonstrate operation of systems	I		P/I		I	P	L	V
Complete construction checklists as the work is accomplished	I	I		I	I	S	L	A
Continuously maintain the record drawings and submit as detailed in the contract documents	A	S			I	S	L	V
Coordinate functional testing for all commissioned systems & assemblies	I	I	I	P/A	I	S	S	L/A
Perform quality control inspections	I			I/P		L	S	P/I
Maintain record of functional testing	I	I	I	I/P	I	S	S	L

Commissioning Roles & Responsibilities Matrix

Legend
L = Lead P = Participate
S = Support I = Inform
A = Approve V = Verify

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

* Commissioning Agent Services will likely be required for the periodic recommissioning of the facility. While contracting with the original project CxA may offer some efficiencies, GSA may or may not elect to contract with the project CxA.



Identify Commissioning Team

Define Owner's Project Requirements with the Customer Agency

Develop Preliminary Commissioning Plan

Establish Initial Budget for Commissioning

Cx Integrated into Feasibility and Program Development Studies

GSA PM Lead
Cx Team Support

CxA Lead
Cx Team Support

Customer Agency Lead

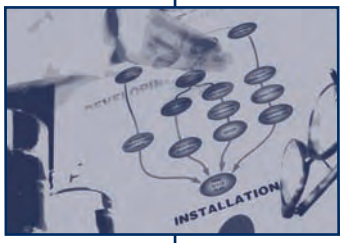
Final Phase Step

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, 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 will form the basis from which all design, construction, acceptance and operational decisions are made. The following suggested categories provide a framework for the types of requirements that shall be considered.

Accessibility	Access and use by children, aged and disabled persons
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 avoided in this facility (i.e. glare, uneven air distribution, etc.)
Communications	Capacity to provide inter- and intra-telecommunications throughout the facility
Constructability	Transportation to site, erection of facility and health & safety during construction
Design Excellence	Potential/Objectives for design recognition
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 & Life Safety	Fire protection and life safety systems
Flexibility	For future facility changes and expansions
Green Building Concepts	Sustainability concepts including LEED certification goals
Health & Hygiene	Protection from contamination from waste water, garbage and other wastes, emissions & toxic materials

Indoor Environment	Including hygrothermal, air temperature, humidity, condensation, indoor air quality and weather resistance
Life Safety	Fire protection and life safety systems
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
Security	Protection against intrusion (physical, thermal, sound, etc.) and vandalism and chemical/biological/radiological threats
Standards Integration	Integration of approved Federal, State & local as well as GSA and Customer Agency standards & requirements
Structural Safety	Resistance to static & dynamic forces, impact and progressive collapse



Identify Commissioning Team

Define Owner's Project Requirements with the Customer Agency

Develop Preliminary Commissioning Plan

Establish Initial Budget for Commissioning

Cx Integrated into Feasibility and Program Development Studies

Obtaining the information and criteria for the Owner's Project Requirements 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 *Project Planning Guide* including use of *P-100* standards, facility specific (i.e. courthouse, border station, etc.) design guidelines and project programming methodologies. In some cases the owner is likely to have a canned set of project requirements. Note that the Project Planning Tools' input data includes typical GSA program goals, which when activated, triggers default/suggested commissioning language the PPT's Commissioning Plan outputs.

The Owner's Project Requirements will evolve throughout each project stage. As decisions are made throughout the Planning, Design and Construction Stages, the Project Requirements will be updated. It is the primary tool for benchmarking success and will ultimately become part of the Systems Manuals documentation.

Develop Preliminary Commissioning Plan

The Commissioning Plan establishes the framework for how commissioning will be handled and managed on a given project. This includes a discussion of the commissioning process, schedule, team and team member responsibilities,

GSA PM Lead
Cx Team Support

CxA Lead
Cx Team Support

Customer Agency Lead

Final Phase Step

Commissioning Systems Selection Matrix

Appendix B of the Building Commissioning Guide provides a tool for selecting systems to commission for a particular facility type. Exact systems shall be determined an a project to project basis.

communication structures and a general description of the systems to be commissioned. This preliminary version of the Plan shall be developed by the GSA PM in conjunction with the Customer Agency. The suggested structure of the Commissioning Plan is as follows. All information in the Commissioning Plan must be project specific.

Introduction	Purpose and general summary of the Plan.
General Project Information	Overview of the project, emphasizing key project information an 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 & 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 Planning, Design, Construction and Tenant Occupancy Stages with associated roles & responsibilities.
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 Agent 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 stage (see "Turnover Commissioning Record").

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 & Seasonal Testing
L	Warranty Review
M	Test Data Reports

The initial commissioning scope is derived from Customer Agency, GSA PM & Operating Personnel input as well as previous experience with similar buildings. 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 shall be determined on a project to project basis.

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

Development of the preliminary Commissioning Plan and initial commissioning scope shall also include a discussion regarding project certifications and goal attainment (i.e. LEED, Energy Star, Energy Goals, Design Awards, etc.).

For the project to be LEED certified, commissioning process activities must comply with the prerequisite requirements for fundamental building commis-

Commissioning for LEED Certification

The process provided in GSA's Building Commissioning Guide provides the necessary steps to comply with the United States Green Building Council's (USGBC) prerequisite and additional commissioning requirements for Leadership in Energy & Environmental Design (LEED) Certification.

sioning and the project team may opt to pursue an added LEED point for additional commissioning. The process provided in this Guide provides the necessary steps to comply with both prerequisite and additional commissioning requirements. The LEED 2.1 commissioning criteria is explained in more detail below.

LEED Commissioning Criteria Energy & Atmosphere Prerequisite 1

Fundamental Building Systems Commissioning

INTENT

Verify and ensure that fundamental building elements and systems are designed, installed and calibrated to operate as intended.

REQUIREMENTS & SUBMITTALS

1. Engage a commissioning authority
2. Review design intent & Basis of Design (BOD) documentation
3. Include Cx requirements in construction documents
4. Develop & utilize a Commissioning Plan
5. Verify installation, functional performance, training and documentation
6. Complete a commissioning report

Energy & Atmosphere Credit 3 (1 Pt.) Additional Commissioning

INTENT

Verify and ensure that entire building is designed, constructed and calibrated to operate as intended.

REQUIREMENTS & SUBMITTALS

(7-9 must be done by independent 3rd Party)

1. Engage a commissioning authority
2. Review design intent & BOD documentation
3. Include Cx requirements in construction documents
4. Develop & utilize a Commissioning Plan
5. Verify installation, functional performance, training and documentation
6. Complete a commissioning report
7. Conduct a focused review of the design prior to CD phase
8. Conduct a focused review of the Construction Documents when close to completion
9. Conduct a selective review of contractor submittals of commissioned equipment
10. Develop a recommissioning management manual
11. Have a contract in place to review with operational staff current building operation, including plan for resolution of outstanding commissioning related issues within 1 year after completion of construction.

Establish Initial Budget for Commissioning

Based upon the Preliminary Commissioning Plan, the GSA Project Manager includes budgetary costs for commissioning in the Feasibility Study and the Program Development Study. It is critical that the overall established budget which is submitted for funding approval contains necessary monies for commissioning.

Specifically, Feasibility Study and Program Development Study deliverables per GSA's *Project Planning 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.

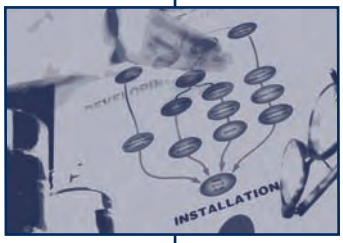
Commissioning Agent Costs

Total building commissioning costs for Commissioning Agent services can range from 0.5% to 1.5% of total construction costs (according to U.S. Department of Energy's Rebuild America Program, written by the Portland Energy Conservation, Inc. (PECI)). The National Association of State Facilities Administrators (NASFA) recommends budgeting 1.25 to 2.25% of the total construction costs for total building Commissioning Agent services.

GSA's commissioning practice is expected to cost approximately 0.5% of the construction budget for federal buildings and border stations. More complex projects such as courthouses could run 0.8 - 1% of the construction budget, and even more complex facilities such as laboratories can exceed 1%. Factors influencing commissioning costs include facility type, 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 chart on the following pages shows benchmark costs per square foot for Commissioning Agent services by facility type.

