

the



collaborative



for high



performance



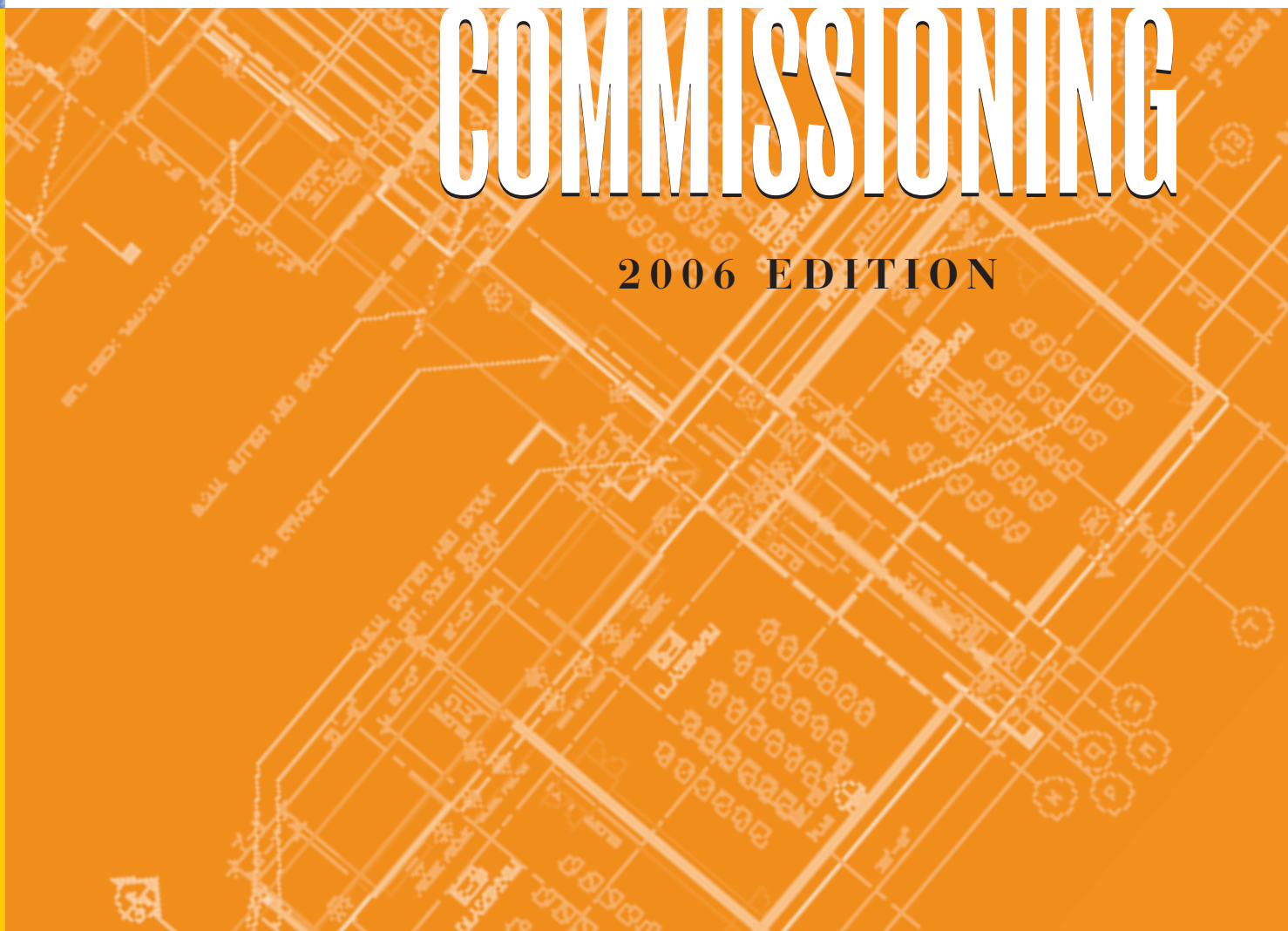
schools

# Best Practices Manual

VOLUME V

# COMMISSIONING

2006 EDITION



# Best Practices Manual

Volume V

**COMMISSIONING**

High Performance Schools

Best Practices Manual

2006 Edition

## **Disclaimer**

IMPORTANT NOTICE TO THE READER: This publication is designed to provide accurate and authoritative information with regard to the subject matter covered. It is distributed with the understanding that local, state and federal laws, regulations and requirements will vary based on the particular circumstances such as building characteristics, geographic region and similar factors. It is also distributed with the understanding the publisher is not engaged in rendering engineering, architectural, legal, or other professional advice or service. The publisher and its participants, officers, directors, employees, contractors and affiliates cannot be responsible for errors or omissions, or any material set forth or referenced in this publication. If professional advice or other expert assistance is required, the services of a competent advisor familiar with the law, regulation, practices and circumstances of the project should be sought.

All rights reserved. Published 2006, [www.chps.net](http://www.chps.net)

Preface .....	i
The CHPS Best Practices Manual.....	ii
The Collaborative for High Performance Schools .....	iii
Acknowledgements .....	iii
Introduction .....	5
What Is Building Commissioning? .....	6
Commissioning Approaches.....	7
Commissioning Assistant Tool .....	7
Why Commission? .....	9
Proper and Efficient Equipment Operation .....	9
Improved Coordination .....	10
Improved Indoor Air Quality, Comfort, and Productivity.....	10
Reduced Liability .....	11
Reduced Costs .....	12
What Will It Cost? .....	13
Costs of Building Commissioning .....	13
Savings from Building Commissioning .....	14
Selecting a Commissioning Provider .....	15
Independent Third Party.....	16
Architect or Engineer Overseer .....	17
Contractor.....	17
QualificatioNs .....	18
The Commissioning Team .....	19
District Representative .....	20
Commissioning Provider.....	20
Design Professionals.....	21
Installing Subcontractors and Manufacturer Representatives .....	22
Facility Manager/Building Operator .....	22
Testing Specialists.....	23
Commissioning Phases.....	25
Pre-Design.....	25
Design .....	26
Construction .....	27
Warranty.....	29
When Does Commissioning End?.....	30

Operation and Maintenance for Persistence .....	31
Begin During Design .....	32
Operation and Maintenance Manuals .....	32
Training .....	33
Preventive Maintenance .....	34
Developing a Preventive Maintenance Plan.....	36
Outsourcing Preventive Maintenance.....	37
References and Resources .....	39
Key to commissioning guidelines .....	39
Overviews and Case Studies .....	41
Web Sites .....	43
Appendix A: Case Studies.....	45
Georgina Blach Intermediate School.....	45
South Pasadena Unified School District.....	46
Appendix B: Sample RFPs .....	47
Request for Commissioning Services.....	48
Background .....	48
Objectives .....	49
Scope of Work.....	49
Pre-Design Phase .....	50
Design Phase.....	50
Bid Phase .....	51
Construction Phase.....	51
Warranty Period .....	54
Systems to Be Commissioned .....	55
Desired Qualifications .....	56
Pre-Proposal Meeting .....	57
Proposal .....	57
Budget .....	60
Selection Process.....	60
Change in Personnel.....	61
Exhibit 1: Focused Design Review Scope.....	61
Exhibit 2: Commissioning Firm Experience .....	63
Commissioning Activities .....	63
Exhibit 3: Commissioning Task Experience On Similar Projects.....	64

---

# Preface

This is a unique period in California history. The state, already educating one out of every eight students in America, has seen historical enrollment rates four times higher than national averages. Hundreds of schools a year are being built to house the influx of new students moving into the system. The California Department of Education predicts that there will be more than 900,000 students without a classroom through the year 2009<sup>1</sup>. At the same time, school facility infrastructure across the state is aging—the Department of Education predicts more than 1.2 million California students are in classrooms that are more than 25 years old, with almost 50,000 of the classrooms scheduled for modernization between now and 2009.

California schools are spending nearly \$700 million per year on energy<sup>2</sup> in a time of rising concern over energy supplies and tight school budgets. These figures illustrate an enormous opportunity for our state's school districts to build the next generation of school facilities that improve the learning environment while saving energy, resources, and money.

The goal of this Best Practices Manual is to create a new generation of high performance school facilities in California. The focus is on public schools and levels K-12, although many of the design principles apply to private schools and higher education facilities as well. High performance schools are healthy, comfortable, energy efficient, resource efficient, water efficient, safe, secure, adaptable, and easy to operate and maintain. They help school districts achieve higher test scores, retain quality teachers and staff, reduce operating cost, increase average daily attendance (ADA), and reduce liability, while at the same time being friendly to the environment.

---

<sup>1</sup> California Department of Education, [www.cde.ca.gov/ls/fa/sf/facts.asp](http://www.cde.ca.gov/ls/fa/sf/facts.asp)

<sup>2</sup> California Energy Commission

---

# THE CHPS BEST PRACTICES MANUAL

This Best Practices Manual is split into six volumes:

- *Volume I: Planning.* This volume addresses the needs of school districts, including superintendents, parents, teachers, school board members, administrators, and those persons in the school district that are responsible for facilities. These may include the assistant superintendent for facilities (in large districts), buildings and grounds committees, energy managers, and new construction project managers. Volume I describes why high performance schools are important, what components are involved in their design, and how to navigate the design and construction process to ensure that they are built.
- *Volume II: Design Guidelines.* This volume contains design guidelines for high performance schools. These are tailored for California climates and are written for the architects and engineers who are responsible for designing schools as well as the project managers who work with the design teams. Organized by design discipline, the guidelines present effective strategies for the design of schools that meet the CHPS high performance school criteria.
- *Volume III: Criteria.* The CHPS criteria are a flexible yardstick that precisely defines a high performance school. School districts are encouraged to adopt the criteria for their new buildings and major modernizations.
- *Volume IV: Maintenance and Operations.* This volume presents high performance guidelines for the maintenance and operation of schools. Information in this volume will help ensure that high performance school buildings continue to operate as their designers intended, providing optimal health, efficiency, and sustainability.
- *Volume V: Commissioning.* This volume provides important information on commissioning high performance schools—a critical step in ensuring that the technologies and high performance elements are actually built and tested to meet specifications.
- *Volume VI: High Performance Relocatable Classrooms.* This volume provides a guide to the CHPS specification for high performance relocatable classrooms. Related issues such as placement on the site, applicable codes and the procurement process are covered to ensure that all new relocatable classrooms are efficient and good learning environments.

The Best Practices Manual is supported by the Collaborative for High Performance Schools' Web site ([www.chps.net](http://www.chps.net)) which contains research papers, support documents, databases and other information that support the manual.

---

# THE COLLABORATIVE FOR HIGH PERFORMANCE SCHOOLS

The Collaborative for High Performance Schools (CHPS) began in November 1999, when the California Energy Commission called together Pacific Gas and Electric Company, San Diego Gas and Electric, and Southern California Edison to discuss the best way to improve the performance of California's schools. Out of this initial partnership, CHPS grew to include a diverse range of government, utility, and non-profit organizations with a unifying goal to improve the quality of education for California's children. In early 2002, CHPS incorporated as a non-profit organization, further solidifying its commitment to environmentally sound design that enhances the educational environment for all schoolchildren.

## ACKNOWLEDGEMENTS

A great number of people have contributed to the development of the Best Practices Manual and this 2006 update. Charles Eley is the executive director of CHPS, Inc. and served as the technical editor.

For this 2006 edition of Volume V, the CHPS Best Practices Manual 2006 update review team contributed many hours reviewing the document and providing valuable direction and input. The review team included:

- Architectural Energy Corporation: Ray Dodd, Erik Jeannette, Erik Kolderup
- Pacific Gas & Electric: Ken Gillespie
- Portland Energy Conservation, Inc. (PECI): Phil Welker
- Keithly Barber Associates: Pete Keithly

Volume V, Commissioning, is a modified version of the Building Commissioning Guidelines prepared for Pacific Gas & Electric Company by Portland Energy Conservation, Inc. (PECI) for the Energy Design Resources program. Certain sections of this document were excerpted and modified from *Commissioning for Better Buildings in Oregon*, written by PEGI for the Oregon Office of Energy, and *Building Commissioning: the Key to Quality Assurance*, written by PEGI for the U.S. Department of Energy's Rebuild America program.

