

**PART 1 - GENERAL**

**1.1 COMMISSIONING DESCRIPTION**

- A. This Section 01 91 13 GENERAL COMMISSIONING REQUIREMENTS shall form the basis of the construction phase commissioning process and procedures. The Commissioning Agent shall add, modify, and refine the commissioning procedures, as approved by the Owner, to suit field conditions and actual manufacturer's equipment, incorporate test data and procedure results, and provide detailed scheduling for all commissioning tasks.
- B. Various sections of the project specifications require equipment start-up, testing, and adjusting services. Requirements for start-up, testing, and adjusting services specified in the Division 07, Division 08, Division 21, Division 22, Division 23, Division 26, Division 27, Division 28, and Division 31 series sections of these specifications are intended to be provided in coordination with the commissioning services and are not intended to duplicate services. The Contractor shall coordinate the work required by individual specification sections with the commissioning services requirements specified herein.
- C. Where individual testing, adjusting, or related services are required in the project specifications and not specifically required by this commissioning requirements specification, the specified services shall be provided and copies of documentation, as required by those specifications, shall be submitted to the OWNER and the Commissioning Agent to be indexed for future reference.
- D. Where training or educational services for OWNER are required and specified in the Division 7, Division 08, Division 21, Division 22, Division 23, Division 26, Division 27, Division 28, and Division 31 series sections of the specification, these services are intended to be provided in addition to the training and educational services specified herein.
- E. Commissioning is a systematic process of verifying that the building systems perform interactively according to the construction documents and the OWNER's operational needs. The commissioning process shall encompass and coordinate the system documentation, equipment startup, control system calibration, testing and balancing, performance testing and training. Commissioning during the construction, acceptance, and warranty phases is intended to achieve the following specific objectives according to the contract documents:
  - 1. Verify that the applicable equipment and systems are installed in accordance with the contract documents and according to the manufacturer's recommendations.

2. Verify and document proper integrated performance of equipment and systems.
  3. Verify that O&M documentation is complete.
  4. Verify that all components requiring servicing can be accessed, serviced and removed without disturbing nearby components including ducts, piping, cabling or wiring.
  5. Verify that the OWNER's operating personnel are adequately trained.
  6. Document the successful achievement of the commissioning objectives listed above.
- F. The commissioning process does not take away from or reduce the responsibility of the Contractor to provide a finished and fully functioning product.

**1.2 RELATED WORK**

- A. Section 01 00 00 GENERAL REQUIREMENTS.
- B. Section 22 08 00 COMMISSIONING OF PLUMBING SYSTEMS.
- C. Section 23 08 00 COMMISSIONING OF HVAC SYSTEMS.
- D. Section 26 08 00 COMMISSIONING OF ELECTRICAL SYSTEMS.

**1.3 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.
- B. Owner's Project Requirements (OPR) and Basis of Design (BOD) documentation prepared by Owner and Architect contains requirements that apply to this Section.

**1.4 SUMMARY**

- A. This Section includes general requirements that apply to implementation of commissioning without regard to systems, subsystems, and equipment being commissioned.

**1.5 DEFINITIONS**

- A. Architect: Includes Architect identified in the Contract for Construction between the Department of Veterans Affairs and

Contractor, plus consultant/design professionals responsible for design of fire suppression, plumbing, HVAC, controls for HVAC systems, electrical, communications, electronic safety and security, as well as other related systems.

- B. BOD: Basis of Design - The Basis of Design is a document developed by the A/E detailing the basis at which they are designing the facility in order to meet the Owner's Project Requirements and key stakeholder goals.
- C. CxA: Commissioning Agent.
- D. Commissioning Plan: a dynamic document that describes how the commissioning process will be applied to this project. It is an overall plan that provides the structure, schedule and coordination for the commissioning process.
- E. Commissioning Issue or Deficiency: a condition in the installation or function of a component, piece of equipment or system that affects the system operations, maintenance, and/or repair.
- F. Commissioning Observation: a condition in the installation or function of a component, piece of equipment or system that may not be in compliance with the Contract Documents, or may not be in compliance with the manufacturer's installation instruction, or may not be in compliance with generally accepted industry standards.
- G. OPR: Owner's Project Requirements - The OPR is a dynamic document outlining the Owner's goals and objects for the building space functions as it relates to Mechanical, Electrical, Plumbing and Electronic Safety and Security Systems.
- H. OWNER: Includes the OWNER, or other authorized representative of the Owner.
- I. Systems Functional Performance Test: a test, or tests, of the dynamic function and operation of equipment and systems using manual (direct observation) or monitoring methods. Systems Functional Performance Testing is the dynamic testing of systems (rather than just components) under full operation (e.g., the chiller pump is tested interactively with the chiller functions to see if the pump ramps up and down to maintain the differential pressure setpoint). Systems are tested under various modes, such as during low cooling or heating loads, high loads, component failures, unoccupied, varying outside air temperatures, fire alarm, power failure, etc. The systems are run through all the control system's sequences of operation and components are verified to be responding as the sequences state. Traditional air or water test and balancing (TAB) is not functional testing, in the commissioning sense of the word. TAB's primary work is setting up the system flows and pressures as specified, while functional testing is verifying that which has already been set up. The Commissioning Agent develops the Systems Functional Test Procedures in a sequential

written form, coordinates, directs and documents the actual testing. Systems Functional Testing is performed by the Contractor. Systems Functional Performance Tests are performed after System Readiness Checklists, startups, and control systems are complete and functional, and TAB functions are complete.

- J. System: A system is defined as the entire complex which must be coordinated to work together during normal operation to produce results for which the complex is designed. For example, air conditioning supply air is only one component of an entire system which provides comfort conditions for a building. Other related components are return air, exhaust air, steam supply, chilled water supply, refrigerant supply, hot water supply, controls and electrical service, etc. Another example of a complex which involves several components of different disciplines is a boiler installation. Efficient and acceptable boiler operation depends upon the coordination and proper operation of the fuel supply, combustion air, controls, steam, feed water supply, condensate return and other related components.
- K. System Readiness Checklist: a list of items provided by the Commissioning Agent to the Contractor that require inspection and elementary component tests conducted to verify proper installation of equipment. System Readiness Checklists are primarily static inspections and procedures to prepare the equipment or system for initial operation (e.g., belt tension, oil levels OK, labels affixed, gages in place, sensors calibrated, etc.). However, some System Readiness Checklist items entail simple testing of the function of a component, a piece of equipment or system (such as measuring the voltage imbalance on a three-phase pump motor of a chiller system). The term "System Readiness" refers to before functional testing. System Readiness Checklists augment and are combined with the manufacturer's start-up checklist and the Contractor's Quality Control checklists.
- L. Seasonal Performance Tests Functional Performance Test: a test or tests that are deferred until the system will experience conditions closer to their design conditions.
- M. TAB: Testing, Adjusting, and Balancing.
- N. Warranty Period - warranty period for entire project, including equipment components. Warranty begins at Substantial Completion and extends for at least one year, unless specifically noted otherwise in the Contract Documents and accepted submittals.

#### 1.6 SYSTEMS TO BE COMMISSIONED

- A. Commissioning of a system or systems specified for this project is part of the construction process. Documentation and testing of these systems, as well as training of the OWNER's Operation and Maintenance

personnel, is required in cooperation with the OWNER and the Commissioning Agent.

- B. The systems to be commissioned as part of this project include at a minimum:

**a. HVAC:**

1. Air Handling Units
2. Return Air Fans
3. Exhaust Fans
4. Hot Water Heat Exchangers
5. VAV Boxes with Reheat
6. Steam PRV
7. Chilled Water & Hot Water Piping & Insulation
8. Air & Water Testing & Balancing
9. Piping & Equipment Identification
10. DDC Controls and BAS Tie-in; aka; Automation System & Temperature Controls
11. Seasonal Inspection & Testing
12. Training

**b. Plumbing:**

1. Hot Water Supply & Return
2. Cold Water Supply
3. Plumbing Fixtures
4. Piping Insulation
5. Identification of Piping

**c. Fire Protection:**

1. Stand Pipe
2. Flow Switch, Tamper Switches, and Valves
3. Pressure in Piping System
4. Sprinkler Heads
5. Identification of piping

**d. Electrical:**

1. Electrical distribution from switchgear room normal power, emergency power and life safety.
2. Electrical Panels
3. Transformers (If applicable)
4. Receptacles
5. Automatic Doors
6. Lights/Switches/Controls
7. Exit Signs
8. Fire Alarm
9. Tele/Data Communications System
10. Security System
11. Nurse Call

**1.7 COMMISSIONING TEAM**

- A. Members Appointed by Contractor:

1. Contractor: The designated person, company, or entity that plans, schedules and coordinates the commissioning activities for the construction team.
2. Contractor's Commissioning Representative(s): Individual(s), each having authority to act on behalf of the entity he or she represents, explicitly organized to implement the commissioning process through coordinated actions. The commissioning team shall consist of, but not be limited to, representatives of Contractor, including Project Superintendent and sub-contractors, installers, suppliers, and specialists deemed appropriate by the OWNER and Commissioning Agent.

**B. Members Appointed by Owner:**

1. Commissioning Agent: The designated person, company, or entity that plans, schedules, and coordinates the commissioning team to implement the commissioning process. The OWNER will engage the CxA under a separate contract.
2. Representatives of the facility user and operation and maintenance personnel.
3. Architect and engineering design professionals.

**1.8 OWNER'S RESPONSIBILITIES**

- A. Develop and provide the Owner's Project Requirements (OPR) documentation to the design team for use in developing the Basis of Design (BOD) document and the CxA for use in reviewing the design documents (basis of design document, drawings and specifications), developing the commissioning plan, system readiness checklists, and functional test procedures.
- B. Assign operation and maintenance personnel and schedule them to participate in commissioning team activities including, but not limited to, the following:
  1. Coordination meetings.
  2. Training in operation and maintenance of systems, subsystems, and equipment.
  3. Testing meetings.
  4. Witness and assist in systems functional testing.
  5. Demonstration of operation of systems, subsystems, and equipment.

- C. Provide the design documents, prepared by Architect and approved by OWNER, to the Commissioning Agent and for use in directing the commissioning process, developing the commissioning plan, systems manuals, and reviewing the operation and maintenance training plan.
- D. Provide utility services required for the commissioning process.

**1.9 CONTRACTOR'S COMMISSIONING RESPONSIBILITIES**

- A. The Contractor shall assign a Commissioning Manager to manage commissioning activities of the Contractors, subcontractors, installers and vendors.
- B. The Contractor shall ensure that the commissioning responsibilities outlined in these specifications are included in all sub-contracts and that sub-contractors comply with the requirements of these specifications.
- C. The Contractor shall ensure that each installing sub-contractor shall assign representatives with expertise and authority to act on behalf of the sub-contractor and schedule them to participate in and perform commissioning team activities including, but not limited to, the following:
  - 1. Participate in construction-phase commissioning coordination meetings.
  - 2. Conduct operation and maintenance training sessions in accordance with approved training plans.
  - 3. Verify that Work is complete and systems are operational according to the Contract Documents, including calibration of instrumentation and controls.
  - 4. Evaluate commissioning issues and commissioning observations identified in the Commissioning Issues Log, field reports, test reports or other commissioning documents. In collaboration with entity responsible for system and equipment installation, recommend corrective action.
  - 5. Review and comment on commissioning documentation.
  - 6. Participate in meetings to coordinate systems functional testing.
  - 7. Provide schedule for operation and maintenance data submittals, equipment startup, and testing to Commissioning Agent for incorporation into the commissioning plan. Update schedule on a weekly basis throughout the construction period.
  - 8. Provide information to the Commissioning Agent for developing construction-phase commissioning plan.

9. