



**The
California
State
University**
Office of the Chancellor

**Commissioning Guideline
for CSU Capital Projects**

Acknowledgement

The California State University (CSU) gratefully acknowledges the effort and work of Jai Agaram, Douglas Effenberger, Paulo Fundament, Malcolm Lewis, Kent Peterson, Steven Taylor and Satinder Gulati. Comments or inquiries may be directed to:

The California State University
Office of the Chancellor
Capital Planning Design and Construction
Long Beach, California
Attention: Thomas Kennedy, Chief Architecture and Engineering
Telephone: (562) 951-4129
E-mail: tkennedy@calstate.edu

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1.0 INTRODUCTION

1.1 Purpose of the Document

The purpose of this commissioning guideline is to outline the commissioning process and identify players' roles and responsibilities. It specifically provides information to guide the campus representative or University involved in a commissioning project. This document provides definitions of various commissioning terms; outlines the commissioning tasks chronologically during each phase of the project; and provides a description of each team player's responsibility throughout all phases of the project.

1.2 Commissioning Objectives

The objective of commissioning is to provide documented confirmation that a facility fulfills the functional and performance requirements of the building campus, occupants, and operators. To reach this goal, it is necessary for the commissioning process to establish and document the campus criteria for system function, performance, and maintainability; as well as to verify and document compliance with these criteria throughout design, construction, start-up, and the initial period of operation. For the process to work successfully, it is important that the campus, commissioning agent, design team, contractors, and operators work together as a team throughout their involvement with the project.

1.3 Systems to be Commissioned

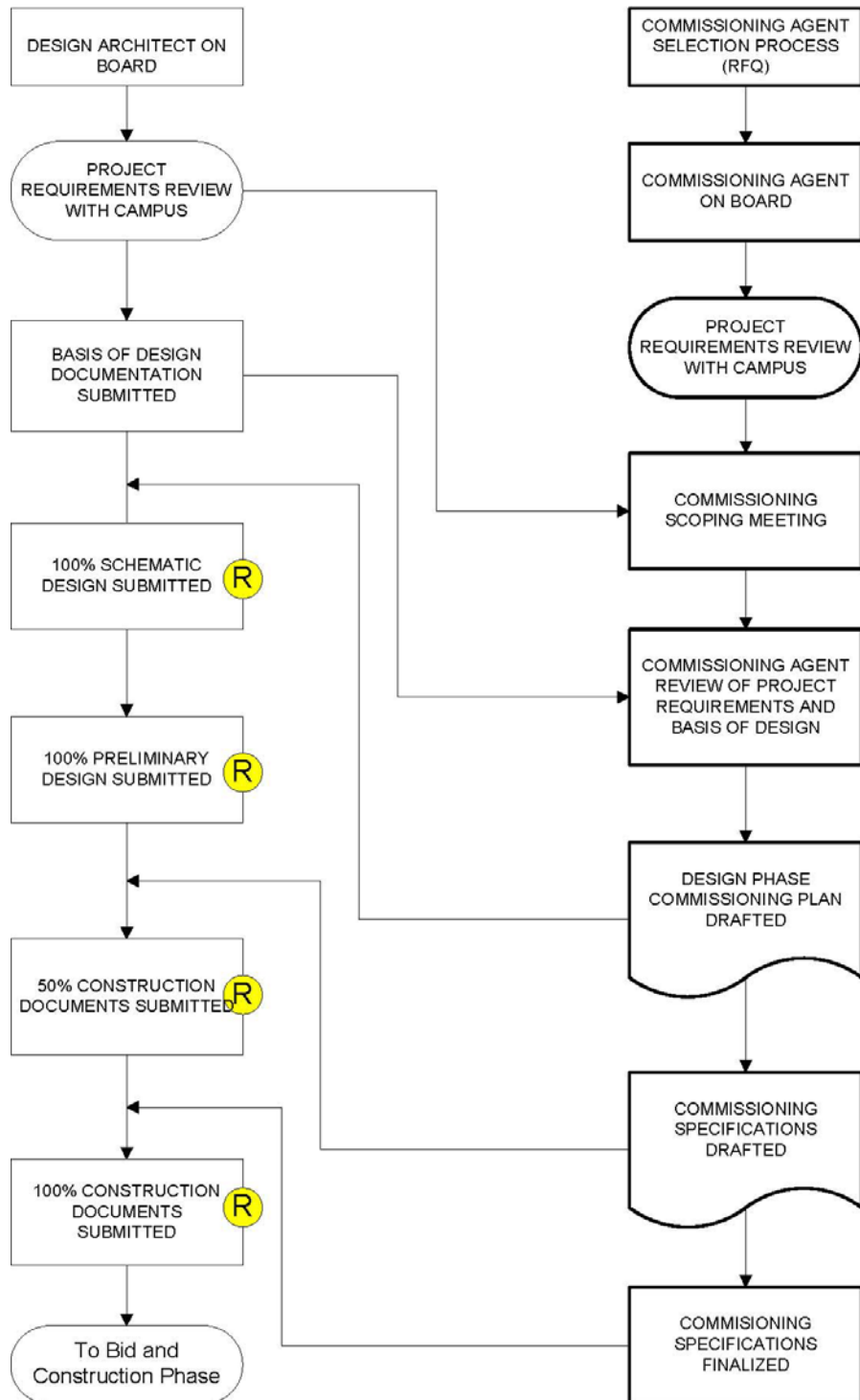
A systematic process of quality control and assurance should apply in every construction project. However, under prevailing construction practices, the level of appropriate rigor and the respective tasks of the project team will vary with project objectives, complexity, and criticality of the systems. Commissioning is a systematic process of quality control and assurance, and is required, for all capital projects. In general, the heating, ventilating and air conditioning systems, building control systems, occupancy sensor lighting controls and daylight dimming control systems should be commissioned. The following questions are intended to assist the University in deciding the appropriate commissioning rigor to apply to specific systems and equipment.

- Is the system under consideration simple or complex, both in operation and design?
- Does the equipment operate independently of other equipment and systems?
- Can the facility afford the equipment's malfunction without endangering the occupants' health, safety and comfort?

If the system is simple and some degree of latitude in equipment operation can be afforded, then a less rigorous commissioning scope may be acceptable. However, if the answer to any one of the questions above indicates a more complex system, then a comprehensive commissioning process is strongly recommended.