Finally, the current and past CHPS Board of Directors deserves special acknowledgement for their continued guidance and support. Current chair Jackalynne Pfannenstiel (California Energy Commission) and past chairs Steve Castellanos (State Architect) and Robert Pernell (California Energy Commission) provided exceptional leadership and directions. Current board members include: Gregg Ander (Southern California Edison), Jessica Mack (Southern California Gas), Chip Fox (San Diego Gas & Electric), Jim Barnett (Sacramento Municipal Utility District), John Palmer (San Juan Unified School District), Brian Dougherty (Dougherty + Dougherty), Bill Orr (California Integrated Waste Management Board) and Oliver Kesting (Pacific Gas and Electric). The current Advisory Board includes: Kathleen



---

Moore (California Department of Education) and Karen Mandell (Office of Public School Construction). Past board and advisory board members include Randall Higa (Southern California Gas), Chuck Angyal (San Diego Gas and Electric, Duwayne Brooks (California Department of Education), and Grant Duhon (Pacific Gas & Electric).

---

# Introduction

Building owners spend more on complex building systems than ever before, yet many find they are not getting the performance they expect. A 2004 study<sup>3</sup> of 224 buildings across 21 states, representing 30.4 million square feet of commissioned floor area (73 percent in existing buildings and 27 percent in new construction) identified 3,500 deficiencies (11 per building, 85 projects reporting) among existing buildings and 3,305 (28 per building, 34 projects reporting) among new construction. HVAC systems present the most problems, particularly within air-distribution systems. Through this study, approximately 7,000 largely energy-related deficiencies were identified across 224 buildings. Once identified, many of these problems were remedied in a cost-effective manner, yielding higher performance buildings. “Commissioning is one of the most cost-effective means of improving efficiency in commercial buildings,” as found in this study. Beyond those reported in this study, problems frequently occur with the envelope, structural, and electrical systems of new buildings.

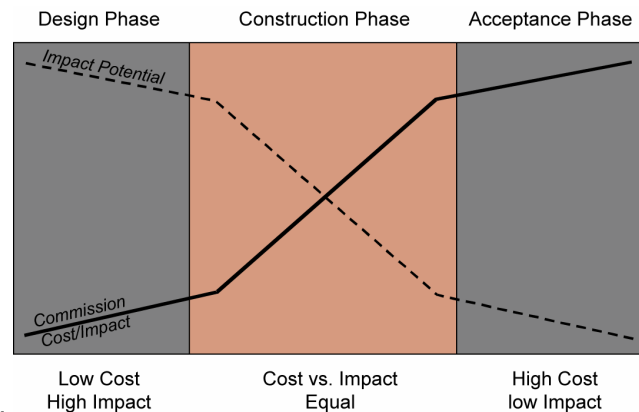
Schools are investments, and every new school is unique. In essence, each school design is a prototype expected to perform as if it were something that had been built before. Combining a new school design with modern technology, a tight construction schedule, and a fixed budget can lead to a building that does not perform as anticipated.

---

<sup>3</sup> Mills, E., H. Friedman, T. Powell, N. Bourassa, D. Claridge, T. Haas, M.A. Piette. 2004. “The Cost-Effectiveness of Commercial-Building Commissioning. A Meta-Analysis of Energy and Non-Energy Impacts in Existing Buildings and New Construction in the United States.” LBNL-56637 (Rev.).

Building commissioning is one way to improve the outcome of a construction project. Neither the design team nor the district desires a poorly performing school. Unfortunately, school districts are frequently the ones left to deal with the resulting financial consequences, including excessive repair and replacement costs, student absenteeism, indoor air quality problems, and construction team liability. Building commissioning can ensure that a new school begins its life cycle at optimal productivity, and improve the likelihood that it will maintain this level of performance.

Commissioning is a quality-assurance process that increases the likelihood that a newly constructed building will meet district expectations. Commissioning can optimize the energy-efficient design features and improve overall building performance. Districts can use this proven, systematic approach to reduce change orders and liability exposure, and to ensure that they receive buildings that function according to their original project requirements and design intent.



*Figure 1—Benefits of Commissioning Decrease throughout Project Life*

## WHAT IS BUILDING COMMISSIONING?

Commissioning is a systematic process of ensuring that all building systems perform interactively according to the contract documents, the design intent and the school's operational needs. This is ideally achieved by beginning in the design development phase with design intent and basis of design documentation, and continuing through design, construction, and the warranty period with actual verification through review, testing, and documentation of performance. The commissioning process integrates and enhances the traditionally separate functions of design peer review; equipment start-up; control system calibration; testing, adjusting and balancing; equipment documentation; and facility staff training. Furthermore, it adds the activities of documented functional testing and verification.

Commissioning is occasionally confused with testing, adjusting, and balancing. Testing, adjusting, and balancing involves only the measurement of building air and water flows. In contrast, commissioning encompasses a much broader scope of work. Commissioning typically involves four distinct "phases:" pre-design, design, construction, and warranty. During the construction phase, commissioning involves functional testing to determine how well mechanical and electrical systems meet the operational goals established during the design process. Although commissioning can begin during the construction phase, districts receive the most cost-effective benefits when the process begins during the design development phase at the time the project team is assembled. Beginning proper commissioning during

---

the design phase can help identify and solve problems that later may turn into performance problems, occupant comfort complaints, indoor air quality issues, and decreased equipment life.

A properly commissioned school can result in fewer change orders during the construction process, fewer callbacks, long-term occupant satisfaction, lower energy bills, and reduced equipment replacement costs. Commissioning also ensures that the building's operational staff is properly trained, with correctly compiled operation and maintenance manuals delivered at project turnover.

## COMMISSIONING APPROACHES

In recent California focus group studies, building owners and their representatives repeatedly stressed lack of communication between the design team and construction team as a major problem. This lack of communication means that the original design intent of a project is unlikely to be carried through to project completion. (Documenting design intent—the expectations for building performance—is a critical component of commissioning and is discussed in more detail later.) Commissioning provides a means of linking the traditionally fragmented phases of the design and construction process. It encourages the project team to view the process holistically. The commissioning process facilitates communication between parties, thereby allowing problems to be solved earlier in the construction process.

Although commissioning works best when it begins during design, projects already under construction can still benefit from commissioning. Bringing a commissioning provider into a project during the construction phase can be invaluable in helping solve start-up problems that have gone undetected by both designers and contractors. The commissioning provider can also document the start-up and functional testing results, thereby reducing future liability exposure for the designers and district. The provider also oversees operation/maintenance staff members training, thus improving the operating procedures of the facility.

## COMMISSIONING ASSISTANT TOOL

Energy Design Resources' (EDR) Commissioning Assistant Tool is a Web-based reference designed to provide project-specific commissioning information to the design team. The tool enables the users to accomplish the following:

- Evaluate probable commissioning cost.
- Identify the appropriate commissioning scope for each project, and develop sample scope documents.
- Develop a sample design intent document with specific inputs from their projects.
- Develop a sample basis of design document with specific inputs from their projects.

- Access sample commissioning specifications related to specific inputs for his/her construction project.
- View sample sequence of operations for their HVAC equipment.

The tool was updated in 2005 and three new modules were added: a commissioning plan generator; a training plan generator; and a systems manual generator. The EDR Web site ([www.energydesignresources.com](http://www.energydesignresources.com)) has more information about the Cx Assistant as well as a wealth of other commissioning resources including their Commissioning Handbook, and the EDR Building Commissioning Design Brief.

---

# Why Commission?

Commissioning improves a building's value. Properly functioning buildings with reliable equipment kept in good condition are worth more than their non-commissioned counterparts. Commissioned systems and equipment retain their value longer. An ongoing demand exists for comfortable, healthy working space. Additionally, systems that function properly use less energy, experience less down time, and require less maintenance, thereby saving money for school districts.

Until recently, the most frequently mentioned benefit of commissioning was its ability to ensure the correct implementation of the energy savings in the design intent. While these benefits are significant, the non-energy related benefits of commissioning far outweigh them:

- Proper and efficient equipment operation.
- Better coordination between design, construction, and occupancy.
- Improved indoor air quality, occupant comfort, and productivity.
- Decreased potential for liability related to indoor air quality, or other HVAC problems.
- Fewer occupant complaints and warranty callbacks.
- Reduced operation and maintenance costs.

## PROPER AND EFFICIENT EQUIPMENT OPERATION

Commissioning verifies that equipment is installed and operating properly. Equipment that operates as intended lasts longer, works more reliably, and needs fewer repairs during its lifetime. By promoting equipment reliability, commissioning can reduce service, energy, and maintenance costs. Equipment that operates properly tends to use less energy; require fewer service calls and replacement parts; and

demand less “crisis maintenance” from on-site staff (or expensive outside contractors), allowing them to concentrate on their normal duties.

## IMPROVED COORDINATION

Commissioning can result in greater cooperation among the professionals involved in the project and provide a platform for cross-checking the performance of a building’s equipment and combined systems, which ultimately leads to fewer callbacks and litigation problems.

On many projects, a lack of understanding and coordination between the design, installation, and/or operational team members can lead to systems that function inefficiently. Commissioning allows for a broad perspective and consistent focus throughout the design and construction process on whether the building will function as intended. It also identifies the best long-term solutions for problems that arise during the project. Commissioning can facilitate improved integration and communication among team members throughout these phases and can also ensure that systems function as intended and specified.

Many districts mistakenly believe that adding commissioning quality assurance procedures to their design process will lead to scheduling delays and increased costs. Many who have incorporated commissioning into the design phase of their projects have discovered just the reverse. Commissioning can significantly reduce change orders,<sup>4</sup> which in turn avoids project delays and decreases the use of contingency funds. These benefits may not be realized if the commissioning process begins during the equipment start-up phase of a project.

## IMPROVED INDOOR AIR QUALITY, COMFORT, AND PRODUCTIVITY

The benefits of high performance schools are all dependent on how well the building performs.

Surveys indicate that comfort problems are common in many U.S. buildings. A recent Occupational Safety and Health Administration (OSHA) report noted that 20%–30% of commercial buildings suffer from indoor air quality problems. Building occupants complain of symptoms ranging from headaches and fatigue to severe allergic reactions. In the most severe cases, occupants have developed Legionnaire’s disease, a potentially fatal bacterial illness. The National Institute of Occupational Safety

---

<sup>4</sup> Savage, Jerry. Commissioning a Materials Research Laboratory, in the Proceedings of the National Conference on Building Commissioning, 2000.

and Health surveyed 350 buildings with deficient indoor air quality and found that more than half of the complaints stemmed from HVAC systems that were not operating properly.

Building commissioning allows districts to avoid the expenses and productivity losses associated with poor indoor air quality and student/teacher discomfort. Because commissioning assures that HVAC and other building systems are installed and operating properly, commissioned buildings tend to have fewer comfort-related problems.

## REDUCED LIABILITY

Building commissioning protects schools on multiple fronts.

First, it provides documented verification of a building's performance and operation. Ventilation rates are a good example of a primary factor that affects indoor air quality. HVAC commissioning typically includes testing these flow rates under varying load conditions to assure that the ventilation systems are operating properly. If a school has deficiencies, the commissioning provider documents the original condition and records the repairs made. Commissioning should be repeated throughout the life of the school, and performance documentation should be updated regularly. This documentation provides districts with a record of building performance that can be used as evidence in the event of a lawsuit.

Commissioning also helps prevent many indoor air quality problems through its focus on training the staff in the proper maintenance of building systems. Properly run and maintained HVAC systems, with clean coils and air intakes as well as regularly changed filters, are less likely to contribute to indoor air quality problems. In addition, trained school staff can spot potential air quality and ventilation problems before they develop.

Both local and state government agencies in California have begun using commissioning as a tool to ensure that indoor air quality standards are met.

### **Kern High School District—Liberty High School Commissioning**

The Kern High School District, like many other districts in California, has been constructing new schools to satisfy its increasing student population. On many of its new construction projects, equipment did not function properly at turnover, resulting in numerous contractor callbacks. Projects with 100 or more callbacks were the rule, rather than the exception.

