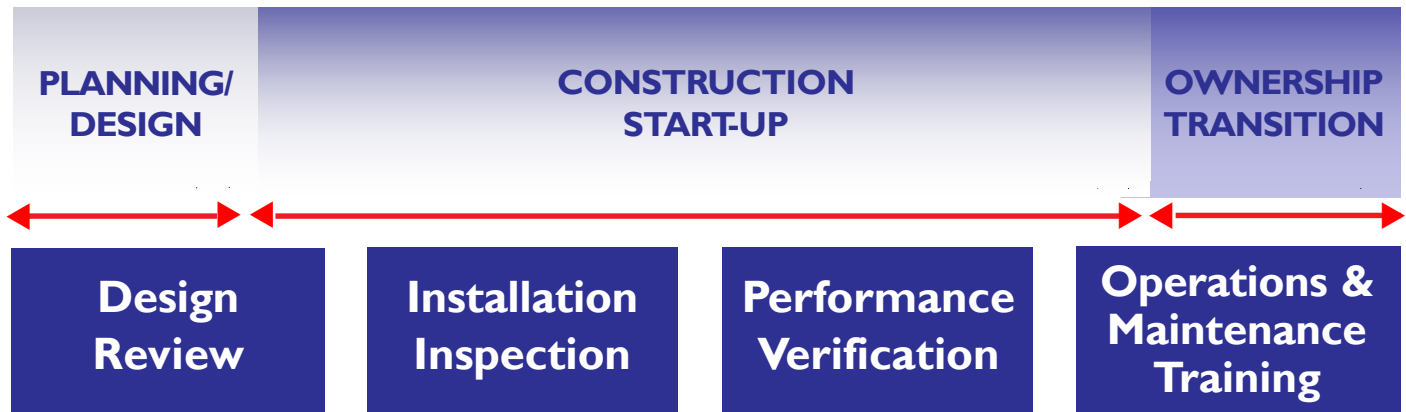




Building Commissioning Services: The Process



Building Commissioning: Value Adds for our Clients

- ✓ An Operations and Building Ownership Perspective Integrated into the Design, Construction, and Acceptance Process
- ✓ Avoided Construction Cost Over-runs from Design Reviews
- ✓ Independent System Performance Validation
- ✓ Smoother Transition from Construction to Operations
- ✓ Well Trained Staff in Operations and Maintenance
- ✓ Reduced Energy and Operational Costs
- ✓ Improved Occupant Health and Comfort
- ✓ Verification of Project Completion/Acceptance



Building Commissioning Services: Scope of Work



Design Review	Installation Inspection	Performance Verification	Operations & Maintenance Training
1) Establish Systems' Performance Criteria	1) Develop Commissioning Schedule	1) Oversee Air and Water Systems Balancing	1) Review O&M Documentation, Training and Warranty Submittals for Approval
2) Develop Acceptance Testing Protocols	2) Inspect Systems to Verify Quality of Work	2) Verify Mechanical, Electrical, and Fire Life Safety Functional Performance Tests	2) Oversee/Verify Training of Owner's Staff
3) Develop O&M Documentation, Training and Warranty Requirements	3) Oversee and Validate Corrective Actions	3) Verify Completion of Corrective Actions	3) Develop Planned Maintenance Strategy
4) Provide Peer Review of Systems Design		4) Validate Commencement of Warranty Periods	4) Verify Transaction of Systems' Operations and Maintenance
5) Identify Excessive Operating Costs		5) Provide Commissioning Results	
6) Advocate Operational Perspective During "Value Engineering Process"		6) Recommend Acceptance	

Building Performance Commissioning Services

Bridging the Gap between Building Construction and Smooth, Cost Efficient Operations

Why do so many construction projects *fail* to meet the Owner's expectations?

- Fail to perform as promised.
- Fail to provide comfortable and healthy environments.
- Fail to operate cost efficiently.
- Fail to meet occupant's expectations.
- Fail to last.

What's wrong with the way we design, construct and accept new buildings?

- Architects and contractors generally are not responsible for managing the facilities they construct and therefore have little experience in operational issues.
- Building systems' performance and occupant comfort typically do not become high priorities until the building is occupied.
- During construction, long term (50 years +) operating costs are over-shadowed by short-term (2-3 years) construction costs and project schedules.
- The lack of a clear, bright (operational) finish line makes it difficult for architects, contractors and administrators to have the same definition of "acceptance".

Another problem is that the quality assurance testing comes at the very end of the project, when it is often too late to correct design errors or construction defects easily or inexpensively.

How do you commission for success?

First, the commissioning process must begin during the project design to ensure that the administration's operational expectations are fully understood and incorporated into the design documents.