Figure 1 shows the commissioning process during the design phase of a project. This could vary depending on when the University contracts the commissioning agent. Figure 2 shows the commissioning process during the bid and construction phases of a project

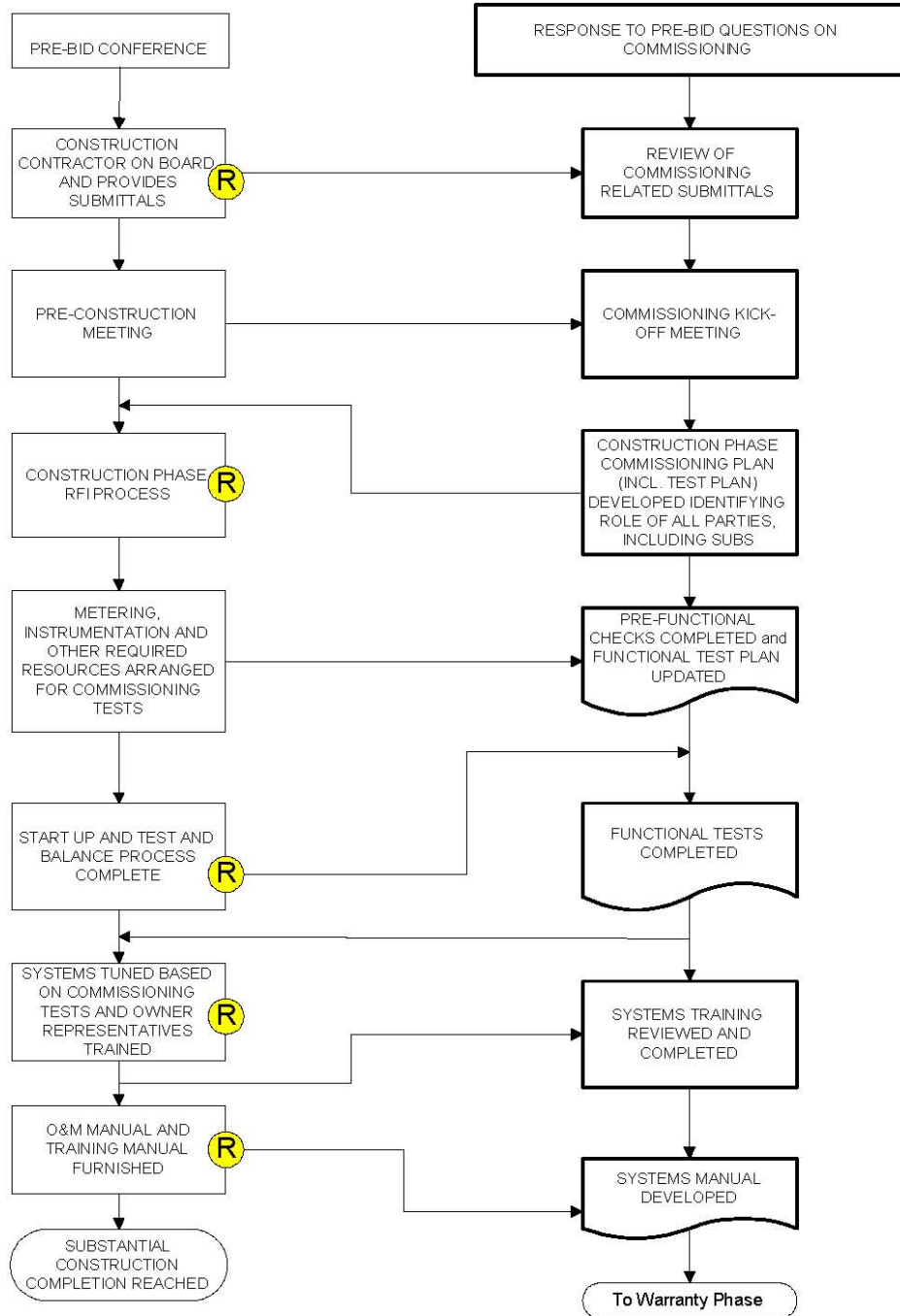
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(R) Each Design Phase submittal reviewed by Commissioning Agent, with documented comments to the University

Figure 1 – Design Phase Commissioning Process

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R Construction period RFI and other submittals reviewed by Commissioning Agent, with documented comments to the University/Engineer

Figure 2 – Bid and Construction Phase Commissioning Process

1.4 Funds for Commissioning CSU Capital Projects

Commissioning is required, for all CSU major capital projects over \$6,000,000 in construction cost. Commissioning for capital construction projects less than \$6,000,000 is the campus choice. Leased buildings, parking lots and other non-energy related facilities are exempted from Commissioning.

Funding for commissioning the projects is included as a separate line item on CPDC Form 2-7. This budget is based on approximately 0.5% of the construction budget with higher percentage for smaller projects and lower percentage for larger projects. This budget may not be adequate to provide full MEP commissioning on certain smaller capital projects. Campus may choose to supplement with additional funding to provide additional commissioning or negotiate with the commissioning agent and scale back the scope of services for commissioning to match with the available funds. It is recommended that campuses utilize funds on these smaller projects late in the design phase to obtain more commissioning services in construction.

The campus should be able to obtain more commissioning services for larger capital projects (>\$30M) due to the fact that there is a certain fixed amount of commissioning activities on every project, irrespective of the construction budget.

Above budgets have been established based on typical CSU average project. Campus may negotiate a reduced scope of services with the service provider for a complicated project like a Science laboratory building. Campus may also negotiate a reduced fee with the service provider for a less complicated project or a project with multiple mechanical systems. An example of such a project may be a Student Housing Project.

1.5 Definitions

Basis of Design. The documentation of the primary thought processes and assumptions behind design decisions are made to meet the campus objectives. The Basis of Design describes the assumptions used for sizing and selection of systems (i.e. codes, standards, operating conditions, and design conditions, weather data, interior environmental criteria, other pertinent design assumptions, cost goals, and references to applicable codes, standards, regulations and guidelines). The Basis of Design is written by the design team and increases in detail as the design progresses. Refer to *Submittal Requirements and Procedure Guide for CSU Capital Projects* for more information.

Campus Project Requirements. (Also referred to as Design Intent.) A document that provides the campus vision for the planned facility and expectations for how it will be used and operated. It also provides a detailed explanation of the rationale behind the ideas, concepts and criteria that are defined by the campus to be important and to be tracked through design and construction. These concise concepts are likely to originate from the campus program. The requirements may be written by the University, the commissioning agent, or the design team in consultation with the campus. The University Project Requirements remain relatively fixed from their initial development unless budget or other factors require a modification.

Campus Representative. Person designated by the University to manage the project and make all appropriate decisions on behalf of the University (approve schedule, design,

change orders, etc.).

Commissioning. A systematic process of ensuring that building systems perform interactively according to the contract documents, the campus objectives and operational needs. This is achieved ideally by developing and documenting Campus Project Requirements beginning in the design phase with reviews of design and contract documents; and continuing through construction and the warranty period with actual verification through review, testing and documentation of performance.

Commissioning Agent. An independent party or engineer-of-record, at the University's discretion, implementing the overall commissioning process. Independence is recommended to assure unbiased performance without conflict of interest.

Construction Manager. The person designated to manage day-to-day activities of a construction process, including supervision and providing on-site management authority. The construction manager works closely with the commissioning agent and contractors to ensure that both the construction and commissioning processes move forward smoothly. In some instances the Campus may also serve as the construction manager.

Construction Phase Commissioning Plan. An update of the commissioning plan developed during the design phase, which outlines the roles and responsibilities of each project team member, specifies procedures for documenting commissioning activities and resolving issues, and sets a preliminary schedule for conducting commissioning activities during the construction phase of the project. It is updated as construction progresses.

Contract Documents. Documents binding on all parties involved in the construction of the project, including, but not limited to, drawings, specifications, change orders, addenda, requests for information, and commissioning plan. Any formal documentation that affects a contractual requirement is considered to be a contract document. The contract document's initial form is the bid set of plans and specifications.

Contractor and Equipment Suppliers. Those who provide completed systems that are constructed and operate to meet design objectives in accordance with the contract documents. They also assist in the development and execution of the functional performance test procedures and training of building operators.

Construction Coordination Drawings. Drawings that eliminate logistical and spatial conflicts between equipment and systems installed by the various trades, and also facilitate fabrication and installation of an individual contractor's system. Coordination drawings are generated by a contractor prior to system installation and show additional detail and resolution beyond what is provided in the original drawings.

Design Record. A collection of documents that address all aspects of design starting with the Campus Project Requirements, Basis of Design, through the Performance Metrics.

Design Phase Commissioning Plan. The commissioning plan developed during the design phase which outlines each team member's role and responsibilities, sets protocols for communication and reviews, specifies procedures for documenting commissioning activities and resolving issues, and sets the initial schedule for

commissioning activities during the design phase of the project.

Design Team. The design team generally includes the campus representative, an architect, an HVAC mechanical designer/engineer, an electrical designer/engineer, and other specialty sub consultants. The design team develops the building's design, including documents, plans, and specifications, that meet campus expectations for the building. They also monitor construction activities and review as-built drawings and documentation for compliance with the contract documents.

Functional Tests. Tests that evaluate the dynamic function and operation of equipment and systems using manual (direct observation) or monitoring methods. Functional testing is the assessment of the system's (rather than just component's) ability to perform within the parameters set up in the Basis of Design. Systems are tested under various modes, such as during low cooling or heating loads, high loads, component failures, varying outside air temperatures, fire alarm, power failure, etc. The systems are run through all the control system's sequences of operation to determine whether they respond as the sequences state. Functional tests are performed after Pre-functional checklists are complete.

Performance Metrics. Measurable indicators that allow verification that a specific Campus Project Requirement or element in the Design Narrative has been met. Performance Metrics are identified throughout the design of the project with as many as possible being generated during the development of the Campus Project Requirements. Metrics at the equipment or component level are generally identified later in design. The design team and commissioning agent are responsible for their development. Ideally one or more performance metrics are developed for each Campus Objective and discrete design description element.

Pre-functional 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 (e.g., belt tension, fluids topped, labels affixed, gages in place, sensors calibrated, voltage balanced, rotation correct, etc.).

2.0 SELECTION OF COMMISSIONING AGENT

2.1 Recommended Qualifications

It is desired that the firm designated as the Commissioning Agent satisfy as many of the following requirements as possible:

- Previous experience in providing commissioning services for projects
- Extensive experience in the operation and troubleshooting of HVAC systems, energy management control systems
- Extensive field experience
- Knowledgeable in building operation and maintenance and O&M training
- Knowledgeable in test and balance of both air and water systems
- Experienced in energy-efficient equipment design and control strategy optimization.
- Direct experience in monitoring and analyzing system operation using energy management control system trending and stand-alone data logging equipment
- Excellent verbal and writing communication skills.
- Highly organized and able to work with both management and trade contractors
- Experienced in writing commissioning specifications
- Membership with the Building Commissioning Association and/or AABC Commissioning Group

2.2 Independent Commissioning Agent versus Design Team

In general it is recommended that the Commissioning Agent be an independent party that is not affiliated with the design team, contractor, equipment manufacturer or any other party with a contractual financial interest in the project. For certain projects, qualified members of the project design or construction team may act as the Commissioning Agent as long as they meet the recommended qualifications listed in Section 2.1 and have commissioning experience with the systems involved in the project.

The duties and responsibilities of project team members performing the tasks of the Commissioning Agent are the same as those of an independent Commissioning Agent as outlined in this guideline document.

2.3 Request for Proposal

A sample Request for Proposal for Commissioning Services has been provided in Appendix 1 to assist the campus in obtaining proposals for commissioning services.

3.0 COMMISSIONING PROCESS

The basic commissioning process is integrated with the phases of construction and should begin in the design phase and continue through construction and the warranty period. Commissioning enhances communication among project team members and ensures that they all understand the project goals. This allows the project team to identify problems early, before they can affect later phases of the project and cause delays. A brief description of each phase and expected commissioning activities are outlined below.

3.1 Design Phase (Schematic, Preliminary & Construction Documents)

3.1.1 Activities

- a. **Basis of Design.** The design team develops formal Basis of Design documentation. The commissioning agent and university ensure that these documents are written and updated, and review them for clarity, completeness and compliance with the campus objectives and earlier design narratives.
- b. **Campus Project Requirements Review.** The commissioning agent or design team may assist the campus in developing or reviewing the Campus Project Requirements documentation for the building. The campus objectives may be developed through a meeting of owner stakeholders with the design team and commissioning agent in attendance. At a minimum, the commissioning agent reviews the Campus Project Requirements for clarity and completeness.
- c. **Commissioning Agent Selection.** CSU has contracted with six service providers for commissioning services via master enabling agreements. The University may either select one of these service providers or send out requests for proposals (RFPs) or requests for qualifications for commissioning services and select a commissioning agent. For some small projects university may contract A/E of record to provide these services.

Additional Resource: Sample RFP in Appendix 1

- d. **Commissioning Scoping Meeting.** The commissioning agent assembles the commissioning team and holds a scoping meeting with the team to communicate the campus goals, needs and expectations for building operation and function and to identify commissioning responsibilities. Items discussed in this meeting are used to develop the scope and rigor of the commissioning effort.
- e. **Commissioning Plan.** The commissioning agent develops the design phase commissioning plan.
- f. **Commissioning Specifications.** The commissioning agent develops detailed commissioning specifications to be included by the design team in the final contract document. The specifications comprise commissioning-related requirements that will be the contractor's responsibility, including equipment installation and start-up, documentation and functional testing. In addition, the

commissioning agent may recommend enhanced language regarding training, documentation, installation, and system checkout for inclusion in non-commissioning sections of the specifications.

- g. **Design Review.** The commissioning agent attends selected design team meetings and formally reviews and comments on the design at various stages of development (ideally at least once during schematic design, preliminary design, and construction document phases). Potential system performance problems, energy-efficiency improvements, indoor environmental quality issues, operation and maintenance issues, and other issues may be addressed in these design reviews, depending on the commissioning agent's scope and the needs of the project. The commissioning agent ensures that the design follows and meets the original Campus Project Requirements. The commissioning agent does not approve the design, but makes recommendations to facilitate commissioning and improve building performance. It is the responsibility of the University to evaluate and discuss all findings with the design team and implement those approved.

3.1.2 Responsibilities

3.1.2.1 University

- a. University is responsible for developing the Campus Project Requirements.
- b. University sends out requests for proposals (RFPs) or requests for qualifications (RFQs) for commissioning services.
- c. University selects commissioning agent.
- d. University coordinates commissioning scoping meeting to develop overall commissioning goals.
- e. University ensures that the commissioning roles and scope for all members of the design and construction teams be clearly defined in each party's contract and project specifications.
- f. University reviews the draft construction phase commissioning plan developed by the commissioning agent.
- g. University discusses all findings presented by the commissioning agent during formal design reviews with the design team.
- h. University reviews the commissioning specification language and draft construction phase commissioning plan developed by the commissioning agent.