In 1994, as it began the planning for the construction of the new 200,000-ft<sup>2</sup> Liberty High School campus, the school district decided to incorporate commissioning as a quality assurance process. The commissioning goal was to improve the outcome of this project, and to reduce or eliminate this callback problem. The commissioning budget was set at \$40,000 of the total construction budget of \$28 million.

The district wrote their own RFP for commissioning services. They hired a commissioning provider to conduct construction-phase commissioning on the mechanical systems and verify proper electrical phasing. After the provider was selected and hired, he began development of the commissioning plan. As construction commenced, regular meetings were held between the commissioning provider and the construction team. When construction was completed, the district maintenance staff worked with the commissioning provider and contractors to perform functional testing of each system and verify proper operation. Although no major deficiencies were found, numerous minor adjustments and system integration issues were identified and rectified as part of this commissioning process.

The net result was a 75% reduction in contractor callbacks after the turnover of the new facility. This reduction also resulted in significant labor and maintenance budget savings for the district. Resources normally used to address these turnover problems are now being redirected elsewhere.

The district learned many lessons on its first commissioning project. They now recognize that if budget will allow for it on their next commissioning project, they would like to include analysis of the systems, specification review, and possibly design review as part of the commissioning provider's scope of work.

## REDUCED COSTS

Operation, maintenance, and equipment replacement costs will always consume a portion of building budgets. However, more operation and maintenance departments are realizing they minimize life-cycle costs by changing their practices. That is, proper operation and maintenance can actually save money compared to poor practices. Many businesses are reinvesting their operation and maintenance savings in more efficient building systems. The commissioning process establishes sound building operation and maintenance practices, and trains operators in carrying out these practices. (Some of these practices are discussed in more detail in “Maintenance and Operations for Persistence.”)

---

# What Will It Cost?

## COSTS OF BUILDING COMMISSIONING

Currently, no standard method of reporting the costs and savings associated with commissioning exists. For many projects, commissioning costs are not separated from other project costs. For projects where these costs have been tracked separately, various methods have been used to report both the costs and associated benefits. The following table lists some of the most common cost estimation methods. No matter which estimation method is used, commissioning is a process that adds value and accounts for only a very small portion of overall construction and retrofit budgets.

*Table 1—Estimated Commissioning Costs for New Equipment<sup>5</sup>*

<b>Commissioning Scope</b>	<b>Estimated Cost Range</b>
Whole building (controls; electrical; mechanical) commissioning from design through warranty.	0.5% to 3% of total construction cost.
HVAC and automated controls system only.	1.5% to 2.5% of mechanical contract.
Electrical system only.	1% to 1.5% of electrical contract.

---

<sup>5</sup> Estimated costs adopted from PECl Data and Ron Wilkinson's article "Establishing Commissioning Fees," ASHRAE Journal-February, 2000.

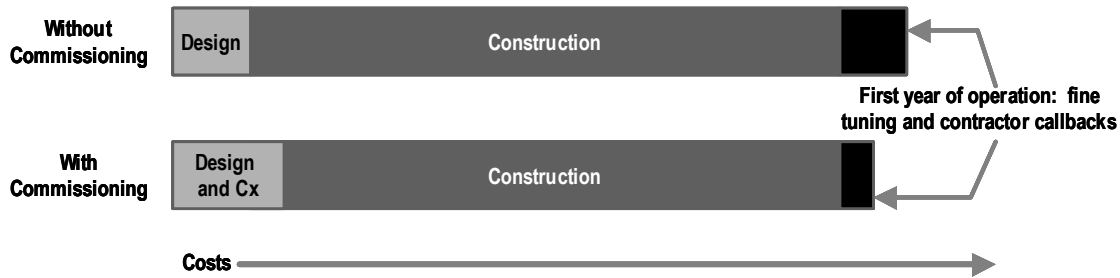
# SAVINGS FROM BUILDING COMMISSIONING

Districts and their servicing utilities are interested in the energy (kWh) savings achieved from commissioning energy systems and equipment. Additionally, they are also interested in how much commissioning will save them in operation and maintenance costs. Just as commissioning costs can vary from project to project, so do commissioning savings. Savings will depend on the scope of the commissioning and the performance of the construction team. Table 2 shows the reported savings for three different types of commercial buildings commissioned during the past few years. When commissioning is done properly, savings can be quite substantial for schools as well.

*Table 2—Savings from Commissioning New Equipment (Mechanical Systems)<sup>6</sup>*

Building Type	Annual Monetary Savings	Annual Energy Savings
110,000-ft <sup>2</sup> Office	\$22,320	279,000 kWh
22,000-ft <sup>2</sup> Office	\$13,080	130,800 kWh
60,000-ft <sup>2</sup> High Tech Manufacturer	\$26,880	336,000 kWh

Many districts question whether they can pay for commissioning with a limited design and construction budget. Because commissioning can identify potential problems earlier in the design or construction process, the result is a lower overall construction budget, fewer contractor callbacks, and lower operating costs during the first year of operation. By transferring those potential savings to the design and commissioning team budgets, the total project costs can be roughly equivalent to a project that is not commissioned, as illustrated in Figure 2.



*Figure 2—How to Pay for Commissioning: One Option*

*Shift 2% of total project costs to the commissioning provider and 3% to the design team<sup>7</sup>*

<sup>6</sup> Annual energy savings calculated from three Northwestern United States commissioning projects. Cost savings estimates based on a blended 2000 California kWh rate of \$0.10 for smaller office buildings and \$0.08 for larger offices and industrial facilities.

<sup>7</sup> The Farnsworth Group, as presented in *How to Achieve Top Performance in Your Building: Commissioning Benefits, Process and Performance*, a workshop series by the Association of State Energy Research and Technical Transfer Institutes, 1998.

---

# Selecting a Commissioning Provider

One of the most important commissioning decisions is selecting the commissioning provider and determining who will hold the commissioning provider's contract. Two primary methods exist for selecting a commissioning provider: competitive bid and selection by qualification. The Building Commissioning Association (BCA) can provide a list of commissioning providers. Contact information for the BCA can be found in the Resources section at the end of this chapter. In the Request for Qualifications (RFQ), be sure to ask for details on previous and relevant commissioning experience. Have them include the depth of their commissioning experience (what some firms call commissioning is no more than traditional equipment start-up.<sup>8</sup>) Make sure that the provider's definition of commissioning corresponds to the one at the beginning of this chapter. Recommended commissioning provider qualifications are discussed in more detail in the following pages. Based on the responses, develop a list of firms to receive a Request for Proposal (RFP) that details exactly what commissioning services the construction project will require. A sample RFP/RFQ is included in Appendix B of this volume. Districts can also select a commissioning provider based on qualifications and rate schedules, rather than by competitive bid. This process warrants careful interviewing and contact with the providers' current or past clients.

---

<sup>8</sup> "Start-up" refers to the process of starting up equipment to determine whether it operates. Commissioning goes beyond start-up to ensure that new equipment performs in conformance with design expectations in all modes and conditions of operation.

Any of the following parties can be selected to manage the commissioning provider's contract:

- District Project Manager.
- Architect/Design Engineer.
- Contractor.

Each option has its advantages and disadvantages. The final choice will depend on the complexity and the specific needs of the particular project. As building commissioning has evolved and more practitioners with different ideas have entered the field, a group of interested parties worked to form the BCA in 1998. According to the BCA Web site ([www.bcx.org](http://www.bcx.org)), "The BCA's goal is to achieve high professional standards, while allowing for diverse and creative approaches to building commissioning that benefit our profession and its clients. For this reason, their focus is on identifying critical commissioning attributes and elements, rather than attempting to dictate a rigid commissioning process." The association believes that "the basic purpose of building commissioning is to provide documented confirmation that building systems function in compliance with criteria set forth in the project documents to satisfy the owner's operational needs." Paramount to this is the understanding that if the commissioning provider is not an independent party under contract directly with the district/owner then he or she must develop a formal plan for managing the potential conflict of interest. One method that has been used successfully to manage, but not eliminate these potential conflicts of interest, is parallel and simultaneous reporting of all findings to the district's representative and contract manager for the commissioning services.

## INDEPENDENT THIRD PARTY

Many districts/owners who have commissioned their buildings recommend using an independent third party as the commissioning provider. An independent commissioning provider can play an objective role and ensure that the district will truly get the building performance expected. For large and/or complex projects, especially in buildings with highly integrated and sophisticated systems, future savings from commissioning outweigh the slightly higher costs with an additional contract. Independent third party commissioning providers bring a fresh perspective to the project as they collaborate with the design team. By joining the project team during the design, the commissioning provider can identify more opportunities for improvements and savings early before the project goes out for bid. This approach is preferable to waiting to fix the problems through the change order process as the building is being constructed.

Independent commissioning providers, who are often trained as engineers, should meet the qualifications listed under "Commissioning Provider Qualifications." They should be able to write commissioning specifications for bid documents as well as have hands-on experience with building systems. It is important to involve the independent authority as early in the project as possible. This allows the authority the opportunity to review the design intent for the project, begin scheduling

commissioning activities, and begin writing commissioning specifications into bid documents for other contractors involved in the commissioning process.

## ARCHITECT OR ENGINEER OVERSEER

If commissioning requirements in the project specifications are rigorous and detailed, districts may consider having the architect manage the contract of a commissioning provider. This is appropriate when the architect or the mechanical designer has qualified field engineers on staff and those engineers do not have responsibility for the design of the project. One advantage of using the architect or mechanical designer is that he or she is already familiar with the design intent of the project. Districts considering this option should bear in mind that commissioning is not included in a design professionals' basic fees. Districts should require that all findings of the commissioning process be directly reported to both the designer and to the district, as they occur to manage the potential conflict of interest. Districts must also recognize that even if this option is not chosen and an independent third party is used, designers might increase their fees slightly to offset the additional time requirements to coordinate their work with the commissioning provider.

## CONTRACTOR

It is standard practice for contracting firms to conduct a systematic checkout for all equipment they installed. Although contractors may have the knowledge and capability to start up the equipment they install, they may not be skilled at diagnosing system integration problems, nor do they routinely perform functional tests on equipment or systems. In addition, some contend that it is difficult for contractors to objectively test and assess their own work, especially since repairing deficiencies found through commissioning may increase their costs. For districts that only wish to have the commissioning process begin during the construction phase, it may be appropriate to use the installing contractor as the commissioning provider in cases where:

- The building size is less than 20,000 ft<sup>2</sup>.
- The project specifications clearly detail the commissioning requirements.
- The district has skilled staff that can review the contractor's commissioning work.

Another option for districts that have a good relationship with the general contractor is to require that the general contractor hire a test engineer to commission the equipment. This scenario can work well when specifications and contract documents clearly detail the commissioning requirements and when the district has technical staff that is qualified to oversee the test engineer. Still, many general contractors welcome the opportunity to work with an independent commissioning provider, because of the objectivity they bring and because they assist in ensuring that the subcontractors perform their work properly, improving client satisfaction and ultimately reducing callbacks.

# QUALIFICATIONS

Currently no single certification or licensing process for commissioning providers has met with broad acceptance. It is therefore up to each district to determine if the commissioning provider's qualifications are appropriate for a given project. See the sidebar for guidelines on selecting a qualified commissioning provider.

Regardless who is chosen to act as the commissioning provider, there are certain minimum qualifications any commissioning provider should have, yet the sidebar list is by no means all-inclusive. Certain projects may require more or less experience depending on size, complexity, and specific building characteristics. Direct the commissioning provider to subcontract work in which he or she lacks sufficient experience.

**Commissioning Provider Qualifications Checklist**

See Appendix B: Sample Commissioning RFP for more detailed guidance on hiring a commissioning agent.

*For complex projects, a commissioning provider who will personally develop the commissioning test plans and directly supervise the commissioning work should meet these qualifications. These qualifications are focused on HVAC and control systems. Where electrical and other systems will be commissioned, the firm's experience in these areas should also be considered. However, often the prime commissioning provider will team with other subconsultants to provide a team that can expertly address all the systems being commissioned. In such cases, the management skill of the prime commissioning provider is also important.*

**Recommended Minimum Qualifications**

- Experience in design, specification, installation, or operating of commercial building mechanical and control systems
- Experience commissioning projects of similar size and equipment in the last three years. This includes writing functional performance test plans.
- History of responsiveness and proper references.
- Meet district's liability requirements.
- Experience working with project teams, project management, conducting scoping meetings, and good communication skills.

