

Appendix A – Commissioning Plan

Phase II BLO Coastguard Headquarters District
Heating Line Replacement



Public Works and
Government Services
Canada

COMMISSIONING PLAN CANADIAN COASTGUARD HEADQUARTERS DISTRICT ENERGY



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INTRODUCTION

F.C. O'Neill, Scriven & Associates Limited (ONSA) was engaged by Public Works and Government Services Canada (PWGSC) to provide the mechanical and electrical engineering design and contract administration services for the replacement of the district heating lines to/from the Bedford Institute of Oceanography's Canadian Coastguard Headquarters.

Commissioning Goals

Commissioning is often misinterpreted to focus solely on the functional performance testing during the end of the construction phase. Commissioning is a collaborative process for planning, delivering and operating buildings that function as intended by the design and as expected by the owner. Commissioning is the process of ensuring that systems are designed, installed, functionally tested and capable of being operated and maintained to perform. Commissioning begins with planning and includes design, construction, start-up, acceptance and training and can be applied throughout the life of the building. Accordingly, the goals of commissioning are to:

- ✓ Define and document the Owner's Project Requirements clearly and update through the process;
- ✓ Verify and document compliance;
- ✓ Establish and document commissioning process tasks;
- ✓ Deliver buildings and construction projects that meet the Owner's Project Requirements; and
- ✓ Verify that operation and maintenance personnel and occupants are properly trained.

New building commissioning is an intensive quality assurance process that begins during the concept design of a new building and continues through the detailed design, the construction, the start-up, the occupancy and the first year of operation of the building. The commissioning process ensures that the new building operates as initially intended, meeting the Owner's Project Requirements and that building staff are prepared to operate and maintain its systems and equipment. The intent of the commissioning process is to verify and ensure that the fundamental building elements and systems are designed, installed and calibrated to operate as intended.

This commissioning report provides the necessary documentation for both the initial commissioning plan as well as the final commissioning report. As a result, this report will be continuously updated throughout the commissioning process as well as the progress of the project as new information is received and as the project moves through the various development stages towards completion.



COMMISSIONING PRINCIPLES AND OBJECTIVES

Regardless of the extent of the building systems commissioning determined to be appropriate for a particular project and the approach utilized, there are three overarching principles in the commissioning process that begin during the project concept development and continue through occupancy and operation of the building.

Determine Project Performance Requirements

Every project goes through pre-design and design stages that establish the Owner's Project Requirements as well as the goals, scope and design solutions for a proposed project. Proposed designs and constructed work can only be evaluated against objective criteria and measures that are well-documented in project requirement documents. Project development is a learning process where building performance decisions are refined to successive levels of detail over the course of a project's life cycle.

Plan the Commissioning Process

Commissioning involves the process of planning team member roles and responsibilities as well as tasks for all project phases and activities, including review and acceptance procedures, documentation requirements, development and approval of commissioning plans, commissioning schedules as well as testing and inspection plans. Planning the commissioning process includes identification of special testing needs for unique equipment and systems as well as measures that will assure adequate operation and maintenance training.

Document Compliance and Acceptance

Commissioning serves as the historical record of an owner's expectations for project performance throughout the project delivery process. The purpose of commissioning documentation is to record the key delivery team decisions throughout the planning and delivery process. Commissioning documents the establishment of standards of performance for building systems and verifies that designed and constructed work meets those standards.



BUILDING DESCRIPTION AND DESIGN INTENT

The Canadian Coastguard Headquarters has heating provided by the Bedford Institute of Oceanography's central heat plant through buried hot water supply and return piping. The purpose of this project is to replace the buried piping (due to leaks resulting from significant corrosion) and install a leak detection system for the new piping.

Owner's Project Requirements

The Owner's Project Requirements provide details regarding the owner's expectations of how the facility will be used and operated. The document provides a description of the Building's physical and functional characteristics as well as performance and acceptance criteria. It is an essential document because it will serve as a baseline for decision making throughout the rest of the design and construction process and be used by the Commissioning Authority to evaluate the project's development.