3.1.2.1 Commissioning Agent

- a. Commissioning agent reviews Basis of Design documentation produced by the design team for clarity, completeness and compliance with the Campus Project Requirements documentation and reports findings to the University.
- b. Commissioning agent attends selected design team meetings.
- c. Commissioning agent reviews design at various stages of development (ideally

at least once during schematic design, design development, and contract document phases). The commissioning agent reports all findings to the University.

- d. Commissioning agent develops a draft construction phase commissioning plan and submits the plan to the University and design team for review.
- e. Commissioning agent develops commissioning specifications to be included in the final contract documents and submits the specifications to the University and design team for review. These specifications shall also include “Contractor and Equipment Suppliers” requirements listed in paragraph 3.3.2.
- f. Commissioning agent specifies State of California Title 24 Energy Efficiency Standards Acceptance Requirements for code compliance.
- g. Commissioning agent compiles and updates the Design Record.
- h. Commissioning Agent coordinates a controls integration meeting(s) where the electrical and mechanical engineers and the Commissioning agent discuss integration issues between equipment, systems and disciplines to ensure that integration issues and responsibilities are clearly described in the specifications.

3.1.2.3 Design Team

- a. Design team develops and updates formal Basis of Design as the design process continues.
- b. Design team addresses in writing all findings and recommendations presented by the commissioning agent during formal design reviews.
- c. Design team reviews and incorporates the commissioning and related specifications developed by the commissioning agent.

3.1.2.4 Contractor and Equipment Suppliers

Generally, there is no participation at this phase unless the project delivery is Design-Build or CM-at-Risk.

3.1.2.5 Mechanical Review Board (MRB)

- a. As part of the Mechanical Systems Review, MRB member reviews Basis of Design documentation produced by the design team for clarity, completeness and compliance with the Campus Project Requirements documentation and reports findings to the University.
- b. MRB member reviews system design at various stages of development and reports all findings to the University.

3.2 Bidding Phase

3.2.1 Activities

- a. During the bidding phase, contractors review the contract documents and submit bids for constructing the project.
- b. **Pre-Bid Conference.** The commissioning agent may be asked to attend the pre-bid conference(s) to answer any questions about commissioning and may review bids, alternates, and addendums to ensure that commissioning, and the Campus Project Requirements, are not compromised by the changes.
- c. **Bid Addenda.** The commissioning agent may be asked to answer bid commissioning questions from the Design Team in preparation of bid addenda.

3.2.2 Responsibilities

3.2.2.1 University

In the pre-bid conference, the University advises that commissioning is part of the project.

3.2.2.2 Commissioning Agent

Commissioning agent may attend the pre-bid meeting(s) to answer any commissioning questions and may review contractor bids relative to commissioning for the Campus.

3.2.2.3 Design Team

No special commissioning tasks.

3.3 Construction Phase

3.3.1 Activities

The main construction phase commissioning tasks are listed chronologically below.

- a. **Commissioning Kickoff Meeting.** The commissioning agent coordinates a construction phase commissioning kickoff meeting. The meeting should include the Campus, construction manager, design team, commissioning agent, and respective representatives from the general contractor and mechanical, electrical, controls, and testing, adjusting & balancing (TAB) subcontractors. At this meeting, the commissioning agent outlines the roles and responsibilities of each project team member, specifies procedures for documenting commissioning activities and resolving issues, and reviews the preliminary construction phase commissioning plan and schedule. Team members provide comments on the plan and schedule, and the commissioning agent uses these suggestions to help finalize the commissioning plan and schedule. These requirements for the kick-off meeting shall become part of the project

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specifications.

- b. **Commissioning Meetings.** During construction the commissioning agent may coordinate entire meetings devoted to commissioning issues.
- c. **Submittals.** The commissioning agent reviews contractor submittals of equipment to be commissioned during the normal submittal review process. The commissioning agent reviews and comments on each submission, and forwards them to the University or the design team.
- d. Additional information requested in the specifications by the commissioning agent includes installation and start-up procedures, operation and maintenance information, equipment performance data, and control drawings prior to formal O&M manual submittals. This data is used by the commissioning agent to become familiar with the systems and to write functional test procedures. Campus support for obtaining these additional documents from the contractors is critical.
- e. **Changes Impacting Systems to be Commissioned.** All Requests for Information (RFIs) and change orders applicable to the commissioned systems shall be provided to the commissioning agent for review for impacts on commissioning and Campus Project Requirements.
- h. **Pre-functional Checklists and Start-up.** The installation, start-up and initial checkout of the equipment and systems are executed and documented by the contractor on Pre-functional checklists provided by the commissioning agent and on manufacturer checklists shipped with the equipment. These checklists are submitted to the commissioning agent, who makes sure they are complete before functional testing begins. The commissioning agent may witness some of the start-up execution and will spot-check selected items on the checklist prior to functional testing.
- f. **Functional Testing.** After developing written test procedures, the commissioning agent manages, witnesses, and documents the functional tests, with the actual hands-on execution of the test procedures typically carried out by subcontractors, particularly the controls contractor. Acceptable performance is reached when equipment or systems meet specified design parameters under specified conditions during different modes of operation, as described in the commissioning test requirements of the specifications and commissioning plan. Some testing is completed by monitoring system operation over time through the building automation system or dataloggers and is not normally completed until a few weeks after occupancy. The commissioning agent does not normally retest systems that have been tested and approved by regulatory authorities. The commissioning agent may prepare test plans for, assist with execution of, and document tests of commissioned equipment overseen by regulatory authorities and should ensure that such tests meet the testing rigor desired by the Campus.
- g. **O&M Manuals.** The design team and commissioning agent reviews the operation and maintenance manuals and verifies that they are complete, clear, explicit, and available for use during the training sessions.

- i. **Systems Manual.** The commissioning agent compiles a Systems Manual that consists of the design record; space and use descriptions; single line drawings and schematics for major systems; control drawings; sequences of control; table of key setpoints and implications when changing them; time-of-day schedules; seasonal adjustment, startup and shutdown; instructions for energy savings operations and descriptions of the energy savings strategies in the facility; recommendations for recommissioning frequency by equipment type; energy tracking recommendations; and recommended standard trend logs with a brief description of what to look for in them. The Systems Manual with O&M Manuals will form Master O&M Manual.
- j. **Systems Training.** Ideally, enhanced systems training requirements are included in the specifications. The commissioning agent assists the Campus in ensuring that adequate training plans are used by the contractor and that the training is completed per the contract documents. The commissioning agent may provide training agendas in the specifications to the contractor's/manufacturer's trainers to review and use. The agendas should list, among the other things, the areas of particular concern to the Campus that should be covered in the training.
- k. **Commissioning Record.** Shortly after occupancy, the commissioning agent typically writes a final commissioning report, which summarizes the commissioning effort and gives the commissioning agent's disposition on each piece of commissioned equipment relative to installation and start-up, functional performance, O&M documentation, and training. The Commissioning Record also contains the commissioning plan, functional tests, individual commissioning reports and reviews, and issues log.

