New Construction Commissioning Handbook

for Facility Managers

Prepared for the Oregon Office of Energy

By Portland Energy Conservation, Inc.(PECI)

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OREGON OFFICE OF ENERGY

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1.0 Purpose of the Handbook

The purpose of this new construction commissioning handbook is to outline the commissioning process and identify players' roles and responsibilities. It specifically provides information to guide the owner's representative or project manager 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.

2.0 Objective of Commissioning

The objective of commissioning is to provide documented confirmation that a facility fulfills the functional and performance requirements of the building owner, occupants, and operators. To reach this goal, it is necessary for the commissioning process to establish and document the owner's 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 owner, commissioning provider, design team, contractors, and operators work together as a team throughout their involvement with the project.

3.0 Applicability

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 recommended, as qualified, for all state projects. In general, the heating, ventilating and air conditioning systems and controls, lighting controls and life safety systems should be commissioned.

The following questions are intended to assist the project manager 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 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.

4.0 Definitions

Basis of Design. The documentation of the primary thought processes and assumptions behind design decisions that are made to meet the owner's 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.

Commissioning. A systematic process of ensuring that all building systems perform interactively according to the contract documents, the owner's objectives and operational needs. This is achieved ideally by developing and documenting Owner's Project Requirements beginning in the pre-design phase; continuing through design, 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 Provider. An independent party, ideally with no affiliation to the design team or participating contractors, who implements the overall commissioning process. Independence is recommended to assure unbiased performance without conflict of interest. (Sometimes referred to as the commissioning authority.)

Construction Checklist. A checklist to ensure that the specified equipment has been provided, is properly installed, and initially started and checked out adequately in preparation for full operation and functional testing (e.g., belt tension, fluids topped, labels affixed, gages in place, sensors calibrated, voltage balanced, rotation correct, etc.).

&Additional Resource: Appendix 2 (Sample in Model Commissioning Guide and Specifications, PECI, http://www.peci.org)

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 provider and contractors to ensure that both the construction and commissioning processes move forward smoothly. In some instances the project manager 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.

&Additional Resource: Appendix 2 (Sample in Model Commissioning Guide and Specifications, PECI, http://www.peci.org)

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.

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 Narrative. During early schematic design: a document that describes how the design team intends to meet the Owner's Project Requirements at the least possible cost. During later design phases: a narrative submitted with each design submittal describing the concepts and features in the drawings. The Design Narrative is written by the design team and is updated and increased in detail with each phase of the design. In some literature, this has been incorrectly referred to as the design intent. During schematic design, the Design Narrative is similar to the AIA term Preliminary Project Description. It includes descriptions of the facility, spaces, equipment, and their uses.

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

Design Phase Commissioning Plan. The commissioning plan developed during the pre-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.

& Additional Resource: Appendix 2 (Sample in Model Commissioning Guide and Specifications, PECI, http://www.peci.org)

Design Team. The design team generally includes the owner's 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 owner's 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, unoccupied, 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 construction checklists are complete.

& Additional Resource: Appendix 2 (Sample in Model Commissioning Guide and Specifications, PECI, http://www.peci.org)

Owner's Project Requirements. (Also referred to as Design Intent.) A document that provides the owner's 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 owner to be important and to be tracked

through design and construction. These concise concepts are likely to originate from the owner's program. The requirements may be written by the owner, the commissioning provider, or the design team in consultation with the owner. The Owner's Project Requirements remain relatively fixed from their initial development unless budget or other factors require a modification.

& Additional Resource: Sample in Appendix 2

Performance Metrics. Measurable indicators that allow verification that a specific Owner 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 Owner's Project Requirements. Metrics at the equipment or component level are generally identified later in design. The design team and commissioning provider are responsible for their development. Ideally one or more performance metrics are developed for each Owner Objective and discrete design description element.

Project Manager (Owner's Representative). Person designated by the owner to manage the project and make all appropriate decisions on behalf of the owner (approve schedule, design, change orders, etc.).

5.0 Commissioning Process

The basic commissioning process is integrated with the phases of construction and should begin in the pre-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.

5.1 Pre-Design Phase

5.1.1 Description and Activities

During pre-design, the commissioning team should include at least the project manager, commissioning provider, and design team. Generally for a new construction project, contractors have not been selected yet, nor have building operators been assigned; however, representatives from both disciplines should be included in the team as soon as possible. The main commissioning tasks of the pre-design phase are listed chronologically below.

Commissioning Provider Selection. The project manager sends out requests for proposals (RFPs) or requests for qualifications for commissioning services and selects a commissioning provider

& Additional Resource: Sample RFP in Appendix 1

Commissioning Scoping Meeting. The commissioning provider assembles the commissioning team and holds a scoping meeting with the team to communicate the owner's 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.

Design Phase Commissioning Plan. The commissioning provider begins to develop a design phase commissioning plan. The plan will be enhanced as the design progresses.

Owner's Project Requirements Review. The commissioning provider or design team may assist the owner in developing or reviewing the Owner's Project Requirements documentation for the building. The owner's objectives may be developed through a meeting of owner stakeholders with the design team and commissioning provider in attendance. At a minimum, the commissioning provider reviews the Owner's Project Requirements for clarity and completeness.

Written Work Products. During pre-design, the project manager should receive a written commissioning plan from the commissioning provider, as well as comments on the Owner's Project Requirements document.

5.1.2 Responsibilities

Project Manager

a. Project manager is responsible for developing the Owner's Project Requirements.
b. Project manager sends out requests for proposals (RFPs) or requests for qualifications (RFQs) for commissioning services.
c. Project manager selects commissioning provider and design team.
d. Project manager coordinates commissioning scoping meeting to develop overall commissioning goals.
e. Project manager 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. Project manager reviews the draft design phase commissioning plan developed by the commissioning provider.
g. Project manager projects a clear and unwavering support for the commissioning process to all team members.

Commissioning Provider

a. Commissioning provider assists with the development of or reviews the Owner's Project Requirements documentation.
b. Commissioning provider assembles the commissioning team and provides the direction for the commissioning scoping meeting.
c. Commissioning provider recommends 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.
d. Commissioning provider develops a draft design phase commissioning plan.

e. Commissioning provider begins the compilation and care of the Design Record.

Design Team

a. Design team assists with the development of or reviews the Owner's Project Requirements document.

b. Design team attends the commissioning scoping meeting.

c. Design team reviews the draft design phase commissioning plan submitted by the commissioning provider.

Contractor and Equipment Suppliers

Generally, no participation at this phase.