Additional Project Costs

The above costs only cover Commissioning Agent fees. There are also costs to



Identify Commissioning Team

Define Owner's Project Requirements with the Customer Agency

Develop Preliminary Commissioning Plan

Establish Initial Budget for Commissioning

Cx Integrated into Feasibility and Program Development Studies

GSA PM Lead
Cx Team Support

CxA Lead
Cx Team Support

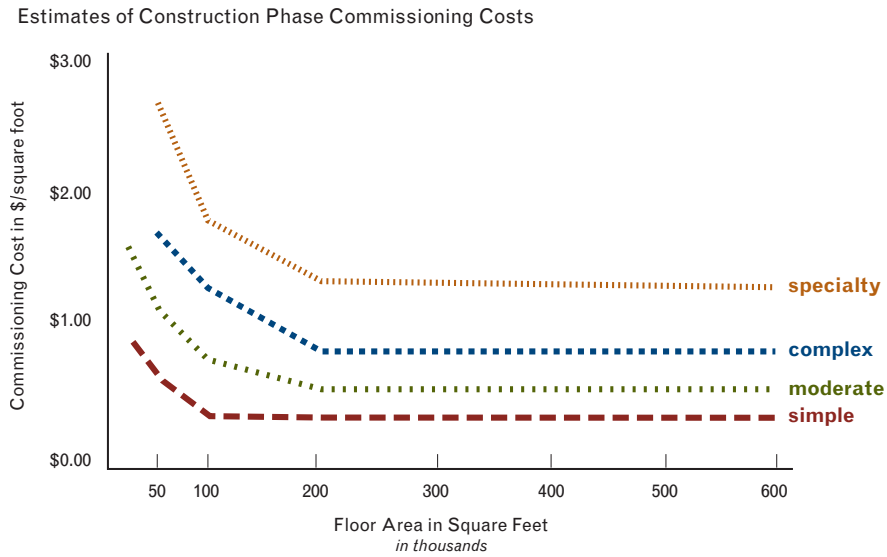
Customer Agency Lead

Final Phase Step

the Construction Manager, 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.

Benchmark Commissioning Costs by Facility Type

Portland Energy Conservation, Inc. (PECI), 2000



specialty = Very complex facilities–Neutral Buoyancy Laboratory; Mission Control Center; etc.

complex = Moderate plus most of floor area in complex systems (hospitals, labs, operating rooms, clean rooms, fume hoods or other non-HVAC systems are commissioned such as electrical quality, transformers, security, communications, etc. Traveling requirements and high cost of living locations increase costs.

moderate = More complex office, classroom with some labs, building automation, more control strategies, fewer packaged equipment; more systems (fire, emergency power, etc.).

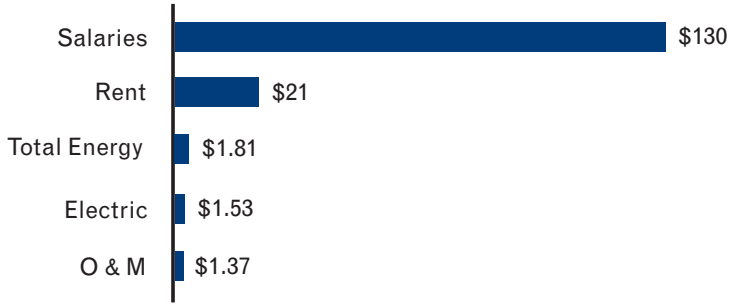
simple = Office buildings, classrooms, packaged equipment and controls; common systems, fewer pieces of equipment.

Cost-Benefit Analysis for Commissioning

Recent PECI studies indicate that on average the operating costs of a commissioned building range from 8% to 20% below that of a non-commissioned building. BOMA cost data for office buildings suggests that building commissioning can result in energy savings of 20 to 50% and maintenance savings of 15 to 35%.

Beyond operating efficiency, successful building commissioning has been linked to reduced occupant complaints and increased occupant productivity. The example below demonstrates the financial impact of increased occupant productivity.

Average Annual Commercial Expenditure
in $ per square foot



Source: Data from Building Owners and Managers Association; Electric Power Research Institute; Statistical Abstract of the United States, 1991

This chart illustrates that salaries dominate average annual commercial expenditures when compared to other operating costs such as facility operations and rent costs. For a standard office building of 250,000 sf, there are approximately 1500 occupants at an average salary of $40,000 each (taken from US Census Bureau March 2002). This equates to $78 million/year in salary expenses including fringe benefits. Analyzing potential cost savings, a 10-20% increase in productivity could result in an $8–16 million dollar impact each and every year.

building commissioning process

design stage

design stage

Design Stage commissioning activities serve to assure that the Owner's Project Requirements for items such as energy efficiency, sustainability, indoor environmental quality, fire protection & life safety, etc. are sufficiently defined and adequately & accurately reflected in the contract documents. The Design Stage 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 contract documents.

Incorporate Commissioning into A/E & CM Scope of Services

GSA commissioning activities may be more rigorous than A/Es and CMs typically include in their scope of services. Design, Construction & Post-Construction commissioning activities must be defined and written into the Architect/Engineer and Construction Manager scopes of work and executed contracts.

By this stage of project development, the GSA Project Manager must have an awareness of how commissioning services will be delivered. GSA's preferred method for engaging a Commissioning Agent is to arrange for the Construction Manager to contract directly with a Commissioning Agent, however there will be exceptions based on project specific drivers. Should the project team determine that the CM will contract the commissioning agent, this must be written into the CM's scope of work.

Commissioning services for Design and Construction Management professionals shall minimally include, but are not limited to the items listed on the following page.

Incorporate Commissioning into A/E & CM Scope of Services

- Retain Commissioning Agent Services
- Review Owner's Project Requirements & Basis of Design
- Concept, DD and CD Design Reviews
- Update/Refine Commissioning Plan
- Develop Commissioning Specifications

Contact Documents Aligned with Owner's Project Requirements

- GSA PM Lead Cx Team Support
- CxA Lead Cx Team Support
- Customer Agency Lead
- Final Phase Step

A/E & CM Commissioning Scope Items

Design Professional

1. Participate & 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. Integrate Cx process requirements & activities provided by the CxA into the contract documents.

5. Attend Commissioning Team meetings (3 Design Review Meetings and monthly Construction Stage Cx Team meetings).

6. Specify & verify that the operation & maintenance of the systems & assemblies have been adequately detailed in the construction documents.

7. Review & incorporate as appropriate the CxA's comments into the contract documents.

8. Participate in the operations and maintenance personnel training as specified in the training program.

9. Review test procedures submitted by the contractor.

10. Review & comment on the CxA's progress reports and issue logs.

11. Witness the functional testing of all commissioned systems and assemblies.

12. Review and accept record documents as required by the contract documents.

13. Review and comment on the final Commissioning Record.

14. Recommend final acceptance of the systems to GSA.

15. Verify systems are installed as specified.

Construction Manager

1. If appropriate, lead the RFQ process for commissioning services and award a contract to a Commissioning Agent directly under the Construction Manager.

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 contract documents.

5. Attend Commissioning Team meetings (3 Design Review Meetings and monthly Construction Stage Cx Team meetings).

6. Coordinate with the Commissioning Agent in development of a Commissioning Plan.

7. Perform quality control 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. Coordinate & document Owner/Operator training.

11. Issue a statement that certifies all work has been completed and the facility is operational, in accordance with the contract documents.

12. Coordinate General Contractor remedies for deficiencies identified by the Commissioning Agent during their verification of the installation or tests.

13. Review and comment on the final Commissioning Record.

Retain Commissioning Agent Services

GSA's suggested practice is to have the Construction Manager hire a subcontractor to act as the Commissioning Agent, resulting in no additional contract management responsibilities for GSA. In this case the CM 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 Commissioning Agent. Regardless of the contracting method, the Commissioning Agent shall be on board by the beginning of Design Development.

Commissioning Agent Qualifications

The Commissioning Agent and the Construction Manager generally have different skills. In general, the Construction Manager 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 Agent has technical background and in depth expertise with the commissioning process including verification techniques, functional performance testing, system equipment and O&M knowledge.

A list of recommended criteria, which shall be incorporated into an RFQ for commissioning services, is included in Appendix B. The Commissioning Agent must have significant in-building commissioning experience, including technical and management expertise on projects of similar scope, size and type . Further the CxA shall bring a total building commissioning perspective to the project, be knowledgeable in national building fire codes, as well as water-based extinguishing systems, detection systems, LEED, energy efficiency imperatives and demonstrate experience with Federal requirements (i.e. blast, progressive collapse, security, etc.).