3.3.2 Responsibilities

3.3.2.1 Campus

The roles of the Campus, construction manager, and contractor site supervisor are sometimes blurred, and some projects do not have a construction manager. The following tasks should be divided between the construction manager and Campus, as appropriate, for the specific project.

- a. Campus *and* construction managers review the updated construction phase commissioning plan scope, roles and responsibilities, communication and resolution protocols, and general schedule.
- b. Campus *and* construction managers review regular commissioning progress reports and memoranda submitted by the commissioning agent.
- c. Campus *or* construction manager sees that the commissioning agent receives all RFIs and change orders impacting commissioning activities.
- d. Campus *or* construction manager attends periodic construction meetings and commissioning meetings as necessary and discusses commissioning progress report and issues with team members.

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- e. Campus *and* construction managers participate with the design team and contractors to resolve issues raised by the commissioning agent in a timely manner.
- f. Campus identifies a lead facility maintenance contact and arranges for facility operating personnel to assist in field commissioning activities and attend training sessions.
- g. Campus *and* construction managers support the development and execution of a training plan.
- h. Campus receives and reviews Systems Manual and Commissioning Record submitted by commissioning agent and makes the final decision regarding satisfactory completion of commissioning activities and initial acceptance of system operation.

3.3.2.2 Commissioning Agent

- a. Commissioning agent refines the construction phase commissioning plan, including scope, responsibilities, and schedule, and submits the plan to the Campus and construction manager for review.
- b. Commissioning agent coordinates a construction phase commissioning kickoff meeting.
- c. Commissioning agent coordinates commissioning meetings with various team members as necessary.
- d. Commissioning agent develops and updates a record of all issues and findings throughout the construction phase. Issues are presented without delay to the project and construction managers, and to contractors according to predetermined protocols.
- e. Commissioning agent reviews all commissioned equipment submittals.
- f. Commissioning agent reviews all RFIs and contractor change order requests regarding systems to be commissioned.
- g. Commissioning agent provides Pre-functional checklists to the contractors.
- h. Commissioning agent reviews all Pre-functional checklists completed by the contractors, spot checks some equipment, and witnesses the start-up and checkout of critical pieces of equipment.
- i. Commissioning agent writes detailed functional test procedures for all commissioned equipment.
- j. Commissioning agent manages and witnesses all functional tests and documents findings and recommended corrective measures.

3.3.2.3 Design Team

- a. Design team reviews the updated construction phase commissioning plan.
- b. Design team attends the construction phase commissioning kickoff meeting.

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- c. Design team reviews all commissioning findings requiring their participation for resolution.
- d. If requested, members of the design team present a systems overview during facility staff training.

3.3.2.4 Contractor and Equipment Suppliers

- a. Contractor facilitates the coordination of the commissioning work by the commissioning agent to ensure that commissioning activities are incorporated into the master schedule.
- b. Contractor furnishes a copy of all construction documents, RFIs, addenda, change orders, and approved submittals and shop drawings related to commissioned equipment to the commissioning agent.
- c. Contractor includes requirements for submittal data, O&M manuals, commissioning tasks and training in each purchase order or written subcontract.
- d. Contractor ensures that all subcontractors execute their commissioning responsibilities according to the contract documents and schedule.
- e. Contractor attends construction phase commissioning kickoff meeting and other meetings scheduled by the commissioning agent.
- f. Contractor is responsible for coordinating and executing the training of campus personnel.
- g. Contractor prepares O&M manuals, according to the specifications.
- h. Contractor provides required metering and instrumentation for the Functional Tests as specified by the Commissioning Agent.

3.4 Warranty Period

3.4.1 Activities

- a. **Seasonal Testing.** Seasonal testing is conducted to verify proper operation during, at minimum, both winter and summer conditions. Presumably, one of the “seasons” was tested at building turnover. The testing should be performed by the appropriate contractor and witnessed by the commissioning agent and building operators. However, the campus may have their operations staff and commissioning agent execute the tests and bring contractors back only if there are issues to be resolved.
- b. **Near Warranty End Review.** The Commissioning Agent may also be tasked with returning a few months prior to the expiration of the contractor’s one-year warranty to interview facility staff and review system operation. Acting as the campus technical resource, Commissioning Agent assists the facility staff in addressing any performance or warranty issues. If there are still any outstanding issues, the campus shall address them with the contractors or design team.

3.4.2 Responsibilities

3.4.2.1 Campus

- a. Campus works with the commissioning agent to review system operation prior to equipment warranty expiration. The Campus works with contractors to resolve any issues raised by the commissioning agent.
- b. Campus ensures that facility staff provides support to the commissioning agent during seasonal testing.

3.4.2.2 Commissioning Agent

- a. Commissioning agent coordinates, supervises and documents required seasonal testing.
- b. Commissioning agent reviews system operation and performance prior to expiration of equipment warranties and assists facility staff in resolving outstanding warranty and performance issues.
- c. Commissioning Agent makes any revisions to the Systems Manual.

3.4.2.3 Design Team

Design team may be asked to participate in the near warranty end review.

3.4.2.4 Contractor and Equipment Suppliers

- a. Contractor executes seasonal functional testing, witnessed by the commissioning agent, according to the specifications.
- b. General contractor ensures that subcontractors correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.

Appendix 1 Request for Proposal for Commissioning Services
REQUEST FOR PROPOSAL
FOR INDEPENDENT COMMISSIONING AGENT SERVICES

RFP Writer:

This RFP is intended for the University to contract a commissioning agent.

Issuance Date: _____

Closing Date and time: _____

(Campus), requests written proposals to secure Commissioning (CA) services for the [insert *project name*] _____ Project in, __[insert *city*] _____, California. The Campus is committed to commissioning this facility to ensure that all systems are well designed, complete and functioning properly upon occupancy, and that campus staff has adequate system documentation, and training.

BACKGROUND

The Campus is seeking the services of a qualified commissioning agent/firm for a capital construction project. The project currently is a _____ gross sf, ___ story, Class ___ [*type*] _____ building in [city] _____, California, with a project budget of \$_____ million. The facility is expected to be comprised of _[ssg comment: what is supposed to be inserted here?_]____.

RFP Writer: Delete and add spaces to match specific project requirements. Provide as much information as possible.

The current phase of the project is: _____ (schematic design, preliminary design, construction documents). The construction documents are planned to be completed by _____. Construction is anticipated to begin in _____ and final occupancy by _____. Project documents available for review are:

_____.

RFP Writer: Provide proposers a copy of the programming report and any design documents completed to date.

RFP Writer: Alter these objectives as appropriate for your project desires and for the phases being commissioned.

OBJECTIVES

The objective of commissioning is to provide documented confirmation that a facility fulfills the functional and performance requirements of the campus, occupants, and operators. To reach this goal, it is necessary for the commissioning process to establish and document the campus criteria for system function, performance, and maintainability; and also to verify and document compliance with these criteria throughout design, construction, start-up, and the initial period of operation and warranty period. In addition, complete operation and maintenance (O&M) manuals, as well as training on system operation, should be provided to the building operators to ensure the building continues to operate as intended. The commissioning agent should be involved throughout the project from the design phase through the warranty phase. The primary role of the Commissioning Agent (CA) during the design phase is to develop detailed commissioning specifications and review design to ensure it meets the campus objectives. During construction, the CA develops and coordinates the execution of a testing plan, which includes observing and documenting all system's performance to ensure that systems are functioning in accordance with the Campus Project Requirements and the contract documents. The CA is not responsible for design or general construction scheduling, cost estimating, or construction management, but may assist with problem-solving or resolving non-conformance issues or deficiencies.

SCOPE OF WORK

The CA shall be responsible for carrying out the following tasks. The proposer 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 commissioning services are required during the design phase, construction phase, and the warranty period.

RFP Writer: If the plans and specifications are nearing completion, delete the appropriate design phase tasks. It is advised that the Commissioning Agent conduct a design review similar to Design Phase Task 3 and possibly Task 4 and that they provide some language for the commissioning requirements in the specifications. Clarifications to the bid package could be handled by addenda.

Design Phase

1. Coordinate the commissioning work during design.
2. Develop or update the design phase commissioning plan.
3. Perform focused reviews of the design, drawings and specifications at various stages of development (during schematic design, preliminary design and construction document phases), as described in Exhibit 1.
4. Assist, review and approve the development and updating of the Design Record documentation by design team members (Campus Project Requirements, Design Narrative; Basis of Design).
5. Develop a draft construction phase commissioning plan using a Campus-approved outline.

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6. Develop full commissioning specifications for all commissioned equipment. Coordinate with and integrate into the specifications of the architect and engineers. 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.

The commissioning specification will include 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 startup requirements; the functional testing process; specific functional test requirements, including testing conditions and acceptance criteria for each piece of equipment being commissioned.

7. Coordinate a controls integration meeting where the electrical and mechanical engineers and the Commissioning agent discuss integration issues between equipment, systems and disciplines to ensure that integration issues and responsibilities are clearly described in the specifications.

Bid Phase

1. Attend pre-bid meeting(s) to answer commissioning related questions.
2. Answer RFI's regarding commissioning during the bid phase.

Construction Phase

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 and, with the contractor and construction manager (CM), 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 startup, 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 normal Contractor submittals applicable to systems being commissioned for compliance with commissioning needs, concurrent with the A/E reviews.
7. Review requests for information and change orders for impact on commissioning and campus objectives.
8. Write and distribute Pre-functional checklists for commissioned equipment.
9. Develop an enhanced start-up and initial systems checkout plan with contractors for selected equipment.

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10. Review construction meeting minutes for revisions/substitutions relating to the commissioning process. Assist in resolving any discrepancies.
11. Witness HVAC piping pressure test and flushing, sufficient to be confident that proper procedures were followed. Include testing documentation in the Commissioning Record.
12. Witness any ductwork testing and cleaning sufficient to be confident that proper procedures were followed. Include documentation in the Commissioning Record.
13. Document construction checklist completion by reviewing completed Pre-functional checklists and by selected site observation.
14. Document systems startup by reviewing start-up reports and by selected site observation.
15. Approve air and water systems balancing by spot testing and by reviewing completed reports and by selected site observation.
16. With necessary assistance and review from installing contractors, write the functional performance test procedures for equipment and systems. This will include manual functional testing, energy management control system trending and may include stand-alone datalogger monitoring. Submit to CM for review and approval if required.
17. Analyze functional performance trend logs and monitoring data to verify performance.
18. Coordinate, witness and document manual functional performance tests performed by installing contractors. Coordinate retesting as necessary until satisfactory performance is achieved. 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 startup, 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 agent during functional testing.

Tests on respective HVAC equipment shall be executed, if possible, during both the heating and cooling season. 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 read-outs or stand-alone dataloggers, to provide a high level of confidence in proper system function, as deemed appropriate by the commissioning agent and the campus.
19. Prepare test plans for, assist with execution of, and document tests of commissioned equipment overseen by regulatory authorities and ensure that such tests meet the testing rigor desired by the campus.
20. Oversee and approve the systems training of the campus operating personnel.
21. Review and approve the preparation of the O&M manuals for commissioned equipment.
22. 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 should 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,

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- 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, inspection, trend log, etc. where the deficiency is documented.
- C. Commissioning Systems Manual shall include the commissioning plan, progress reports, submittal and O&M manual reviews, training record, test schedules, Pre-functional checklists, start-up reports, functional tests, and trend log analysis.
23. Compile a Systems Manual that consists of the following: Campus Project Requirements (by campus); Basis of Design (by Design Team); Performance Metrics, if completed during design; space and use descriptions, single line drawings and schematics for major systems (by designer); control drawings, sequences of control (by contractor); and a table of all setpoints and implications when changing them, schedules, instructions for operation of each piece of equipment for emergencies, seasonal adjustment, startup and shutdown, instructions for energy savings operations and descriptions of the energy savings strategies in the facility, recommendations for recommissioning frequency by equipment type, energy tracking recommendations, and recommended standard trend logs with a brief description of what to look for in them (all by Commissioning Agent).

Warranty Period

1. Coordinate and supervise required opposite season or deferred testing and deficiency corrections and provide the final testing documentation for the Commissioning Record 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 campus facility staff in developing reports and documents and requests for services to remedy outstanding problems.

SYSTEMS TO BE COMMISSIONED

RFP Writer:

- a. Delete and add systems as appropriate.
- b. If this RFP is offered during early design, the list and description of equipment and systems should be kept fairly general, as shown below.
- c. For RFPs sent out once the plans and specifications are mostly complete, more detail to the list below should be provided. List the components and issues that will be commissioned for the following: HVAC, mechanical equipment, and building control systems.

The following systems and assemblies will be commissioned:

1. Building control system
2. All equipment of the heating, ventilating and air conditioning systems
3. Scheduled or occupancy sensor lighting controls
4. Daylight dimming controls
5. Emergency power generators and automatic transfer switching
6. Uninterruptible power supply systems
7. Life safety systems (fire alarm, egress pressurization, fire protection)
8. Laboratory, , hoods and pressurization
9. Electrical
10. Plumbing
11. Data and communication
12. Refrigeration systems
13. Domestic and process water pumping and mixing systems
14. Equipment sound control systems and testing
15. Paging systems
16. Security system
17. Irrigation
18. Vertical transport
19. Medical gas
20. Building envelope
21. Process instrumentation and controls

RFP Writer: Add to and edit the desired qualifications according to your specific project.