**Optional Qualifications**

- Direct responsibility for project management of at least two commercial construction or installation projects with mechanical costs greater than or equal to current project costs.
- Experience installing designs and/or troubleshooting direct digital controls and energy management systems, if applicable.
- Demonstrated familiarity with metering and monitoring.
- Knowledge and familiarity with air/water testing and balancing.
- Experience planning and delivering O&M training.
- Building contracting background.
- Overall understanding by the commissioning team of all building systems including building envelope, structural, and fire/life safety components.

---

# The Commissioning Team

Members of a design-construction project team, like components of integrated building systems, need to interact in order to perform their tasks successfully. Commissioning actually facilitates this interaction, because it sets clear performance expectations and requires communication among all team members.

Any construction project involving commissioning should begin with a commissioning scoping meeting that all team members are required to attend. At this meeting, the roles of each team member are outlined, and the commissioning process and schedule are described.

Commissioning team members most often include the district representative or project manager, commissioning provider, design professionals, installing contractors, and manufacturer's representatives. The team may also include facility staff and possibly testing or diagnostic specialists and utility representatives. The commissioning team does not manage the design and construction of the project. Rather, its purpose is to promote communication among team members and to identify and resolve problems early in the process. To that end, the design professional and district representative are key members of the commissioning team.

Of course, few situations are ideal. Budget considerations and special project characteristics may expand or minimize the commissioning roles and responsibilities described below. Districts should consult with their commissioning providers about potentially combining some of the following roles. The commissioning provider can review the scope of commissioning and advise the district on how to consolidate roles and tasks to best fit the size and complexity of the project.

## DISTRICT REPRESENTATIVE

The district's most significant responsibility is to clearly communicate expectations about the project outcome. The district's expectations are used by the designer to establish the design intent of the project and by the commissioning provider to evaluate whether this intent is met. Other responsibilities of the district representative include:

- Determining the objectives and focus of the project.
- Hiring the commissioning provider (if using an independent third party) and other members of the project team.
- Determining the project's budget, schedule, and operating requirements.
- Working with the commissioning provider to determine commissioning goals.
- Facilitating communication between the commissioning provider and other project team members.
- Approving start-up and functional test completion (or delegating this task to a construction or project manager).
- Attending building training sessions when appropriate.

## COMMISSIONING PROVIDER

The commissioning provider's primary tasks include:

- Ensuring the completion of adequate design intent documentation.
- Providing input on design features that facilitate commissioning; monitoring and persistence of adjustments as a result of commissioning; and future operation and maintenance procedures.
- Assisting in developing commissioning specifications for the bid documents.
- Developing a commissioning plan that includes equipment and systems to be commissioned.
- Ensuring that team members understand their specified commissioning responsibilities; work to promote a positive, solutions-based team approach; and facilitate bringing a quality project to completion.
- Developing diagnostic and/or test plans for systems to be commissioned that include functional performance tests.
- Submitting regular reports to the district representative.
- Inspecting the installation of commissioned systems during and at completion of the construction phase to ensure compliance with specifications and desired workmanship.

- Witnessing selected contractor start-up tests; air and water testing and balancing (TAB); and duct pressure testing.
- Performing all functional and performance testing of systems.
- Reviewing and commenting on technical considerations from design through installation, in order to facilitate sound operation and maintenance of the building.
- Reviewing contractor and manufacturer training plans prior to delivery to facility staff.
- Reviewing operation and maintenance manuals documentation for completeness.
- Writing a final commissioning report documenting the final evaluation of the systems' capabilities to meet design intent and district needs.
- Developing a systems concepts and operations manual that details the most important operation parameters and equipment instructions.

## DESIGN PROFESSIONALS

The primary commissioning-related responsibilities of design professionals are to document the design intent for all systems. If not completed in pre-design, they should also write system descriptions; record design basis information; answer questions and issues brought up by the commissioning provider during design; and make sure that commissioning is included in the bid specifications. If the design professional is hiring the commissioning provider, he or she should do so as early in the design process as possible. During construction, the designers are tasked with clarifying design issues related to system operation and design intent and assisting in the resolution of construction and operational deficiencies illuminated by the TAB and commissioning process. For complex projects, the designer may review commissioning plans, functional performance test plans, and/or witness select functional testing. If this is the case, the design professional's proposal should include funds to cover these activities.

# INSTALLING SUBCONTRACTORS AND MANUFACTURER REPRESENTATIVES

Contractors, subcontractors, and manufacturer representatives are responsible for performing commissioning functions described in the specifications. These may include:

- Assisting with developing the commissioning schedule,
- Assisting in conducting performance tests (under the supervision of the commissioning provider or facilities staff) of the systems they install,
- Adjusting systems or correcting deficiencies when commissioning indicates this is needed, and
- Documenting system start-up.

Contractors and manufacturer representatives are also responsible for training building staff in the proper operation and maintenance of systems, and providing operation and maintenance manuals on the equipment they install.

## **Expected Deliverables during Commissioning**

*Districts who decide to commission their buildings should expect to receive the following written deliverables:*

- *Commissioning plan and schedule detailing each step of the commissioning process and each team member's role and responsibilities.*
- *A diagnostic and functional test plan detailing the objective of each test, how each test will be accomplished, and noting expected performance parameters.*
- *A list of findings and potential improvements identified by the commissioning provider for design phase and construction phase activities.*
- *A training plan recommending specific topics and training schedules.*
- *At the completion of the project, a final commissioning report detailing all of the commissioning provider's findings and recommendations including copies of all functional performance testing data.*
- *A systems concepts and operations manual which gives a description of each system with specific information about how to optimally operate and control the system during all modes of operation such as during fire, power outage, shutdown; etc., including special instructions for energy efficient operation and recommissioning.*
- *In retrocommissioning projects, deliverables may also include energy savings and implementation cost estimates for recommendations developed in the process .*

# FACILITY MANAGER/BUILDING OPERATOR

The building operator should assist with (or at least observe) as much of the functional testing as possible. To achieve even greater impact on the commissioning process as early as possible, the district should try to hire its new operator or assign an existing operator who will be responsible for this building to become closely involved with the construction commissioning team. The insight of an operator in the final phases of design can be quite beneficial. Often there are details of the design that can be adjusted and modified at no cost that will provide significant benefits to the ongoing operation of the building. Specific examples might include point-naming conventions, alarm messages, and graphic layouts of the energy management system. The operator can also help in interfacing any existing facilities management software, district standards, and equipment preferences into the project. Observation of the commissioning tests will improve the operator's understanding of the equipment and control

strategies. It also trains the employee to be able to retest systems periodically as part of their ongoing operation and maintenance. In addition, the operator should attend training sessions provided by manufacturer's representatives and or contractors.

## TESTING SPECIALISTS

If the complexity of the project requires special testing, the specialists performing these tests should also be involved in commissioning. Test results and recommendations from these specialists should be submitted to the commissioning provider for review. Testing specialists may also be required to review documentation relating to the systems they test and to train operators on the proper use of this equipment.<sup>9</sup>

---

<sup>9</sup> Dunn, Wayne. Roles and Responsibilities, in Proceedings of the National Conference on Building Commissioning, 1995.



---

# Commissioning Phases

The commissioning process helps facilitate and establish continuity between each step of the construction process. Commissioning enhances communication among project team members and ensures that everyone understands the project goals. This allows the project team to identify problems early, before they can affect later phases of the project and cause delays.

## PRE-DESIGN

The pre-design phase is the ideal time for the district to select a commissioning provider. Early selection allows the commissioning provider to play an advisory role during the conceptual process, suggesting ways to make the overall building more energy efficient and identify key design strategies that can facilitate operation and maintenance. Involving the provider early on can also increase buy-in for commissioning from other team members because the provider is involved from the beginning. Otherwise, the team may view the commissioning provider as an outsider who does not really understand the project. During this phase, the commissioning provider may assist in developing the district's goals, or at minimum, ensuring that these goals are clearly documented and distilled into a design intent narrative.

The design intent narrative, typically developed by the district, is an explanation of the ideas, concepts, and criteria that are important. It should generally describe the project both physically and functionally, and it should set the performance requirements for the design, construction, and operation. The level of detail will vary with the size and complexity of the project, the district demands, and the experience of the design team. The design intent should describe how the project will operate, and should present known goals and objectives as measurable metrics when possible. It may also state specific contractual performance requirements or energy consumption targets, if the district establishes them. The design intent sets the criteria for all subsequent design decisions.

# DESIGN

The goal of commissioning during the design phase is to ensure that the efficiency and operational concepts for building systems that were developed during programming are included in the final design. The main commissioning tasks during this phase are compiling and reviewing design intent documents if not already developed, incorporating commissioning into bid specifications, and reviewing bid documents. During the beginning of design, the designer develops their design concepts that he or she proposes to use to meet the district's program and intent. They also document the assumptions (design basis) used in their design for sizing and selection of systems (e.g., codes followed, temperature parameters, and occupancy loads). The design concepts and design basis are compiled into a design narrative document that the commissioning provider reviews for clarity, completeness, and compliance with the design intent. As the design progresses, the design narrative is updated and compared against the design intent.

The bid specifications developed during the design phase include commissioning requirements for the contractors. Specifications should include any special equipment or instrumentation that must be installed for obtaining measurements during performance testing. They should also describe the responsibility that contractors will have for assisting the commissioning agent; preparing operation and maintenance manuals; and training facility staff. The commissioning provider reviews these bid documents, updated design narratives, and all other design intent and contract documents.

The commissioning provider attends selected design team meetings and formally reviews and comments on the design at various stages of development. They note potential system performance problems, and may provide input on energy efficiency, indoor environmental quality, maintainability, commissionability, sustainability, and life cycle cost. Their feedback will depend on their skillset, the design team, and the interests of the district. Making these changes during the design phase, rather than after construction begins, reduces costly change orders, saving money in the long run.

The commissioning provider does not approve the design. He or she makes recommendations to facilitate commissioning and improve building performance in a collegial manner in concert with the designated design team.

During this phase, the commissioning provider can also play a significant role in developing a building's operation and maintenance program or suggesting improvements for a program already in place. The provider interviews the facility manager to determine operating staff ability and availability to operate and maintain building equipment and systems. Careful consideration is given to whether the proper level of staffing resources is available to fully implement a successful long-term operation and maintenance system to ensure continued building performance. The commissioning provider also reviews the design documents and drawings to ensure that equipment is accessible for maintenance.

# CONSTRUCTION

The optimum time to hold the commissioning scoping meeting is during the construction phase. At this meeting, the commissioning provider outlines the roles and responsibilities of the project team members with respect to commissioning and reviews the commissioning plan outline and schedule. Team members provide comment on the plan and schedule, and the commissioning provider uses these suggestions to complete the final commissioning plan. The final plan will include:

- The scope or level of commissioning.
- Commissioning schedule.
- Team member responsibilities.
- Communication, reporting, and management protocols.
- Documentation requirements of each team member.
- Detailed scope of testing.
- Detailed scope of monitoring.
- Recommended training format.

During this phase, the commissioning provider reviews contractor submittals of commissioned equipment and the operation and maintenance manuals and may write test plans for each system and piece of equipment to be commissioned. The provider also visits the construction site periodically and notes any conditions that might affect system performance or operation.

During the construction phase, construction checklists—sometimes referred to as “pre-functional tests,” usually completed by the contractors—are used to ensure that equipment is properly installed and ready for functional testing. The commissioning provider approves and may oversee start-up and the use of construction checklists, as well as making sure that any deficiencies are remedied before functional testing begins.

The commissioning provider should involve the building operation staff in the construction checklist procedures and functional testing as much as possible. Doing so improves staff understanding of the proper operation of equipment and systems. It also provides operators with valuable hands-on training in running and troubleshooting the equipment they will manage.