The primary role of the Commissioning Authority during the Building concept design is to help the owner and the project team document the Owner's Project Requirements. The development of the document was a team effort and involved the owner, design professionals and the Commissioning Authority. The document states the owner's goals and objectives for the Building as well as defines performance and acceptance criteria for each item listed within the document. The Owner's Project Requirements will be reviewed by the Commissioning Authority and assessed for clarity and completeness prior to the approval of contractor submittals of any equipment and/or systems to be commissioned.

Where this project is within an existing facility, the Owner's Project Requirements are focused solely to aspects, or objectives, of the renovation scope of work. Please see below for a summary of the Owner's Project Requirements: [to be insert].

Basis of Design

The Basis of Design is a document developed by the design professionals based on the goals and objectives outlined within the Owner's Project Requirements. The document provides design specifics, such as local climatic conditions, occupancy levels, space conditions required, process and efficiency requirements, to achieve the Owner's Project Requirements. In addition, it documents concept design decisions on systems and types of products selected.

Applicable regulatory requirements, standards and guidelines to be followed are also summarized within the Basis of Design document. It will also include narrative descriptions as well as lists of individual items that the design was based on. The Basis of Design is also a continually evolving document that will be reviewed by the Commissioning Authority and updated by the design professionals throughout the design phase of the project. The Basis of Design includes the concepts and features the design professionals intend to incorporate into the design to meet the Owner's Project Requirements. The document includes:

- ✓ Objectives and purpose of each system and how the objectives will be met;
- ✓ Indoor and/or outdoor design conditions;
- ✓ Occupancy, usage and schedule assumptions;
- ✓ Zoning descriptions;
- ✓ Ventilation requirements;
- ✓ Envelope requirements;
- ✓ Equipment sizing and criteria;
- ✓ Basic sequence of operation
- ✓ Energy and water efficiency strategies;
- ✓ Design intent for efficiency measures; and
- ✓ Reference to pertinent local, provincial and/or federal compliance documents.

Similar to the Owner's Project Requirements above, where the project is within an existing facility, the Basis of Design focused solely to aspects, or objectives, of the renovation. Please see below for a summary of the Basis of Design: [to be inserted]

Project Commissioning Specifications

The project's commissioning specifications define the contractors' commissioning-related responsibilities, including equipment installation and start-up, documentation and functional performance testing. As discussed in the section, Commissioning Team and Member Responsibilities, it is the design professionals' responsibility to develop the detailed commissioning specification requirements, however, the Commissioning Authority will have input into the language used and will review the requirements prior to the specifications being released. The commissioning specifications provide details relating to the:

- ✓ Contractors' expected communication and interface with the Commissioning Authority's construction oversight and testing procedures;
- ✓ Appropriate staff training requirements, especially when installing contractors and/or manufacturers' representatives were required to participate;
- ✓ Special equipment and/or instrumentation required to obtain measurements during performance testing; and
- ✓ Responsibility for compiling equipment installation verification, start-up reports and functional performance testing reports, developing operation and maintenance manuals and the deadline for their delivery to the commissioning authority.

BUILDING COMMISSIONING

The buildings designed and built today are sophisticated structures designed with the aid of sophisticated computer aided drafting software. In recent years, there has been a growing interest in the design and construction of sustainable buildings, resulting in greater emphasis on building commissioning. Buildings, if not properly commissioned, can be plagued by complaints and operational issues. Studies have been completed that demonstrate building commissioning can save building owners and property managers five (5) to twenty (20) percent in annual operating and maintenance costs.

A 1994 study of sixty (60) commercial buildings found that more than fifty (50) percent of the buildings surveyed suffered from temperature control problems, while forty (40) percent had problems with heating, ventilation and air conditioning equipment and thirty-three (33) percent had sensors that did not function properly. Furthermore, fifteen (15) percent of the buildings were actually missing specified equipment. A recent study also reported that twenty (20) to thirty (30) percent of commercial buildings suffer from indoor air quality problems. Uncomfortable building occupants will lead to increased complaints, resulting in increased expenses and hassles for the building owner. Building commissioning helps to prevent these problems. It has been reported that commissioning can reduce indoor environmental complaints by up to thirty-five (35) percent.