DESIRED QUALIFICATIONS

It is the campus desire that the Commissioning Agent satisfy as many of the following requirements as possible:

- Provided commissioning services for previous projects
- Extensive experience in the operation and troubleshooting of HVAC systems, energy management control systems
- Extensive field experience
- Knowledgeable in building operation and maintenance and O&M training
- Knowledgeable in test and balance of both air and water systems
- Experienced in energy-efficient equipment design and control strategy optimization.
- Direct experience in monitoring and analyzing system operation using energy management control system trending and stand-alone data logging equipment
- Excellent verbal and writing communication skills. Highly organized and able to work with both

- management and trade contractors
- Experienced in writing commissioning specifications
- Membership with the Building Commissioning Association and/or AABC Commissioning Group

PRE-PROPOSAL MEETING

A pre-proposal meeting will be held to answer questions and clarify any project issues. Attending the meeting is **not required** to submit a proposal. The meeting will be held at:

[State the location and time of the meeting]

PROPOSAL

Proposals need not be voluminous, but shall provide sufficient information to allow the campus 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. 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.
3. Provide an organization chart for managing and executing this contract.
4. List the individual(s) who will serve as the Commissioning Agent for the design phase and for the construction phase of the contract (they may be different people). Describe his or her relevant qualifications and experience. This information is required in addition to any resumes the proposer submits.
5. 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, etc.).
6. Briefly describe relevant experience of the proposer's team in the following areas. List each party's involvement.
 - a) projects similar to this one;
 - b) traditional test and balance;
 - c) energy-efficient equipment design and control strategy optimization;
 - d) system design (specify).
7. 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.
8. Provide a fixed, lump sum total cost to accomplish the work. Use the budget table format below to provide a cost breakdown. Also provide an hourly rate for each team member for work that may exceed the scope.

RFP Writer: Add or delete items in the above list for areas you want the commissioning agent to provide specific task work.

The respondent must submit three (3) copies of the proposal. Facsimiles will not be accepted. Proposals must be submitted to arrive no later than *[insert date and time]* to:

[insert, contact person, address, telephone number, fax number, e-mail address]

Budget

Task	Budget (\$)
Design	
1. Develop or review Campus Project Requirements (per scope)	_____
2. Design documents reviews of plans, specifications; narratives	_____
3. Commissioning plan, specification development and bid meeting	_____
4. Other	_____
Subtotal	_____
Construction	
1. Commissioning plan and submittal reviews	_____
2. Pre-functional checklists; observation of installation and startup	_____
3. Functional test writing	_____
4. Functional test execution and documentation	_____
5. O&M manual review and training review	_____
6. Compilation of Commissioning Record	_____
7. Systems Manual development	_____
8. Other	_____
Subtotal	_____
Warranty Period	
Seasonal Testing	_____
Near-warranty end review	_____
Subtotal	_____
Total	_____

SELECTION PROCESS

Campus staff shall review all proposals and select and rank the *[insert number]* most qualified Consultants.

The selection and ranking shall be based on the following criteria:

- Proposed approach to the project.
- Past experience in performing similar projects.
- Expertise of the team in performing the services required by the project.
- Fee proposal

The Campus will negotiate/interview with the highest ranked Consultant on the tasks, staffing, schedule and fee proposal. Negotiations may be formally terminated if they fail to result in a contract within a reasonable time period. Negotiations will then ensue with the second ranked Consultant, and if necessary, the third ranked Consultant. If the second and third rounds of negotiations fail to result in a contract within a reasonable time period, the solicitation may be formally terminated.

CHANGE IN PERSONNEL

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

EXHIBIT 2 COMMISSIONING FIRM EXPERIENCE
FILL OUT A SEPARATE FORM FOR EACH FIRM ON THE TEAM

Company Name	Contact Person	Title
Address	City	State/Prov.
		Zip/Postal Code
Telephone	Fax	E-mail

Description of Business

Commissioning Activities

Percentage of overall business devoted to commissioning services _____ %

How long has the firm offered commissioning services? _____ years

Average number of commissioning projects performed each year: _____ projects

Systems or technologies for which firm has provided commissioning services (check all that apply)

- | | | |
|--|---|---|
| <input type="checkbox"/> Air Handlers | <input type="checkbox"/> Daylighting | <input type="checkbox"/> Telecommunications |
| <input type="checkbox"/> Chiller system | <input type="checkbox"/> Electrical, general | <input type="checkbox"/> Thermal Energy Storage |
| <input type="checkbox"/> Boiler system | <input type="checkbox"/> Electrical, emerg. power | <input type="checkbox"/> _____ |
| <input type="checkbox"/> Control Systems | <input type="checkbox"/> Envelope | |
| <input type="checkbox"/> Labs & Cleanrooms | <input type="checkbox"/> Fire/Life Safety | |
| <input type="checkbox"/> Lighting Controls | <input type="checkbox"/> Plumbing | |

Number of registered engineers on staff: _____

The firm has provided commissioning services in the following: (check all that apply)

<u>Building Sector</u>	<u>New Construction Major Renovation</u>	<u>Existing Building Tune-up</u>	<u>Equipment Replacement</u>
<input type="checkbox"/> Schools or universities	<input type="checkbox"/>	. <input type="checkbox"/>	. <input type="checkbox"/>
<input type="checkbox"/> Laboratories	. <input type="checkbox"/>	. <input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Food Service	<input type="checkbox"/>	. <input type="checkbox"/>	. <input type="checkbox"/>
<input type="checkbox"/> Office Buildings	. <input type="checkbox"/>	. <input type="checkbox"/>	. <input type="checkbox"/>
<input type="checkbox"/> Housing	. <input type="checkbox"/>	. <input type="checkbox"/>	. <input type="checkbox"/>
<input type="checkbox"/> Library Buildings	. <input type="checkbox"/>	. <input type="checkbox"/>	. <input type="checkbox"/>
<input type="checkbox"/> Computer Facilities	. <input type="checkbox"/>	. <input type="checkbox"/>	. <input type="checkbox"/>
<input type="checkbox"/> Cogeneration Plants	. <input type="checkbox"/>	. <input type="checkbox"/>	. <input type="checkbox"/>
<input type="checkbox"/> Central Heating & Cooling plants	. <input type="checkbox"/>	. <input type="checkbox"/>	. <input type="checkbox"/>
<input type="checkbox"/> Bookstores	. <input type="checkbox"/>	. <input type="checkbox"/>	. <input type="checkbox"/>
<input type="checkbox"/> Auditoriums	. <input type="checkbox"/>	. <input type="checkbox"/>	. <input type="checkbox"/>
<input type="checkbox"/> Parking Structures	. <input type="checkbox"/>	. <input type="checkbox"/>	. <input type="checkbox"/>
<input type="checkbox"/> Physical Education/Gymnasiums	. <input type="checkbox"/>	. <input type="checkbox"/>	. <input type="checkbox"/>