5.2 Design Phase

5.2.1 Description and Activities

The goals of commissioning during the design phase are to:

- Ensure that the concepts for building systems developed during pre-design and earlier design phases are included in subsequent design phases
- Ensure that Design Record document is updated
- Ensure that commissioning is adequately reflected in contract documents
- Ensure that no significant deficiencies exist in the contract documents.

If the commissioning process does not begin until the design phase, the project manager should ensure that tasks outlined in the pre-design phase are completed. The main design phase commissioning tasks in chronological order are outlined below.

Design Phase Commissioning Plan. The commissioning provider updates the design phase commissioning plan (or develops if not started during pre-design).

Design Narrative and Basis of Design. The design team develops formal Design Narrative and Basis of Design documentation. The commissioning provider and owner ensure that these documents are written and updated and review them for clarity, completeness and compliance with the owner's objectives and earlier design narratives.

Design Record. The commissioning provider compiles and updates the Design Record as design progresses.

Design Review. The commissioning provider 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, design development, and contract 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 provider's scope and the needs of the project. The commissioning provider ensures that the design follows and meets the original Owner's Project Requirements. The commissioning provider does not

approve the design, but makes recommendations to facilitate commissioning and improve building performance. It is the responsibility of the project manager to evaluate and discuss all findings with the design team and implement those approved.

Construction Phase Commissioning Plan. The commissioning provider should begin developing the commissioning plan for construction, which will guide the development of the commissioning specifications.

& Additional Resource: Appendix 2 (Sample in Model Commissioning Guide and Specifications, PECI, http://www.peci.org)

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

& Additional Resource: Appendix 2 (Sample in Model Commissioning Guide and Specifications, PECI, http://www.peci.org)

Contract Documents. The design team is responsible for producing the formal contract or bid documents. These documents include a complete set of mechanical, electrical and structural drawings and a detailed set of specifications that include equipment performance requirements and comprehensive sequences or control. An update of the Design Record is included as an attachment.

Written Work Products. During design, the project manager should receive regular commissioning progress reports from the commissioning provider, as well as updated comments and recommendations from design reviews that the project manager must resolve with the design team. The commissioning provider submits updates of the Design Record. The commissioning provider also submits an initial construction phase commissioning plan and commissioning specifications.

5.2.2 Responsibilities

Project Manager

a. If the commissioning process does not begin until the design phase, project manager should ensure that tasks outlined in the pre-design phase are completed.

b. Project manager discusses all findings presented by the commissioning provider during formal design reviews with the design team. He or she evaluates them with the design team, and implements those approved.

c. Project manager reviews the commissioning specification language and draft construction phase commissioning plan.

Commissioning Provider

a. Commissioning provider reviews Design Narrative documentation produced by the design team for clarity, completeness and compliance with the Owner's Project Requirements documentation and reports findings to the project manager.

b. Commissioning provider attends selected design team meetings.

c. Commissioning provider reviews design at various stages of development (ideally at least once during schematic design, design development, and contract document phases). The commissioning provider reports all findings to the project manager.

d. Commissioning provider develops a draft construction phase commissioning plan and submits the plan to the project manager and design team for review.

e. Commissioning provider develops commissioning specifications to be included in the final contract documents and submits the specifications to the project manager and design team for review.

f. Commissioning provider compiles and updates the Design Record which is later submitted as an attachment to the bid documents.

Design Team

a. Design team develops and updates formal Design Narrative as the design process continues.

b. Design team addresses in writing all findings and recommendations presented by the commissioning provider during formal design reviews.

c. Design team reviews and incorporates the commissioning and related specifications developed by the commissioning provider.

Contractor and Equipment Suppliers

Generally, no participation at this phase.

5.3 Bidding Phase

5.3.1 Description and Activities

During the bidding phase, contractors review the contract documents and submit bids for constructing the project. The commissioning provider may be asked to attend the pre-bid conference to answer any questions about commissioning and may review bids, alternates, and addendums to ensure that commissioning, and the Owner's Project Requirements, are not compromised by the changes.

5.3.2 Responsibilities

Project Manager

a. In the pre-bid conference, project manager makes everybody aware that the project will be commissioned.

Commissioning Provider

a. Commissioning provider may attend the pre-bid meeting to answer any commissioning questions and may review contractor bids relative to commissioning for the project manager.

Design Team

No special commissioning tasks.

Contractor and Equipment Suppliers

No special commissioning tasks.

5.4 Construction Phase

5.4.1 Description and Activities

The main construction phase commissioning tasks are listed chronologically below.

Construction Phase Commissioning Plan. The commissioning provider updates the construction phase commissioning plan, which includes a list of all systems and specific equipment and components to be commissioned, the process to be followed, communications, reporting and documentation protocols, and an estimated schedule for the commissioning process.

Construction Phase Commissioning Kickoff Meeting. The commissioning provider coordinates a construction phase commissioning kickoff meeting. The meeting should include the project manager, construction manager , design team, commissioning provider, and respective representatives from the general contractor and mechanical, electrical, controls, and TAB subcontractors. At this meeting, the commissioning provider 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 provider uses these suggestions to help finalize the commissioning plan and schedule.

Issues Log. The commissioning provider develops and keeps a record of issues and findings throughout the construction phase commissioning process that require further attention, tracking, or correction. The log is updated regularly and submitted to the project and construction managers and each contractor for discussion and resolution during construction meetings.

Construction and Commissioning Meetings. The commissioning provider attends periodic planning and job-site meetings in order to remain informed on construction progress and to update parties involved in commissioning. During the initial stages of construction, the commissioning provider may attend regular construction meetings and hold a line item on the agenda. Later in construction the commissioning provider may coordinate entire meetings devoted to commissioning issues.

Submittal Review. The commissioning provider reviews contractor submittals of equipment to be commissioned during the normal submittal review process. The commissioning provider reviews and comments on each submission, and forwards them to the project manager or designer.

Additional information will be requested by the commissioning provider including 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 provider to become familiar with the systems and to write functional test procedures. Project manager support for obtaining these additional documents from the contractors is critical.

Monitor Coordination Drawing Development. The commissioning provider may assist the project manager in monitoring the development of coordination drawings to ensure reasonable interface between trades.

Change Order Review. All requests for information (RFIs) and change orders applicable to the commissioned systems should be provided to the commissioning provider for review for impacts on commissioning and Owner's Project Requirements.

Construction Observation. The commissioning provider visits the construction site periodically and notes any conditions that might affect system performance or operation. Construction observation reports are provided to the project manager.

Construction Checklists and Start-up. The installation, start-up and initial checkout of the equipment and systems are executed and documented by the contractor on construction checklists provided by the commissioning provider and on manufacturer checklists shipped with the equipment. These checklists are submitted to the commissioning provider, who makes sure they are complete before functional testing begins. The commissioning provider may witness some of the start-up execution and will spot-check selected items on the checklist prior to functional testing.

