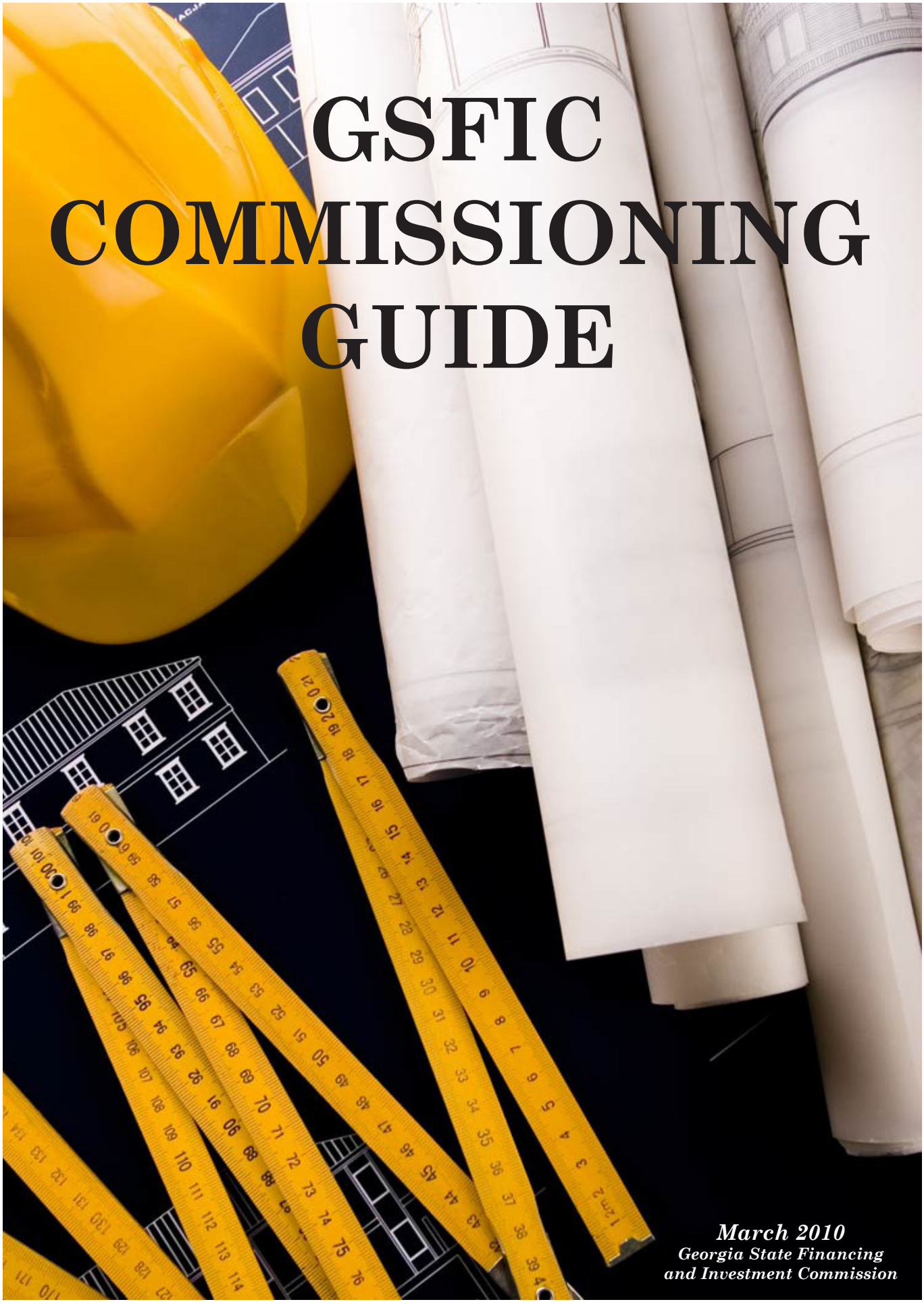
GSFIC COMMISSIONING GUIDE



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Georgia State Financing and Investment Commission

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PART I – What Agencies Should Know About Commissioning

Commissioning
The Commissioning Guide is intended to serve as a resource for facility managers and agencies contemplating construction or renovation of a state facility.

Building commissioning is the process of ensuring that systems are designed, installed, functionally tested and capable of being operated and maintained in accordance with the design intent and owner's requirements. **Commissioning** is performed in new construction projects and in major capital improvements. **Retro-commissioning** is applied to existing buildings to improve and optimize operations and maintenance.

Commissioning is a systematic process of communication, coordination, documentation, adjustment, testing and verification that begins in pre-design and continues through design, construction, and occupation of the building.

There are many benefits to third-party commissioning of installations and systems, both during construction and after occupancy. During construction, the process will help reduce change orders and project delays and shorten building turnover period. Once the building is occupied, it will improve air quality and comfort, building maintainability and reliability, energy performance and facility staff preparedness.