All forms of building commissioning share the same goals: to produce a building that meets the unique needs of its owner and occupants, operates as efficiently as possible, provides a safe, comfortable work environment and is operated and maintained by a well-trained staff or service contractor.

The commissioning process is a team effort, led by the Commissioning Authority who verifies the building meets the Owner's Project Requirements at each stage of the commissioning process. Since each building project is unique, the Commissioning Authority adapts the process to meet the project's specific goals. The Commissioning Authority should be an individual that is not involved in the design or construction of the building. However, there are projects where it may not be possible for the Commissioning Authority to be independent of the design or construction of the building, such as with the design and construction of smaller buildings (i.e. less than 50,000 square feet).

Commissioning Process Benefits

Commissioning benefits are far-reaching. Each of the participants in the design and construction process will benefit from commissioning and so will the building's owner, staff and future occupants. One study of six (6) new construction projects found that commissioning reduced change orders by eighty-seven (87) percent as well as contractor call-backs by ninety (90) percent, reducing the total construction cost by an estimated four (4) percent to nine (9) percent. Some of the benefits of commissioning have been briefly outlined below (the following list is not meant to be comprehensive summary or a guarantee of the benefits).

Cost Savings:

When commissioning starts during the design phase of a new construction project, the result is significant cost savings. Errors caught on paper, rather than

on the job site, are much less expensive to fix. Because commissioning identifies and helps resolve potential problems, it reduces costly change orders and contractor call-backs. This in turn helps to keep the project on schedule and on budget.

Improved Coordination: Commissioning improves communication between all team members. Without clear and frequent communication, there is little chance the new building will meet the Owner's Project Requirements. Throughout the project, commissioning tracks and resolves issues, focusing communication on passing problems. During commissioning meetings, participants are encouraged to consider one another's perspectives while maintaining a consistent focus on the owner's expectations for building performance. This improves the ability of the project team to identify the best long-term solutions for problems like oversized and inefficiently functioning systems, installation of the wrong equipment and incorrect programming of the sequences of operation.

Energy Savings: More and more building owners want to reduce energy use in their facility. Building commissioning ensures that the building's systems and equipment, as well as any special energy efficiency features, are installed and work correctly.

Fewer Deficiencies: During the last few months before turnover, the project team often focuses its attention on the systems and equipment most critical to obtain permits and readying the building for occupancy. At this stage it is easy to overlook incomplete or deficient systems, but problems that remain after turnover do not go away without attention.

Improved Environment: The quality of a building's indoor environment affects the health, comfort and productivity of its occupants. The consequences of poor indoor environmental quality range from mildly inconvenient to very serious. Temperature and lighting can cause an uncomfortable work environment that hinders learning and lowers an organization's efficiency and productivity. In more severe cases, poor air quality can cause headaches, fatigue or severe allergic reactions.

COMMISSIONING PLAN

The commissioning plan is an evolving document and will be continually shaped throughout the commissioning process as well as reviewed at major milestones throughout the project. For example, the plan below outlines specific commissioning-related activities to be completed during the pre-design phase, however, certain specific commissioning-related activities to be completed during the construction phase may not yet be determined at this point in the project. The commissioning plan will be updated to reflect the required commissioning-related activities as they are determined.

Generally speaking, the commissioning plan provides an outline of the project's commissioning activities, schedule, documentation requirements and the roles and responsibilities of the commissioning team. The specifics of the commissioning plan include:

- ✓ Building information and contact information;
- ✓ Project goals;
- ✓ An overview of the commissioning process, including the scope of commissioning;
- ✓ Building and system descriptions, including a list of components and systems to be commissioned;
- ✓ Commissioning process schedule;
- ✓ A List of team members, their responsibilities and expected deliverables;
- ✓ Description of communication, reporting and management protocols;
- ✓ Detailed description of testing procedures;
- ✓ Detailed description of monitoring procedures; and
- ✓ Recommended training activities.