Request for Qualifications (RFQ) for Commissioning Agent

The RFQ for Commissioning Agent services is based upon the Preliminary Commissioning Plan and the commissioning budget established in the Program

Incorporate Commissioning into A/E & CM Scope of Services

Retain Commissioning Agent Services

Review Owner's Project Requirements & Basis of Design

Concept, DD and CD Design Reviews

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GSA PM Lead
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Scope for Commissioning Agent Services

Appendix A of the Building Commissioning Guide provides a Sample Scope for Commissioning Agent Services, which is a useful starting point for tailoring and customization by project teams.

Development Study (PDS). Depending on the CxA delivery method (i.e. CM versus GSA contracts the CxA), this may be the responsibility of either GSA or the CM. If the RFQ is performed by the CM, this format may vary slightly. For reference, a sample Scope for Commissioning Services is included in Appendix A.

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 & Post-Construction Stage expectations for the Commissioning Agent
Systems and Assemblies	Preliminary identification of the systems and assemblies to be Commissioned. Once contracted, the CxA will further develop this matrix.
Qualifications	Desired qualification of the CxA
Proposal	Expectations for format & content of prospective CxA's proposal
Change in Personnel	Statement on GSA review of CxA changes in personnel for the project
Selection Criteria	A table indicating the selection criteria and scoring system for evaluating CxA proposals
Proprietary Information (disclaimer)	
Protection and Control of Government Documents (disclaimer)	

Commissioning Agent Selection

This service shall be acquired in the same manner as other professional services. The Commissioning Agent shall be chosen on the primary basis of qualifications and not solely based on price. The involved work order and selection procedures should adhere to the involved IDIQ provisions for work order issuance, and be fitted with requirements/contents that are aligned with standard work order formats. National IDIQ contracts are in place that can support commissioning services.

It is recommended that the CxA is contracted according to a two phase fee negotiation process. The first phase includes Design Stage responsibilities and the second phase includes Construction and Post-Construction activities. This two phase process allows for the negotiation of the initial fee to be based on known general factors, and negotiation of the Construction and Post-Construction Stage fee based upon a substantially completed design and the actual type and number of equipment, systems and assemblies to be inspected, started and tested. Within the Design Stage proposal, the CxA shall be asked to provide budgetary numbers for the Construction and Post-Construction Stages.

Incorporate Commissioning into A/E & CM Scope of Services

Retain Commissioning Agent Services

Review Owner's Project Requirements & Basis of Design

Concept, DD and CD Design Reviews

Update/Refine Commissioning Plan

Develop Commissioning Specifications

Contact Documents Aligned with Owner's Project Requirements

Review Owner's Project Requirements & 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 Stage 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 envelope, 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 done 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 Agent is brought on board early in the design development 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 carried through in the Basis of Design Document. The CxA's review ensures clarity and completeness with an eye toward commissioning process activities (benchmarks, standards, performance targets, etc.). The CxA may recommend changes to improve energy efficiency, operation &

GSA PM Lead
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CxA Lead
Cx Team Support

Customer Agency
Lead

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Concept, DD and CD Design Reviews

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GSA PM Lead
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Final Phase Step

maintenance and equipment reliability. Making changes in the Design Stage, rather than after installation begins, saves money.

Through the design process, a key role for the Commissioning Agent is to facilitate a clear understanding of expectations by the design team. To do this, the practice of conducting program review workshops is to be used to offer all stakeholders the opportunity to indicate what they want to see in the next design submission. The Project Planning Tools' Commissioning Tool identifies such practices in the work breakdown structure associated with defining roles and responsibilities.

Concept, DD and CD Design Reviews

The Commissioning Agent provides three focused reviews of the design documents. It is recommended that these reviews occur first at the end of Design Concepts, the second shall occur during Design Development (50%) and the third toward the end of Construction Documents Phase (95%) (see *P-100* for definition of Concept, DD and CD design phases).

The CxA compares the design with the interests and needs of GSA as identified in the Owner's Project Requirements. The CxA also compares the proposed design against GSA design standards as defined in the latest version of the *PBS P-100 Facilities Standards*. The CxA identifies any improvements that can be made in areas such as energy efficiency, indoor environmental quality, operations & maintenance, etc. Though the CxA is responsible for reviewing the design from a commissioning perspective, the CxA is not responsible for design concepts and criteria or compliance with local, State and Federal Codes (unless it is specifically called out in their contract).

Commissioning Agent Focused Design Review Scope

Certification Facilitation	Review contract documents to facilitate project certification goals (i.e. does design meet Energy Star requirements; does Cx meet LEED criteria, etc.)
Commissioning Facilitation	Review contract 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 & 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.
Envelope	Review envelope design and assemblies for thermal and water integrity, moisture vapor control and assembly life, including impacts of interior surface finishes and impacts and interactions with HVAC systems (blast, hurricane, water penetration).
Fire Protection & Life Safety*	Review contract documents to facilitate effective Cx of fire protection & life safety systems and to aid Fire Protection Engineer in system testing to obtain the GSA Occupancy Permit
GSA Design Guidelines & Standards	Verify that the design complies with GSA design guidelines and standards (i.e. GSA P-100, 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 Owner's Project Requirements.
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 P-100, including off peak chiller heating/cooling AHU operations, and size and zoning of AHUs and thermostated areas
Operations and Maintenance (O&M)	Review for effects of specified systems and layout toward facilitating O&M (equipment accessibility, system control, etc.).

*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 safety system testing. Therefore, it is recommended that the A/E, CxA, 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. In addition, the CxA must coordinate all Fire Protection & Life Safety system commissioning with the GSA Fire Protection Engineer.

O&M Documentation	Verify adequate building O&M documentation requirements.
Owner's Project Requirements	Verify that contract documents are in keeping with and will meet the Owner's Project Requirements.
Structural	Review the structural concepts/design for enhancements (i.e. blast & progressive collapse).
Sustainability	Review to ensure that the building materials, landscaping, water & waste management create less of an impact on the environment, contribute to creating a healthful & productive workspace, & are in accordance with Owner's Project Requirements. See also P-100 LEED 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 shall contain at a minimum:

- Description of Issue
- Cause
- Recommendation
- Cost & Schedule Implications (on design, construction & 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 CxA and becomes part of the final Commissioning Record.

Design Review Meetings

The Cx Team shall have a minimum of 3 Design Review Meetings (Kick-off,

Concept/DD and CD). Additional meetings may be required to resolve outstanding issues. The CxA 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 CxA's comments, the A/E is responsible to incorporate all approved changes into the design documents.

Update/Refine Commissioning Plan

Now that the Commissioning Agent is on board and has performed Design Stage reviews, the team realigns & updates the Commissioning Plan in preparation for the Construction Stage. The Commissioning Team shall formally accept the updated Commissioning Plan before moving into construction. Further, all outstanding comments and issues relative to the CxA's review of the design shall be resolved, and accepted changes shall be incorporated into the contract and construction bid documents.

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

The Commissioning Team shall formally accept the updated Commissioning Plan before moving into construction. Further, all outstanding comments and issues relative to the CxA's review of the design shall be resolved, and accepted changes shall 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:

Incorporate Commissioning into A/E & CM Scope of Services

Retain Commissioning Agent Services

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Develop Commissioning Specifications

Contact Documents Aligned with Owner's Project Requirements

GSA PM Lead
Cx Team Support

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Customer Agency Lead

Final Phase Step

Fire Protection Engineering & 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 Project Planning Guide). The CxA's role in commissioning of fire protection & life safety systems is to assist the GSA regional fire protection engineer.