The commissioning provider may write various progress reports during construction that document testing progress as well as deficiencies that may affect future building performance. These reports may be submitted to the district, design engineer, project manager or contractors, depending on the contract arrangements for the project. (Establishing a clear process prior to the construction phase for delivering correction orders to the responsible contractors and tracking their responses is critical to the success of commissioning.)

The commissioning provider uses the functional tests to document and verify the proper operation of equipment and systems according to the sequence of operations, building specification plans, and change orders, as well as the architect's instructions. Most often, the commissioning provider directs the tests, but the subcontractors, particularly the controls contractor, perform the actual equipment operation during the tests. If corrective measures are required, the commissioning provider ensures they meet the district's criteria and the design intent, involving the owner and architect for resolution of responsibility or strategy when necessary. 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 outlined in the commissioning test plan.

After completing functional testing, the provider writes a final commissioning report and submits it to the district for review. In addition to the final report, some commissioning projects include a more comprehensive documentation package to assist the district in understanding, operating and maintaining their systems. The American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) call this package a systems manual and recommends that it include:<sup>10</sup>

- Index of all commissioning documents with notations as to their storage locations.
- Commissioning report.
- Initial and final design intent documents.
- As-built documents.
- Description of systems, including capabilities and limitations.
- Operating procedures for all normal, abnormal, and emergency modes of operation.
- Sequence of operation as actually implemented, with control systems data including all set points, calibration data, etc.
- Location of all control sensors and test ports.
- Seasonal start-up and shutdown procedures.
- Control schematics and computer graphics.
- Complete terminal interface procedures and capabilities of any Direct Digital Control (DDC) system.
- A list of recommended operation record keeping procedures, including sample forms, trend logs, etc.
- Maintenance procedures.

---

<sup>10</sup> ASHRAE Guideline 1-1996-American Society of Heating Refrigerating and Air-Conditioning Engineers, Atlanta Georgia, 1996.

The construction phase is complete when the facility has moved from the static construction state to the dynamic operating state essentially free of deficiencies. Control of the building may have been transferred from the design/construction team to the district and building operators prior to the completion of this phase. Part of this transfer involves training building operators in the operation and maintenance of equipment and systems. Preferably this training begins during the construction/installation phase, as discussed previously.

The commissioning provider is responsible for interviewing the project manager and operation and maintenance staff to determine their training needs. With the district representative, the provider then selects the appropriate topics, level of detail, sequence of training, and training methods. Training may include both classroom sessions and hands-on site demonstrations of proper equipment operation and maintenance.

In addition, the commissioning provider oversees training sessions as specified in the bid documents that installing contractors, designers, and manufacturers representatives will conduct. The provider also verifies that operation and maintenance manuals are complete and available for use during the training sessions. The commissioning provider may arrange for videotaping of the training and coordinate this videotaping with vendors. Videotaping training sessions often provides an extra incentive for vendors to ensure the quality of the sessions.

## WARRANTY

Upon turnover, the building is in the hands of the owner and operators. Even though the project is considered complete, some commissioning tasks (such as short-term monitoring) from the initial commissioning contract continue throughout the typical one-year warranty period to ensure that full operation of building systems is achieved.

Any testing delayed because of site/equipment conditions or inclement weather will be completed during warranty. Although some testing of heating and cooling systems can be performed under simulated conditions during the off-season, natural conditions usually provide more reliable results. Seasonal testing is conducted to verify proper operation during, at minimum, both winter and summer.

When performing testing during post-occupancy, the commissioning provider or test engineer must be careful not to void any equipment warranties. The district should require that contractors provide the commissioning provider with a full set of warranty conditions for each piece of equipment to be commissioned. Some warranty provisions may require that the installing contractor actually perform the testing, under the supervision of the commissioning provider.

The commissioning provider may also be tasked with returning a few months prior to the expiration of the contractor's one-year warranty to review system operation and interview facility staff. Acting as the district's technical resource, he or she assists the facility staff in addressing any performance problems or warranty issues.

It is a good idea for districts to consider recommissioning their facilities periodically to ensure that equipment performance levels continue to meet design intent. If school staff has been involved in the original commissioning effort, and if they received training that included the components listed in the Suggested Training Topics sidebar, they may be able to conduct the recommissioning process themselves.

## WHEN DOES COMMISSIONING END?

Commissioning ensures that a building is performing as intended at the time that commissioning occurs. This means that to maintain this level of performance, commissioning, in a sense, never ends. Certainly no one could reasonably expect building operation staff to perform functional tests on equipment and systems daily. However, operation and management staff should be encouraged to recommission selected building systems on a regular basis, perhaps every two to three years depending on building usage, equipment complexity, and operating experience. The commissioning provider can recommend an appropriate interval for the building and systems. In the meantime, implementing regular, sound operation and maintenance practices ensures that the savings from commissioning last.

---

# Operation and Maintenance for Persistence

Sound operation and maintenance practices can help keep the school operating at commissioning levels. Some of these practices include:

- Establishing and implementing a preventive maintenance program for all building equipment and systems.
- Using commissioning documentation such as commissioning checklists and functional tests as a basis for periodic testing of equipment.
- Reviewing monthly utility bills for unexpected changes in building energy use.
- Using energy accounting software to track building energy use.
- Tracking all maintenance, scheduled or unscheduled, for each piece of equipment. Periodic reviews of these documents will often indicate whether certain pieces of equipment require tuning up or replacement.
- Updating building documentation to reflect current building usage and any equipment change-outs.
- Establishing an indoor air quality program for the building.
- Assessing operator training needs annually.
- Monitoring from the Building Automation System.

## BEGIN DURING DESIGN

Like commissioning, successful operation and maintenance begins in the design phase of a project. Soliciting input from operation and maintenance staff during the early stages of building design can facilitate good operation and maintenance practices. The more convenient it is for staff to perform regular checks and maintenance on building systems, the more likely it is that building performance needs are met and costly maintenance avoided. In addition, the installing contractor's responsibilities concerning operation and maintenance should be clearly detailed in the project contract specifications during the design stage, so that the contractor can adjust the bid price accordingly. For instance, specifications should explicitly state that contractors will be required to provide information needed to facilitate the commissioning process and to coordinate activities with the commissioning provider as needed. The specifications should also require the contractor to provide comprehensive operation and maintenance manuals for equipment and provide training for staff.

## OPERATION AND MAINTENANCE MANUALS

The contractor prepares operation and maintenance manuals for each piece of equipment. The commissioning provider reviews each manual for compliance with the specifications as part of the commissioning process. Operation and maintenance manuals should contain:

- Name, address, and telephone number of installing contractor.
- Product data.
- Test data.
- Performance curves (for pumps, fans, chillers, etc.).
- Installation instructions.
- Operation requirements.
- Preventive maintenance requirements.
- Parts list.
- Troubleshooting procedures specific to the equipment design and application.

If the provider believes it would be beneficial, additional information, already gathered during the commissioning process, can also be included in the operation and maintenance manuals. This information may include equipment submittals, design intent documents including control strategies and sequence of operations (normal and emergency), and copies of the commissioning tests (pre-functional checklists and functional performance test forms).

Operation and maintenance manuals are useful reference tools for current facilities staff and can also be used as a training resource for new staff members. The operation and maintenance manuals should be placed in three-ring binders. Contractors should be required to provide at least three copies of each manual to the district. Typically, one copy becomes the master copy, and remains in the facility manager's office. "Hard-binding" the master copy, so that pages cannot be removed and misplaced, is recommended. The second copy functions as a field copy, and selected pages from it may be removed for use during site work. The third copy resides at district offices. If building equipment will be maintained and operated by an outside firm, a fourth copy should be requested and provided to them as a reference. Because manuals lose their usefulness if they are not kept up to date, any pages added to them, such as checklists or preventive maintenance work orders, must be included in each copy.

## TRAINING

Sound energy management practices. Perhaps the most essential component of operation and maintenance is training. Unless building operators and managers are given the skills to perform quality operation and maintenance practices, there is little hope that a building will continue to perform optimally.

As with all training, instruction should be structured to meet the needs of building operator staff. Training session topics should ideally be specified in the bid documents.

If the budget is available for a good-quality videotape, these tapes of each training session, including the hands-on start-up and shutdown procedures for equipment, provide building operation staff with a permanent on-site training aid.

For buildings where a facility manager without a technical background provides maintenance, the commissioning provider can still coordinate with contractors to ensure that the manager is educated about the capabilities, intended function, and required maintenance of the building systems. This education should enable the facility manager to respond to occupant complaints in a manner that

### **Suggested Training Topics**

*Descriptions of equipment and systems installed and their warranties or guarantees.*

*Equipment start-up and shutdown procedures, operation in normal and emergency modes, seasonal changeover, and manual/automatic control.*

*Requirements and schedules for maintenance on all operation and maintenance-sensitive equipment.*

*Indoor air quality, health, visual comfort, acoustic comfort, and safety issues.*

*Recommendations for special tools and spare parts inventory.*

*Emergency procedures.*

*Operation and adjustment of dampers, valves, and controls.*

*Hands-on operation of equipment and systems.*

*Common troubleshooting problems, their causes, and corrective actions.*

*Review of operation and maintenance manuals, and their location onsite.*

*Building walk-through.*

*Review of related design intent documents.*

*Energy management control system operation and programming.*

*Control sequences and strategies.*

*Thermostat programming.*

*Relevant commissioning reports and documents.*

*When and how to recommission building systems.*

*The maintenance work order management system.*

does not circumvent the systems' design intent. It is important to provide a list of resources for the manager to call for maintenance assistance when necessary.

Once a building is operating and occupied, problems occasionally develop that were not apparent during the commissioning process. These problems often occur during the first year of operation after construction or renovation. Sometimes the service contractor or operating staff can effectively troubleshoot and solve the problem. However, if a problem becomes chronic (for example, repeated comfort complaints), or if operating staff is unable to solve a problem in a reasonable amount of time, the district should request expert troubleshooting assistance.

Because the commissioning provider and design engineer are very familiar with the building systems, the district may want to consider contracting with one and/or both of them for the first year of operation to provide troubleshooting assistance on an as-needed basis. In traditional construction projects, the mechanical engineer is only responsible to help correct problems if their contract stipulates a warranty period and the problems are "design" related. The district may find that it is more cost-effective to purchase troubleshooting services from the commissioning provider or engineer, because their knowledge of the building systems and design saves them time in diagnosing problems. This contract could be written in a "fee-for-service" or an "amount-not-to-exceed" manner.

In the long run, districts may also find it beneficial to train operation and maintenance staff in energy accounting. In addition to tracking the building's energy use, energy accounting can also indicate problems or potential problems with equipment operation.

## PREVENTIVE MAINTENANCE

Another important operation and maintenance practice is preventive maintenance. Preventive maintenance can save school districts time and money by:

- Maintaining facility operation.
- Extending equipment life.
- Identifying equipment degradation.
- Preventing losses of equipment, time, productivity, and resulting revenue.

### **Preventive Maintenance Software Modules**

*Many major controls contractors also offer preventative maintenance modules for their software that will track and automatically advise operation and maintenance staff when equipment maintenance needs to occur. These systems can provide good value because the controls system already knows a lot about many of the building systems. To set these systems up properly to be operational when the building is first occupied, the district should allow some extra budget for a facilities operator to assist in setup during construction. This will also allow the operator to become familiar with the system and maximize its benefits once the building is occupied.*

Effective maintenance and operations procedures are fundamentally important to sustaining the performance of all building systems. Student health and productivity can be affected when building systems fail to operate as designed. Sub-standard maintenance or incorrect operation of building systems usually results from a combination of factors. One, maintenance budgets are often the first to be reduced or eliminated when money becomes tight. Two, designers and contractors typically provide

the building staff minimal or no training about how the building systems are supposed to operate or be maintained. Finally, schools eventually lose their institutional knowledge of the building systems because of staff turnover and lack of communication.

When estimating service life, manufacturers usually assume regular preventive maintenance of the equipment and system components. Many preventive maintenance procedures recommended by manufacturers are intended to extend the life of the component and the system as a whole. Lack of preventive maintenance reduces equipment life.

Identifying degradation of the system's components is another benefit of preventive maintenance. A proper facility operation and maintenance system that includes reporting and documentation reduces the incidence of failure. For example, if a component of the system is identified as potentially failing to operate as intended, a work order for replacement parts can be set up immediately and work scheduled during unoccupied hours. Preventive maintenance can reduce the number and cost of emergency corrective maintenance bills.

Performing regular preventive maintenance can result in energy and cost savings. For example, simply replacing worn fan belts on a regular basis can save 2%–4% of the energy used to run the fans. Cleaning air filters and cooling coils regularly can save 1%–3% of the building's energy use for cooling. These basic activities cost very little to perform, but can add up to dramatic savings.

Preventive maintenance also makes buildings safer and can reduce potential district liability. For example, increasingly, building ventilation systems function as part of an engineered smoke control system and therefore proper maintenance can decrease liability.

Energy accounting is a method of tracking a facility's energy use over time. Many facility managers seeking peak performance in their building have found that energy accounting software gives them a better understanding of their utility expenditures. Each month's usage and expenditures are input into a software program. The software then tacks the usage while normalizing for temperature changes over the period being analyzed. The energy "accountant" can then watch and see whether the facility performs as expected or uses more energy than expected over time. If higher than expected usage occurs, further investigation can identify the occupancy and or usage changes, equipment problems, or other unknown problems that have increased the energy bills.

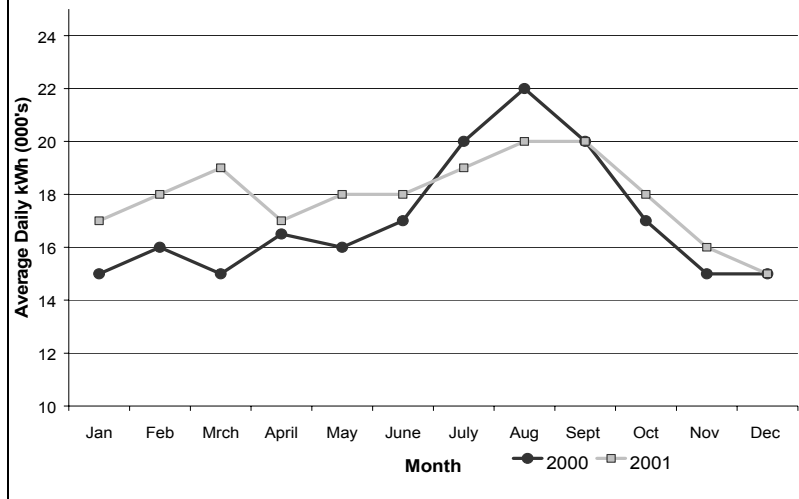


Figure 3—Energy Accounting

# DEVELOPING A PREVENTIVE MAINTENANCE PLAN

The commissioning provider can assist the district or facility manager in developing a preventive maintenance plan for a building's HVAC and electrical systems. Most of the information required for developing a preventive maintenance plan is gathered as part of the commissioning process or can be obtained from the operation and maintenance manuals.

A preventive maintenance plan consists of a checklist of tasks that are performed at manufacturer-recommended intervals (usually measured in hours of equipment run time). This checklist is usually kept in the form of a log and updated manually when tasks are performed. In buildings that use computerized maintenance management systems, the equipment that requires preventive maintenance should be entered into the system. If the computerized system is used for generating preventive maintenance work orders, the system should be updated each time work is performed and hard copies of completed work orders should be kept in a file or notebook. Another low-cost measure to consider is programming the energy management system to track and archive equipment run times. This option is easy and inexpensive if done when the initial system programming takes place, and it should be outlined in the original equipment specification in the contract.

The preventive maintenance plan for each piece of equipment should include the following fundamental information, gathered during the commissioning process:

- Unique equipment identification number.
- Name plate information.
- Manufacturer's name.
- Vendor's name and telephone number.
- Equipment location.
- Date installed.

Additionally, if information is available:

- Expected equipment life.
- Expected annual energy use.

Preventive maintenance should be performed according to manufacturer requirements. Consult the manufacturer's operation and maintenance manual for each piece of equipment for requirements such as frequency, chemical treatments, proper lubricants, spare parts, and special tools. This information should also become a part of the preventive maintenance plan.

The preventive maintenance work order form or task list for each piece of equipment should have a verification section with at least two signature lines: one for the technician performing the preventive maintenance and one for the supervisor verifying that the maintenance was performed.

## OUTSOURCING PREVENTIVE MAINTENANCE

If a new piece of equipment does not require frequent maintenance, and current staff time is committed, a contract for outside help may be less costly than hiring and training full-time staff. If a sophisticated new piece of equipment is purchased, compare the cost of training in-house staff to the cost of hiring a trained outside contractor to perform maintenance on the equipment to determine the best option.

In buildings where operating staff is not available or trained to perform the required preventive equipment maintenance, districts may obtain a service contract from the vendor, installing contractor, or a maintenance service contractor. Ensure that the service contract covers all of the manufacturer's recommended preventive maintenance procedures as described in the operation and maintenance manuals. After each site visit, require the contractor to provide an invoice or preventive maintenance form stating clearly which preventive maintenance activities or repairs were performed. Keep these forms on-site in a file or three-ring binder for future reference. Regardless of who actually performs the preventive maintenance, the district is responsible for making sure that the preventive maintenance plans are complete.

Maintenance contracts tend to be site-specific, but in general, there are two basic types of services.

- *Preventive maintenance contract.* Normally, this variety of contract does not cover the cost of replacement parts, but does include labor and supplies. The equipment owner is responsible for parts replacement. The duration of a preventive maintenance contract is usually one year. Frequency of site visits may depend on the equipment being serviced. Corrective maintenance may or may not be included.
- *Guaranteed service and repair contract.* Large maintenance contractors usually offer this type of contract. Under this arrangement, the contracting firm not only maintains but also replaces failed components. It is essentially an insurance policy with a low deductible, and typically is a multi-year contract. The cost for this type of contract is comparatively high.

Regardless of the type of contract used, it is important to carefully evaluate the cost for the service, quality of service, and the existing contractor's familiarization with the facility's equipment and operating procedures when the contract is up for renewal. Because any new contractor will face a learning curve when taking over a facility, it might not be a wise decision to choose a new contractor just because they offer a lower price. Careful consideration of the quality of service already received and successful renegotiations with the existing service contractor might provide better long-term value.



# References and Resources

## KEY TO COMMISSIONING GUIDELINES

Source	Design		Construction		Sample Tests
	Guidelines	Specs	Guidelines	Specs	
Appendix VII <i>Idaho New Building Commissioning Guidelines</i> , State of Idaho, 2000. <a href="http://www2.state.id.us/adm/pubworks/archengr/app7nbcg.pdf">www2.state.id.us/adm/pubworks/archengr/app7nbcg.pdf</a>	○	○	○	○	○
<i>Building Commissioning Assistance Handbook</i> Appendices. Seattle City Light, 1999. Standardized functional test procedures. <a href="http://www.ci.seattle.wa.us/seattle/light/conserva/business/bdgcoma/cv6_bcam.htm">www.ci.seattle.wa.us/seattle/light/conserva/business/bdgcoma/cv6_bcam.htm</a>	○	○	○	○	*●
<i>Procedural Standards for Building Systems Commissioning</i> , National Environmental Balancing Bureau (NEBB), 1999. (301) 977-3698.	●	●	●	●	●
<i>A Practical Guide for Commissioning Existing Buildings</i> , PECl and Oak Ridge National Labs (ORNL), 1999. NTIS (800) 553-6847.	●	○	○	○	○
<i>Model Commissioning Plan and Guide Commissioning Specifications</i> , USDOE/PECl, 1997. NTIS: # DE 97004564 (800) 553-6847.	*○	*●	●	●	*●
<i>Building Commissioning Guide</i> , U.S. GSA. & DOE, 1995, revised in 1998 (Ver. 2.2). Ver. 1 by Enviro-Management & Research, Inc.	*●	○	●	○	○
<i>The HVAC Commissioning Process</i> , ASHRAE Guideline 1-1996, 1996. ASHRAE Publications Dept., 1791 Tullie Circle, NE, Atlanta, GA 30329. (404) 636-8400. <a href="http://www.ashrae.org">www.ashrae.org</a> .	●	●	●	●	○
<i>Functional Test Protocol Library</i> , Pacific Gas & Electric Company, 2001. Available on the EDR Commissioning Resources CD-ROM. For ordering information visit: <a href="http://www.energydesignresources.com/">www.energydesignresources.com/</a> or by call 925-866-5329.	○	○	○	○	●
<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. (703) 684-1446. <a href="http://www.appa.org">www.appa.org</a> .	●	○	●	●	○
<i>Beyond Lighting DSM: Life After Green Lights</i> , Montgomery Co., MD, 1995. Existing building commissioning case study with sample process and detailed procedures. 70 pgs. (301) 217-6000.	●	○	○	○	●

## References and Resources

Source	Design		Construction		Sample Tests
	Guidelines	Specs	Guidelines	Specs	
<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.	●	●	●	●	○
<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.	○	○	○	*●	○
<i>Model Construction Document Specifications and A/E Services Contract Clauses</i> , Bonneville Power Administration/John Heinz, U. of WA, 1995. 503-230-7334. <a href="http://depts.washington.edu/fsesweb/fdi/fdi.html">http://depts.washington.edu/fsesweb/fdi/fdi.html</a>	○	○	○	*●	●
<i>Commissioning Guidelines, Instructions for Architects &amp; Engineers</i> , State of WA., 1995. Dept. of General Admin., Div. of Engin. & Arch., (360) 902-7272.	●	○	●	○	○
<i>Commissioning of HVAC Systems</i> , seminar/workshop training materials, Univ. of Wisconsin, Madison, 1994. (800) 462-0876 or (608) 262-2061.	○	○	●	●	●
<i>Laboratory HVAC Systems: Design, Validation and Commissioning</i> , ASHRAE collection of 11 papers, 1994. ASHRAE Publications Dept., 1791 Tullie Circle, NE, Atlanta, GA 30329. (404) 636-8400. <a href="http://www.ashrae.org">www.ashrae.org</a>	○	○	●	○	○
<i>Commissioning Smoke Management Systems</i> , ASHRAE Guideline 5-1994. ASHRAE Publications Dept., 1791 Tullie Circle, NE, Atlanta, GA 30329. (404) 636-8400. <a href="http://www.ashrae.org">www.ashrae.org</a>	●	○	●	○	○
<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.	○	○	○	○	●
<i>Contractor Quality Control and Commissioning Program—Guidelines and Specification</i> , Montgomery Co. Gov., St of Maryland, 1993. (301) 217-6071.	○	○	*●	*●	*●
<i>HVAC Systems Commissioning Manual</i> , Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), 1993. SMACNA, 4201 Lafayette Center Dr., Chantilly, VA 22021.	○	○	●	●	●
<i>Commissioning Guide</i> , Public Works Canada, Western Region, 1993. (403) 497-3770.	●	●	●	●	○
<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.	○	○	○	*●	*●
<i>Building Commissioning Guidelines</i> , Bonneville Power Administration/PECI, 1992. (503) 230-7334.	●	○	●	●	●
<i>HVAC Functional Inspection and Testing Guide</i> , U.S. Dept. of Commerce and the General Services Administration, 1992. NTIS: (800) 553-6847.	○	○	○	○	●
<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.	○	*●	○	●	○
<p><i>Procedural Guidelines, Specifications and Functional Tests</i>                      Last Updated: 10/25/01                      *Denotes documents available on electronic disk.                      Legend: ● Comprehensive Information ● Average/Partial Information ○ No Information</p>					

## OVERVIEWS AND CASE STUDIES

*Building Commissioning: The Key to Quality Assurance.* U.S. DOE Rebuild America/PECI, 1998.

*Commissioning Retrofits and Existing Buildings: Overview, Process and Case Studies.* Dedicated solely to retrocommissioning. 68 pgs. (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.

*New Construction Overview, Benefits, Process and Case Studies.* Contains some data on recommissioning. 44pgs. (503) 378-4040 or download at:  
[www.energy.state.or.us/bus/comm/bldgcx.htm](http://www.energy.state.or.us/bus/comm/bldgcx.htm)

*What Can Commissioning Do For Your Building?* PECI, 1997.

*Commissioning Overview and Report of 175 Building Case Studies.* Contains some data on recommissioning. 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.

A Web site dedicated to providing access to documents dealing with the Guidelines for Total Building Commissioning is being developed under the auspices of the National Institute of Building Sciences. The site is maintained by the Florida Design Initiative and is organized around the individual technical guidelines that will comprise the complete set of Guidelines for Total Building Commissioning. [www.sustainable.state.fl.us/fdi/edesign/resource/totalbcx](http://www.sustainable.state.fl.us/fdi/edesign/resource/totalbcx).

*Implement Building Commissioning*, published by U.S. Department of Energy, Rebuild America, EnergySmart Schools program (Washington, DC, 2000); available at:  
[www.eren.doe.gov/energysmartschools/om\\_implement.html](http://www.eren.doe.gov/energysmartschools/om_implement.html). Defines building commissioning; discusses the selection of a commissioning agent; the benefits, approaches, and components of commissioning; and lists resources.

*Sustainable Building Technical Manual: Green Building Design, Construction, and Operations*, produced by Public Technology, Inc., U.S. Green Building Council (USGBC), and U.S. Department of Energy,

with support from EPA, 1996. See Chapter 15, "Building Commissioning." Available from USGBC, San Francisco, CA; Phone: (415) 445-9500 or download at: [www.sustainable.doe.gov/pdf/sbt](http://www.sustainable.doe.gov/pdf/sbt).

*Four Case Studies.* Seattle City Light.

[www.ci.seattle.wa.us/seattle/light/conserve/business/bdgcoma/cv6\\_bcam.html](http://www.ci.seattle.wa.us/seattle/light/conserve/business/bdgcoma/cv6_bcam.html).

## WEB SITES

Building Commissioning Association. [www.bcxa.org/](http://www.bcxa.org/)

California Commissioning Collaborative. [www.cacx.org/resources.html](http://www.cacx.org/resources.html)

Energy Design Resources. [www.energydesignresources.com/resource/37/](http://www.energydesignresources.com/resource/37/)

Florida Design Initiative. <http://fcn.state.fl.us/fdi/index.html>. Ongoing articles & forum.

Lawrence Berkeley National Laboratory. [//eetd.lbl.gov/emills/PUBS/Cx-Costs-Benefits.html](http://eetd.lbl.gov/emills/PUBS/Cx-Costs-Benefits.html).

National Institute of Health Model Commissioning Guide.

[www.des.od.nih.gov/farhad2/Commissioning/nih\\_cx\\_guide/ComGuideTitle.htm](http://www.des.od.nih.gov/farhad2/Commissioning/nih_cx_guide/ComGuideTitle.htm)

NEBB. [www.nebb.org/](http://www.nebb.org/). Certification program and manuals.

Oregon Office of Energy. [www.energy.state.or.us/bus/comm/bldgcm.htm](http://www.energy.state.or.us/bus/comm/bldgcm.htm) Benefits of Cx, case study, the full text of Commissioning for Better Buildings in Oregon. Contains some data on recommissioning.

PECI. [www.peci.org/](http://www.peci.org/) NCBC information, downloadable Model Cx Plan and Guide Specifications, Cx and O&M resources.

Seattle City Light. [www.ci.seattle.wa.us/seattle/light/conserves/business/bdgcoma/cv6\\_bcam.htm](http://www.ci.seattle.wa.us/seattle/light/conserves/business/bdgcoma/cv6_bcam.htm)  
Standardized test procedures and case studies.

Texas A&M Energy Systems Lab. [www-esl.tamu.edu/](http://www-esl.tamu.edu/). Retrocommissioning process and software, for purchase. Dedicated solely to retrocommissioning.

University of Washington. [www.depts.washington.edu/fsesweb/fdi2001/15\\_mech/doc/19-15t.doc](http://www.depts.washington.edu/fsesweb/fdi2001/15_mech/doc/19-15t.doc).  
University Cx guide specs distributed throughout the specs. Vols 1–4.

DOE / FEMP. [www.eren.doe.gov/femp/techassist/bldgcomgd.html](http://www.eren.doe.gov/femp/techassist/bldgcomgd.html). Full text of GSA/USDOE Building Commissioning Guide; early version of Model Cx Plan and Guide Specifications.

DOE. [www.eren.doe.gov/](http://www.eren.doe.gov/). Links to commissioning documents. Search on “commissioning.”

Whole Building Design Guide (NIBS). [www.wbdg.org/](http://www.wbdg.org/). National Institute of Building Sciences. Find commissioning information by searching on “commissioning.”



---

# Appendix A: Case Studies

## GEORGINA BLACH INTERMEDIATE SCHOOL

Los Altos Unified School District finished construction on the Georgina Blach modernization in 2002. With grants from Saving By Design and PG&E, Georgina Blach has achieved an expected energy savings of 38% over the 2003 Title 24 standards.

With PG&E funding for commissioning, the district hired a third-party commissioning agent to ensure that the project was completed as intended and designed. The commissioning agent, Keithly Welsh Associates, completed the following tasks:

- Created a commissioning plan.
- Reviewed designs and specifications.
- Documented the district's design intent.



*Figure 4—Georgina Blach Intermediate School, Los Altos, Ca*

*Source: Lawrence Schadt*

- Worked with designers/construction team to make sure that the building followed the design intent.
- Trained the occupants to use the systems efficiently.

A commissioning report at the end of the process provided results of system testing, tracked the issues that had been identified, and documented the verification of energy efficiency measures.

Of the 142 issues identified by the commissioning agent throughout the process, 87% were successfully resolved before the warranty period had expired. Pleased with the results of the commissioning process, the district is using the same process in five other new facilities currently under design and paying for these services with their own funds.

## **SOUTH PASADENA UNIFIED SCHOOL DISTRICT**

Since 1999, South Pasadena Unified School District (USD) has completed work on three elementary schools and a high school, and is currently designing a middle school. Initially, District Director of Facilities Bob Vanderwall tried to secure funding for commissioning for the projects, but it was cut from the budget.

In response, like many districts, South Pasadena USD came up with its own internal commissioning process including district-wide specifications for commissioning that accept no substitutions from contractors.

Vanderwall, who has a background in construction, acts as the commissioning agent—doing his own constructability reviews to ensure that architects understand the district’s requirements and appropriately address user groups.

During construction, Vanderwall is on the job site every day to try to anticipate problems as or before they occur and work as an advocate for the district with both designers and contractors.

Vanderwall particularly keeps an eye on low voltage systems such as EMS, lighting, and fire alarm systems, which he says cause about 90% of the commissioning issues in his schools.

Lessons learned through the process, he says, include the following:

- Involve maintenance and operations staff before the project goes out to bid.
- Hire or involve a good HVAC technician.
- Make sure that the architect understands what the district wants and how the building will be used.
- Have the construction manager prepare a complete list of warranties and submittals, including operations and maintenance manuals and training manuals.
- Use the Inspector of Record, either hired by the Division of the State Architect or privately by the district, to do as much commissioning as possible.
- Document, document, document—when you think something will be easy to remember, it never is!

---

# Appendix B: Sample RFPs

Some tools available to assist in creating an RFP are:

- Energy Design Resources' Commissioning Assistant Tool, available at EDR's Web site: [www.energydesignresources.com](http://www.energydesignresources.com).
- The Building Commissioning Association has a number of commissioning process templates, including a Commissioning RFP template, available at BCA's Web site: [www.bcxa.org/resources/index.shtm](http://www.bcxa.org/resources/index.shtm).
- The Request for Commissioning Services template, found on the following page, is intended to be applicable for cases when commissioning starts in design or 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.

# REQUEST FOR COMMISSIONING SERVICES

OWNER OF

\_\_\_\_\_

REQUEST FOR PROPOSAL  
(RFP)/QUALIFICATIONS (RFQ)

FOR INDEPENDENT COMMISSIONING  
PROVIDER SERVICES

Issuance Date: \_\_\_\_\_

Closing Date: \_\_\_\_\_, 5 PM

The \_\_\_\_\_ (Owner) requests written proposals to secure Commissioning Provider (CP) services for the \_\_\_\_\_ facility in, \_\_\_\_\_, (Location). The Owner is committed to commissioning this facility to ensure that all systems are well designed, complete and functioning properly upon occupancy, and that the Owner's staff has adequate system documentation, and training.

*This template is intended to be applicable for cases when commissioning starts in design or 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.*

*Commissioning is viewed by many as a professional service best obtained through a request for qualifications, selection and negotiated fee rather than through a firm RFP. If a firm RFP is required, the owner must invest the effort in developing a clear and comprehensive request and carefully evaluate the fee proposals and approach of each proposer.*

*This RFP/RFQ 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. When the contractor is required to hire a "test engineer" or "commissioning coordinator," etc., the responsibilities in this document should be appropriately modified.*

## Background

The Owner is seeking the services of a qualified commissioning provider/firm for a new construction project. The project currently is a \_\_\_\_\_ gross ft<sup>2</sup>, \_\_\_ 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.

*Delete and add spaces to match specific project. Provide as much information as possible.*

*Provide the proposers with a copy of the programming report and any design documents completed to date.*

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:

\_\_\_\_\_.



## Objectives

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 (Design Intent); 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.

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

The commissioning provider (CP) should be involved throughout the project from the pre-design through the warranty phase. Note: The term "Commissioning Provider" is sometimes referred to as the "Commissioning Authority". The primary role of the CP during the overall design phase is to develop detailed commissioning specifications and review the 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 systems' performance to ensure that the systems are functioning in accordance with the owner's Design Intent (DI) 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. For this proposal, it is assumed by the owner that all of these tasks will be completed, unless any proposed changes to the following task list are "clearly" highlighted and noted in the respondent's proposal. For this proposal

*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 (see below) and that they provide some language for, or at least a review of the commissioning or quality control language in the specifications. Clarifications to the bid package can be handled by addenda.*

- Pre-design phase,
  - Design phase,
  - Construction phase,
  - Warranty phase services
- are requested.

## Pre-Design Phase

- Assemble commissioning team, hold a scoping meeting and identify responsibilities.
- Develop a draft design-phase commissioning plan.
- Attend commissioning meetings as needed with project manager and design team.
- Review the design intent documentation for clarity and completeness.
- Develop the written Owner's design intent 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 by: \_\_\_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 design intent requirements will be \_\_\_general in nature, \_\_\_specific in nature, \_\_\_include specific performance criteria for \_\_\_some, \_\_\_most concepts.

*The checklisted tasks are generally included. Select as appropriate.*

*The remainder of the tasks may be included. Edit as appropriate.*

## Design Phase

- Coordinate the commissioning work during design.
- Develop or update the design phase commissioning plan.
- 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.
- Assist and review the development and updating of the Design Record documentation by design team members (Design Intent, Design Narrative; Design Basis).
- Develop a draft construction phase commissioning plan using an Owner-approved outline.
- Develop full commissioning specifications for all commissioned equipment. Coordinate this with the architect and engineers and integrate the commissioning specifications into the overall project specification package. One or more of the following documents can be used as a guide for content, rigor and format: 1) Model Commissioning Plan and Guide Specifications, USDOE/FEMP; Portland Energy Conservation, Inc. (PECI), 2) The HVAC Commissioning Process, ASHRAE Guideline 1-1996. The Peci Document can be downloaded free at [www.peci.org](http://www.peci.org) and a copy of the ASHRAE document can be obtained by contacting ASHRAE at 404-636-8400.

*If the Commissioning Provider was not brought on during pre-design, it is recommended that they perform pre-design tasks 1 and 4 (see previous).*

- 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 start-up requirements; the functional testing process; specific functional test requirements, including testing conditions and acceptance criteria for each piece of equipment being commissioned.
- Coordinate a controls integration meeting where the electrical and mechanical engineers, owner's representative, 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**

- Attend pre-bid meeting to answer commissioning related questions.

## **Construction Phase**

- Perform the tasks and functions in the specifications ascribed to the \_\_\_\_\_ (title of the commissioning party, e.g., commissioning provider, commissioning authority etc., as identified in the specifications), dated \_\_\_\_\_.