Commissioning Program Overview and Process Activities

The commissioning process began during the pre-design phase of the project and will be carried through the construction phase and into the occupancy and operations phase. The table provided below provides a high-level overview of the commissioning activities outlined in the commissioning plan and to be completed during each phase of the building project, including the building concept design, the detailed design, the construction, the occupancy and the operation.

Project Phase	Commissioning Activity Description
Concept Design Phase	Commissioning Authority Selected
	Commissioning Team Formed
	Owner's Project Requirements and Basis of Design Developed
	Commissioning Plan Developed
Design Phase	Design Drawings and Specifications Reviewed
	Commissioning Plan Updated

Project Phase	Commissioning Activity Description
	Commissioning Specifications Developed
	Verification Checklists, Functional Tests, Systems Manual and Training Requirements Developed and Planned
	Develop Design Phase Issues Logs
	Owner's Project Requirements and Basis of Design Reviewed
Construction Phase	Contractor Submittals and Coordination Drawings Reviewed
	Functional Performance Testing, Diagnostic Monitoring and Verification Check Lists Prepared (finalized based on contractor submittals)
	Verification Checklists Completed
	Functional Testing, Diagnostic Monitoring and Verification Checks Performed
	Issues Track and Rectified
	Training of Owner's Staff Verified and Reviewed
	Commissioning Report and Systems Manual Developed
	O&M Manuals Reviewed
	Owner's Project Requirements and Basis of Design Reviewed
	Commissioning Plan Updated
Occupancy and Operations Phase	As-Built Sequence of Operations Finalized
	Outstanding Commissioning Issues Resolved
	Occupant Concerns Reviewed and Resolved
	Final Issues Log Prepared
	Final Commissioning Report Prepared

The information shown in the table above is meant to provide a summary of the phases and relevant activities outlined in the commissioning plan and completed during the commissioning process, additional details regarding the successful completion of the activity and supporting documentation have been provided within the remaining sections of the report and appendices.

Commissioning Team

Roles and responsibilities will be outlined at a commissioning scoping meeting, which will occur early in the project and which all team members will be required to attend. At this meeting, the owner and the Commissioning Authority will describe each team member's responsibilities, as well as the commissioning



scope, process and schedule. Furthermore, the commissioning plan will clearly define and document the responsibilities of each team member.

It is important to note that neither the commissioning team nor the Commissioning Authority manages the design and construction process. Team members will be informed that they are not authorized to direct work, nor accept a building or system. Rather, their purpose is to facilitate communication, resolve issues and document performance.

The commissioning team includes the Commissioning Authority, the building owner (and the owner's representative), the building manager (and facility staff), the contractors (and manufacturers' representatives) and the design professionals. For further details regarding the roles and responsibilities of the various team members please see the section titled, Commissioning Team and Member Responsibilities.

Communication Protocol, Coordination, Meetings and/or Management

Throughout the commissioning process, it is the intent of the meetings and commissioning plan to create and maintain a cooperative and mutually-beneficial working environment between the owner, the design professionals, the contractors and the Commissioning Authority. As the Commissioning Authority was engaged by the owner, to provide commissioning service, all reports and correspondence related to commissioning will be directed to include the Commissioning Authority. All of the parties involved in commissioning will be directed to coordinate their activities with the Commissioning Authority and, where required, provide the necessary equipment to enable the Commissioning Authority to fulfill the required commissioning activities.

COMMISSIONING TEAM AND MEMBER RESPONSIBILITIES

The commissioning team will work together to identify and resolve problems early in the design and construction process, following them through to their eventual resolution and ensuring that the delivered building meets the owner's requirements and expectations. Clearly defined and documented responsibilities for each team member are vital to the success of the commissioning project.

Commissioning Authority

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The Commissioning Authority is responsible for delivering the commissioning requirements for the building. The Commissioning Authority leads the commissioning process and planning as well as schedules and coordinates the commissioning activities.

During the design phase, the Commissioning Authority works with the project team to ensure that the owner's requirements and expectations for building operations are adequately documented in the Owner's Project Requirements and submits peer review comments on the design submissions, including the Basis of Design, design drawings and design specifications.