- 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 & documentation requirements & 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
- As-built drawings
- Training

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

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 shall be defined by the Commissioning Team in the Design Stage 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 CM, Construction Contractor, specific subcontractor(s)), designer, GSA PM, GSA Operating Personnel, 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 CxA must coordinate tests with the CM 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

Development of project specific test procedures can be expensive. Where possible, baseline GSA test procedures shall be referenced and used as a guide from which to customize project specific procedures.

building commissioning process

construction stage

construction stage

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 shall be forwarded to the CxA. In general the CxA reviews the following types of submittals:

- Coordination drawings
- Redline As-builts
- Product data and key operations data submittals
- Systems manuals
- Training program

Clearly, the CxA cannot review every project submittal. The CxA's review of submittals shall be limited to those items that are critical to the focus of the commissioning process. This review allows the CxA to check the submittals for adherence to Owner's Project Requirements, Basis of Design and Project Specifications. The CxA shall pay special attention to substitutions and proposed deviations from contract documents & the BOD. The CxA will only comment on submittals to the extent that there is a perceived deviation from the Owner's

Review Submittals for Performance Parameters

Develop & Utilize Construction Checklists

Oversee & Document Functional Performance Testing

Hold Cx Team Meetings and Report Progress

Conduct Owner Training

Turnover Commissioning Record

System Performance Documented & Accepted

GSA PM Lead
Cx Team Support

CxA Lead
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Final Phase Step

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Final Phase Step

Project Requirements or Commissioning Plan. All CxA comments shall be resolved by the GSA PM, CM, A/E and CxA in a team spirit and documented.

Develop & Utilize Construction Checklists

Construction checklists are developed by Commissioning Agent, maintained by the Construction Manager 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 contract 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 & storage checks
  - Document & track delivery of equipment & materials to site
  - Verify submittal information (avoid accepting & installing equipment which does not meet specifications)
  - Ensure equipment/materials remain free of contamination, moisture, etc.
- Installation & start-up
  - Component-based checks
  - Systems-based checks

The development of the construction checklists takes close coordination between the GSA PM, GSA Operating Personnel, GSA Technical Experts, CxA,

Construction Manager, Construction Contractor, and in some cases, State and local government officials to maximize the benefits and tailor the checklists to the way the CM and Construction Contractor will manage the project. Generally the checklists are developed as follows:

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

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

GSA PMs are encouraged to reference the Construction Industry Institute's *Planning for Start-up* Education Module (edited for GSA) for more detail on start-up processes and checklists.

Oversee & Document Functional Performance Testing

Functional performance testing takes over where the construction checklists ended. 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 & 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.

Review Submittals for Performance Parameters

Develop & Utilize Construction Checklists

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Final Phase Step

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 shall 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 shall 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 & Follow-up

The functional performance tests are the heart of the commissioning process and they are also the most difficult and time consuming. System troubleshooting is a critical function of the CxA. As inspecting and testing proceed, despite the team's best efforts, the CxA 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 CxA because of system deficiencies during the initial testing. In order to assure success, the GSA PM shall allow some time in the schedule and money in the budget for retesting. The GSA PM shall be apprised that issues resolution and associated financial implications are a common point of contention between parties.

Fire Protection Engineering & Life Safety

In accordance with the requirements within the P-100, 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.

If equipment or systems are found to be malfunctioning, these problems shall 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 shall be very clearly spelled out in the contracts.

Hold Commissioning Team Meetings & 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 shall be defined, documented and included in appropriate bid documents during the Design Stage (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 shall include items such as previous action items, outstanding issues, schedule review, new issues, etc.

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

- Progress & 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 & measures for correction)
- Test procedures & data
- Deferred & seasonal tests (and reason for deferring)
- Suggestions for enhancements which will improve the commissioning process and/or the delivered facility

Review Submittals for Performance Parameters

Develop & Utilize Construction Checklists

Oversee & Document Functional Performance Testing

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System Performance Documented & Accepted

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Final Phase Step

Review Submittals for Performance Parameters

Develop & Utilize Construction Checklists

Oversee & Document Functional Performance Testing

Hold Cx Team Meetings and Report Progress

Conduct Owner Training

Turnover Commissioning Record

System Performance Documented & Accepted

GSA PM Lead
Cx Team Support

CxA Lead
Cx Team Support

Customer Agency Lead

Final Phase Step

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

Conduct Owner Training

An important step in the commissioning process is ensuring that GSA Operating Personnel are properly trained in the required care, adjustment, maintenance and operations of the new facility equipment and 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 shall 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 Agent Role in Training

Because of the Commissioning Agent's in-depth knowledge of the design intent and building systems, it is important to have the CxA intimately involved in the training. The CxA is responsible for facilitating the entire owner training process. This process begins in the Design Stage by assuring that appropriate levels of training are planned and included in the specifications. The CxA maintains a system-based as opposed to component-based focus in the training to ensure

that operating personnel understand the interrelationships of equipment, systems and assemblies. The CxA also reviews agendas and material developed by the contractors in advance of the trainings for quality, completeness and accuracy. The CxA shall also attend a number of the key training sessions to evaluate effectiveness and suggest improvements in the delivery of the material.

Training Timing & Requirements

The majority of training shall be done during the construction phase prior to substantial completion. Some systems and assemblies may require ongoing training during occupancy and post-construction. 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 CM utilizes attendee sign-in sheets to verify that the training was delivered to the intended staff.

The instruction shall 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 trainings be videotaped. Videotaping trainings allows for future reference of the material and training of new employees down the road. The team may also wish to consider DVDs in lieu of videotapes for reasons of longevity and convenience. The Contractor shall be required to provide the GSA PM with an edited draft version of the taped training sessions (generally within seven days), which include all aspects of the operation, inspection, testing and maintenance of the systems. The CxA, GSA Operating Personnel and GSA Technical Experts will review the videotape and provide the Contractor with comments. The Contractor will then resubmit an edited final version of the tape (generally within seven days of receipt of comments).

Instructor Qualifications

The instructor shall have received specific training from the manufacturer regarding the inspection, testing and maintenance of the system provided. The

Owner Training

An important step in the commissioning process is ensuring that GSA Operating Personnel are properly trained in the required care, adjustment, maintenance and operations of the new facility equipment and 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.

Review Submittals for Performance Parameters

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Cx Team Support

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Customer Agency Lead

Final Phase Step

instructor shall 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 shall be thoroughly familiar with all parts of the installation. The instructor shall 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 & turned over before substantial completion. Commissioning documentation turned over at this stage 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	Planning	GSA PM
Commissioning Plan Appendices		
A. Owner's Project Requirements	Planning	GSA PM
B. Basis of Design	Design	A/E
C. Commissioning Specifications	Design	A/E/CxA
D. Design Review	Design	CxA
E. Submittal Review	Design	CxA
F. Test Procedures	Design	CxA
G. Issues Log	Construction	CxA
H. Construction Checklists	Construction	CxA/Construction Contractor
I. CxA Site Visit & Cx Team Mtg. Minutes	Construction	CxA

J. O&M Review	Construction	CxA
K. Training Documentation	Construction	CxA/Construction Contractor
L. Warranty Review	Construction	CxA
M. Test Data Reports	Construction	CxA/Construction Contractor
Summary Report	Construction	CxA
Recommissioning Management Manual	Construction	CxA/GSA PM

The Commissioning Record shall 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 shall contain the disposition of the Commissioning Agent regarding the adequacy of the equipment, documentation and training meeting the contract documents in the following areas:

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

Recommissioning Management Manual

The Recommissioning Management Manual provides guidance and establishes timelines for recommissioning of building systems and components. The format of the Recommissioning Management Manual will closely parallel the Commissioning Plan for the facility.

Recommissioning Management Manual

The Commissioning Record includes a Recommissioning Management Manual which provides guidance and establishes timelines for recommissioning building systems and components. The Recommissioning Management Manual is a requirement for LEED's Energy & Atmosphere Credit 3.

building commissioning process

post-construction stage

post-construction stage

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 Post-Construction Stage allows for the continued adjustment, optimization and modification of building systems to meet specified requirements.

The objective of the Post-Construction Stage is to maintain building performance throughout the useful life of the facility. The active involvement of the Commissioning Agent and the Commissioning Team during initial facility operations is an integral aspect of the commissioning process.

Commissioning activities during Post-Construction include issues resolution, seasonal testing, delivery of the Final Commissioning Report, performing a post-occupancy review with the Customer Agency and developing a plan for recommissioning the facility throughout its life cycle.

Perform Deferred & 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 shall include off-season 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 Post-Construction Stage to complete all deferred testing.

Perform Deferred & Seasonal Testing

- Reinspect/Review Performance before End of Warranty Period
- Complete Final Commissioning Report
- Final Satisfaction Review with Customer Agency

Recommission Facility Every 3-5 Years

System Performance Sustained

- GSA PM Lead Cx Team Support
- CxA Lead Cx Team Support
- Customer Agency Lead
- Final Phase Step

Perform Deferred & Seasonal Testing

Reinspect/Review Performance before End of Warranty Period

Complete Final Commissioning Report

Final Satisfaction Review with Customer Agency

Recommission Facility Every 3-5 Years

System Performance Sustained

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Cx Team Support

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Customer Agency Lead

Final Phase Step

Requirements for deferred and seasonal testing must be clearly defined in the contract documents as it will require some contractor personnel to return to the site after the project is completed. It is also 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 in to a 12 month warranty period, operation of system and components is critically reviewed by CxA, Owner and CM to identify any items that must be repaired or replaced under warranty. This review is based on warranty items and continued performance with 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 CxA documents the results and forwards recommendations to Owner and CM for resolution.

The GSA PM shall 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 Post-Construction 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 & 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 Post-Construction, the Commissioning Agent 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 shall include at a minimum:

- A statement that systems have been completed in accordance with the contract 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, contract 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 & 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 P-100, etc.)

The Final Commissioning Report will serve as a critical reference and benchmark document for future recommissioning of the facility.

In addition, the CxA is responsible at this stage to assure the A/E's update to the CAD As-Built drawings is completed.

Final Satisfaction Review with Customer Agency

As one of the benefits of commissioning is to increase occupant and user satisfaction, it is important that the GSA PM lead a final satisfaction review with the Customer Agency. This review shall occur at one year after occupancy (according to GSA's Facility Performance Evaluation Process). Minimum attendees shall

Perform Deferred & Seasonal Testing

Reinspect/Review Performance before End of Warranty Period

Complete Final Commissioning Report

Final Satisfaction Review with Customer Agency

Recommission Facility Every 3-5 Years

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Final Phase Step

Perform Deferred & Seasonal Testing

Reinspect/Review Performance before End of Warranty Period

Complete Final Commissioning Report

Final Satisfaction Review with Customer Agency

Recommission Facility Every 3-5 Years

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Customer Agency Lead

Final Phase Step

include the Commissioning Team and other selected Customer Agency representatives.

The purpose of this review is to obtain honest, objective and constructive feedback on what worked well throughout the commissioning process and what the Commissioning Team could have done better. The group shall be focused on identifying root causes and proposing corrective action for future projects. Specific discussion topics may include:

- Owner's Project Requirements
- Systems selected for commissioning
- Coordination issues
- Commissioning budget and costs
- Commissioning schedule relative to project schedule
- Occupant comments/complaints
- Documentation issues
- Lessons learned

The GSA PM takes the lead on documenting this session in a formal lessons learned report. This information will be an important input to future projects.

Recommission Facility Every 3-5 Years

At this stage 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 that Customer Agencies consider recommissioning facilities every 3-5 years. 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.

Recommissioning shall 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 or other methods
- Performing energy analysis
- Recommending repairs/modifications to optimize building performance

It is important to recognize that at 3-5 years after occupancy, the GSA PM will likely not still be involved with a particular project. Therefore, the Customer Agency will take the lead on facility recommissioning. Recommissioning shall include Commissioning Agent services. While there are obvious benefits of familiarity, the Customer Agency may or may not bring back the project Commissioning Agent. Recommissioning is not part of the original CxA's contract, and therefore the Customer Agency must procure these services through a RFQ/RFP process at the time of recommissioning.

appendices

sample scope for commissioning services

The General Services Administration (GSA) requests written proposals to secure Commissioning Agent (CxA) services for the <PROJECT NAME> facility in <PROJECT LOCATION>. GSA is committed to commissioning this facility to ensure that all systems are well designed, complete and functioning properly upon occupancy, are economical to operate and maintain, and that GSA staff has adequate system documentation and training.

Scope and Procurement Approach

If Commissioning services are to be incorporated into the contract of a CM, which is procured using source selection procedures, then the following material offers sample language that can be incorporated into the scope for the CM. Scope of Work material can be considered adapted to suite either Brooks Act or IDIQ work order procurements.

Background

GSA is seeking the services of a qualified commissioning provider/firm for this new construction project. The project currently is a <INSERT PROJECT DESCRIPTION INCLUDING SIZE, FACILITY TYPE, PROJECT BUDGET, GENERAL PROGRAM, DELIVERY METHOD AND MILESTONE SCHEDULE OVERVIEW>.

Objectives

The objective of commissioning is to provide documented confirmation that a facility fulfills the functional and performance requirements of GSA, occupants and operators. To reach this goal, it is necessary for the commissioning process to establish and document Owner's Project Requirements, which are criteria for system function, performance, and maintainability (design intent); and to also verify and document compliance with these criteria throughout design, construction, start-up, and the initial period of operation. In addition, complete operation and maintenance (O&M) manuals, as well as training on system operation, shall be provided to the building operators to ensure the building continues to operate as intended.

The CxA shall be involved throughout the project from design development through the warranty phase. The primary role of the CxA during the overall Design Stage is to review the design to ensure it meets GSA objectives and develop detailed commissioning specifications. During construction, the CxA coordinates the execution of a testing plan, which includes observing and documenting all systems' performance to ensure that the systems are functioning in accordance

sample scope for commissioning services (continued)

with the Owner's Project Requirements and the contract documents. The CxA is not responsible for design or general construction scheduling, cost estimating, or construction management, but may assist with problem-solving or resolving nonconformance issues or deficiencies.

The CxA will provide commissioning services required by LEED 2.1 (or current version). The CxA will serve as an objective advocate of the owner, oversee and coordinate the commissioning process, and present final recommendations to the owner regarding the performance of the commissioned building systems. The CxA works in conjunction with the project design team through the design process, prepares a commissioning plan, and a Final Commissioning Record to meet the requirements of the LEED Energy & Atmosphere commissioning credits.

Scope of Work

The CxA shall be responsible for carrying out the following tasks. The CxA is free to suggest changes and improvements to the following task list, but for this proposal it is assumed that these tasks will be completed. For this proposal, total commissioning services to meet the LEED requirements for Design Stage, construction phase, and warranty phase services are requested.

The criteria governing the work shall be LEED 2.1 (or current version), the GSA P-100, and the Federal Facilities Council requirements.

Design Stage

1. Assemble commissioning team, hold a scoping meeting and identify responsibilities.
2. Review the Preliminary Commissioning Plan developed by the GSA PM during the Planning Phase and fill in additional detail including team member responsibilities & directory, communication structure, specific systems & equipment to be commissioned and commissioning process schedule.
3. Schedule and lead commissioning meetings as needed with the Commissioning Team
4. Coordinate the commissioning work during design.

5. Review Owner's Project Requirements & Basis of Design documentation for clarity and completeness.

6. Perform focused reviews of the design, drawings and specifications at various stages of development (during design development and contract document phases), as described in Exhibit 1.

7. Conduct/facilitate program review meetings at the beginning of each design phase, before any design work is done

8. Assist and review the development and updating of the Owner's Project Requirements and Basis of Design by design team members after each design review submission.

9. Update the Commissioning Plan in preparation for Construction Stage.

10. Develop full commissioning specifications for all commissioned equipment. Coordinate this with the architect and engineers and integrate the commissioning specifications into the overall project specification package. One or more of the following documents can be used as a guide for content, rigor and format: 1) ***Model Commissioning Plan and Guide Specifications***, USDOE/FEMP; Portland Energy Conservation, Inc. (PECI), 2) ***The HVAC Commissioning Process***, ASHRAE Guideline 1-1996. The PECI Document can be downloaded free at http://www.peci.org and a copy of the ASHRAE document can be obtained by contacting ASHRAE at 404-636-8400.

    A. The commissioning specification will include general commissioning requirements common to all systems and assemblies and a detailed description of the responsibilities of all parties, details of the commissioning process; reporting and documentation requirements, including formats; alerts to coordination issues, deficiency resolution; construction checklist and start-up requirements; the functional testing process; specific functional test requirements, including testing conditions and acceptance criteria for each piece of equipment being commissioned.

    B. The specifications will clearly indicate who is witnessing and documenting start-up of each commissioned system. The specifications will be clear as to who is writing, directing, conducting and documenting functional tests and regulatory-required tests. This may vary between systems, especially between electrical and mechanical. Provide language to enhance current project specifications to ensure comprehensive controls submittals, full control contractor accountability for documented point-to-point checkout and commissioning participation, comprehensive test, adjusting and balanc-

sample scope for commissioning services (continued)

ing, full contractor documentation of start-up and superior training and O&M manual documentation.

11. Review the project specifications and provide comments and additional language, as needed, to the contractor qualifications, submittal requirements, test, adjust and balance specifications, training requirements and operations and maintenance and system manual requirements.