Appendix 2 Resources for Commissioning Information

Web Sites Containing Commissioning Documents

AABC Commissioning Group	http://www.acgcommissioning.com Commissioning Guideline and information on selecting a commissioning provider
American Society of Heating, Refrigerating & Air Conditioning	http://www.ashrae.org Commissioning Guidelines 0 and 1
Building Commissioning Association	http://www.bcxa.org
National Institute of Health Model Commissioning Guide	http://des.od.nih.gov/farhad2/Commissioning/nih_cx_guide/ComGuideTitle.htm
NEBB	http://www.nebb.org/search.htm (certification program and manuals)
Oregon Office of Energy	http://www.energy.state.or.us/bus/comm/bldgex.htm (benefits of Cx, case study, the full text of <i>Commissioning for Better Buildings in Oregon</i>) [rcx]
PECI	http://www.peci.org/ (Cx conference announcement, downloadable <i>Model Cx Plan and Guide Specifications</i> , Cx information sources, Cx & O&M training locator database)
Texas A&M Energy Systems Lab	http://www-esl.tamu.edu/ (retro-commissioning process and software, for purchase) [RCX]
University of Washington	http://depts.washington.edu/fsesweb/fdi/index.html Univ. Cx guide specs distributed throughout the specs. Vol's 1-4)
USDOE / FEMP	http://www.eren.doe.gov/femp/ (full text of GSA/USDOE <i>Building Commissioning Guide</i> ; early version of <i>Model Cx Plan and Guide Specifications</i>)
USDOE	http://www.eren.doe.gov/ (Links to commissioning documents. Search on "commissioning.")
Seattle City Light	http://www.ci.seattle.wa.us/seattle/light/conserves/business/bdgcoma/cv6_bcam.htm (standardized test procedures and case studies)
Whole Building Design Guide	http://www.wbdg.org/index.htm National Institute of Building Sciences

Procedural Guidelines, Specifications and Functional Tests

* Denotes documents available on electronic disk. [RCX] = dedicated solely to retrocommissioning; [rcx] = contains some data on, retro-commissioning. D = for design phase, C = for construction phase. All CAPS denotes document is more comprehensive than lower case.

Source	Guide-lines	Guide Specs	Sample Tests
<i>Appendix VII Idaho New Building Commissioning Guidelines</i> . State of Idaho, 2000. Available at: http://www2.state.id.us/adm/pubworks/archengr/commgl97.htm	YES	No	No
<i>Building Commissioning Assistance Handbook Appendices</i> . Seattle City Light, 1999. (standardized functional test procedures http://www.ci.seattle.wa.us/seattle/light/conserves/business/bdgcoma/cv6_bcam.htm .)	No	No	*YES
<i>Procedural Standards for Building Systems Commissioning</i> , National Environmental Balancing Bureau (NEBB), 1999. 301-977-3698	Yes d, c	Some d, c	Some
<i>A Practical Guide for Commissioning Existing Buildings</i> , PECE and Oak Ridge National Labs (ORNL), 1999. NTIS 1-800-553-6847 [RCX]	YES	No	No
<i>Model Commissioning Plan and Guide Commissioning Specifications</i> , USDOE/PECE, 1997. NTIS: # DE 97004564 1-800-553-6847. http://www.peci.org/cx/mcpgs.html .	*Some D, c	*YES D, C	*YES
<i>Building Commissioning Guide</i> , U.S. GSA. & USDOE, 1995, revised in 1998 (Ver. 2.2). Ver. 1 by Enviro-Management & Research, Inc. Version 2.2 available on the web: http://www.eren.doe.gov/femp/techassist/bldguide.pdf	*Yes D, C	No	No
<i>The HVAC Commissioning Process</i> , ASHRAE Guideline 1-1996, 1996. ASHRAE Publications Dept., 1791 Tullie Circle, NE, Atlanta, GA 30329.	Yes d, C	Some d, c	No
<i>The Building Commissioning Handbook</i> , The Association of Higher Education Facilities Officers (APPA), written by John Heinz and Rick Casault, 1996. APPA, 1643 Prince Street, Alexandria, VA 22314.	YES d, C	YES C	No
<i>Beyond Lighting DSM: Life After Green Lights</i> , Montgomery Co., MD, 1995. [RCX] Existing building commissioning case study with sample process and detailed procedures. 70 pgs. 301-217-6000.	Yes	No	Yes
<i>Engineering and Design Systems Commissioning Procedures</i> , U.S. Army Corps of Engineers, 1995 (ER 1110-345-723). Dept. of the Army, U.S. Army Corps of Engineers, Washington, DC 20314-1000.	Some d, c	Some d, c	No
<i>Commissioning Specifications</i> , C-2000 Program, Canada, 1995. C-2000 Program, Energy Mines & Resources, Energy Efficiency Division, 7th Floor, 580 Booth St., Ottawa, Ontario, Canada K1A 0E4.	No	*YES C	No
<i>Model Construction Document Specifications and A/E Services Contract Clauses</i> . Bonneville Power Administration/John Heinz, U. of WA, 1995. 503-230-7334. Also available on the Univ. of Washington web site below.	No	*YES C	Some
<i>Commissioning Guidelines, Instructions for Architects & Engineers</i> , State of WA., 1995. Dept. of General Admin., Div. of Engin. & Arch., (360) 902-7272.	Yes d, c	No	No
<i>Commissioning of HVAC Systems</i> , seminar/workshop training materials, Univ. of Wisconsin, Madison, 1994. 800-462-0876 or 608-262-2061	Some C	Some C	Some

Source	Guide- lines	Guide Specs	Sample Tests
<i>Laboratory HVAC Systems: Design, Validation and Commissioning</i> , ASHRAE collection of 11 papers, 1994. And,	Yes C	No	No
<i>Commissioning Smoke Management Systems, ASHRAE Guideline 5-1994</i> . ASHRAE Publications Dept., 1791 Tullie Circle, NE, Atlanta, GA 30329.	Yes d, c	No	No
<i>Standard HVAC Control Systems Commissioning and Quality Verification User Guide</i> , U.S. Army Const. Engineering Research Labs, 1994. Facilities Engineering Applications Program, U.S. Army Engineering and Housing Support Center, Ft. Belvoir, VA 22060-5516. FEAP-UG-GE-94/20.	No	No	Yes
<i>Contractor Quality Control and Commissioning Program—Guidelines and Specification</i> , Montgomery Co. Gov., St of Maryland, 1993. 301-217-6071.	*Yes c	*YES C	*Some
<i>HVAC Systems Commissioning Manual</i> , Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), 1993. SMACNA, 4201 Lafayette Center Dr., Chantilly, VA 22021.	Yes c	Some c	Some
<i>Commissioning Guide</i> , Public Works Canada, Western Region, 1993. 403-497-3770.	Some d, c	Yes d, C	No
<i>Guide Specification for Military Construction—Commissioning of HVAC Systems</i> , Dept. of the Army, U.S. Army Corps of Engineers, 1993. Washington, DC 20314-1000	No	*Some c	*YES
<i>Building Commissioning Guidelines</i> , Bonneville Power Administration/PECI, 1992. 503 230-7334.	YES d, C	Some c	Some
<i>HVAC Functional Inspection and Testing Guide</i> , U.S. Dept. of Commerce and the General Services Administration, 1992. NTIS: 800-553-6847.	No	No	YES
<i>Thermal Energy Storage (TES) Commissioning Guidelines</i> , California Institute for Energy Efficiency, San Diego State University, 1991. San Diego State University, Energy Engineering Institute, San Diego, CA 92182.	Yes C	No	Yes
<i>AABC Master Specification</i> , Associated Air Balance Council. (Primarily for how the TAB fits into the commissioning process) AABC National Hdqrs, 202-737-0202.	No	*Yes d, C	No