During the construction phase, the Commissioning Authority visits the job site frequently, documents concerns and issues, witnesses' system start-up and functional testing of systems and/or components as well as verifies that all of the necessary documentation and training has been completed. Specific responsibilities of the commissioning authority include, but are not limited to:

- ✓ Organizes and leads the commissioning team;
- ✓ Ensures that the owner's expectations are adequately documented in the Owner's Project Requirements;
- ✓ Peer reviews design submittals and shop drawings;
- ✓ Assists in documenting the commissioning requirements to be included in the design specifications;
- ✓ Prepares and updates the commissioning plan;
- ✓ Develops and maintains review documents and issue logs;
- ✓ Observes construction;
- ✓ Observes and documents functional performance testing;
- ✓ Reviews operation and maintenance documentation to ensure complete and applicable;
- ✓ Attends staff training sessions and verifies training was acceptable; and
- ✓ Prepares and submits final commissioning report.

Building Owner or Owner's Representative



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The owner's and/or the owner's representative's primary responsibilities are to support the commissioning team and to clearly communicate expectations about how the building is to operate. These expectations will be documented and serve as the foundation for the commissioning process as well as the design and construction phases of the project. Specific responsibilities of the owner and/or the owner's representative include, but are not limited to:

- ✓ Clearly communicate expectations and goals for the project;
- ✓ Assign staff to represent interests during the commissioning process;
- ✓ Work with the commissioning authority to determine the scope and goals of the commissioning process;
- ✓ Review and comment on reports submitted by the Commissioning Authority;
- ✓ Approve start-up and functional performance test completion; and
- ✓ Include future building staff in the process.

Building Manager and Facility Staff

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By participating in the commissioning process, the building manager and/or the facility staff gain an understanding of the building's systems, the inter-system interactions as well as of the original design intent in advance of turnover and occupancy. Training will also be provided by the contractors for the building manager and/or the facility staff regarding the installed equipment and control strategies. Specific responsibilities of the building manager and/or facility staff include, but are not limited to:

- ✓ Review designs for maintainability;
- ✓ Participate in periodic site walkthroughs;
- ✓ Observe functional performance testing; and
- ✓ Participate in training sessions.

Contractor and Manufacturer Representatives

Name: T.B.D.
Company: T.B.D.
Phone: T.B.D.

E-mail: T.B.D.

The contractor and/or the manufacturer representatives construct the facility. They provide, install, start and test the building's systems and components. Their commissioning responsibilities are limited to what appear in the project design specifications.

It is the responsibility of the contractor and/or the manufacturer representatives to ensure that the completed building systems operate as intended in the design. Their specific tasks include working with the Commissioning Authority to conduct functional performance tests on the systems they install, helping to resolve any deficiencies and providing documentation on system start-ups. They are also responsible for providing system operation and maintenance documentation as well as training building staff. Specific responsibilities of the contractor and/or the manufacturer representatives include, but are not limited to:

- ✓ Supply the Commissioning Authority with all of the requested shop drawings and respond to requests for information;
- ✓ Review functional performance tests developed by the Commissioning Authority;
- ✓ Assist the Commissioning Authority during the functional performance tests;
- ✓ Work with the commissioning team to remedy deficiencies;
- ✓ Prepare operation and maintenance manuals;
- ✓ Provide documentation for the system manuals; and
- ✓ Develop and conduct training for building staff.