Functional Testing. After developing written test procedures, the commissioning provider 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 full-load and part-load conditions during all 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 provider does not normally retest systems that have been tested and approved by regulatory authorities. The commissioning provider 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 Owner.

O&M Manuals. The commissioning provider reviews the operation and maintenance manuals and verifies that they are complete, clear, explicit, and available for use during the training sessions.

Training. Ideally, enhanced training requirements are included in the specifications. The commissioning provider assists the project manager in ensuring that adequate training plans are used by the contractor and that the training is completed per the contract documents. The commissioning provider may provide training agendas 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 Owner that should be covered in the training.

Systems Manual. The commissioning provider 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 all setpoints and implications when changing them; time-of-day 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. The Systems Manual with O&M Manuals will form Master O&M Manual.

Commissioning Record. Shortly after occupancy, the commissioning provider typically writes a final commissioning report, which summarizes the commissioning effort and gives the commissioning provider'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.

Written Work Products. The commissioning process generates a number of written work products during the construction phase of the project. The project manager should receive at least the following products from the commissioning provider.

- ✓ Updated construction commissioning plan
- ✓ Updated commissioning schedule
- ✓ Minutes from commissioning meetings
- ✓ Periodic commissioning progress reports
- ✓ Reports of submittal reviews
- ✓ Updates to the commissioning issues and related memoranda
- ✓ Blank construction checklists and functional test forms
- ✓ Completed construction checklists and functional test forms
- ✓ Report of training completion

- ✓ Report of O&M manual review
- ✓ Systems Manual
- ✓ Commissioning Record

5.4.2 Responsibilities

Project Manager

The roles of the project manager, 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 and project managers, as appropriate, for the specific project.

a. Project *and* construction managers review the updated construction phase commissioning plan scope, roles and responsibilities, communication and resolution protocols, and general schedule.

b. Project *and* construction managers review regular commissioning progress reports and memoranda submitted by the commissioning provider.

c. Project *or* construction manager sees that the commissioning provider receives all RFIs and change orders.

d. Project *or* construction manager attends periodic construction meetings and commissioning meetings as necessary and discusses commissioning progress report and issues with team members.

e. Project *and* construction managers participate with the design team and contractors to resolve issues raised by the commissioning provider in a timely manner.

f. Project manager identifies a lead facility maintenance contact and arranges for facility operating personnel to assist in field commissioning activities and attend training sessions.

g. Project *and* construction managers support the development and execution of a training plan.

h. Project manager receives and reviews Systems Manual and Commissioning Record submitted by commissioning provider and makes the final decision regarding satisfactory completion of commissioning activities and initial acceptance of system operation.

Commissioning Provider

a. Commissioning provider refines the construction phase commissioning plan, including scope, responsibilities, and schedule, and submits the plan to the Project and construction manager for review.

b. Commissioning provider coordinates a construction phase commissioning kickoff meeting.

c. Commissioning provider attends periodic construction meetings and coordinates commissioning meetings with various team members as necessary.

d. Commissioning provider 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 provider reviews all commissioned equipment submittals.

f. Commissioning provider monitors development of coordination drawings.

g. Commissioning provider reviews all RFIs and contractor change order requests.

h. Commissioning provider periodically visits the construction site and notes conditions that may affect system performance and operation.

i. Commissioning provider provides construction checklists to the contractors.

j. Commissioning provider reviews all construction checklists completed by the contractors, spot checks some equipment, and witnesses the start-up and checkout of critical pieces of equipment.

k. Commissioning provider writes detailed functional test procedures for all commissioned equipment.

l. Commissioning provider manages and witnesses all functional tests and documents findings and recommended corrective measures.

m. Commissioning provider reviews all operation and maintenance manuals submitted by the contractor for each piece of commissioned equipment.

n. Commissioning provider sees that the specified training plans are developed and executed.

o. Commissioning provider compiles and submits a System Manual and Commissioning Record to the project manager.

Design Team

a. Design team reviews the updated construction phase commissioning plan.

b. Design team attends the construction phase commissioning kickoff meeting.

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.

Contractor and Equipment Suppliers

a. Contractor facilitates the coordination of the commissioning work by the commissioning provider 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 provider.

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 provider.

f. Contractor is responsible for coordinating and executing the training of owner personnel.

g. Contractor prepares O&M manuals, according to the specifications.

5.5 Warranty Period

5.5.1 Description and Activities

Although the project is essentially considered complete, some commissioning tasks from the initial commissioning contract continue throughout the typical one-year warranty period. The main commissioning tasks during the warranty period are listed chronologically below.

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 under at building turnover. The testing should be performed by the appropriate contractor and witnessed by the commissioning provider and building operators. However, the owner may have their operations staff and the commissioning provider execute the tests and bring contractors back only if there are problems.

Near Warranty End Review. The commissioning provider 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 owner's technical resource, they assist the facility staff in addressing any performance problems or warranty issues. If there are still any outstanding issues, the owner shall address them with the contractors or design team.

Written Work Products. The project manager should receive an "as operated" sequence of operations from the commissioning provider or controls contractor, as well as a finalized issues log outlining all deficiencies identified throughout the entire process and their resolutions. The commissioning provider should also submit a summary report after performing seasonal testing and the pre-warranty expiration review of each system.

5.5.2 Responsibilities

Project Manager

a. Project manager works with the commissioning provider to review system operation prior to equipment warranty expiration. The project manager works with contractors to resolve any issues raised by the commissioning provider.

b. Project manager ensures that facility staff provides support to the commissioning provider during seasonal testing.

Commissioning Provider

a. Commissioning provider coordinates, supervises and documents required seasonal testing.

b. Commissioning provider reviews system operation and performance prior to expiration of equipment warranties and assists facility staff in resolving outstanding warranty issues and performance problems.

Design Team

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

Contractor and Equipment Suppliers

a. Contractor executes seasonal functional testing, witnessed by the commissioning provider, 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.

The following attachments have been included for further reference:
Appendix 1 – Request for Proposal for Commissioning Services - sample

Appendix 2 – Resources

Appendix 3 – Tips for Project Managers for Working with Commissioning Providers

Appendix 4 – Commissioning Costs

Appendix 1
Reqest for Proposal for Commissioning Services

DEPARTMENT OF _____

REQUEST FOR PROPOSAL

FOR INDEPENDENT COMMISSIONING PROVIDER SERVICES

RFP Writer:

This template was intended to be applicable for cases when commissioning starts in design or when it starts during early construction, and for cases where the proposal is a fixed fee or a negotiated contract. The instruction boxes guide the modifications to fit each scenario.

For the construction phase tasks, the RFP Writer should understand clearly the management and responsibility scenario in the specifications and contracts.

When the contractor is required to hire a "test engineer" or "commissioning coordinator," etc., the roles of that party can easily be confused and overlapped with the commissioning provider or authority that may be hired by the owner.

This RFP is intended for the independent commissioning provider or authority when there is not a contractor-hired test engineer or commissioning coordinator performing many of the day-to-day commissioning functions.

Issuance Date: _____
VIP (Vendor Information Program) Date: _____
Closing Date: _____, 5 PM

The State of Oregon, acting by and through its Department of _____(Department) requests written proposals to secure Commissioning Provider (CP) services for the _____ facility in, _____, Oregon. The Department is committed to commissioning this facility to ensure that all systems are well designed, complete and functioning properly upon occupancy, and that Department staff has adequate system documentation, and training.

BACKGROUND

The Department is seeking the services of a qualified commissioning provider/firm for a new construction project. The project currently is a _____ gross sf, ___ story, Class ___ [type] _____ building in [city & state] _____, _____, with a project budget of $_____ million. The facility is expected to be comprised of ____% office space, ____% retail, _____ %parking garage, _____% medical laboratory, etc.

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

The current phase of the project is: _____ (pre-design, schematic design, design development, 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.**

OBJECTIVES

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

The objective of commissioning is to provide documented confirmation that a facility fulfills the functional and performance requirements of the building owner, occupants, and operators. To reach this goal, it is necessary for the commissioning process to establish and document the owner's 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. 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 provider should be involved throughout the project from the pre-design through the warranty phase. The primary role of the CP during the overall design phase is to develop detailed commissioning specifications and review design to ensure it meets the Owner's objectives. During construction, the CP 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 Owner's Project Requirements and the contract documents. The CP 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 CP 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 ___pre-design phase, ___design phase, ___construction phase, ___warranty phase services are requested.

RFP Writer:

If the plans and specifications are complete or nearing completion, delete all the Pre-Design and Design Phase tasks. However, it is advised that if the project hasn't gone out to bid, the Commissioning Provider conduct a design review similar to Design Phase Task 3 and possibly Task 4 and that they provide some language for, or at least a review the commissioning or quality control language in the specifications. Clarifications to the bid package could be handled by addenda.

Pre-Design Phase

RFP Writer: **The following tasks are generally included. Select as appropriate.**

1. Assemble commissioning team, hold a scoping meeting and identify responsibilities.
2. Develop a draft design-phase commissioning plan.
3. Attend commissioning meetings as needed with project manager and design team.
4. Review the Owner's Project Requirements documentation (design intent) for clarity and completeness.

RFP Writer: **The following tasks may be included. Select and edit as appropriate.**

5. Develop the written Owner's Project Requirements for the following features: mechanical, electrical, plumbing, architectural, structural, lighting, energy consumption, commissioning, indoor environmental quality, environmental sustainability, siting, exteriors, landscaping, interiors, functionality for tenants, budget, _____, and _____. This will be accomplished by the Commissioning Provider: ___extracting salient concepts from the Owner's existing programming report and/or ___conducting a focus group, ___conducting interviews with owner stakeholders [describe how many]. The Owner's Project Requirements will be ___general in nature, ___specific in nature, ___include specific performance criteria for ___some, ___most concepts.

Design Phase

RFP Writer: If the Commissioning Provider was not brought on during Pre-Design, it is recommended that they perform Pre-design Tasks 1 and 4.

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, design development and contract 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 (Owner's Project Requirements, Design Narrative; Design Basis).
5. Develop a draft construction phase commissioning plan using an Owner-approved outline.
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 and 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 Provider 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 to answer commissioning related questions.

Construction Phase

RFP Writer: Include the article 1 if commissioning specifications already exist for the project.

1. Perform the tasks and functions in the specifications ascribed to the _____ (title of the commissioning party as identified in the specifications), dated _____.
2. 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.
3. Coordinate the commissioning work and, with the contractor and construction manager (CM), ensure that commissioning activities are being incorporated into the master schedule.
4. Revise, as necessary, the construction phase commissioning plan developed during design, including scope and schedule.
5. Plan and conduct commissioning meetings as needed and distribute minutes.
6. 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.
7. Review and approve normal Contractor submittals applicable to systems being commissioned for compliance with commissioning needs, concurrent with the A/E reviews.
8. Review requests for information and change orders for impact on commissioning and owner's objectives.
9. Review coordination drawings to ensure that trades are making a reasonable effort to coordinate.
10. Write and distribute construction checklists for commissioned equipment.
11. Develop an enhanced start-up and initial systems checkout plan with contractors for selected equipment.
12. Perform site visits, as necessary, to observe component and system installations. Attend selected planning and job-site meetings to obtain information on construction progress. Review construction meeting minutes for revisions/substitutions relating to the commissioning process. Assist in resolving any discrepancies.
13. Witness HVAC piping pressure test and flushing, sufficient to be confident that proper procedures were followed. Include testing documentation in the Commissioning Record.
14. Witness any ductwork testing and cleaning sufficient to be confident that proper procedures were followed. Include documentation in the Commissioning Record.
15. Document construction checklist completion by reviewing completed construction checklists and by selected site observation.
16. Document systems startup by reviewing start-up reports and by selected site observation.
17. Approve air and water systems balancing by spot testing and by reviewing completed reports and by selected site observation.
18. 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.
19. Analyze functional performance trend logs and monitoring data to verify performance.

20. 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 provider 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 provider and the Department.

21. 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 Owner.
22. Maintain a master issues log and a separate record of functional testing. Report all issues as they occur directly to the CM. Provide directly to the CM written progress reports and test results with recommended actions.
23. Review equipment warranties to ensure that the Department's responsibilities are clearly defined.
24. Oversee and approve the training of the Department's operating personnel.
25. Review and approve the preparation of the O&M manuals for commissioned equipment.
26. 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 provider regarding the adequacy of the equipment, documentation and training meeting the contract documents in the following areas:
        1) Equipment meeting the equipment specifications,
        2) Equipment installation,
        3) Functional performance and efficiency,
        4) Equipment documentation, and
        5) Operator training.
    B. All outstanding non-compliance items shall be specifically listed. Recommendations for improvement to equipment or operations, future actions, commissioning process changes, etc. shall also be listed. Each non-compliance issue shall be referenced to the specific functional test, inspection, trend log, etc. where the deficiency is documented.
    C. Also included in the Commissioning Record shall be the issues log, commissioning plan, progress reports, submittal and O&M manual reviews, training record, test schedules, construction checklists, start-up reports, functional tests, and trend log analysis.
27. Compile a Systems Manual that consists of the following: Owner's Project Requirements (by owner); Design Narrative and Basis of Design (by designer); 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 provider).

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 facility staff in developing reports and documents and requests for services to remedy outstanding problems.

SYSTEMS TO BE COMMISSIONED

The following systems and assemblies will be commissioned:

RFP Writer:

a. Delete and add systems as appropriate.

b. If this RFP is offered during pre- or early design, the list and description of equipment and systems should be kept fairly general, as shown below.

c. For RFP's 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: electrical, data and communications, paging, security, plumbing, building envelope and process instrumentation and controls.

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

DESIRED QUALIFICATIONS

RFP Writer: Add to and edit the desired qualifications according to your specific project, particularly for non-HVAC systems you are having commissioned.

It is the Department's desire for the person designated as the site Commissioning Provider to satisfy as many of the following requirements as possible:

- Acted as the principal Commissioning Provider for at least three (3) projects over _____sf.
- Extensive experience in the operation and troubleshooting of HVAC systems, energy management control systems.
- Extensive field experience is required. A minimum of five (5) full years in this type of work is required.
- 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 datalogging equipment.
- Excellent verbal and writing communication skills. Highly organized and able to work with both management and trade contractors.
- Experienced in writing commissioning specifications.
- A bachelor's degree in mechanical or electrical engineering is strongly preferred, and P.E. certification is desired, however, other technical training, past commissioning, and field experience will be considered.
- Membership with the Building Commissioning Association will be considered a plus.

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

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 Department to evaluate the Consultant's approach, experience, staff and availability.

The proposer shall:

1. Limit their proposal to 15 single-sided pages, including graphics. A letter of introduction, section dividers, detailed resumes and the sample work products of item five below are not included in this limit.
2. Have the proposal signed by an officer of the proposing firm with the authority to commit the firm.
3. Fill out the attached *Commissioning Firm Experience* form and the *Commissioning Task Listing* form (Exhibits 2 and 3) for each firm on the team. List no more than four projects in Exhibit 3.
4. Provide an organization chart for managing and executing this contract.
5. List the individual(s) who will serve as the Commissioning Provider 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.
6. Provide resumes for key staff and subconsultants. The resumes shall include specific information about expertise in commissioning tasks, (e.g. design reviews, specification writing, commissioning management, troubleshooting, test writing, test execution, energy management, etc.).
7. 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) O&M experience;
   d) energy-efficient equipment design and control strategy optimization;
   e) building simulation;
   f) life cycle costing;
   g) experience in sustainable design;
   h) project and construction management; and
   i) system design (specify).

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

8. Describe your proposed approach to managing the project expertly and efficiently, including distribution of tasks, travel, duration of which staff will be on site during what periods of time, etc. Describe what approach you will take to integrate the commissioning into the normal design and construction process in order to minimize potential time delays. Describe what you will do to foster teamwork and cooperation from contractors and design team and what you will do to minimize adversarial relationships. Describe how you intend to determine the appropriate level of commissioning effort for the various systems and equipment.
9. As an attachment, provide the following work products that members of the proposer's team wrote. List the team member who actually wrote the document and the projects on which they were used. Work from the designated Commissioning Provider is preferred.
   a) commissioning plan that was executed (the process part of the plan);
   b) commissioning specifications; and
   c) an actual functional test procedure form that was executed.

RFP Writer: If this is a fixed lump sum proposal for the work, include the following paragraph, otherwise delete it.

10. 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. For each phase, provide the percentage level of effort for each primary team member.

RFP Writer: If this is a request for qualifications with a rate proposal, include the following paragraph, otherwise delete it.

11. This project will be set up on a time-and-materials basis. Provide both an *estimated* total fee to accomplish the work and an hourly rate for each team member, along with rates and fees for all other costs that the Department could incur from the proposer in this contract (travel, mileage, per diem, communications, etc.). For each phase, provide the percentage level of effort for each of the primary team members.

RFP Writer: It is normally not appropriate to ask for a fixed budget figure for construction phase commissioning until the plans and specifications are nearing completion. However, if this RFP is sent out in early to mid-design, ask for budget details in the table below of the Pre-Design and Design Phase tasks only and include the following paragraph. Also, in the budget table delete all but one line for the total Construction phase budget.

Otherwise, if the commissioning project was started late in or after design, delete the following paragraph.

12. The Department desires a cost proposal with a budget breakdown for the Pre-Design and Design Phase commissioning tasks. For planning purposes, the proposer must also provide a cost estimate range for the Construction and Warranty Phase tasks using the form below.

RFP Writer: If the RFP was sent out near the end of, or after the design phase, delete the Pre-Design and Design tasks that are not going to be done from the budget table below.

13. Provide a proposed dollar budget to complete this scope of work in the following format. All task amounts include associated meetings, progress reports and direct costs (travel, etc.).

The respondent must submit three (3) copies of the proposal, each signed by an authorized representative of the firm. Facsimiles will not be accepted. Proposals must be submitted to arrive no later than close of business, **5:00 p.m**. on **_____, _____** to:

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

Budget

	Task	Budget ($)
Pre-Design and Design		
1	Develop or review Owner's 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	Construction 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

Department staff shall review all proposals and select and rank the _____ 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 Department 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 round 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 Department must review and approve the replacement personnel, in advance. The replacement personnel shall have, at minimum, equivalent qualifications as the original personnel.

EXHIBIT 1
FOCUSED DESIGN REVIEW SCOPE

RFP Writer: Check the areas for which you want the commissioning firm to provide input.

The commissioning provider will perform a review of the design documents for the following issues at the phases checked for each system commissioned.

Key: SD: Schematic Design Review DD: Design Development Review
CD1: Contract Document Review #1 CD2: Contract Document Review #2

Design Area	Review Description	SD	DD	CD1	CD2
Design narrative and design basis	Ensure that design narrative and basis of design are clear, complete, and meet the original Owner's Project Requirements				
Commissioning facilitation	Review to facilitate effective commissioning (see Exhibit 2). (sufficient accessibility, test ports, monitoring points, etc.)				
Energy efficiency	Review for adequacy of the effectiveness of building layout and efficiency of system types and components for building shell, HVAC systems and lighting systems.				
Control system & control strategies	Review ___HVAC, ___lighting, ___fire control, ___emergency power, ___security control system, strategies and sequences of operation for adequacy and efficiency.				
Operations and maintenance (O&M)	Review for effects of specified systems and layout toward facilitating O&M (equipment accessibility, system control, etc.).				
Indoor environmental quality	Review to ensure that systems relating to ___thermal, ___visual, ___acoustical, ___air quality comfort, ___air distribution maximize comfort and are in accordance with the Owner's Project Requirements. (See Exhibit 3 for IAQ checklist).				
O&M documentation	Verify adequate building O&M documentation requirements.				
Training	Verify adequate operator training requirements.				
Commissioning specifications	Verify that bid documents adequately specify building commissioning, including testing requirements by equipment type.				
Department's design guideline or standard	Verify that the design complies with the owner's own design guideline or standard.				
Environmental sustainability	Review to ensure that the ___building materials, ___landscaping, ___use of water, ___waste management create less of an impact on the environment and are in accordance with Owner's Project Requirements.				
Mechanical	Review the mechanical concepts/design for enhancements.				
Electrical	Review the electrical concepts/systems for enhancements.				
Envelope	Review envelope design and assemblies for thermal and water integrity, moisture vapor control and assembly life.				
Structural	Review the structural concepts/design for enhancements.				
Functionality	Ensure the design maximizes the functional needs of the occupants.				
Life cycle costs	Perform a life cycle assessment of the primary competing mechanical systems relative to ___energy efficiency, ___O&M, ___IEQ, ___functionality, ___sustainability.				

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)

❑ Pkg. or split HVAC	❑ Daylighting	❑ Commercial refrigeration
❑ Chiller system	❑ Electrical, general	❑ Telecommunications
❑ Boiler system	❑ Electrical, emerg. power	❑ Thermal Energy Storage
❑ Energy Mgmt. Sys.	❑ Envelope	❑ Labs & Clean Rooms
❑ Variable Freq.Drives	❑ Fire/Life Safety	❑ _____
❑ Lighting Controls	❑ Plumbing	

Number of registered engineers on staff who have directed commissioning projects: _____

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

Building Sector	**New Construction Major Renovation**	**Existing Building Tune-up**	**Equipment Replacement**
• Office or retail	❑	❑	❑
• Grocery	❑	❑	❑
• Hospitals	❑	❑	❑
• Laboratories	❑	❑	❑
• Schools or universities	❑	❑	❑
• Industrial / Manufacturing	❑	❑	❑
• Special purpose–prisons, museums, libraries, etc.	❑	❑	❑

EXHIBIT 3
COMMISSIONING TASK EXPERIENCE LISTING ON SIMILAR PROJECTS
FILL OUT A SEPARATE FORM FOR EACH FIRM ON THE TEAM

KEY:

Design Review:	Reviewed design and provided comment during design phase	Data/Trending:	Used data loggers or EMS trend logs for testing
Cx Plan:	Wrote the commissioning plan	Training:	Developed or approved staff training
Specifications:	Wrote commissioning specifications for construction team	Review O&Ms:	Reviewed completed O&M manuals
Funct. T. Plans:	Wrote functional test procedures	CP in firm:	Commissioning provider was part of the firm
Witnessed FT:	Witnessed and documented functional tests	Supervised CP:	Supervised commissioning provider subconsultant to the firm
Hands-on Tests:	Performed functional tests (hands-on)	Worked w/CP:	Worked with a commissioning provider hired by others

Project Name, Date Bldg Size & Type (New/Exist)	**City & State Owner Contact Title and Phone**	**Name & Role of Persons(s) Assigned to Project by Firm** (identify any subconsultants)	**Systems Commissioned** (Identify if tested by subsconsultants)	(Enter "X" if by own firm, "S" if by subconsultant)											
				Commissioning Tasks Performed									**Management**		
				Design Review	Cx Plan	Specifications	Funct. T. Plans	Witnessed FT	Hands-on Tests	Data/Trendings	Training	Review O&Ms	CP in firm	Supervised CP	Worked w/CP

Appendix 2

Resources

Available Sources for Major Commissioning Information

Procedural Guidelines, Specifications and Functional Tests Last Updated: 9/12/00

* 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
Appendix VII Idaho New Building Commissioning Guidelines. State of Idaho, 2000. Available at: http://www2.state.id.us/adm/pubworks/archengr/commgl97.htm	YES	No	No
Building Commissioning Assistance Handbook Appendices. Seattle City Light, 1999. (standardized functional test procedures http://www.ci.seattle.wa.us/seattle/light/conserve/business/bdgcoma/cv6_bcam.htm.	No	No	*YES
Procedural Standards for Building Systems Commissioning, National Environmental Balancing Bureau (NEBB), 1999. 301-977-3698	Yes d, c	Some d, c	Some
A Practical Guide for Commissioning Existing Buildings, PECI and Oak Ridge National Labs (ORNL), 1999. NTIS 1-800-553-6847 *[RCX]*	YES	No	No
Model Commissioning Plan and Guide Commissioning Specifications, USDOE/PECI, 1997. NTIS: # DE 97004564 1-800-553-6847. http://www.peci.org/cx/mcpgs.html.	*Some D, c	*YES D, C	*YES
Building Commissioning Guide, 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
The HVAC Commissioning Process, ASHRAE Guideline 1-1996, 1996. ASHRAE Publications Dept., 1791 Tullie Circle, NE, Atlanta, GA 30329.	Yes d, C	Some d, c	No
The Building Commissioning Handbook, 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
Beyond Lighting DSM: Life After Green Lights, Montgomery Co., MD, 1995. *[RCX]* Existing building commissioning case study with sample process and detailed procedures. 70 pgs. 301-217-6000.	Yes	No	Yes
Engineering and Design Systems Commissioning Procedures, 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
Commissioning Specifications, 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
Model Construction Document Specifications and A/E Services Contract Clauses. 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
Commissioning Guidelines, Instructions for Architects & Engineers, State of WA., 1995. Dept. of General Admin., Div. of Engin. & Arch., (360) 902-7272.	Yes d, c	No	No
Commissioning of HVAC Systems, 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
Laboratory HVAC Systems: Design, Validation and Commissioning, ASHRAE collection of 11 papers, 1994. And,	Yes C	No	No
Commissioning Smoke Management Systems, ASHRAE Guideline 5-1994. ASHRAE Publications Dept., 1791 Tullie Circle, NE, Atlanta, GA 30329.	Yes d, c	No	No
Standard HVAC Control Systems Commissioning and Quality Verification User Guide, 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
Contractor Quality Control and Commissioning Program—Guidelines and Specification, Montgomery Co. Gov., St of Maryland, 1993. 301-217-6071.	*Yes c	*YES C	*Some
HVAC Systems Commissioning Manual, Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), 1993. SMACNA, 4201 Lafayette Center Dr., Chantilly, VA 22021.	Yes c	Some c	Some
Commissioning Guide, Public Works Canada, Western Region, 1993. 403-497-3770.	Some d, c	Yes d, C	No
Guide Specification for Military Construction—Commissioning of HVAC Systems, Dept. of the Army, U.S. Army Corps of Engineers, 1993. Washington, DC 20314-1000	No	*Some c	*YES
Building Commissioning Guidelines, Bonneville Power Administration/PECI, 1992. 503-230-7334.	YES d, C	Some c	Some
HVAC Functional Inspection and Testing Guide, U.S. Dept. of Commerce and the General Services Administration, 1992. NTIS: 800-553-6847.	No	No	YES
Thermal Energy Storage (TES) Commissioning Guidelines, 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
AABC Master Specification, 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