12. Coordinate a controls integration meeting where the electrical engineers, fire protection engineers, mechanical engineers, GSA representative, and the CxA discuss integration issues between equipment, systems and disciplines to ensure that integration issues and responsibilities are clearly described in the specifications.

13. Participate in a value engineering / management workshop.

14. Review and make recommendations from the value engineering / management workshop for commissioning and O&M issues.

15. Review the recommendations from the constructability review for commissioning and O&M issues.

16. Write step-by-step functional test procedures and documentation formats for all commissioned equipment and assemblies. Test procedures will include manual functional testing, energy management control system trending and may include stand-alone data-logger monitoring.

17. The final acceptance tests of all fire protection and life safety systems shall be witnessed by the GSA Fire Protection Engineer or their designated representative. Plan to assist the GSA Fire Protection Engineer or their designated representative in those tests. Testing and commissioning for the fire protection and life safety systems shall be per the requirements of those sections of the specifications and the applicable governing codes and standards.

Construction Stage

1. Coordinate and direct the commissioning activities in a logical, sequential and efficient manner using consistent protocols and forms, centralized documentation, clear and regular communications and consultations with all necessary parties, frequently updated timelines and schedules and technical expertise.

2. Coordinate the commissioning work with the design team and construction manager, to ensure that commissioning activities are being incorporated into the master schedule.

3. Revise, as necessary, the construction phase commissioning plan developed during design, including scope and schedule.

4. Plan and conduct commissioning meetings as needed and distribute minutes.

5. Request and review additional information required to perform commissioning tasks, including O&M materials, contractor start-up and checkout procedures. Before start-up, gather and review the current control sequences and interlocks and work with contractors and design engineers until sufficient clarity has been obtained, in writing, to be able to write detailed testing procedures.

6. Review submittals applicable to systems being commissioned for compliance with commissioning needs, concurrent with the design team and Construction Manager reviews.

7. Review requests for information and change orders for impact on commissioning and GSA objectives.

8. Review coordination drawings to ensure that trades are making a reasonable effort to coordinate.

9. Write and distribute construction checklists for commissioned equipment.

10. Develop an enhanced start-up and initial systems checkout plan with contractors for selected equipment.

11. Perform site visits, as necessary, to observe component and system installations. Attend selected planning and job-site meetings to obtain information on construction progress. Review construction meeting minutes for revisions/substitutions relating to the commissioning process. Assist in resolving any discrepancies.

12. Witness HVAC piping pressure test and flushing, sufficient to be confident that proper procedures were followed. Include testing documentation in the Commissioning Record.

13. Witness any ductwork testing and cleaning sufficient to be confident that proper procedures were followed. Include documentation in the Commissioning Record.

14. Document construction checklist completion by reviewing completed construction checklists and by selected site observation.

15. Document systems start-up by reviewing start-up reports and by selected site observation.

sample scope for commissioning services (continued)

16. Approve air and water systems balancing by spot testing and by reviewing completed reports and by selected site observation.

17. Coordinate functional testing for all commissioned systems and assemblies. Witness and document manual functional performance tests performed by the Construction Contractor for all commissioned systems and assemblies, except: a) some smaller equipment may be tested and documented by the Construction Contractor at the Commissioning Agent's discretion, b) electrical equipment testing and regulated testing may be directed and documented by the Construction Contractor with only spot witnessing and report review by the Commissioning Agent.

    The functional testing shall include operating the system and components through each of the written sequences of operation, and other significant modes and sequences, including start-up, shutdown, unoccupied mode, manual mode, staging, miscellaneous alarms, power failure, security alarm when impacted and interlocks with other systems or equipment. Sensors and actuators shall be calibrated during construction check listing by the installing contractors, and spot-checked by the commissioning provider during functional testing. Analyze functional performance trend logs and monitoring data to verify performance. Coordinate retesting as necessary until satisfactory performance is achieved.

    Tests on respective HVAC equipment shall be executed, if possible, during both the heating and cooling seasons. However, some overwriting of control values to simulate conditions shall be allowed. Functional testing shall be done using conventional manual methods, control system trend logs, and readouts or stand-alone dataloggers, to provide a high level of confidence in proper system function, as deemed appropriate by the Commissioning Agent and GSA.

18. After manual testing and initial trouble shooting is complete, monitor system operation and performance for selected data points for up to two weeks by requesting trend logs from the Construction Contractor from the building automation system. For needed system points not able to be trended by the building automation system, furnish and install temporary portable data loggers that will monitor up to 20 points. Analyze monitored data to verify operation and performance and issue a written report. This time frame and monitoring points may be modified to accurately commission the building.

19. The final acceptance tests of all fire protection and life safety systems shall be witnessed by the GSA Fire Protection Engineer or their designated representative. Testing and commissioning for the fire protection and life safety systems shall be per the requirements of those sections of the specifications and the

applicable governing codes and standards. No building or portion thereof shall be occupied until the GSA Fire Protection Engineer has issued a certificate of occupancy. Once the GSA Fire Protection Engineer has ensured that to the best of their knowledge all the fire protection and life safety systems have been completed, inspected, successfully tested and approved and all outstanding fire and life safety deficiencies have been corrected to afford a reasonable degree of safety to the building occupants from fire and similar emergencies, a certificate of occupancy will be issued.

20. Maintain a master issues log and a separate record of functional testing. Report all issues through the Construction Manager as they occur. Provide through the Construction Manager written progress reports and test results with recommended actions.

21. Review equipment warranties to ensure that GSA responsibilities are clearly defined.

22. Facilitate, oversee and review the training of GSA operating personnel. Oversee the videotaping of this training. Attend and participate in key training sessions.

23. Review and review the preparation of the O&M manuals for commissioned equipment.

24. Compile a Commissioning Record, which shall include:

    A. 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 shall contain the disposition of the commissioning provider regarding the adequacy of the equipment, documentation and training meeting the contract documents in the following areas:

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

    B. All outstanding non-compliance items shall be specifically listed. Recommendations for improvement to equipment or operations, future actions, commissioning process changes, etc. shall also be listed. Each non-compliance issue shall be referenced to the specific functional test, inspec-

sample scope for commissioning services (continued)

tion, trend log, etc. where the deficiency is documented.

C. Also included in the Commissioning Record shall be the commissioning plan, Owner's Project Requirements (from GSA PM), Basis of Design (from A/E), commissioning specifications, design review, submittal review, issues log, construction checklists, CxA site visit and Commissioning Team meeting minutes, O&M review, training documentation, test procedures, warranty review and test data reports.

D. A Recommissioning Management Manual which provides guidance and establishes timelines for recommissioning of building systems and components. The format of the Recommissioning Management Manual will closely parallel the Commissioning Plan for the facility.

E. Submit 3 bound text copies of the Commissioning Records with 3 CD copies including all information listed in B & C above.

Post-Construction Stage

1. Coordinate and supervise required opposite season or deferred testing and deficiency corrections and provide the final testing documentation for the Final Commissioning Report and O&M manuals.

2. Return to the site at 10 months into the 12 month warranty period and review with facility staff the current building operation and the condition of outstanding issues related to the original and seasonal commissioning. Also interview facility staff and identify problems or concerns they have with operating the building as originally intended. Make suggestions for improvements and for recording these changes in the O&M manuals. Identify areas that may come under warranty or under the original construction contract. Assist facility staff in developing reports and documents and requests for services to remedy outstanding problems.

Systems and Assemblies To Be Commissioned

The following is a general list of systems and assemblies to be commissioned. GSA plans to work with the CxA to write this section to make it more robust and holistic.