Design Professional

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The design professionals include the mechanical design engineer and electrical design engineer. The design professionals develop plans and specifications for the building that met the owner's needs and expectations. Their role in commissioning is to work with the Commissioning Authority to document the owner's expectations for building operations in the owner's project requirement document, prepare their respective bases of design and work with the commissioning team to resolve issues that arise during the design and construction phases. Specific responsibilities of the design professionals include, but are not limited to:

- ✓ Complete and issue municipal and/or provincial Design Compliance Letters of Undertaking and Project Completion Forms;
- ✓ Review shop drawings;
- ✓ Review Commissioning Authority's commissioning activities;
- ✓ Review the Authorities Having Jurisdiction inspection reports;
- ✓ Conduct periodic site reviews and prepare site review reports;
- ✓ Supervise and/or witness tests conducted on-site;



- ✓ Review Contemplated Change Orders, Change Directives and Site Instructions;
- ✓ Attend project site meetings;
- ✓ Prepare deficiency reports and confirmed deficient work completed;
- ✓ Review operation and maintenance manuals;
- ✓ Review manufacturer installation verification, start-up and material test reports;
- ✓ Review testing, adjusting and balancing report;
- ✓ Review warranty letters; and
- ✓ Review As-Built and/or Record drawings.

COMMISSIONING PROCESS

As discussed above, the commissioning process begins during the pre-design phase of the project and carries through the construction phase and into the occupancy and operations phase. The table below provides a high-level overview of the commissioning activities outlined in the commissioning plan.

Project Phase	Commissioning Activity Description	Date
Concept Design Phase	Commissioning Authority Selected	-
	Commissioning Team Formed	-
	Owner's Project Requirements and Basis of Design Developed	-
	Commissioning Plan Developed	-
Design Phase	Design Drawings and Specifications Reviewed	-
	Commissioning Plan Updated	-
	Commissioning Specifications Developed	-
	Verification Checklists, Functional Tests, Systems Manual and Training Requirements Developed and Planned	-
	Develop Design Phase Issues Logs	-
	Owner's Project Requirements and Basis of Design Reviewed	-
Construction Phase	Contractor Submittals and Coordination Drawings Reviewed	-
	Verification Checklists Completed	-
	Functional Testing, Diagnostic Monitoring and Verification Checks Performed	-
	Issues Track and Rectified	-
	Training of Owner's Staff Verified and Reviewed	-
	Commissioning Report and Systems Manual Developed	-
	O&M Manuals Reviewed	-
	Owner's Project Requirements and Basis of Design Reviewed	-
	Commissioning Plan Updated	-

Project Phase	Commissioning Activity Description	Date
Occupancy and Operations Phase	Seasonal / Deferred Testing Performed	-
	Near Warranty-End Review Performed	-
	As-Built Sequence of Operations Finalized	-
	Outstanding Commissioning Issues Resolved	-
	Occupant Concerns Reviewed and Resolved	-
	Final Issues Log Prepared	-
	Final Commissioning Report Prepared	-

Installation Verification and Functional Performance Testing

As discussed above, the Commissioning Authority is responsible for the verification of the installation and performance of the commissioned systems. Commissioning is conducted to verify that the performance of the commissioned systems (as installed) meet the Owner's Project Requirements, Basis of Design and contract documents. Commissioning process activities will be completed for the following systems, including: [to be inserted, refer to Section 01 91 13 - General Commissioning (Cx) Requirements].

The verification of the installation and performance of the commissioned systems includes three steps for each system to be commissioned: the installation inspection, the performance testing and a comparison of the results with the Owner's Project Requirements.

Installation Inspection: Sometimes referred to as pre-functional inspections, installation inspections will be developed and conducted as a systemic set of procedures intended to identify whether individual system components were installed correctly. This process will occur during the start-up of individual units of equipment and involve the use of pre-functional checklists as well as start-up forms to ensure the consistency of the inspections and document the process. The installation inspections will be completed by the appropriate contractor at the time of installation and be verified by the Commissioning Authority as well as design professionals. The installation inspections provide quality control and ensure that relatively minor issues will be discovered and corrected prior to system performance testing.

Performance Testing: Referred to as functional performance testing, performance testing occurs once all of the system components have been installed, energized, programmed, balanced and made otherwise ready for operation under part-load and full-load conditions. Testing will include each process in the sequence of operations under central and packaged equipment control, including the start-up, shut-down, capacity modulation, emergency and failure modes, alarms and interlocks to other equipment.

The Commissioning Authority is responsible for the development of the system performance testing procedures. The procedures used will rely on a wide range of methods to simulate and evaluate that the system being tested performed as expected (as per the Owner's Project Requirements, Basis of Design and Contract Documents) in all modes of operation.

Systems performance testing will be completed by the appropriate contractor and verified by the Commissioning Authority, as outlined in the commissioning specifications and the commissioning plan. The performance testing will reveal problems with the performance of the commissioned systems that require follow-up and coordination amongst the contractors to replace and/or repair.

Evaluation of Results: The evaluation of the results is the final step, at each point during the process of installation inspections and systems performance testing, the Commissioning Authority evaluates whether the installed systems met the criteria for the project as set forth in the Owner's Project Requirements and the Basis of Design.

Training Program Evaluation

Operation and maintenance documentation and training are vital to the long term operational health of the facility. Thorough training provided by the contractor will provide the staff with the information they need to operate and maintain the facility. The Commissioning Authority will work with the owner's representative and building staff to ensure that the training agenda meet the specifications in the contract documents as well as the Owner's Project Requirements. The requirements for the training will be outlined in the specifications and the Commissioning Authority will verify that they are carried out as intended.

The contractor and manufacturers' representatives will conduct the training for the owner's representative and facility staff. The training program will consist of:

- ✓ Description of systems and/or equipment and the warranties;
- ✓ Operating instructions and procedures, including seasonal changeover and manual/automatic control;
- ✓ Emergency instructions and procedures;
- ✓ Operation and adjustment of dampers, valves and controls;
- ✓ Adjustment instructions, including information for maintain operational parameters;
- ✓ Requirements and schedules for maintenance on all sensitive equipment;
- ✓ Common problems, their causes and corrective actions;
- ✓ Indoor air quality, health, visual comfort, acoustic comfort and safety issues;
- ✓ Recommendations for special tools and spare parts inventory;
- ✓ Hands-on operation of equipment and systems;
- ✓ Review of operation and maintenance manuals and location on-site;
- ✓ Building walk-through;

- ✓ Review of related Owner's Project Requirement documents;
- ✓ Energy management control system operation and programming;
- ✓ Control sequences and strategies;
- ✓ Thermostat programming;
- ✓ Relevant commissioning reports and documents;
- ✓ Sound energy management practices; and
- ✓ Exotic or special equipment.

Operation & Maintenance Manual Evaluation

Operation and maintenance manuals contain essential information about building equipment that will be used for years to come. The final version of the operation and maintenance manuals will be a well-organized, detailed and delivered in time for staff training. In order for the facility staff to use the operation and maintenance manuals effectively, the information they contain must be well-organized. An index or table of contents improves the usability, and when created early in the project, it will also serve as a checklist to ensure all of the required contents have been received. It is typically more helpful to organize the manuals by system, rather than specification number. The information in the operation and maintenance manuals will be detailed enough to help building staff operate, maintain and troubleshoot equipment.

The contractors will be responsible to produce the operation and maintenance manuals, as outlined in the specifications. Furthermore, the specifications will include the level of detail, the layout and organization requirements, all items required in the manuals and their due date. The Commissioning Authority's scope of work will also include reviewing the draft and final operation and maintenance manuals to ensure that they meet the specifications as well as the owner's requirements. The operation and maintenance manuals will include:

- ✓ Installing contractor contact information;
- ✓ Supplier's and/or manufacturer's contact information;
- ✓ Product data, including tag number, manufacturer, model number, serial number as well as all options identified;
- ✓ Test data and performance curves;
- ✓ Installation instructions;
- ✓ Operation requirements;
- ✓ Preventative maintenance requirements;
- ✓ Parts lists, including replacement parts, special tools and local sources;
- ✓ Troubleshooting procedures specific to the equipment design and application;
- ✓ Equipment submittals;
- ✓ Design documents;
- ✓ Control strategies;
- ✓ Sequences of operations;
- ✓ Copies of commissioning test reports;
- ✓ Copy of testing, adjusting and balancing report;



- ✓ Warranty information;
- ✓ Single line schematic of control drawings; and
- ✓ Field wiring diagrams for line voltage and controls connections.