State Requirements
In 2008, the Georgia General Assembly determined that "the welfare of this state is enhanced by the promotion of effective energy and environmental standards for construction, rehabilitation and maintenance of state-funded facilities …", and Senate Bill 130, known as the *Energy Efficiency and Sustainable Construction Act of 2008*, was passed.

A task force was created with representatives from the Department of Community Affairs, Georgia State Financing and Investment Commission, Board of Regents, Department of Natural Resources, Technical College System of Georgia, Georgia Environmental Facilities Authority and the Governor's Office of Planning and Budget, as well as members of the design, engineering and construction industry. The task force created the Energy Efficiency and Sustainable Construction Standards for State Buildings, which highlights requirements and recommendations.

The Act, which is effective July 1, 2010, requires basic commissioning on all new buildings, most renovation projects and most roof replacements. A set of checklists in the Act helps to establish the level of sustainable achievement for each project.

In addition to the required minimum standards, the Act encourages additional strategies to attain enhanced efficiency and conservation. These strategies are outlined in a point system of incentives that rates the successes of the design. The point system, called the Georgia Peach Green Building Rating System, rates the project's ability to optimize energy performance, conserve energy and utilize local and renewable energy sources. Certain requirements are mandatory. The incentives are optional and earn points based upon category and analysis. When totaled, these points will qualify the project for increasing levels of public recognition.

Basic Commissioning (Required)
The Act requires that the basic commissioning scope of work include the mechanical systems (heating, ventilating, air conditioning, and refrigeration equipment and controls, heat recovery and renewable energy systems, laboratory systems, test and balance verification), electrical systems (lighting and daylighting controls and renewable energy systems), and plumbing systems (domestic hot water systems).

Enhanced Commissioning (Optional)
In addition to the state's required basic commissioning, the using agency may include optional commissioning for the building envelope; normal, standby, and emergency power systems; potable water and booster pump systems; and irrigation systems. A decision to expand commissioning should involve input from the design professional, project manager, and using agency during the design phase.

LEED Certification
LEED (Leadership in Energy & Environmental Design) is an internationally recognized green building certification system. This certification provides third-party verification that a building's design and construction utilized strategies to improve performance in energy savings, water efficiency, CO_2 emissions reduction, improved indoor environmental quality, and stewardship of resources.

Developed by the U.S Green Building Council, LEED provides building owners and operators with a concise framework for identifying and implementing practical and measurable green building design, construction, operations, and maintenance solutions. LEED certified buildings would meet and exceed Georgia's commissioning requirements.

Retro-Commissioning
Retro-commissioning is the commissioning of an older building. The benefits of retro-commissioning are similar to those for commissioning of new buildings – energy and operating cost savings, improved indoor environment and better maintainability and reliability. Typical candidates for retro-commissioning include buildings with complex systems from 5 to 10 years old, buildings with excessive operational or utility costs, any building that is experiencing significant environmental control problems, or buildings where the intended use or occupancy has changed.

Selecting a Method of Service
The selection of a commissioning agent or authority should occur in the planning or pre-design phase of the building project. Determining a basic scope of work will assist in determining who will provide commissioning services: an independent commissioning agent, the design firm or the using agency.

> **Independent Consultant-Led Commissioning**
> This is the most common method of service. It is also the most highly recommended, due to the neutrality of third-party verification. This method provides an independent and separate entity to oversee and manage the commissioning design and construction process. Like consulting architects and engineers, the commissioning firm is selected based upon experience. The selection process is known as Quality Based Selection.
>
> **Designer-Led Commissioning**
> In this method of service, the design professional assumes responsibility for conducting the commissioning process. This method may be preferable if the design professional has a separate in-house commissioning team or the project is small or relatively uncomplicated. The method encourages greater interaction between the commissioning agent and the design team, but it may obscure design flaws.
>
> **Owner-Led Commissioning**
> If the owner of the building has an experienced field commissioning and management team on staff, this team can lead the commissioning process. Owner-led commissioning can be very efficient and effective, if the staff is familiar with the building systems to be included, have sufficient time to complete the commissioning work properly and have the support of the agency or administration.

Securing an Agreement with a Commissioning Agent
Upon determining the method of service for commissioning, the using agency may contact the Procurement Department at GSFIC to obtain assistance with a contractual agreement. The GSFIC project manager should be notified of these decisions as well.

PART II – Defining the Scope of Your Project (Tool for Implementation)

1. State of Georgia Requirements for Commissioning

The State of Georgia requires by law that commissioning be performed on state construction projects. The Energy Efficiency and Sustainable Construction Act of 2008 (codified in O.C.G.A. § 50-8-18) promotes effective energy and environmental standards for construction, rehabilitation, and maintenance of state-funded facilities. It provides a set of instructions for state agencies, design professionals, contractors, and building operators.

The Act becomes effective on July 1, 2010, and applies to design agreements for major facilities projects entered into on this date or after.

The tables in this guide are based upon the Act and include all required systems and items to be commissioned, as well as optional items to be considered in the project scope. In case of discrepancies between this guide and the Act, the Act will take precedence. The Act contains Sustainable Construction Standards for state buildings and a green building rating system to encourage additional sustainability achievements. The rating system is known as the Georgia Peach Green Building Rating System.

The provisions of these Standards shall apply to the construction, rehabilitation and maintenance of state-funded facilities that meet any one of the following criteria:

1) New construction building projects exceeding 10,000 square feet;
2) A renovation project that is more than 50 percent of the replacement value of the facility; (as determined by the Department of Administrative Services Risk Management Division)
3) A change in occupancy;
4) Any roof replacement project exceeding 10,000 square feet; or
5) A commercial interior tenant fit-out project exceeding 10,000 square feet of leasable area where the state is intended to be the lessor of such property.

- Exception: Any building, regardless of size, that does not have conditioned space as defined by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), or a state-owned building that is on the historical registry or any local, county or municipal building.

A professional engineer, design professional, or commissioning agent shall certify that the building project's systems for heating, ventilating, air conditioning, energy conservation, and water conservation are installed and working properly to ensure that each building project performs according to the building's overall environmental design intent and operational objectives.

The project manager or using agency shall engage a member of the design team (owner-led), a member of the design firm (designer-led), or an independent third-party (independent consultant-led) commissioning agent. Commissioning activities should be completed for the mechanical systems (heating, ventilating, air conditioning, and refrigeration equipment and controls, heat recovery and renewable energy systems, laboratory systems, test and balance verification), electrical systems (lighting and daylighting controls and renewable energy systems), and plumbing systems (domestic hot water systems).

(See this website for the Energy Efficiency and Sustainable Construction Standards for State Buildings.)

2. Optional Systems for Commissioning

Other systems that may be considered in the commissioning process include the building envelope; normal, standby and emergency power systems; potable water and booster pump systems; and irrigation systems. The design team and agency should determine the appropriate level of commissioning (Cx) based upon the size and complexity of the building and its components. The commissioning agent (CxA)

should verify the installation and performance of all commissioned systems no later than 10 months after material completion of the project.

3. Georgia Peach Green Building Rating System
The Act includes a rating system entitled the Georgia Peach Green Building Rating System. Similar to the LEED rating system, the Peach rating encourages additional sustainable strategies for enhanced efficiency and conservation and promotes the use of Georgia-based products.

The rating system point scale consists of two major components: basic requirements (which are mandatory) and incentives (which are optional). The "Total Point Certification Level" earned will qualify the project for Peach ratings. The Peach ratings are from one Peach (minimum possible points) to four Peaches (maximum possible points). The project and agency will be recognized for energy efficiency and sustainable construction achievements.

4. Paper vs. Field Commissioning ("Process" vs. "Technical" Commissioning)
There are two types of commissioning performed on projects. These are paper or "process" commissioning and field or "technical" commissioning. Paper Cx is the assembling and reviewing of reports and documentation, and field Cx is the actual testing and verifying of installation.

Paper Cx handles all of the paperwork and background research. In this process, the CxA gathers and reviews reports from the subcontractors. These reports should indicate that systems have been field tested and are acknowledged to be working by the subcontractor. Paper Cx might include the review of design review reports, field tests, start-up reports, check-out reports, test and balance reports, O&M manuals, training plans for operating personnel and random sampling. The CxA assembles a final report, with all appropriate data provided by the subcontractors, to indicate adherence to the specifications.

Field Cx ensures, by the active involvement of the CxA, that each building system works as specified. The CxA must have an understanding of the engineering principles of the design, detailed knowledge of construction methods, and proficiency with systems controls and testing and balancing. Field Cx begins during the design phase, when the CxA makes recommendations on systems design and documentation. During the construction phase, the CxA makes site visits to observe installation and operation. Rather than simply reviewing the test and balance report, the CxA will actually observe the test and balance (TAB) set-up and procedures. Other tasks include the verification of all readings in the TAB, the review of control testing and set-up, functional performance tests, the observation of equipment and accessories before closing of walls and trenches, participation in personnel training, sensor and loop checkouts, and physical testing of all loops for control and stability ("tuning the loop"). The CxA assembles a final report, with all testing data that the CxA has produced, to verify that the building systems function as specified.

For state projects, field Cx should be included on all commissioned systems, and contracts should be written to include this requirement.

5. Tables for Commissioning Scope of Work, per Building System

The tables below will assist the team in selecting the building systems and items to be commissioned. The tables indicate items required by state law as well as those which are optional and for consideration.

Table 5.1 – Building Envelope

System to be Commissioned:			
Building Envelope			
No.	**Main Items Included in Scope**	**Required**	**Optional**
1.	Roofing system – water-proofing, insulation, roof membrane, rain and ice shield, pitch, coping, flashing, curbs for mechanical equipment, downspouts, drains, scuppers	-	X
2.	Exterior skin – curtainwall, storefront, masonry, brick / stone veneers, precast panels, metal panels, stucco / EIFS, siding	-	X
3.	Walls – vapor barriers, insulation, mortar nets, weeps, joints, sealants, masonry ties	-	X
4.	Slab on grade – vapor barriers, water-proofing, drainage, foundation drains	-	X
5.	Doors and windows – sealants, mechanical operation, sills, flashing, end dams, hardware	-	X
6.	Water tests, mockups, wind loads, thermal infiltration	-	X
7.	Special design features – dome, cornice, canopy, skylight, etc.	-	X

Table 5.2 – Mechanical Systems

System to be Commissioned:			
Mechanical Systems - Heating, Ventilating, and Air Conditioning (HVAC) and Refrigeration Equipment			
No.	**Main Items Included in Scope**	**Required**	**Optional**
1.	Thermometers and gauges	**X**	**-**
2.	Vibration isolation	**X**	**-**
3.	Steam condensate system	**X**	**-**
4.	Hot water heating systems	**X**	**-**
5.	Computer room HVAC systems	**X**	**-**
6.	Chemical water treatment systems	**X**	**-**
7.	Chillers	**X**	**-**
8.	Cooling towers	**X**	**-**
9.	Condenser water system	**X**	**-**
10.	Air terminal unit systems, VAV, PIU, AHU, etc.	**X**	**-**
11.	Humidifiers and controls	**X**	**-**
12.	Duct silencers	**X**	**-**
13.	Dampers	**X**	**-**
14.	Variable frequency drives and motors	**X**	**-**
15.	Air distribution systems	**X**	**-**
16.	Exhaust air systems and building pressurization controls	**X**	**-**
17.	Building automation systems, including controlled devices, sensors, control loops, and logic	**X**	**-**
18.	Test and Balance verification	**X**	**-**
19.	Refrigeration equipment and controls	**X**	**-**
20.	Chilled water system	**X**	**-**

Table 5.3 – HVAC Controls Systems

System to be Commissioned:			
HVAC Controls Systems			
No.	**Main Items Included in Scope**	**Required**	**Optional**
1.	Component FPT and calibration	**X**	**-**
2.	Control air supply	**X**	**-**
3.	Air terminal units (non-lab)	**X**	**-**
4.	Sequence controls to include: • AHU, 100% OSA • EAHU, HVAC equipment • AHU, H&V • Exhaust air fans • Differential bypass valve • Air terminal units, CV • Air terminal units, VAV / CV • Air terminal units, VAV • Heat exchanger • Variable speed pumps • Cabinet unit heaters • Condenser water system • Humidifiers • Water heaters • Heating coils / radiant panels • Labs with VAV fume hoods • Condenser water filters • Steam generator	**X**	**-**
5.	Graphic display	**X**	**-**
6.	Trend logs	**X**	**-**
7.	Status review screens, checks and alarming	**X**	**-**
8.	Network communication	**X**	**-**

Table 5.4 – Plumbing Systems

System to be Commissioned:			
Plumbing Systems			
No.	**Main Items Included in Scope**	**Required**	**Optional**
1.	Cleaning / flushing water systems	-	X
2.	Trap primers	-	X
3.	Vibration isolation	-	X
4.	High purity water system	-	X
5.	De-ionized water system	-	X
6.	Thermometers and gauges	-	X
7.	Irrigation systems	-	X
8.	Water filtration (general use)	-	X
9.	Domestic hot water systems	X	-
10.	Tempered water systems	X	-
11.	Fuel oil / gas systems	-	X
12.	Potable water and booster pump systems	-	X
13.	Sump pumps and electors	-	X
14.	Backflow preventers and relief valves	-	X
15.	Compressed air systems (non-lab use)	-	X

Table 5.5 – Electrical Systems

System to be Commissioned:			
Electrical Systems			
No.	**Main Items Included in Scope**	**Required**	**Optional**
1.	Service switchgear	-	X
2.	Emergency power system	-	X
3.	Generators	-	X
4.	Lighting controls (scheduled activators and occupancy sensors)	X	-
5.	Daylight dimming controls	X	-
6.	Lighting - exterior	-	X
7.	Lighting - interior	-	X
8.	Switchboards	-	X
9.	Distribution panel boards	-	X
10.	Motor control centers	-	X
11.	Power monitoring and metering	-	X
12.	Transient voltage surge suppressors	-	X
13.	Variable frequency and speed drives	-	X
14.	Grounding and ground fault systems	-	X
15.	Over-current protective devices	-	X
16.	Low voltage bus ways	-	X
17.	Thermographic survey	-	X
18.	White noise system	-	X
19.	Paging system and security	-	X
20.	ATS auto transfer switches	-	X
21.	Buss duct and tap devices	-	X
22.	Fire alarm and smoke detectors	-	X
23.	Standby and emergency power systems	-	X
24.	Emergency lighting	-	X
25.	Security systems	-	X
26.	Electrical primary voltage system	-	X
27.	Transformers	-	X

Table 5.6 – Laboratory Systems

System to be Commissioned:			
Laboratory Systems			
No.	**Main Items Included in Scope**	**Required**	**Optional**
1.	Lab waste neutralization	X	-
2.	Fume hoods	X	-
3.	Special gas manifolds	X	-
4.	Vacuum air system	X	-
5.	Compressed air system (lab use)	X	-
6.	Emergency shower / eyewash	-	X
7.	Sinks and drains	-	X
8.	Electronic calendaring or directory	X	-

Table 5.7 – Renewable Energy Systems

System to be Commissioned:			
Renewable Energy Systems			
No.	**Main Items Included in Scope**	**Required**	**Optional**
1.	Heat recovery systems	**X**	**-**
2.	Controls and thermostats	**X**	**-**
3.	Photovoltaic cell panels (solar power systems)	**X**	**-**
4.	Solar hot water systems	**X**	**-**
5.	Geothermal systems	**X**	**-**

Telecommunications Systems
Telecommunications Systems typically are not commissioned. These systems, also referred to as Cabling or Low Voltage, include voice, data, video, and security. The basic scope of work for their installation includes testing, verification and certification as an industry standard. Manufacturers of low voltage systems provide a complete system and certify its functionality. Once installed, the entire system is tested and receives certification only if it passes. Therefore the provision of additional commissioning would duplicate cost with no additional benefit.

The state will not accept a system which fails the certification test. Since most low voltage problems arise during the first year of usage, the state has established minimum requirements for GSFIC projects and strong recommendations for other state projects:

1. The Low Voltage Licensed Telecommunications Contractor (LVLTC) of record shall provide, at a minimum, a one-year performance of work warrantee on all installations.
2. The LVLTC shall furnish a manufacturer's warrantee of the Structured Cabling System (SCS) that includes the products, performance, application assurance and workmanship for a minimum of 15 years from the date of acceptance by the state.
3. The LVLTC shall pass on to the using agency any additional or extended warrantees offered by the manufacturer at no additional cost to the agency.

6. LEED Options for Commissioning

The State of Georgia does not require LEED certification (Leadership in Energy & Environmental Design) for state facilities, although this optional certification can be included at the agency's discretion. The chart below summarizes commissioning criteria for this optional LEED certification. The chart includes fundamental and additional requirements.

In addition to these requirements, LEED certification involves other considerations. LEED building projects require registration and certification fees, additional fees for design consultants and administrators, increased construction costs, and multiple prerequisites beyond basic commissioning. Only third-party or independent consultant-led services are permitted, so owner-led and designer-led services are not options. With the LEED for Existing Buildings: Operations & Maintenance (EB: O&M) rating system, existing buildings must recertify at least once every 5 years to maintain their status.

Projects which include Federal funding may be subject to additional commissioning requirements. The project manager should verify any Federal requirements and communicate them to the team.

Table for LEED Commissioning Criteria Energy & Atmosphere Prerequisite 1 (LEED for New Construction, Version 2.2)
(The latest version of LEED is V.3.0, which is effective January 1, 2010.)

Table 6.1 – LEED Commissioning Criteria

Fundamental Building Systems Commissioning		**Energy & Atmosphere Credit 3 Additional Commissioning**	
Intent: Verify and ensure that fundamental building elements and systems are designed, installed and calibrated to operate as intended.		**Intent:** Verify and ensure that the entire building is designed, constructed, and calibrated to operate as intended.	
No.	**Requirements and Submittals**	**No.**	**Requirements and Submittals**
1.	Engage a commissioning authority (CxA).	1.	Engage a commissioning authority (CxA).
2.	Review design intent and Basis of Design (BOD) documentation.	2.	Review design intent and BOD documentation.
3.	Include Cx requirements in construction documents.	3.	Include Cx requirements in construction documents.
4.	Develop and utilize a Cx plan.	4.	Develop and utilize a Cx plan.
5.	Verify installation, functional performance, training and documentation.	5.	Verify installation, functional performance, training and documentation.
6.	Complete a Cx report.	6.	Complete a Cx report.
		7.	Conduct a focused review of the design prior to CD phase. (Must be performed by an independent 3rd party)
		8.	Conduct a focused review of the Construction Documents when close to completion. (Must be performed by an independent 3rd party)
		9.	Conduct a selective review of contractor submittals of commissioned equipment. (Must be performed by an independent 3rd party)
		10.	Develop a re-commissioning management manual.
		11.	Have a contract in place to review current building operation with operational staff. This should include a plan for resolution of outstanding commissioning-related issues within 1 year of completion of construction.

(For more information on LEED certification, visit the **U.S. Green Building Council (USGBC)** website.)

7. Tables for Commissioning "Roles and Responsibilities" with "Services and Deliverables," per Phase

The tables below will assist the team in understanding the roles and responsibilities of all participants in commissioning. In addition the tables clarify what services and deliverables are required for the items being commissioned. These tables cover the design phase, construction phase, and occupancy and warranty (post-construction) phase for the project.

Table 7.1 - Design Phase

Roles and Responsibilities					
		Agency	**Design Professional**	**Construction Professional (CM / GC only)**	**Commissioning Agent (CxA)**
Services and Deliverables					
1. *	Develop Owner's Project Requirements (OPR)	X	-	-	-
2. *	Develop preliminary Cx scope	X	-	-	-
3. *	Engage the CxA.	X	-	-	-
4.	Review OPR documentation for completeness and clarity	-	-	-	X
5. *	Review OPR to develop Basis of Design (BOD)	-	X	-	-
6.	Review BOD document and ensure consistency with OPR	-	-	-	X
7. *	Develop preliminary Cx plan and provide design team with a draft.	-	-	-	X
8. *	Include CxA activities in initial project design schedule	-	X	-	-
9.	Incorporate Cx specifications into project manual	-	X	-	X
10.	CxA to conduct commissioning design reviews (drawings and specifications) at phases to be determined by agency and CxA. Typically the phases are Design Development (DD) or 50% Construction Documents (CD), followed by additional review at 80-100% CD's or Guaranteed Maximum Price Set (GMP)	-	-	-	X
11.	Incorporate appropriate changes to documents based upon Cx reviews	-	X	-	-
12.	Integrate CxA activities into initial project construction schedule	-	X	X	-
13. *	Create commissioning deficiencies / issues log to be updated throughout Cx	-	-	-	X
14.	Complete checklist verifying that CxA has received latest version of design documents	-	X	-	X

*** Notes and Links for Table 7.1, Design Phase**

1. The Owner's Project Requirements (OPR) should contain the following items: general project information (size, LEED status, and schedule), training operations and maintenance requirements, building space and occupancies summary, and building performance criteria (energy, materials and resources, and indoor air quality). **(See sample OPR outline here.)** **(See sample OPR here.)**

2. Owner determines which systems should be commissioned. Refer to Tables 5.1 – 5.7 that outline systems.

3. Select the CxA using the Quality Based Selection process (QBS). Contact GSFIC PM / Procurement for assistance with the process.

5. The Basis of Design (BOD) is a narrative that satisfies the OPR. The BOD includes an overview of building systems, summer and winter design conditions (interior and exterior), HVAC system selection, utilities, lighting, code and life safety requirements, budget and special systems (pure water, air, etc.) **(See sample BOD outline here.)** **(See sample BOD here.)**

7. **(See sample Cx plan here.)**

8. Design professional and contractor to include CxA activities and deadlines in design and construction schedules.

13. Deficiencies / issues log is used to clarify and track items for Cx, throughout all project phases, including construction. **(See sample issues log here.)**

Table 7.2 - Construction Phase

Roles and Responsibilities					
		Agency	**Design Professional**	**Construction Professional**	**Commissioning Agent (CxA)**
Services and Deliverables					
1.	Update commissioning plan	-	-	-	X
2. *	Review resolution integration issues and responsibilities between equipment, systems, and disciplines	-	X	-	-
3. *	Review submittals for commissioned equipment and systems	-	X	-	X
4.	Develop construction checklists for equipment and systems to be commissioned	-	-	-	X
5.	Develop functional test procedures and documentation formats for all commissioned equipment and systems	-	-	-	X
6. *	Develop and maintain site observation report	-	X	-	X
7.	Prepare Cx progress reports	-	-	-	X
8. *	Hold construction phase Cx meeting in conjunction with construction progress meetings (OAC meetings)	-	-	-	X
9. *	Maintain Cx deficiencies / issues log	-	-	-	X
10.	Coordinate and supervise Cx deficiency corrections	-	-	X	X
11.	Ensure that subcontractors comply with Cx specifications and requirements	-	-	X	-
12.	Review Requests for Information (RFI's) and changes for impacts on Cx	-	-	-	X
13. *	Review completed copies of factory- or contractor-provided pre-start up and start up test forms	-	-	-	X
14.	Continuously maintain record drawings (as-builts) and submit as detailed in the contract documents	-	-	X	-
15. *	Perform on-site validation of successful completion of Functional Performance Test (FPT)	-	X	-	X
16. *	Maintain record of functional testing	-	-	X	X
17. *	Witness the Test & Balance (TAB) testing for completeness and accuracy	-	-	-	X
18.	Review TAB Report	-	X	-	X
19.	Review Operation & Maintenance (O&M) manuals, as-built documentation, and training documentation	-	-	-	X
20. *	Perform installation verification and walk-thru and prepare observation reports	-	X	X	X
21.	Review equipment warranties	-	-	-	X
22. *	Review and participate in contractor-provided training program for agency maintenance personnel	-	-	-	X
23.	Verify that requirements for staff training are complete	-	-	-	X
24.	Develop a systems manual for commissioned systems	-	-	-	X

*** Notes and Links for Table 7.2, Construction Phase**

2. When issues of systems integration arise during construction, the CxA may offer solutions or resolution and incorporate these into the issues log.

3. The review should include comment, recommended action, and responsible vendor.

4. **(See sample prefunctional checklist here.)**

6. On-site review of equipment installations.

8. In addition to regular Owner Architect Contractor (OAC) meetings, an initial introduction and task assignment meeting at the start of construction is required. This meeting will outline the commissioning process and roles and responsibilities of all participants

9. **(See sample issues log here.)**

13. When the contractor or manufacturer produces start-up test forms, the CxA is to review them for acceptability.

15. The CxA is to validate the tests on site as required.

16. **(See sample Functional Performance Test here.)**

17. Witness testing of major equipment (air handler, chiller, boiler, etc. and high percentage of air distribution boxes).

20. **(See sample observation report here.)**

22. Contractor is to train building operators and agency staff to use various equipment and features, and CxA will oversee training.

24. **(See sample systems manual outline here.)**

Table 7.3 - Occupancy and Warranty (Post-Construction) Phase

Roles and Responsibilities					
		Agency	Design Professional	Construction Professional	Commissioning Agent (CxA)
Services and Deliverables					
1. *	Complete final Cx issues log that includes resolved and unresolved issues	-	-	-	X
2. *	Address concerns with operating facility and staff	-	-	-	X
3. *	The CxA should verify the installation and performance of all commissioned systems no later than 10 months after material completion of the project. (Complete and submit checklist form.) **(See form here.)**	-	-	-	X
4. *	Complete final Commissioning Report	-	-	-	X
5.	Assist owner with a 12-month measurement and verification of energy performance (optional)	-	-	-	X
6. *	Coordinate or witness deferred and seasonal testing & balancing	-	-	-	X

*** Notes and Links for Table 7.3, Occupancy and Warranty Phase**

1. Issues log is to clarify closed and outstanding issues.

2. CxA to coordinate meeting with the project team. CxA is to produce and distribute meeting minutes.

3. The 10-month time frame gives the agency and building occupants a chance to identify problems and observe systems performance during occupancy.

4. Final Commissioning Report to contain all relevant information, correspondence, tests, data, findings and summary for the entire project. Typical reports include an executive summary, Cx plan, Cx specifications, issues log and other logs, updates, design reviews, submittal reviews, site observations, TAB reports, history of training, and reports for each commissioned system. **(See sample executive summary of final report here.)**

6. Seasonal testing is highly recommended and is usually required on most projects to confirm performance in wide varieties and extreme weather. Typical seasonal testing is performed during summer and winter peak load periods.

8. Retro-Commissioning

Retro-commissioning optimizes existing HVAC and lighting controls and systems and includes the recommendation of new energy-saving equipment and controls as necessary. By studying the efficiency and operation of a building's systems (usually every 5 to 10 years), a CxA can propose solutions to correct and improve performance. Tuning the existing equipment can typically save 5 – 15% in energy costs annually, with payback in less than two years, according to ASHRAE.

Retro-commissioning is generally more expensive than new building commissioning since it requires a greater level of experience and analysis in developing the desired scope of work. In addition it is usually more difficult to perform because the equipment is already installed and is not always easily accessible.

The agency must provide these items to the CxA before work begins:

- Original design documentation (OPR)
- Equipment lists, with nameplate information
- Drawings for the building's main energy consuming systems and equipment, including mechanical, electrical, and controls
- Control system documentation, including point lists, control diagrams, and narratives on the sequences of operation
- Operation and Maintenance manuals (O&M manuals)
- Testing, Adjusting, and Balancing Reports (TAB Reports)
- Previous Cx reports
- Previous energy studies

The initial step is to determine the original Owner's Project Requirements (OPR) for the building and confirm that it currently meets the agency's needs, which are referred to as the Current Facilities Requirements (CFR). If the OPR is still valid, the CxA performs measurements to locate variances from design and develops a plan to get the systems back into compliance. If the OPR has changed, the CxA will proceed with a revised OPR.

The CxA reviews the initial design intent and analyzes all current data. Testing and adjusting of systems helps the CxA locate problems, malfunctions, and maintenance issues. The CxA then recommends energy devices to retrofit to systems to improve their performance. Examples of modifications that enhance a system include new control cards, energy wheels to reclaim hot and cold exhaust and adjust humidity, variable frequency drive motors for HVAC fans, and VAV boxes. In addition to basic retro-commissioning, the agency can engage the CxA to design and / or install these components.