Second, the requirements of acceptance testing (that defines the project's success) should reflect the administration's design intent and should be clearly spelled out in the contract documents, *before* the bids are let.

Third, the Commissioning Firm performing the acceptance testing should be independent, impartial and working directly for the administration.

Fourth, the Commissioning Firm should have experience and expertise in all three areas of the project, including:

- Design
- Construction
- Operations and Maintenance

Why select the HEA Team?

Forty-five years in the business of designing and managing facilities provides HEA with unique capabilities in this area. Our staff of professional engineers and field technicians can tailor a commissioning plan for your next project that will cost effectively ensure success.

What will the results be?

- Reduced Operating Costs
- Improved Occupant Comfort
- Extended Building/Equipment Life

The commissioning process creates a clear, well-defined standard of care (and operational finish line) for all of the parties involved in the delivery of the project. This results in lower overall project costs, better performance from the facilities, and healthier occupants.

Building Performance Commissioning Services

Start-up, Testing and Acceptance of New Building Systems, Controls and Equipment

Seven Reasons Why new buildings often experience higher operating costs and reliability problems:

- 1) Designer/operator disconnects (designers generally don't operate buildings and vice versa).
- 2) Inadequate understanding and documentation of the administration's intent for the new facilities' operations, comfort and expected performance.
- 3) Numerous operational decisions made by designers, contractors and equipment vendors without the operator's involvement or input.
- 4) Inadequate documentation to operate and maintain the new systems efficiently.
- 5) Insufficient Operations and Maintenance training on the new systems and controls.
- 6) Insufficient *measurable* performance standards for acceptance of the completed systems.
- 7) Over-emphasis on first-costs vs. acceptance of costs.

Typical Problems

- Unreliable system operations
- Comfort/IAQ complaints
- Higher operational costs
- Higher energy costs
- Higher maintenance costs
- Reduced equipment life



A New Model for Success

Part 1:

Develop a Building Commissioning Plan to clearly define the Owner's expectations for system operations, performance and occupant comfort:

- Defines success, and how we get there.
- A strategy document to create continuity, compatibility and reliability for all new systems and equipment.
- A clear guide for future designers, contractors, equipment suppliers *and* operations staff.
- Defined goals of systems' reliability, operating/maintenance efficiencies and extended equipment life.

Part 2:

Implementation of the Commissioning Plan:

- Application of the Commissioning Plan's requirements to each new project.
- Peer review of Project Designs.
- Quality control of construction.
- Proper start-up, functional performance and acceptance testing.
- Systematic and documented transfer of the completed operations to the facility engineer.



Building Performance Commissioning Services

Commissioning Experience in Healthcare Facilities

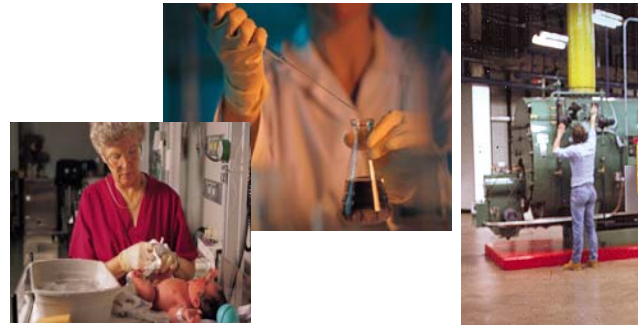
The following are recent examples of Commissioning Services that Halliwell Engineering Associates, Inc. (HEA) has provided for healthcare clients.

St. Jude Children's Research Hospital Memphis, Tennessee

HEA was asked to help identify the true cause of operational and equipment dependability problems experienced in the two years since the new 235,000 square foot hospital building was completed. Earlier attempts by the design engineers, construction manager and equipment manufacturers to reach a successful resolution of the HVAC reliability and performance problems had proven unsuccessful. HEA performed a comprehensive commissioning study of the building, and identified that a significant disconnect had occurred in the design team's understanding of the project requirements. Currently we are in the process of assisting the hospital with resolution of the operating system's design problem and functional performance, by redesigning and recommissioning the affecting systems.

Touro Infirmary New Orleans, Louisiana

A \$5,000,000 energy conservation project was completed at Touro Infirmary in 1996. Four years later, many of the energy project's components were still not working properly, and Touro's electric utility bills had not been reduced as projected. HEA was requested to determine what the problems were with the energy project, and to design corrective measures. Our engineers have completed their initial investigation, have identified the key problems, and are currently working with the Touro Infirmary Energy Project Design Team to facilitate implementation of corrective measures required to get the energy project's components to operate properly.



Packer Hospital Sayre, Pennsylvania

Packer Hospital had struggled through years of deficiencies in cooling and dehumidification capacity in 12 of its operating rooms. HEA was requested to perform an on-site commissioning study and review of the original design to analyze and correct the causes of these deficiencies.

The HEA engineers discovered significant operating deficiencies, but concluded that the major cause of these problems was the inappropriate design criteria used by the architect/engineer for the original HVAC system installation.

Our engineers developed a design for the enhancement of the existing system that would increase the existing cooling/dehumidification capacity by 30%, thereby providing significant improvement in the operating suites.

The hospital has now requested that HEA provide a full commissioning program for the planned design and construction of the new surgical facility in 2002.

Elliot Hospital Manchester, New Hampshire

HEA was requested by Elliot Hospital to perform a peer review of the project design documents and subsequent on-site commissioning of the completed installation. The project was generally comprised of the removal of an existing chiller, cooling tower and related mechanical and electrical equipment. A new 800-ton centrifugal chiller, chilled water and condenser water pumps, piping, controls and associated electrical work were installed in its place.

Building Performance Commissioning Services

Commissioning Experience in Healthcare Facilities (continued)

St. Francis Medical Center Wichita, Kansas

HEA was retained by the Medical Center (through its legal counsel) to conduct commissioning surveys of the installed two years old mechanical and electrical systems.

The Medical Center had been experiencing operational and performance problems during the first two years of occupancy.

Deficiencies identified included:

Excessive operating noise; Excessive air systems air leakage; water damage (condensate flow) from air handling units into occupied spaces; premature failures of AHU dampers; erratic room temperature control; some terminal units installed upside down, resulting in poor automatic control; some air handling unit coils installed upside down and backwards; lack of or absence of appropriate access doors to equipment and dampers, and poor quality duct construction and installation.

The deficiencies were divided into two categories:

1) Those concluded to be caused by improper materials and construction; and 2) those concluded to be caused by engineering problems.

The commissioning survey determined that the vast majority of deficiencies were caused by improper construction, installation and installed materials.

University of New Hampshire Morse Medical Research Building Durham, New Hampshire

HEA provided forensic engineering and commissioning services to resolve design deficiencies in a five year old, 225,000 square foot medical research lab building. HEA designed interim modifications to the existing facility to improve its usefulness, while acting as the owner's commissioning agent during the process of identifying the building's operating intent, and converting the intent to usable design parameters/criteria.

LifeStream Behavioral Center Leesburg, Florida

HEA provided engineering services to evaluate the design and construction of the HVAC systems as they were nearing completion. HEA worked primarily with the owner and architect, since the engineer of record had abandoned the project.

Several notable problems with the HVAC systems were discovered and resolved as part of the design review, construction inspections, and acceptance testing.

These problems were as follows:

Water piping in the ceiling was sweating and dripping condensate on ceiling tiles due to poor installation of the insulation; many of the chilled water valves were failing prematurely because insulation had been installed around the top of the electric actuator, causing condensation to drip into and connect inside the actuator housing; the building was under severe negative pressure due to inadequate outside air being introduced into the building through the make-up air unit, and excessive air being exhausted from the building and the ventilated attic space; relative humidity within the building was high due to negative pressure and inadequate preconditioning of the outside air, resulting in damage to wood finishes caused by mold and mildew; condensate drain lines from the fan coil units in the ceilings were not flowing properly due to inadequate slope; several areas of chilled water piping were found to be uninsulated, causing condensation to leak behind finished walls and ceilings, and causing damage to floors and walls; many installed chilled water balancing valves were too large to properly balance the chilled water flows to the fan coil units; some fan coil units were improperly sized due to errors in the engineer's fan coil unit schedule in the contract documents.

Blue Cross of South Carolina Columbia, South Carolina

HEA provided building commissioning services for the entire mechanical, electrical and architectural renovation of a 14-story office building. HEA assisted the owner in identifying/developing the design criteria and performance requirements in the conceptual design phase, as well as providing design documents and field guidance to the contractors. During construction, testing and training, we provided management assistance to ensure that the renovation work met the owner's requirements.

Building Performance Commissioning Services

Three Scopes of Services Offered

The following are examples of three commissioning scopes of services which can be selected (performed) separately or together, depending upon the needs of the Owner and/or Developer. **Results are optimized when all three services are combined.**

SCOPE NO. 1:

Development of Design Criteria and Acceptance Testing of New Systems and Equipment

Focus:

Systems performance, operating costs, occupant comfort.

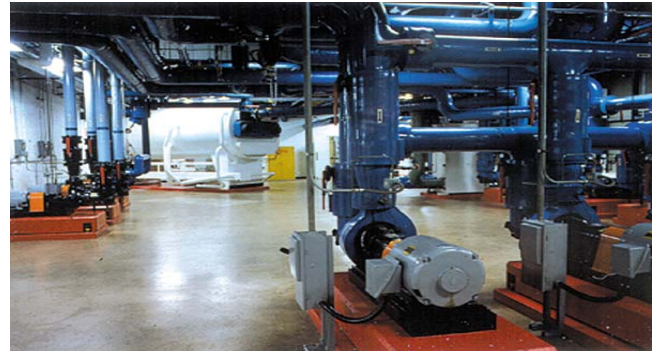
Purpose:

To ensure that an accurate specification and understanding of the Owner's operational and building performance requirements are conveyed to the design team, and that an independent and objective acceptance evaluation of the installed systems is performed during start-up operations to verify that operational requirements have been met. During this phase of the work, the commissioning engineer will verify that:

- The Owner's Performance Criteria are accurately conveyed to the design team.
- The System's Design Concepts are appropriate to meet the Owner's expectations.
- The construction specifications for acceptance testing are clear and accurate.
- Project completion is well defined and validated.
- Acceptance testing will verify that the building's performance criteria has been met.

Scope of Work:

- Conduct meetings with the Owner and the A/E to identify appropriate operational performance criteria of new building systems (i.e. code minimums, engineering standards or state of the art) and ensure these are developed, understood and documented.
- Develop acceptance (performance-based) testing criteria to be included in A/E's final bid documents to reflect the Owner's operational requirements.



- Review the Engineering design concepts to ensure they are likely to meet the Owner's expectations for building performance.
- Review submittals of key systems/equipment for compliance with performance requirements following review/approval by engineer of record.
- Conduct periodic site visits to observe the quality of installation and level of completion.
- Observe and validate performance testing of new systems and equipment by responsible parties.
- Provide commissioning report to the Owner on acceptability of performance testing, Owner training, delivery of record documents, commencement of warranty periods, and recommendations for Owner's acceptance of completed contracts, and discharge of final payments in conjunction with the engineer of record.

Value Proposition:

This scope of work is designed specifically to bring the following additional values to the construction program:

- Independent inspection and validation of the construction quality.
- Independent verification of the performance of the new building system and equipment.
- Objective analysis of the completed project and recommendations of when to issue Owner's acceptance of the project.
- Minimize problems and delays at systems' start-up.
- Provide a smoother transition from construction to operations.
- Provide confidence in performance and reliability of the completed project.

A not-to-exceed allowance amount will be determined for Scope of Services No. 1, based on the specific information provided for each facility(ies).

Building Performance Commissioning Services

Three Scopes of Services (continued)

SCOPE NO. 2:

Design Due Diligence Review/ Recommendations

Focus:

Minimizing design errors, omissions and resulting cost overruns.

Purpose:

To provide an independent and objective review of the project design, minimize errors and omissions, and minimize conflicts that would have a negative impact on project costs, schedule and Owner's satisfaction with the completed project.

Scope of Work:

- Provide a due diligence design review at 20%, 50%, and 95% completion of design documents, to identify errors, omissions and conflicts; operational cost impacts; and life cycle cost impacts.
- Review key submittals of major/critical equipment coincident with review and approval by the engineer of record.
- With each due diligence design review, provide a briefing with the designers to discuss issues, concerns and suggested solutions.

Value Proposition:

This scope of work is designed to minimize the potential for change orders, cost overruns and project delays by providing independent review of the design documents prior to being released for competitive bidding. In addition, the design review will also make note and recommendations on design features that could negatively impact operating costs and life cycle costs of the new facilities.

A not-to-exceed allowance amount will be determined for Scope of Services No. 2, based on the specific information provided for each facility(ies).

SCOPE NO. 3:

Plant Operations and Maintenance Strategic Plan

Focus:

To quickly transition from construction to smooth and efficient operations.

Purpose:

The purpose of this scope of work is to specify and verify the new systems and equipment documentation and training requirements in order to ensure a smooth initial start-up as well as long-term cost-effective operation of the new systems.

Scope of Work:

- Develop the requirements for the operations/maintenance/warranty documentation package to be provided by the contractor for inclusion into the A/E's (designer's) bid package.
- Develop requirements for the operator training package for inclusion into the A/E's (designer's) bid package.
- Inspect, verify and document the completion, full implementation and effectiveness of the operational transfer to the building engineer.

Value Proposition

This scope of work is designed to minimize/resolve problems often experienced at project start-up and throughout the first year of operation, caused by inadequate documentation and training on the operations and maintenance of the new systems. By setting specific standards and expectations for both documentation and training during the bidding phase of the project, we can inspect and verify that these requirements have been met, and that the systems can be cost-effectively operated and maintained by the in-house staff from the first day of project acceptance. This will result in fewer problems at start-up, fewer service calls, lower operating costs, and longer equipment life.

A not-to-exceed allowance amount will be determined for Scope of Services No. 3, based on the specific information provided for each facility(ies).