Commissioning Overviews and Case Studies

Building Commissioning: The Key to Quality Assurance. USDOE Rebuild America / PECI., 1998. *[RCX]*
Commissioning retrofits and existing buildings: overview, process and case studies. 68 pgs. 1-800-363-3736.

Beyond Lighting DSM: Life After Green Lights, Urban Consortium Energy Task Force of Public Technologies, Submitted by Montgomery County Government, MD, Div. of Facilities and Services, 1998.
Existing building commissioning case study with sample process and detailed procedures. 70 pgs. 301-217-6000.

Commissioning For Better Buildings in Oregon. Oregon Office of Energy / PECI, 1997. *[rcx]*
New construction overview, benefits, process and case studies. 44pgs. (see web site below).

What Commissioning Can Do For Your Building. PECI, 1997. *[rcx]*
Commissioning overview and report of 175 building case studies. 12pgs. 503-248-4636.

Commissioning Four New Science Laboratory Buildings (U. of WA). Bonneville Power Admin. / Phoebe Caner, 1997.
Commissioning case studies with detailed "lessons learned" information in all sections. ~70 pgs. 503-230-7334.

Commissioning the Physics/Astronomy Building Control System (U. of WA). Bonneville Power / Phoebe Caner, 1996.
Commissioning case study and report with lessons learned. ~110 pgs. 503-230-7334.

Four case studies. Seattle City Light.
http://www.ci.seattle.wa.us/seattle/light/conserve/business/bdgcoma/cv6_bcam.htm.

Web Sites Containing Commissioning Documents

Building Commissioning Association	http://www.bcxa.org/
Florida Design Initiative	http://www.state.fl.us/fdi/index.html (ongoing articles & forum)
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/bldgcx.htm (benefits of Cx, case study, the full text of *Commissioning for Better Buildings in Oregon*) *[rcx]*
PECI	http://www.peci.org/ (Cx conference announcement, downloadable *Model Cx Plan and Guide Specifications*, 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 *Building Commissioning Guide;* early version of *Model Cx Plan and Guide Specifications*)
USDOE	http://www.eren.doe.gov/ (Links to commissioning doc's. Search on "commissioning.")
Seattle City Light	http://www.ci.seattle.wa.us/seattle/light/conserve/business/bdgcoma/cv6_bcam.htm (standardized test procedures and case studies)
Whole Building Design Guide (NIBS)	http://www.wbdg.org/index.htm National Institute of Building Sciences (find commissioning information by searching on "commissioning"

Appendix 3

Tips For Project Managers For Working With Commissioning Providers

1) **Develop a clear scope of work for the commissioning provider.**
   - Make sure the scope is easy to understand
   - Make sure that there is sufficient detail

2) **Read the commissioning specifications and the commissioning plan front to back.**
   - In order to manage the work, you must be familiar with all aspects of the commissioning requirements.
   - Ask questions as needed.

3) **Give your commissioning provider clear authority (if you hired them).**
   - Give the commissioning provider authority to review documents, procedures and tests and to inspect the installation and operation of equipment. Remember, they are working for you, but are often hand-tied because they do not have any more authority than to "recommend."

4) **Let the construction team and A/E know you support your commissioning provider.**
   - At meetings, verbally express support for the commissioning provider. The A/E and construction teams may use lack of overt support from you as excuse to not give the commissioning provider their full support.

5) **Establish clear reporting and paper paths.**
   - Meet with construction team to decide reporting and paper paths. Decide what commissioning documents will go where, and for what purpose (review, information, approval, etc.).
   - Decide what role the commissioning provider will have in normal construction submittals and operation and maintenance manual reviews and who should receive their comments.

6) **Make sure all change orders, architects supplemental instructions, and requests for information that relate to commissioned equipment are copied to the commissioning provider.**

7) **Insist on frequent progress reports and updates from the commissioning provider.**
   - Have the commissioning provider provide to you frequent updates on how the commissioning process is going. Keep the commissioning provider thinking ahead.

8) **Check in periodically to see how the commissioning provider is doing and how you can assist him or her.**
   - The commissioning provider may need motivation to keep the work moving along as quickly as possible and may need a sounding board to bounce problems and challenges off of.

9) **Follow through in a timely manner on the tasks assigned to you.**
   - Do not be the holdup for any of the commissioning work. Remain accountable for all assigned tasks.

10) **Show interest in mechanical issues.**
   - There are many important issues for project managers to deal with besides what may be mundane mechanical details. However, the commissioning provider needs your support and interest in these areas to fulfill their work.

11) **Make sure the commissioning activities are scheduled in advance.**
    - Have the commissioning provider provide an initial schedule with frequent updates and more detail as the project progresses.
    - Make sure the commissioning gets included in the master construction schedule.

12) **Have the commissioning provider describe the exact format and content of the commissioning records they are keeping and what they'll turn over to you.**
    - Make sure the commissioning provider knows the end format at the beginning of the project and that they show it to you, so there are no surprises.

13) **Review a sample construction checklist and functional test to get an idea of what the commissioning provider will be providing.**
    - To prevent surprises about what exactly will be provided, have the commissioning provider submit these sample documents early in the project.

14) **Require the commissioning provider to keep a current deficiency or issues log.**
    - Receive regular updates.
    - Incorporate items from the log into regular project punch lists, as appropriate.

15) **Develop a clear policy on dealing with identified deficiencies.**
    - Determine when and how deficiencies or issues identified during commissioning will be made known to the A/E and construction team and who will be tracking them and providing feedback to the commissioning provider.

16) **See that all deficiencies are corrected in a timely manner.**
    - To prevent the project and the commissioning work from being delayed, the project manager must tail the contractors until they correct each deficiency.

17) **Schedule or facilitate, regular commissioning meetings.**
    - Increase the frequency of the meetings as the project progresses.
    - Do not let regular construction topics creep in and control the commissioning agenda items.

Appendix 4

Estimating Commissioning Costs

The following summarizes the latest information on commissioning costs taking into account costing studies PECI has completed in-house reconciling their costing models and experience with Ron Wilkinson's (State of Montana) ASHRAE Journal, February 2000 article.
Commissioning costs vary considerably with project size and building type, equipment type, commissioning scope and traveling requirements. Historically, commissioning has focused on HVAC and controls and started during construction. However, the quality control and assurance for more and more systems is being brought under the commissioning umbrella and commissioning is starting more often in the design phase. A few rules of thumb will assist the project manager in planning for commissioning. These costing guidelines must be used with great caution. Understanding what is and is not included in each cost number is critical. The project manager is advised, when possible, to contact a commissioning provider to discuss cost ranges for specific projects before establishing a planning budget.

Design Phase Commissioning Costs

Design phase commissioning may consist of a variety of tasks. At minimum, the process entails the commissioning provider ensuring that the Owner's Project Requirements are clearly documented, that the design team develops a design description and design basis, through an independent design review that the Owner's Project Requirements are met, that the design can be adequately commissioned (ensuring sufficient test ports, monitoring points and control points in the BAS, access panels, etc.) and that commissioning is adequately reflected in the bid documents (by including commissioning language in the project specifications). Technically, the designer's time developing design documentation isn't "commissioning," but as this is rarely done well, if at all, it is included as a commissioning-related cost in this document.

Additional activities may include detailed design review in such areas as indoor environmental quality, maintainability, constructibility, structural, envelope and moisture, energy efficiency, code and policy compliance and sustainability. Rarely would a project warrant a third party taking on all the above tasks. The owner should decide which issues are critical or need special attention from another consultant besides the designer, based on the expertise of the designers of record and the nature of the project.

For a project that includes the minimum tasks listed above and a few of the additional activities listed, the costs for the commissioning provider combined with the additional work of the designers may range from (.1% to .3%) of the total construction cost for a typical office building. Buildings over 100,000 sf. will typically fall near the bottom of the range and buildings less than 100,000 in the top end of the range. More complex building types and larger scopes may cost considerably more. The commissioning provider's costs will roughly be 75%, and the designer's 25% of the total commissioning cost.

Construction Phase Commissioning Costs

The following numbers cover the commissioning provider's costs for the construction and warranty phases, including submittal review, construction checklist development, construction observation, writing, overseeing and documenting functional tests (initial and seasonal), verifying that staff training and O&M manuals are per specification and conducting a near-warranty-end review. Commissioning of the HVAC system includes all systems, including fire, life, safety and controls. Commissioning of the electrical system includes lighting controls, emergency power and limited connection and grounding checks. It does not include infrared scanning, power quality, switchgear, transformer, or low voltage system testing. Complex systems and critical applications will have higher costs.

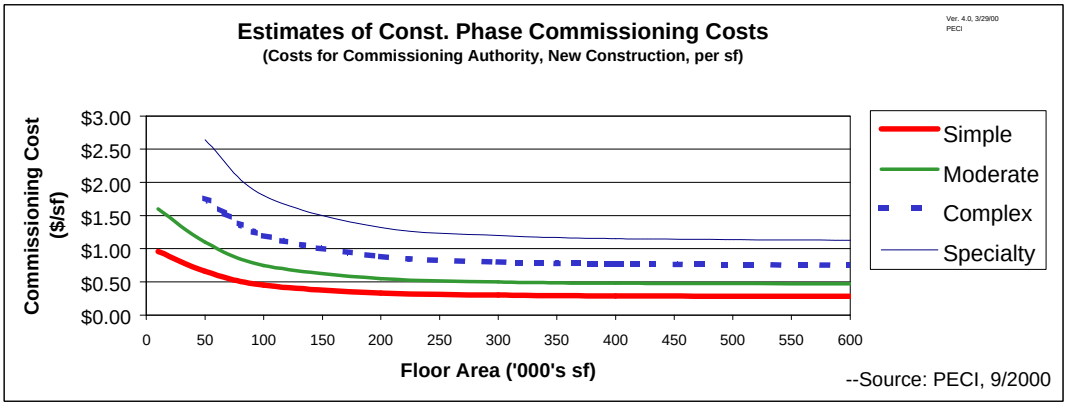
Commissioned System	**Commissioning Cost**
HVAC and controls	2.0% to 3.0% of total mechanical cost
Electrical system	1.0% to 2.0% of total electrical cost
HVAC, controls and electrical	0.5% to 1.5% of total construction cost

--Source for the first two line items: Ron Wilkinson, ASHRAE Journal, Feb. 2000. Third line: PECI, 9/2000

The above costs cover only the commissioning provider fees. There are also costs to the contractor, the designers and owner staff for their part in the commissioning process. The costs for the contractor attending meetings, documenting the construction checklists and assisting with testing will roughly equal 10% to 25% of the commissioning provider's costs. However, in the larger picture, the savings to the contractor in callback costs and holding of final payment retention may exceed the first costs, resulting in little if any net commissioning cost to the contractor. The designer's scope for commissioning during construction is often limited to a review of the commissioning plan and some meetings, resulting in costs of about 5% to 10% of the commissioning provider's fee.

The project manager should realize that the savings to them in reduced change orders (if commissioning starts during design), smoother turnover and less troubleshooting time during the first year will offset the cost of the commissioning provider. Increased energy efficiency also reduces the net cost of commissioning, not to mention the value of more satisfied tenants and reduced indoor air quality liability. Another method for making rough commissioning cost estimates is by floor area.

Costs in the above graph include the cost of the commissioning provider from early construction through warranty for HVAC and controls, including lighting, but does not include low voltage, electrical



grounding, infrared scanning, power quality, switchgear and transformer testing. Tasks include submittal review, construction checklist development, construction observation, writing, overseeing and documenting functional tests and reviewing staff training and O&M manuals. These costs are averages and can vary considerably, since the number of pieces of equipment and commissioning rigor vary.
Simple = office buildings, classrooms, packaged equipment and controls; fewer pieces of equipment.
Moderate = more complex office, classroom with some labs, building automation, more control strategies, fewer packaged equipment; more systems (fire, emergency power, etc.).
Complex = Moderate + most of floor area in complex systems (hospitals, labs, operatories, clean rooms, fume hoods or other non-HVAC systems are commissioned such as electrical quality, transformers, security, communications, etc. Traveling requirements and high cost of living locations increase costs.
Specialty = Very complex facilities like prisons (doesn't include security systems commissioning costs).