*If this RFP/RFQ is being used to solicit a commissioning provider whose scope of work will not begin until the construction phase of the project—and if commissioning specifications already exist for the project, include the first item in the Construction Phase list and modify the other tasks to be consistent with the specifications.*

- 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.
- Coordinate the commissioning work with the contractor and construction manager, to ensure that commissioning activities are being incorporated into the master schedule.
- Revise, as necessary, the construction phase commissioning plan developed during design, including scope and schedule.
- Plan and conduct commissioning meetings as needed and distribute minutes.
- Request and review additional information required to perform commissioning tasks, including O&M materials, contractor start-up and checkout procedures. Before start-up, gather and review the current control sequences and interlocks and work with contractors and design engineers until sufficient clarity has been obtained, in writing, to be able to write detailed testing procedures.
- Review normal Contractor submittals applicable to systems being commissioned for compliance with commissioning needs, concurrent with the A/E reviews.

- Review requests for information and change orders for impact on commissioning and owner's objectives.
- Review coordination drawings to ensure that trades are making a reasonable effort to coordinate.
- Write and distribute construction checklists for commissioned equipment.
- Develop an enhanced start-up and initial systems checkout plan with contractors for selected equipment.
- 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.
- Witness sufficient HVAC piping pressure test and flushing to be confident that proper procedures were followed. Include testing documentation in the Commissioning Record.
- Witness sufficient ductwork testing and cleaning to be confident that proper procedures were followed. Include documentation in the Commissioning Record.
- Document construction checklist completion by reviewing completed construction checklists and by selected site observation.
- Document systems start-up by reviewing start-up reports and by selected site observation.
- Approve air and water systems balancing by spot testing, reviewing completed reports and selected site observation.
- 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.
- Analyze functional performance trend logs and monitoring data to verify performance.
- 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 start-up, shutdown, unoccupied mode, manual mode, staging, miscellaneous alarms, power failure, security alarm when impacted and interlocks with other systems or equipment. Sensors and actuators shall be calibrated during construction check listing by the installing contractors, and spot-checked by the commissioning provider during functional testing. 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 Owner.

- 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.
- Maintain a master issues log and a separate record of functional testing. Report all issues as they occur directly to the Owner's Representative. Provide written progress reports and test results with recommended actions directly to the Owner's Representative.
- Review equipment warranties to ensure that the Owner's responsibilities are clearly defined.
- Oversee and review the training of the Owner's operating personnel. Oversee the videotaping of this training.
- Review and review the preparation of the O&M manuals for commissioned equipment.
- Compile a Commissioning Record, which shall include:
  - A brief summary report that includes a list of participants and roles, brief building description, overview of commissioning and testing scope, and a general description of testing and verification methods. For each piece of commissioned equipment, the report 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:
    - Equipment meeting the equipment specifications,
    - Equipment installation,
    - Functional performance and efficiency,
    - Equipment documentation, and
    - Operator training.
  - 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.
  - 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.
- 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 set points

and implications when changing them, schedules, instructions for operation of each piece of equipment for emergencies, seasonal adjustment, start-up 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**

- 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.
- Return to the site 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:

- Central building automation system.
- All equipment of the heating, ventilating and air conditioning systems.
- Scheduled or occupancy sensor lighting controls.
- Daylight dimming controls.
- Refrigeration systems.
- Emergency power generators and automatic transfer switching.
- Uninterruptible power supply systems.
- Life safety systems (fire alarm, egress pressurization, fire protection).
- Laboratory, clean room, hoods and pressurization.
- Electrical.
- Domestic and process water pumping and mixing systems.
- Equipment sound control systems and testing.
- Data and communication.
- Paging systems.
- Security system.
- Irrigation.
- Plumbing.
- Vertical transport.
- Medical gas.
- Building envelope
- Process instrumentation and controls.

**Delete and add systems as appropriate.**

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

*For RFP/RFQ's sent out once the plans and specifications are mostly complete, more detail to the list below must 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. For example, just saying that "electrical" systems will be commissioned is insufficient and requires considerably more detail.*

## Desired Qualifications

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

*Add to and edit the desired qualifications according to your specific project, particularly for non-HVAC systems you are having commissioned (electrical, envelope, security, communications, etc.).*

- Acted as the principal Commissioning Provider for at least three (3) projects over \_\_\_\_\_ ft<sup>2</sup>.
- 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/RFQ.

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

The proposer shall:

- 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.
- Have the proposal signed by an officer of the proposing firm with the authority to commit the firm.
- 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.
- Provide an organization chart for managing and executing this contract.
- List the individual(s) who will serve as the lead Commissioning Provider for the design phase and for the construction phase of the contract (they may be different people).
- Provide resumes for key staff and subconsultants. The resumes shall include specific information about expertise in commissioning tasks, (e.g. design reviews, specification writing, commissioning management, troubleshooting, test writing, test execution, energy management, sustainable design, etc.).
- Briefly describe "relevant" experience (project phasing, life cycle costing, testing, adjusting and balancing, building simulation, sustainable design, fume hoods, envelope, IAQ, solar, clean rooms, campus projects, etc.) of the proposer's team in the following areas. List involvement of key team members.
  - Projects similar to this one.
  - O&M experience.
  - Energy-efficient equipment design and control strategy optimization.
  - Project and construction management.

*Add or delete items in this list to reflect the areas where the commissioning provider should describe their experience. Only list those that specifically apply.*

- System design (specify).
- Troubleshooting.
- Describe your proposed approach to managing the project expertly and efficiently, including distribution of tasks, travel, and 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.
- As an attachment, provide the following work products that members of the proposer’s team developed. List the team member who actually wrote the document and the projects on which they were used. Work from the designated Commissioning Provider is preferred.
  - Commissioning plan that was executed (the process part of the plan);
  - Commissioning specifications; and
  - An actual functional test procedure form that was executed.
- This project will be set up on a time-and-materials basis. Provide both an hourly rate for each team member, along with rates and fees for all other costs the Owner 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.
 

*If this is a request for qualifications with a rate proposal, include this bottom paragraph and delete the two paragraphs that follow it. If this is to be a bid request for proposal then delete this paragraph and proceed to the next paragraph.*
- Provide a fixed, lump sum total cost to accomplish the work for the following phases: pre-design and design, construction, warranty. All task amounts include associated meetings, progress reports and direct costs (travel, mileage, per diem, communications, etc.). Use the budget table format below to provide a cost breakdown. Also provide 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.
 

*If this is a fixed lump sum proposal for the work, it is normally not appropriate to ask for a budget figure for construction phase commissioning tasks until the plans and specifications are nearing completion.*

*If this RFP is sent out in pre-design to mid-design, ask for budget details in the table below for the pre-design and design phase tasks only. Delete all of the construction phase budget detail lines and instead ask for a cost “estimate” for the construction and warranty phase tasks. Delete the reference to “construction and warranty” in the first sentence of the third bulleted item.*

*Otherwise, if the commissioning project will start late in or after design, delete the fourth bulleted paragraph and edit the first paragraph of the third bulleted paragraph by deleting the reference to “pre-design and design” unless there are some tasks from the pre-design and design phase task lists above that you are retaining in the scope.*
- For planning purposes, the proposer must also

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

- Provide a statement of proposer’s liability insurance coverage (type, and dollar amount of coverage). Proof of this insurance will be required prior to the award of this contract to the winning proposal.
- The respondent must submit 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 start-up	
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

Owner 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 Owner 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 sub-consultants change for this project, the Owner 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

The commissioning provider will perform a review of the design documents for the following issues at the phases checked for each system commissioned. (Check the areas that you want the commissioning firm to provide input on.)

Design Area	Review Description	Schematic Design Review	Design Development Review	Contract Document Re view #1	Contract Document Re view #2
Design narrative and design basis	Ensure that design narrative and basis of design are clear, complete, and meet the original Owner’s Project Requirements.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Commissioning facilitation	Review to facilitate effective commissioning (see Exhibit 2). For example, sufficient accessibility, test ports, and monitoring points.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Control system and control strategies	Review HVAC, lighting, fire control, emergency power, security control system, strategies and sequences of operation for adequacy and efficiency.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Operations and maintenance (O&M)	Review for effects of specified systems and layout toward facilitating O&M. For example, equipment accessibility, and system control.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Indoor environmental quality	Review to ensure that systems relating to: <ul style="list-style-type: none"> <li><input type="checkbox"/> thermal,</li> <li><input type="checkbox"/> visual,</li> <li><input type="checkbox"/> acoustical,</li> <li><input type="checkbox"/> air quality comfort, and</li> <li><input type="checkbox"/> air distribution</li> </ul> maximize comfort and are in accordance with the Owner’s Project Requirements. (See Exhibit 3 for IAQ checklist).	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**Appendix B: Sample RFPs Exhibit 1: Focused Design Review Scope**

Design Area	Review Description	Schematic Design Review	Design Development Review	Contract Document Re view #1	Contract Document Re view #2
O&M documentation	Verify adequate building O&M documentation requirements.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Training	Verify adequate operator training requirements.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Commissioning specifications	Verify that bid documents adequately specify building commissioning, including testing requirements by equipment type.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Owner's design guideline or standard	Verify that the design complies with the owner's own design guideline or standard.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Environmental sustainability	Review to ensure that the: <ul style="list-style-type: none"> <li><input type="checkbox"/> building materials,</li> <li><input type="checkbox"/> landscaping,</li> <li><input type="checkbox"/> use of water, and</li> <li><input type="checkbox"/> waste management</li> </ul> create less of an impact on the environment and are in accordance with Owner's Project Requirements.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Mechanical	Review the mechanical concepts/design for enhancements.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Electrical	Review the electrical concepts/systems for enhancements.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Envelope	Review envelope design and assemblies for thermal and water integrity, moisture vapor control and assembly life.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Structural	Review the structural concepts/design for enhancements.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Functionality	Ensure the design maximizes the functional needs of the occupants.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Life cycle costs	Perform a life cycle assessment of the primary competing mechanical systems relative to: <ul style="list-style-type: none"> <li><input type="checkbox"/> energy efficiency,</li> <li><input type="checkbox"/> O&amp;M,</li> <li><input type="checkbox"/> IEQ,</li> <li><input type="checkbox"/> functionality, and</li> <li><input type="checkbox"/> sustainability.</li> </ul>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

# EXHIBIT 2: COMMISSIONING FIRM EXPERIENCE

Fill out a separate form for each firm on the team.

Company Name	Contact Person
	Title
Street Address	City
State/Province	ZIP/Postal Code
Telephone	FAX
E-mail address	
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 the firm has provided commissioning services (check all that apply):

- |  |   |
|--|---|
| <input type="checkbox"/> Pkg. or split HVAC          | <input type="checkbox"/> Envelope                 |
| <input type="checkbox"/> Chiller system              | <input type="checkbox"/> Fire/Life Safety         |
| <input type="checkbox"/> Boiler system               | <input type="checkbox"/> Plumbing                 |
| <input type="checkbox"/> Energy Mgmt. Sys.           | <input type="checkbox"/> Commercial refrigeration |
| <input type="checkbox"/> Variable Freq. Drives       | <input type="checkbox"/> Telecommunications       |
| <input type="checkbox"/> Lighting Controls           | <input type="checkbox"/> Thermal Energy Storage   |
| <input type="checkbox"/> Daylighting                 | <input type="checkbox"/> Labs & Clean Rooms       |
| <input type="checkbox"/> Electrical, general         | <input type="checkbox"/> _____                    |
| <input type="checkbox"/> Electrical, emergency power |   |

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	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Grocery	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Hospitals	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Laboratories	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Schools or universities	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Industrial / Manufacturing	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Special purpose—prisons, museums, libraries, etc.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

## EXHIBIT 3: COMMISSIONING TASK EXPERIENCE ON SIMILAR PROJECTS

Fill out a separate form for each member of the team.

The following abbreviations are used in this form:

- *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 sub-consultant 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/Existing)	City & State, Owner Contact, Title and Phone	Name & Role of Persons(s) Assigned to Project by Firm (identify any sub-consultants)	Systems Commissioned (Identify if tested by sub-consultants)	(Enter "X" if by own firm, "S" if by sub-consultant)														
				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			