

**Proposal for  
Commissioning and Measurement and Verification  
Services as Specified by LEED™  
for the Ohlone College  
Newark Center for Technology and Health Sciences**

**Prepared for:**

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August 4, 2004



# Commissioning and Measurement and Verification Services for the Ohlone College New Center for Technology and Health Sciences

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### A. Building Commissioning and Diagnostics Qualifications

## **Executive Summary**

Ohlone College has requested Architectural Energy Corporation to provide a proposal for commissioning and measurement and verification services for the New Center for Technology and Health Sciences in Fremont, California, with incorporation of the USGBC LEED Silver rating on the project.

Erik Kolderup, P.E., will be Architectural Energy Corporation's primary point of contact. Mr. Kolderup will be supported by AEC engineering staff as listed in section 5.0 of this proposal. Mr. Kolderup can be reached at (415) 957-1977 or via e-mail at [ekolderup@archenergy.com](mailto:ekolderup@archenergy.com).

Architectural Energy Corporation, with a staff of 60+ people -- of which 13 are dedicated to field engineering activities, is uniquely qualified to undertake the proposed project, having commissioned over 20 educational facilities and provided engineering design assistance to over 200 commercial and educational projects.

## 1.0 Introduction

Ohlone College is designing a new 150,000 square foot university educational facility for technology and health sciences in Newark, California. Ohlone College has requested the assistance of Architectural Energy Corporation (AEC) to provide commissioning and measurement and verification services. Ohlone College has set the goal of at least LEED Silver building for their new educational facility and therefore have requested AEC to provide the required services to achieve the commissioning prerequisite and additional credit, as well as the measurement and verification credit as outlined in LEED 2.1.

The following statement of work presents the goals, activities, deliverables, and budget for providing LEED-related building commissioning services, and measurement and verification (M&V) as described by LEED 2.1 and the International Performance Measurement and Verification (IPMVP). The following LEED credits will be obtained if the proposed statement of work by AEC is accepted:

- EA Prerequisite 1 – Fundamental Commissioning
- EA Credit 3 – Best Practices Commissioning
- EA Credit 5 – Measurement and Verification

AEC is proposing a comprehensive building commissioning approach for the ~150,000 square foot educational facility. Commissioning and M&V activities are proposed to be provided during the design, construction, acceptance, and warranty phases of the building delivery process.

The commissioning effort described herein has been specifically designed to meet the criteria of the LEED rating system for the "Prerequisite" commissioning requirements and the "Additional Credit" commissioning requirements. Building commissioning, as practiced by Architectural Energy Corporation, is a comprehensive and systematic process to verify that the systems of a new or renovated building perform as designed to meet the owner's requirements, and involves the formation of a cooperative commissioning team composed of the owner, design team, and contractors to create an effective, efficient, and high performance building. Architectural Energy Corporation, as a member of the U.S. Green Building Council and the Building Commissioning Association, adheres to the highest standards of professional practice and ethics in the provision of the building commissioning services.

Additionally, a scope of work and fee proposal has been prepared for achieving the Measurement and Verification requirements of the LEED rating system (EA Credit 5). Commissioning and measurement and verification are complementary and can be implemented in an integrated fashion to improve overall effectiveness and reduce costs.

Architectural Energy Corporation commissioning staff have completed 40 formal commissioning projects in the past five years, many related to achieving LEED Certification of the building. AEC's commissioning services include HVAC mechanical systems, building automation systems, lighting controls, renewable energy systems, kitchen equipment, plumbing, and irrigation systems.

Architectural Energy Corporation is a leader in developing and implementing advanced commissioning and diagnostic testing methods. Its ENFORMA<sup>®</sup> Commissioning Toolkit and MicroDataLogger<sup>®</sup> portable data acquisition system are used throughout the building, energy, and commissioning industries to evaluate and commission building systems.