1. Central building automation system

2. All equipment of the heating, ventilating and air conditioning systems

3. Scheduled or occupancy sensor lighting controls

4. Daylight dimming controls and interior dimming system controls
5. Refrigeration systems
6. Emergency power generators and automatic transfer switching; paralleling equipment (if applicable)
7. Uninterruptible power supply systems
8. Fire Protection & Life safety systems (egress system, fire alarm system, fire detection systems, fire suppression systems, smoke management systems, smoke removal systems, emergency lighting systems, security/egress locking interface systems, elevator emergency recall operation, elevator emergency in-car operation)
9. Electrical (service switch gear, 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, thermograhic survey, electronic calendaring or directory, white sound system).
10. Domestic and process water pumping and mixing systems
11. Equipment sound control systems and testing
12. Data and communication
13. Paging systems
14. Security system
15. Irrigation
16. Plumbing
17. Vertical transport
18. Building envelope including the different types of curtain wall assemblies (specify roofing, windows and doors, construction joints, etc.)
19. Process instrumentation and controls
20. Sustainability features (see LEED matrix list)
21. Lighting and Lighting Control Systems and Clock Systems

sample scope for commissioning services (continued)

Desired Qualifications

It is GSA's desire for the person(s) designated as the site Commissioning Agent to satisfy as many of the following requirements as possible:

- Acted as the principal Commissioning Agent for at least three projects of comparable size, type and scope.
- Extensive experience in the operation and troubleshooting of HVAC systems and energy management control systems.
- Extensive field experience is required. A minimum of five full years in this type of work is required.
- Knowledgeable in building operation and maintenance and O&M training.
- Technical training in fire protection engineering, and/ or past commissioning, field experience, and knowledge in national building & fire codes as well as egress systems, water-based fire extinguishing systems, fire detection systems, fire alarm systems, smoke management systems.
- Knowledgeable in national building & fire codes as well as water-based fire extinguishing systems, detection systems and alarms systems.
- Knowledgeable in test and balance of both air and water systems.
- Knowledgeable in LEED and Sustainable design criteria.
- Experienced in energy-efficient equipment design and control strategy optimization.
- Specific experience with specialty systems relative to the particular facility type (i.e. Federal blast and progressive collapse requirements, security systems, etc.)
- Demonstrated experience with total building commissioning approach including building envelope, data and communication systems and other specialty systems
- Direct experience in monitoring and analyzing system operation using energy management control system trending and stand-alone datalogging equipment.
- Excellent verbal and writing communication skills. Highly organized and able to work with both management and trade contractors.
- Experienced in writing commissioning specifications.
- A bachelor's degree in mechanical or electrical engineering is strongly preferred,

and P.E. license is desired; however, other technical training, past commissioning, and field experience will be considered.

- Membership with the Building Commissioning Association is desired.
- Membership with the US Green Building Council is desired.
- Leadership in Energy and Environmental Design (LEED) Accredited Professional is desired.

The required expertise for this project will be based on the skill and experience set of the full team making the proposal. A member of the prime firm will be the designated Commissioning Agent who is the member of the team that will coordinate the commissioning activities from the technical perspective. This party may not necessarily be the team's overall project or contract manager. The Commissioning Agent must have significant in-building commissioning experience, including technical and management expertise on projects of similar scope. If the Commissioning Agent or prime firm does not have sufficient skills to commission a specific system, the prime firm shall subcontract with a qualified party to do so. Subcontractor qualifications shall be included and clearly designated in the response to this scope of work.

Proposal

The Proposal need not be voluminous, but shall provide sufficient information to allow GSA to evaluate the Consultant's approach, experience, staff and availability.

The proposer shall:

1. Limit their proposal to 15 single-sided pages, including graphics. A letter of introduction, section dividers, detailed resumes and the sample work products of item five below are not included in this limit.
2. Have the proposal signed by an officer of the proposing firm with the authority to commit the firm.
3. Fill out the attached *Commissioning Firm Experience* form and the *Commissioning Task Listing* form (Exhibits 2 and 3) for each firm on the team. List no more than four projects in Exhibit 3.
4. Provide an organization chart for managing and executing this contract.

sample scope for commissioning services (continued)

5. List the individual(s) who will serve as the lead Commissioning Agent for the Design Stage and for the construction phase of the contract (they may be different people).
6. Provide resumes for key staff and subconsultants. The resumes shall include specific information about expertise in commissioning tasks, (e.g. design reviews, specification writing, commissioning management, troubleshooting, test writing, test execution, energy management, sustainable design, etc.).
7. Briefly describe relevant experience of the proposer's team in the following areas. List involvement of key team members.
    a) projects similar to this one;
    b) O&M experience;
    c) energy-efficient equipment design and control strategy optimization;
    d) project and construction management; and
    e) system design (specify disciplines)
    f) system troubleshooting
    g) experience in environmental sustainable design
    h) knowledge and experience in fire protection and life safety systems
8. Describe your proposed approach to managing the project expertly and efficiently, including distribution of tasks, travel, duration of which staff will be on site during what periods of time, etc. Describe what approach you will take to integrate the commissioning into the normal design and construction process in order to minimize potential time delays. Describe what you will do to foster teamwork and cooperation from contractors and design team and what you will do to minimize adversarial relationships. Describe how you intend to determine the appropriate level of commissioning effort for the various systems and equipment.
9. As an attachment, provide the following work products that members of the proposer's team developed. List the team member who actually wrote the document and the projects on which they were used. Work from the designated Commissioning Provider is preferred.
    a) commissioning plan that was executed (the process part of the plan);
    b) commissioning specifications; and
    c) an actual functional test procedure form that was executed (the filled out vesion).
10. Provide a fixed, lump sum total cost to accomplish the work for the Design Stage. All task amounts include associated meetings, progress reports and direct costs

(travel, mileage, per diem, communications, etc.). Use the budget table format below to provide a cost breakdown. Also provide a loaded hourly rate for each team member for work that may exceed the scope. For each phase, provide the percentage level of effort for each primary team member.

11. For planning purposes, the proposer must also provide a cost "estimate" range for the Construction and Warranty Phase tasks using the form below. Also provide an hourly rate for each team member for work that may exceed the scope. For each phase, provide the percentage level of effort for each primary team member.

12. Provide a statement of proposer's liability insurance coverage (type, and dollar amount of coverage). Proof of this insurance will be required prior to the award of this contract to the winning proposal.

The respondent must submit two (2) copies of the proposal, each signed by an authorized representative of the firm. Submit to <INSERT NAME AND ADDRESS>.

Change in Personnel

If the commissioning firm's personnel or subconsultants change for this project, GSA must review and approve the replacement personnel, in advance. The replacement personnel shall have, at minimum, equivalent qualifications as the original personnel.

Proprietary Information

In the event that performance of any work under this contract causes the CxA to gain access to proprietary and/or confidential information of other firms/contractors, the CxA is required to immediately execute Technology Exchange Agreements with those firms/contractors, in order to protect the information from unauthorized uses. The CxA is required to refrain from using any such information for any purposes other than for which it was furnished. The CxA must immediately provide the Contracting Officer with a copy of any such agreements with original dated signatures affixed.

sample scope for commissioning services (continued)

Protection and Control of Government Documents

The CxA is required to develop and utilize procedures for custody, use/handling, reproduction, storage, safeguarding, and disposition of all documents and information of this nature. These procedures must be designed and carried out so that there is no unauthorized disclosure of such documents and information throughout the contract performance.

Exhibit 1: Commissioning Agent Focused Design Review Scope

Review is to occur at the end of Concepts/beginning of Design Development and toward the end of Construction Documents phases.

Certification Facilitation	Review contract documents to facilitate project certification goals (i.e. does design meet Energy Star requirements; does Cx meet LEED criteria, etc.).
Commissioning Facilitation	Review contract 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 & 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.
Envelope	Review envelope design and assemblies for themal and water integrity, moisture vapor control and assembly life, including impacts of interior surface finishes and impacts and interactions with HVAC systems (blast, hurricane, water penetration).
Fire Protection & Life Safety*	Review contract documents to facilitate effective commissioning of fire protection & life safety systems and to aid Fire Protection Engineer in system testing to obtain the GSA Occupancy Permit

GSA Design Guidelines & Standards	Verify that the design complies with GSA design guidelines and standards (i.e. GSA P-100, 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 Owner's Project Requirements.
Life Cycle Costs	Perform 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 P-100, including off peak chiller heating/cooling AHU operations, and size and zoning of AHU's and themostated areas.
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 contract documents are in keeping with and will meet the Owner's Project Requirements.
Structural	Review the structural concepts/design for enhancements (i.e. blast & 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 Requirement. See also P-100 LEED requirements.
Training	Verify adequate operator training requirements.