Table 8.1 – Retro-Commissioning

System to be Commissioned:			
Retro-Commissioning			
No.	**Main Items Included in Scope**	**Required**	**Optional**
1.	Compressed air system	-	X
2.	Steam condensate system	-	X
3.	Hot water heating system	-	X
4.	Computer room HVAC system	-	X
5.	Chemical water treatment system	-	X
6.	Chillers	-	X
7.	Cooling towers	-	X
8.	Air terminal unit systems, VAV, PIU, AHU, etc.	-	X
9.	Humidifiers and controls	-	X
10.	Dampers	-	X
11.	Variable frequency drives and motors	-	X
12.	Air distribution systems	-	X
13.	Exhaust air systems and building pressurization controls	-	X
14.	Building automation systems, including controlled devices, sensors, control loops, and logic	-	X
15.	Lighting controls (scheduled activators and occupancy sensors)	-	X
16.	HVAC DX systems	-	X
17.	Domestic hot water systems	-	X

Table 8.2 – Retro-Commissioning

Roles and Responsibilities					
		Agency	**Design Professional (Optional)**	**Construction Professional**	**Commissioning Agent (CxA)**
Services and Deliverables					
1.	Study OPR, BOD, and trend logs to establish baseline for building operation	-	-	-	X
2.	Develop Retro-Commissioning Plan	-	-	-	X
3.	Develop scope and schedule	X	X	-	X
4.	Perform site walk-thru, assessment of O&M practices, and functional tests and monitoring. Potential tests may also include CO2 in occupied spaces, lighting footcandles, and thermal imaging of the envelope.	-	-	-	X
5.	Tune the loop (equipment, dampers, controls, etc.) and adjust systems	-	-	-	X
6.	Conduct a test and balance of HVAC systems (TAB)	-	-	-	X
7.	Analyze the monitoring / trending and test data	-	-	-	X
8.	Demonstrate operation of system, identify problems, calculate energy savings, and identify cost-effective solutions	-	-	-	X
9.	Prepare Cx progress reports	-	-	-	X
10.	Recommend new equipment to improve energy efficiency (VFD's, energy wheels, etc.)	-	-	-	X
11.	Design and / or install new equipment as recommended (optional)	-	X	X	X
12.	Develop and supervise Implementation Plan for installation of improvements	-	-	-	X
13.	Verify that improvements are functioning as specified in the Implementation Plan and indicate cost savings	-	-	-	X
14.	Conduct training of personnel in operation and maintenance of equipment, both new and old	-	-	-	X
15.	Complete final Retro-Commissioning Report	-	-	-	X

Glossary

ASHRAE: American Society of Heating, Refrigerating and Air-Conditioning Engineers

Basis of Design (BOD): The Basis of Design explains how certain systems and space arrangements were selected by the design team to satisfy the Owner's Project Requirements.

CFR: Current Facilities Requirements

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

Commissioning Final Report: The document prepared during the acceptance phase of the commissioning process, after all Functional Performance Tests are complete. It includes an executive summary, building description, completed Commissioning Plan, and all data gathered during the process.

Commissioning plan: The document prepared for each project that describes all aspects of the commissioning process, including schedules, responsibilities, and documentation and testing requirements. The level of detail in the document depends on the scope of the specified commissioning activities.

Construction testing and start-up: The original checking by the contractor and / or manufacturer's representative of the installation and operation of a component or a system, often with the aid of checklists provided by the installing contractor or manufacturer, including model verification.

Functional Performance Test (FPT): The full range of checks and tests carried out to determine whether all components, systems and sub-systems, and interfaces between systems function in accordance with the BOD. "Function" includes all modes and sequences of control operation, all interlocks, and conditional control and specified responses during design day and emergency conditions.

OAC meeting: Owner Architect Contractor meeting

O&M: Operations and Maintenance

Owner's Project Requirements (OPR): A document explaining the owner's intentions and expectations for the design and operation of the building (design intent).

Payback: The length of time that an energy-efficient improvement will take to provide a full return on investment.

Pre-functional checklist: The on-site verification of the existence and installation of equipment, materials, and / or systems as required in the contract documents.

QBS: Quality Based Selection

Retro-commissioning: The process of assessing, analyzing, and upgrading the operational performance of an existing building. Retro-commissioning usually results in a number of low-cost or no-cost activities that save energy while maintaining or improving occupant comfort.

TAB: Testing, Adjusting, and Balancing

Tuning the loop: This involves the adjusting of balancing valves and dampers, calibrating controls and verifying flow rates to achieve maximum efficiency and response on a hydronic or air distribution system. This work is normally performed as part of the TAB.