### **1.1 Scope of Commissioning Services**

The Ohlone College project is currently in the design development phase. The design intent is for innovative design strategies employing daylighting, energy efficient heating and cooling systems, and low energy use and low environmental impact materials, components, and building systems. Thus, the scope of building commissioning will involve the following components and building systems:

- All Mechanical HVAC components
  - Ground source heat pump system
  - Heat pumps
  - Piping and ducts
  - Ground source bore field
  - Makeup air units
  - Exhaust fans
  - Unit heaters
  - Laboratory ventilation systems
- HVAC system: interaction of cooling, heating, and comfort delivery systems, fire / smoke HVAC shutdown or pressurization sequences with energy efficiency optimized
- Building Automation System (BAS): control hardware and software, sequence of operations, integration of factory controls with BAS
- Lighting controls commissioning
  - Verify all lighting control operation
- Photovoltaic system (wiring, inverters, panels)

### **1.2 AEC Technical Approach to Commissioning**

As practiced by AEC, building commissioning is a comprehensive and systematic process to verify that the systems of a new building perform as designed to meet the owner's requirements. The AEC approach to commissioning is to form a cooperative commissioning team involving the owner, design team, and general

contractor and appropriate sub-contractors to create effective, efficient, high performance buildings. Commissioning by AEC is a structured process to verify and document that applicable building systems meet the design intent and owner's operational requirements.

The commissioning agent is involved in design reviews, construction documents review, design intent and basis of design documentation, and a variety of functional testing tasks and performance verification. A common objective of all these activities is to identify and resolve operational and performance issues at the earliest possible time, because to do so saves time and money.

Design and construction document reviews identify and resolve construction, operation, and maintenance issues before they can become physical mechanical problems. Construction observation and pre-functional inspection checklists formalize the start-up process, ensuring that equipment or systems are ready for acceptance testing. Functional performance testing becomes a management tool for the owner to fully understand the "completion stage" of a facility construction process, and associated acceptance and payment procedures.

AEC performs short-term monitoring (either with building automation data or MicroDataLoggers<sup>®</sup>) to ensure that the installed system equipment performs optimally, and that the functional performance testing process did not miss identifying operation performance problems. Using AEC's MicroDataLogger hardware and the ENFORMA<sup>®</sup> building performance analysis software, AEC is able to take system performance data under normal operating conditions and quickly analyze the performance and interaction of the systems and identify problems that may exist. These tools have proven to be a very valuable addition to the commissioning process.

As a formal process, commissioning identifies and resolves operational and performance problems during the construction, start-up, and acceptance phases which reduces warranty call-backs. The occupants and operations staff receive a fully functioning facility to move into. Another important benefit of a formal commissioning process is the active participation of the buildings operation and maintenance (O&M) staff in the commissioning process. The O&M staff's participation in the commissioning activities supports their efforts to operate and maintain the commissioned systems at peak performance.

From our experience, commissioning enables the design and construction processes to run smoothly. It is a win-win situation for owners, occupants, design team, contracting team, and O&M staff. The building has been "checked out" and is ready for occupancy, knowing that commissioned equipment and systems perform as designed. The building systems have also been "benchmarked," and thus their performance can be tracked to maintain their performance over time. To provide for optimal performance longevity, the AEC commissioning report includes detailed information about the equipment design parameters, operation, deficiency history and preventative maintenance requirements. AEC also provides for client access to electronic versions of the report.

### **1.3 LEED Commissioning Requirements**

#### LEED Prerequisite EA 1.0

For LEED certification, LEED Prerequisite EA 1.0 must be performed. The U.S. Green Building Council defines Prerequisite EA 1.0 as "Fundamental Building Systems Commissioning." The following is a list of Prerequisite EA 1.0 requirements and submittals:

1. Engage a commissioning authority
2. Collect and review design intent and basis of design documentation
3. Include commissioning requirements in the construction documents
4. Develop and utilize a Commissioning Plan
5. Verify installation, functional performance, training and documentation
6. Complete a commissioning report
7. Provide a copy of the commissioning plan highlighting the five fundamental commissioning procedures as listed in the credit requirements.
8. Provide a signed letter of certification by the commissioning authority confirming that the commissioning plan has been successfully executed and the design intent of the building has been achieved.

This commissioning proposal is designed around meeting the LEED commissioning requirements.

#### LEED Additional Commissioning Credit 3

Best Practices Commissioning: In order to verify that the building is designed, constructed, and calibrated to operate as intended, the LEED system has created an additional credit that can be earned for "Additional Commissioning." The requirements for this additional credit (EA Credit 3) are:

1. Conduct a focused review of the design prior to the construction documents phase.
2. Conduct a focused review of the construction documents when close to completion.
3. Conduct a selective review of the contractor submittals of commissioned equipment.
4. Develop a recommissioning manual.
5. Have a contract in place for near-end or post occupancy review.

AEC has included all of the above listed scope of work within this proposal.

## 1.4 LEED-Related Commissioning Experience

Architectural Energy Corporation is experienced in providing LEED-related commissioning services. The table below summarizes the completed or in-progress LEED-related commissioning projects, together with the LEED rating level, and whether the Additional Commissioning credit was included in the scope of services.

<b>Project Name</b>	<b>LEED Rating</b>	<b>Additional Commissioning Credit Scope</b>
North Boulder Recreation Center Boulder, Colorado	LEED Silver Awarded	√
Ice Mountain Water Bottling Plant Big Rapids, Michigan	LEED Certified Awarded	√
Fossil Ridge High School Fort Collins, Colorado	LEED Certified expected	√
Department of Transportation Facility U.S. General Services Administration Lakewood, Colorado	LEED Silver expected	√
Pikes Peak Regional County Building Pikes Peak, Colorado	LEED Silver expected	√
Belmar Development 2M3 Building Denver, Colorado	LEED Certified expected	√
Arrowhead Water Bottling Plant Cabazon, California	LEED Certified expected	√
Ozarka Water Bottling Plant Tyler, Texas	LEED Certified expected	
Red Boiling Springs Water Bottling Plant Red Boiling Springs, Tennessee	LEED Certified expected	√
Madison Water Bottling Plant Madison, Florida	LEED Certified expected	
Phipps Conservatory Welcome Center Pittsburgh, Pennsylvania	LEED Certified expected	

<b>Project Name</b>	<b>LEED Rating</b>	<b>Additional Commissioning Credit Scope</b>
Fort Collins Vehicle Storage Buildings Fort Collins, Colorado	LEED Certified expected	√

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In addition to the LEED-related commissioning efforts shown in the above table, Architectural Energy Corporation's sustainable design assistance staff have been responsible for obtaining formal LEED Certification for the following projects:

- New England Regional Laboratory  
U.S. Environmental Protection Agency  
North Chelmsford, Massachusetts Gold Certification awarded
- North Boulder Recreation Center  
Boulder, Colorado Silver Certification awarded
- Science & Technology Center  
U.S. Environmental Protection Agency  
Kansas City, Kansas Gold Certification awarded
- Boulder Community Hospital Foothills Campus  
Boulder, Colorado Silver Certification awarded

Ongoing LEED Certification efforts include the following projects:

- District Courthouse  
U.S. General Services Administration  
Cape Girardeau, Missouri Certified level
- Building 18 Laboratory - Office  
Centers for Disease Control and Prevention  
Atlanta, Georgia Certified level
- Replacement Laboratory - Office  
Centers for Disease Control and Prevention  
Fort Collins, Colorado Certified level
- Building 4601 - Office  
NASA Marshall Space Flight Center  
Huntsville, Alabama Certified level

- Building 4602 - Laboratory  
NASA Marshall Space Flight Center  
Huntsville, Alabama Certified or Silver level
  
- Old National Bancorp Headquarters Silver or Gold level  
Evansville, Indiana

Architectural Energy Corporation is serving as the energy, daylighting and sustainable design consultant on these projects, and is responsible for coordinating the LEED Certification documentation and submittal process.

### 1.5 References

References who can speak to Architectural Energy Corporation's qualifications to provide the LEED-related commissioning services called for in the Request for Proposals are as follows:

Reference Name	Address, Phone, E-mail	Work Performed
Stu Reeve	Poudre School District Energy Manager 2413 LaPorte Avenue Fort Collins, CO 80521 stur@psd.k12.co.us 970-490-3502	New Construction Commissioning and Energy Model Review LEED Commissioning
Bill Griffith	State of Tennessee Department of General Services 500 Deaderick Street, 1 <sup>st</sup> Floor Nashville, TN 37243 Bill.griffith@state.tn.us 615-741-1600	Retrofit Construction Commissioning, Retrocommissioning
Neil Case	Colorado Springs School District 11 Project Manager 5240 Geiger Blvd. Colorado Springs, CO 80915 casenk@d11.org 719-477-6011	Retrocommissioning
Chuck Bell	The Green Team 2 West 6th Street, Suite 304 Tulsa, OK 74119 cbell@thegreenteaminc.com 918-295-8326	New Construction Commissioning LEED Commissioning

### 2.0 Commissioning Statement of Work

The building commissioning services to be provided by Architectural Energy Corporation during the design, construction, acceptance, and warranty phases of

the project are described below. These services will be undertaken in cooperation with and in coordination with the building owner, the architectural and engineering design team, the general contractor, the various subcontractors, the various equipment suppliers, and the building operation and maintenance staff.

## **2.1 Commissioning Goal and Objectives**

The overall goal of the commissioning effort is to verify and document that those building systems selected for commissioning -- HVAC and associated controls, and electric lighting controls -- meet the design intent and owner's requirements for functionality and performance.

Specific commissioning objectives for the project are as follows:

- Fulfill the LEED Prerequisite Commissioning Requirement for a Certified rating.
- Verify and document that the equipment is installed and started per manufacturer's recommendations and to industry accepted standards.
- Verify and document that equipment and systems receive complete operational checkout by the installing contractors.
- Verify and document equipment and system performance.
- Verify the completeness of operations and maintenance materials.
- Verify that the facility's operations personnel are adequately trained on the operation and maintenance of building equipment.

The AEC Commissioning Team will provide and update a Construction Phase Commissioning Plan, which will include a list of all systems and specific equipment and components to be commissioned and a preliminary schedule for the commissioning process.

## **2.2 LEED Prerequisite Commissioning Activities**

Architectural Energy Corporation will consider all aspects of the design from the owner's (building operation and maintenance staff) perspective. The Architectural Energy Corporation Commissioning Team, in cooperation with the design team, will undertake the following activities:

- **Documentation of Design Intent and Basis of Design**

A clear design intent is critical to the commissioning process. Design Intent defines the benchmark for system performance. The Design Intent Report is a detailed explanation of the information developed for the owner's program, focused on those systems included in the scope of work for commissioning. It will clearly define the functional and indoor environmental quality

requirements. The Basis of Design Report details the design teams response to the performance criteria in owner's program and design intent. It will include the heating, ventilation, and air-conditioning requirements for each occupancy type, with references to applicable codes and standards, and other design criteria used as the "basis of design" for other building systems to be commissioned.

- **Review Commissioning Specifications**

Commissioning specifications for the targeted building systems will be prepared by the design team. The proposed specifications will be reviewed for completeness and adequacy relative to defining the commissioning requirements of the general contractor and all installing subcontractors. As appropriate, revised commissioning specifications will be prepared and, as approved the design team and the owner / owner's representative, will be issued to the selected general contractor.

- **Prepare Commissioning Plan**

The Commissioning Plan describes the implementation of the commissioning process and provides a framework for integration of commissioning activities into the construction and acceptance process. The Commissioning Plan also provides an agenda for organizing and focusing the commissioning scoping meeting. The Commissioning Plan expands to incorporate more information as the design, construction, and acceptance and warranty phases of the facility are completed. The Commissioning Plan will be updated during the construction and warranty phases.

The Commissioning Plan will include, at a minimum, the following information:

- A brief overview of the commissioning process.
- A list of all commissioned features and systems.
- Identification of the commissioning team and its responsibilities.
- A description of the management, communication, and reporting of the commissioning process.
- An outline of the commissioning scope, including: development of the owner's project requirements, review of the basis of design, schematic design, construction documents and submittals, construction phase verification, functional performance test development and implementation, and ten-month warranty review.
- A list of the expected work products.

- A list of key commissioning milestones.
- **Commissioning Scoping Meeting**

The scoping meeting brings together all members of the design and construction team that will be involved in the commissioning process. Each building energy system to be commissioned is addressed, including its intended operation, commissioning requirements, and completion and start-up schedules. During the scoping meeting, all parties agree on the scope of work, tasks, schedules, deliverables, and responsibilities for implementation of the Commissioning Plan.
- **Pre-Functional Inspection Checklists**

A Pre-Functional Inspection Checklist will be developed and completed for all major equipment and systems being commissioned. The checklist confirms the as-built status of the equipment or system and ensures that the systems are complete and operational, so that the functional performance testing can be scheduled. Manufacturer's start-up checklists and other technical documentation guidelines will be used as the basis for all pre-functional checklists. AEC reviews and verifies the completed Pre-Functional Inspection Checklists before beginning the functional performance testing. This activity will be coordinated with the design mechanical and electrical engineers' punch list activities.
- **Functional Performance Testing**

Functional performance testing verifies the intended operation of individual components and system interactions under various conditions and modes of operation. Functional Performance Testing Plans will be prepared so that the complete sequence of operations is included in the test procedures.

Under the supervision of AEC commissioning staff, the installing subcontractor performs the hardware and/or software manipulations required for the testing. AEC commissioning staff witness and record the results of functional performance testing. If a building component or system substantially fails the functional performance testing, the installing subcontractor is responsible for making the necessary system adjustments or alterations. The failed component or system will then be re-tested for conformance. It is critical that final start-up procedures, tune-up testing, air and water balancing, and control software de-bugging be complete before any functional performance testing is undertaken.
- **Deficiency Report**

The results from pre-functional checklists, functional performance testing, and short-term diagnostic monitoring will be documented in a Deficiency Report. The report includes all details of the components or systems found to be non-compliant with the drawings and specifications. The report also details the adjustments or alterations required to correct the system

operation, and identifies who is responsible for making the corrective changes. The Deficiency Report is a living document that will be regularly updated to reflect the progress on many components and systems.

- **Operations and Maintenance Training**

AEC will schedule the training sessions and insure that the material covered is appropriate and informative. AEC will coordinate the training sessions with the entire commissioning team (contractors, designers, facility staff, etc.) Minutes and training logs will be generated by AEC to provide proper documentation of the training efforts. The operation and maintenance manuals compiled by the installing contractors will be reviewed for completeness and for adherence to the requirements of the specifications. The agenda for staff training programs proposed by the contractors will also be reviewed. Materials may be added, or requested from the contractors, to stress and enhance the importance of system interactions, troubleshooting, and long-term preventative maintenance and operation. A database will be created from the O&M manuals that contains the information required to start a preventative maintenance program.

- **Commissioning Report**

A final Commissioning Report will be compiled which summarizes all of the tasks, findings, conclusions, and recommendations of the commissioning process. The Commissioning Report serves to “benchmark” the building and is useful in a continuous commissioning process which is recommended for the long term performance of the building.

The commissioning report includes the following information:

- An evaluation of the operating condition of the systems at the time of functional test completion.
- Deficiencies that were discovered and the measures taken to correct them.
- Functional test procedures and results.
- A summary of all commissioning field activities as they progressed, and a description and estimated schedule of required deferred testing.
- LEED Documentation: Documentation will address and certify the LEED section on “Energy and Atmosphere” Prerequisite 1.0 titled “Fundamental Building Systems Commissioning.”

## 2.3 Best Practice Commissioning -- LEED Additional Credit

The LEED best practice commissioning credit requirement addresses commissioning activities during the design and post-occupancy phases, as described in Section 2.1. Architectural Energy Corporation, in cooperation with the design and construction team, will perform the following activities to achieve the intent of the Best Practice (or additional) commissioning credit:

- **Design Review at 100% Design Development**

The 100% design development review seeks to identify building system design issues and potential operation and maintenance issues that should be addressed during the Construction Documents Phase of the project. At this point in the design phase, the building system designs have been refined and many decisions crucial to overall building performance operation and maintenance have been made. This review is designed to ensure that the design team has achieved the major design goals (intent) relative to functionality, energy performance, maintainability and indoor environmental quality.

- **Develop Commissioning Specifications**

The commissioning specifications prepared by the Design Team will be reviewed by AEC for completeness. Any recommended changes to the commissioning specifications will be reviewed and approved by the Design Team prior to inclusion in the construction specifications. The commissioning specifications describe the scope and requirements for commissioning, as well as the roles and responsibilities of the general contractor, installing subcontractors, owner personnel, Design Team, and the AEC Commissioning Team.

- **Design Review at 50% Construction Documents**

The 50% construction documents review is undertaken to ensure that commissioning is adequately specified within the construction documents for those building systems to be commissioned, and that the targeted building systems are likely to meet the design goals (intent) relative to functionality, energy performance, maintainability and indoor environmental quality.

- **Design Review at 95% Construction Documents**

This review focuses on determining if the construction documents and related contract documents contain sufficient detail to fully define the operational requirements of the project. The 95% construction document review is undertaken to ensure that commissioning is adequately specified, that each building system to be commissioned can be commissioned and is likely to meet the design goals relative to functionality, energy performance, maintainability and indoor environmental quality.

- **Submittal Review**

The contractor's standard submittals will be reviewed to ensure that the equipment or system provided will meet the specifications and design intent, as they relate to environmentally responsive characteristics.

- **Develop Re-Commissioning Manual**

A Re-Commissioning Manual will be prepared which includes all information required to effectively maintain the building at optimal performance. The Re-Commissioning Manual will include, at a minimum, the following information:

- Final version of the Owner's project requirements and basis of design.
- As-built sequences of operations for all equipment as provided by the design professionals and contractors, including time-of-day schedules and schedule frequency, and detailed point listings with ranges and initial setpoints.
- Ongoing operation instructions for all energy- and water-saving features and strategies.
- Functional performance test results, blank test forms, and recommended schedule for ongoing benchmarking.
- Seasonal operational guidelines.
- Recommendations for recalibration frequency of sensors and actuators by type and use.
- Single line diagrams of each commissioned system.
- Troubleshooting table for ongoing achievement of the owner's project requirements.
- Guidelines for continuous maintenance of the owner's project requirements (operational requirements) and basis of design (basis of operation).

- **Conduct End-of-Warranty or Post-Occupancy Review**

The Architectural Energy Corporation Commissioning Team will return to the site before the end of the warranty period to review the current building operation with the facility maintenance staff. The review will also include any outstanding issues from original or seasonal testing. The Architectural Energy Corporation Commissioning Team will interview facility staff to identify concerns with building operation and provide suggestions for improvements. In addition, AEC may help identify issues that relate to the original warranty and assist staff in developing reports or documentation to remedy any problems.

## **2.4 Deliverables:**

The following list of deliverables assumes all scope listed above is accepted as part of the commissioning services scope.

### Design Phase

- 50% Design Development Phase Design Review
- 50% Construction Documents Design Review
- Commissioning Specifications
- Preliminary Commissioning Plan
- 95% Construction Documents Design Review

### Construction Phase

- Commissioning Scoping Meeting Minutes
- Submittal Review Reports, as appropriate
- Pre-functional Checklists for all equipment and systems to be commissioned
- Construction Observation Reports
- Deficiency Reports

### Acceptance Phase

- Functional Performance Testing Reports
- Deficiency Reports
- Operation and Maintenance Review
- Operation and Maintenance training agenda reviews
- Preventive Maintenance Database
- Commissioning Report
- LEED Commissioning Certification Documents

### Warranty Phase

- As-built Documentation Review Report
- Seasonal Testing Reports
- End of Warranty Period Review

### **3.0 LEED Measurement and Verification**

Credit 5 in the Energy and Atmosphere section of LEED 2.1 provides for the ongoing monitoring and optimization of building energy and water consumption performance over time. Achieving this credit involves creating a Measurement and Verification (M&V) Plan, as defined by the IPMVP 2001, and implementing the Plan to prove that the installed systems are operating at the design efficiency levels. The Plan is required to address the applicable systems in the following list:

- Lighting systems and controls
- Constant and variable motor loads
- Variable frequency drive (VFD) operation
- Chiller efficiency at variable loads (kW / ton)
- Cooling load
- Air and water economizer and heat recovery cycles
- Air distribution static pressures and ventilation air volumes
- Boiler efficiencies
- Building-specific process energy efficiency systems and equipment
- Indoor water risers and outdoor irrigation systems

To meet the requirements of this LEED M&V credit, AEC will:

- Provide input to the design team as to what monitoring equipment may be required in the mechanical and plumbing system designs to provide for the requirements of this credit.
- Create the M&V Plan per the LEED requirements.
- Implement the M&V Plan.
  - Collect monitored data from the required systems.
  - Analyze the data for equipment performance and efficiency.
  - Provide a report of the M&V efforts per the IPMVP requirements.
- Provide the signed LEED letter template for EA Credit 5
- Provide a copy of the M&V Plan with an executive summary for submission to the USGBC.

#### Short-Term Monitoring

Short-term diagnostic testing is used to investigate the dynamic interaction between building system components. The objectives of the short-term monitoring process are to evaluate scheduling, the interaction between heating and cooling, and the effectiveness of the HVAC system in meeting comfort requirements. When lighting control commissioning is included in the scope of work, AEC will monitor control operation with dataloggers on systems that are automatically controlled.

When M&V is combined with commissioning services, AEC combines the benefits of the M&V scope with the commissioning services to include short-term monitored data collection and a diagnostic testing report. This effort combines seasonal testing, a commissioning activity, with some of the M&V activities to include a more comprehensive building diagnostic report and baseline energy study.

## 4.0 Budgets

### 4.1 Commissioning Budget

The fee proposal for providing the building commissioning services described in this proposal is listed below. A level-of-effort matrix is presented which specifies the number of labor hours various categories of AEC staff will provide for the specified building commissioning activities.

AEC Staff	Loaded Billing Rates
Principal	\$130.00
Senior Engineer	\$95.00
Staff Engineer II	\$85.00
Staff Engineer I	\$75.00
Associate Engineer	\$65.00

#### 4.1.1 LEED Prerequisite Commissioning

##### Level of Effort Matrix

LEED Prerequisite Commissioning Level of Effort		Hours					Total per Task
Project Phase	Task Number	Principal	Senior Engineer I	Staff Engineer II	Staff Engineer I	Associate Engineer	
Design	1) Design Intent, Scoping mtg, CX Specs, CX	25	20	5	0	0	50
Construction	2) CX Database Entry / Project Tracking	0	0	10	0	0	10
	3) Generate PFC Forms & FPT Tests	0	0	19	9	10	38
	4) Construction and Pre-Functional Observation	0	19	39	39	0	96
	5) Construction Meetings	49	0	0	0	19	68
	6) Functional Performance Tests, TAB	40	40	0	60	0	140
Post Occupancy	7) Final Report	40	80	0	9	20	149
	<b>Totals</b>	<b>154</b>	<b>159</b>	<b>73</b>	<b>117</b>	<b>49</b>	<b>551</b>

##### Budget

AEC Commissioning Costs - LEED Prerequisite	
<b>AEC Labor</b>	
Principal	\$21,099
Senior Engineer I	\$17,176
Staff Engineer II	\$6,171
Staff Engineer I	\$8,115
Associate Engineer	\$3,211
<b>Sub-Total AEC Labor</b>	<b>\$55,772</b>
<b>Other Direct Costs</b>	
Transportation/ Travel	\$6,200
Reproduction	\$100
Postage / Overnight Delivery	\$150
<b>Sub-Total Other Direct Costs</b>	<b>\$6,450</b>
<b>Total Prerequisite Commissioning Cost</b>	<b>\$62,222</b>

## 4.1.2 LEED Additional Credit Commissioning

### Level of Effort Matrix

LEED Additional Credit Commissioning Level of Effort		Hours					Total per Task
Project Phase	Task Number	Principal	Senior Engineer I	Staff Engineer II	Staff Engineer I	Associate Engineer	
Design	1) Design Reviews	15	15	8	0	0	38
	2) Submittal Reviews	0	12	20	8	0	40
Post Occupancy	3) Seasonal Testing	22	22	29	0	0	72
	4) Warranty/ Post-Occupancy Review	35	9	0	0	0	44
	5) Re-Commissioning Manual	4	10	0	0	12	26
<b>Totals</b>		<b>76</b>	<b>68</b>	<b>56</b>	<b>8</b>	<b>12</b>	<b>220</b>

### Budget

AEC Commissioning Costs - LEED Additional Credit		
<b>AEC Labor</b>		
	Principal	\$9,880
	Senior Engineer I	\$6,422
	Staff Engineer II	\$4,794
	Staff Engineer I	\$600
	Associate Engineer	\$780
	<b>Sub-Total AEC Labor</b>	<b>\$22,476</b>
<b>Other Direct Costs</b>		
	Transportation/ Travel	\$610
	Postage / Overnight Delivery	\$100
	Supplies	\$100
	<b>Sub-Total Other Direct Costs</b>	<b>\$810</b>
<b>Total Additional Credit Commissioning Cost</b>		<b>\$23,286</b>

## 4.2 Measurement and verification Budget

The fee proposal for providing the M&V services described in this proposal is listed below. A level-of-effort matrix is presented which specifies the number of labor hours for the various categories of AEC staff.

### M&V Level of Effort Matrix

LEED Monitoring and Verification Level of Effort		Hours					
Project Phase	Task Number	Principal	Senior Engineer I	Staff Engineer II	Staff Engineer I	Associate Engineer	Total per Task
Design	1) Preliminary M&V Plan	0	8	20	10	0	38
	2) Design Reviews for Monitoring Equipment	4	12	24	0	0	40
Post Occupancy	3) Final M&V Plan	4	4	12	0	0	20
	4) Data Collection	0	24	20	8	8	60
	5) Data Analysis and Reporting	12	24	20	12	10	78
<b>Totals</b>		<b>20</b>	<b>72</b>	<b>96</b>	<b>30</b>	<b>18</b>	<b>236</b>

### M&V Budget

AEC Monitoring and Verification Costs - LEED EA Credit 5	
<b>AEC Labor</b>	
	Principal \$2,600
	Senior Engineer I \$6,840
	Staff Engineer II \$8,160
	Staff Engineer I \$2,250
	Associate Engineer \$1,170
	<b>Sub-Total AEC Labor \$21,020</b>
<b>Other Direct Costs</b>	
	Transportation/ Travel \$1,100
	<i>Quantity of Person-Trips = 2</i>
	Monitoring Equipment Lease \$2,000
	<b>Sub-Total Other Direct Costs \$3,100</b>
<b>Total M&amp;V Cost</b>	<b>\$24,120</b>

## 4.3 Total Commissioning and M&V Budgets

If all of the above scope is desired, the combined budgets for AEC is:

Total Prerequisite Commissioning Cost	\$62,222
Total Additional Credit Commissioning Cost	\$23,286
Total M&V Cost	\$24,120
<b>Total Costs</b>	<b>\$109,628</b>

## **5.0 Key Personnel**

The key Architectural Energy Corporation personnel assigned to this project would be as follows:

Erik Kolderup, PE	Principal in Charge
Erik Jeannette, PE	Project Manager / Commissioning Engineer
John Wood, PE	Commissioning Engineer, LEED Professional
Kevin Mueller, EI	Commissioning Engineer
Dan Bertini, PE	Commissioning Engineer
Tracy Phillips, EI	M&V and Commissioning Engineer

Resumes for these individuals are provided in Appendix A: Building Commissioning Qualifications.

## **6.0 Qualifications**

Architectural Energy Corporation's qualification for providing the building commissioning and M&V services described in this Statement of Work are presented in Appendix A: Building Commissioning Qualifications.

**Appendix A:**

**Architectural Energy Corporation's  
Building Commissioning Qualifications**