*In certain jurisdictions, State and local government officials may elect to perform code compliance construction inspections of the building systems. Therefore, it is recommended that the A/E, CxA, 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. In addition, the CxA must coordinate all Fire Protection & Life Safety system commissioning with the GSA Fire Protection Engineer.

commissioning systems selection matrix

Commissioned System	Items Included	Federal Office Building (FOB)	Border Station	Courthouse	Laboratory	Data Center
Building Envelope	Walls (vapor barriers, weeps, building joints)	•	•	•	•	•
	Windows	•	•	•	•	•
	Doors	•	•	•	•	•
	Roofing	•	•	•	•	•
	Special arch. elements (dome, cornice, etc.)	•	•	•	•	•
	Envelope (blast, hurricane, thermal, infiltration)	•	•	•	•	•
Plumbing Systems	Cleaning/flushing water systems	•	•	•	•	•
	Cleaning/flushing storm drainage systems		•		•	•
	Cleaning/flushing sanitary sewage systems		•		•	•
	Cleaning/flushing lab drainage systems				•	
	Thermometers & gauges				•	•
	Sump pumps and ejectors	•	•	•	•	•
	Trap primers	•			•	
	Backflow preventors/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	•	•	•	•	•

Commissioned System	Items Included	Federal Office Building (FOB)	Border Station	Courthouse	Laboratory	Data Center
Plumbing Systems	Irrigation systems				•	
	Water filtration (General Use)				•	•
	Showers/Lavs/Toilets	•	•	•	•	•
Heating, Ventilating and Air Conditioning (HVAC)	Thermometers & gauges		•		•	•
	Vibration isolation		•		•	•
	Steam condensate systems	•	•	•	•	•
	Hot water heating systems	•	•	•	•	•
	Computer room air conditioning units	•	•	•	•	•
	Chemical water treatment systems	•	•	•	•	•
	Liquid chillers	•	•	•	•	•
	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				•	

commissioning systems selection matrix (continued)

Commissioned System	Items Included	Federal Office Building (FOB)	Border Station	Courthouse	Laboratory	Data Center
Automatic Temperature Control System (ATC)	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 & alarming	•	•	•	•	•
	Network communication	•	•	•	•	•

Commissioned System	Items Included	Federal Office Building (FOB)	Border Station	Courthouse	Laboratory	Data Center
Electrical Systems	Electrical primary voltage system	•	•	•	•	•
	Service switchgear	•	•	•	•	•
	Emergency power system		•	•	•	•
	Generators	•	•	•	•	•
	Lighting controls (scheduled/occupancy sensors)	•	•	•	•	
	Daylight dimming controls	•	•	•	•	
	Switchboards	•	•	•	•	•
	Distribution panel boards		•		•	
	Transformers		•		•	
	Motor control centers		•		•	•
	Power monitoring & metering	•	•	•	•	•
	Transient voltage surge suppressors	•	•		•	•
	Variable speed drives	•	•	•	•	•
	Grounding & ground fault systems		•		•	•
	Overcurrent protective devices		•		•	•
	Low voltage busway		•		•	•
	Thermographic Survey	•	•	•	•	•
	Electronic calendaring or directory				•	
	White sound system	•			•	
	Data & communication system	•	•	•	•	•
	Paging system	•	•		•	
	Local devices (switches and outlets)	•	•	•	•	•

commissioning systems selection matrix (continued)

Commissioned System	Items Included	Federal Office Building (FOB)	Border Station	Courthouse	Laboratory	Data Center
Life Safety Systems	Fire suppression/protection systems	•	•	•	•	•
	Egress pressurization/Atrium smoke purge	•	•	•	•	•
	Fire alarm	•	•	•	•	•
	Fire suppression/protection systems	•	•	•	•	•
	Emergency lighting systems	•	•	•	•	•
	General egress (panic hardware, etc.)	•	•	•	•	•
	Elevator recall	•	•	•	•	•
Security	Access control	•	•	•	•	•
	Alarm monitoring	•	•	•	•	•
	Surveillance	•	•	•	•	•
Specialties	Elevators	•	•	•	•	•
	Escalators	•		•	•	
	Cold rooms				•	
	Kitchen/food service	•		•	•	
	Audio visual systems	•		•	•	
	Automatic doors	•			•	
	Dark rooms	•			•	
	Oil/water separators	•	•	•	•	•
	Detention mains		•		•	

resources & references

Resources

American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc. (ASHRAE)
1791 Tullie Circle, NE, Atlanta, GA 30329
404.636.8400 • www.ashrae.org

Building Commissioning Association (BCA)
P.O. Box 2016, Edmonds, WA 98020
425.774.6909 • www.bcxa.org

International Society for Pharmaceutical Engineering (ISPE)
3816 W. Linebaugh Ave., Suite 412, Tampa, FL 33624
813.960.2105 • www.ispe.org

National Association of State Facilities Administrators (NASFA)
P.O. Box 11910, Lexington, KY 40578-1910
859.244.8181 • www.nasfa.net

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

Portland Energy Conservation, Inc. (PECI)
921 CS Washington, Suite 312, Portland, OR 97205
503.248.4636 • www.peci.org

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

U.S. Green Building Council
1015 18th Street NW, Suite 805, Washington, DC 20036
202.828.7422 • www.usgbc.org

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 *Building Commissioning Guide*, and GSA would like to recognize the following sources that were instrumental in preparing this Guide.

- American Society of Heating, Refrigeration, and Air-Conditioning Engineers, Inc. (ASHRAE).
- *The HVAC Commissioning Process,* ASHRAE Guideline 1-1996, 1996. ASHRAE Publications Dept., 1791 Tullie Circle, NE, Atlanta, GA 30329.
- Building Commissioning Association (BCA). *Building Commissioning Attributes*. 1999. http://www.bcxa.org/download/index.htm
- National Association of State Facilities Administrators (NASFA). *Building Commissioning - Recommended Guidelines*. 2003. www.nasfa.net
- National Institute of Building Sciences. *Total Building Commissioning General Principals and Procedures*. 1090 Vermont Avenue, NW, Suite 700, Washington, DC 20005. http://sustainable.state.fl.us/fdi/edesign/resource/totalbcx/guidemod/guide01.html
- Oregon Office of Energy/Portland Energy Conservation, Inc. (PECI). *New Construction Commissioning Handbook for Facility Managers.* 2000. http://www.energy.state.or.us/bus/comm/Newcx.pdf
- Portland Energy Conservation, Inc. (PECI). *Model Commissioning Plan and Guide Commissioning Specifications,* USDOE/PECI, 1997. www.peci.org
- U.S. Department of Energy. *Building Commissioning: The Key to Quality Assurance*. Rebuild America Guide Series. http://www.rebuild.org/index.asp
- U.S. General Services Administration and USDOE. *Building Commissioning Guide.* 1995, revised in 1997. Version 1 by Enviro-Management & Research, Inc. Available at USDOE/FEMP Web site.

glossary

Acronyms

A/E	Architect/Engineer
ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers
BAS	Building Automation System
BOD	Basis of Design
CAD	Computer Aided Design
CM	Construction Manager (in this Guide assumed to be CM Agent)
Cx	Commissioning
CxA	Commissioning Agent
HVAC	Heating Ventilating and Air Conditioning
FPT	Functional Performance Test
LEED	Leadership in Energy and Environmental Design
IEQ	Indoor Environmental Quality
O&M	Operations & Maintenance
P-100	*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.).

Commissioning (Cx): The National Conference on Building Commissioning has established an official definition of 'Total Building Commissioning' as follows:

> "Systematic process of assuring by verification and documentation, from the design stage to a minimum of one year after construction, that all facility systems perform interactively in accordance with the design documentation and intent, and in accordance with the owner's operational needs, including preparation of operation personnel"

Commissioning Agent (CxA): The qualified person, company or agency that plans, coordinates and oversees the entire commissioning process.

Commissioning Plan: The document prepared for each project that describes all aspects of the commissioning process including schedules, responsibilities, documentation requirements and communication structures.

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.

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 project development and warranty phases. The purpose of recommissioning is to assure the facility performs as expected over its useful life.

acknowledgements

acknowledgements

This Guide draws from the collective body of knowledge of the GSA Regions and the GSA Office of the Chief Architect, and elaborates upon the efforts of the Commissioning Advisory Group, who contributed to the GSA Building Commissioning brochure. Special thanks are due to Bob Hixon who drove the direction of this Guide and to Curt Smith who provided countless edits.

Charles Matta, FAIA

Chair, Building Commissioning Guide Task Force

GSA Regional Input

Regional experts provided their first-hand knowledge and experiences toward ensuring a sound commissioning process and practical information which can be implemented in day-today project management. These contributors included:

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- Jaime Quinones; GSA R2
- David Frable; GSA R5
- Chuck Hardy; GSA R5
- John Mayes; GSA R7
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April 2005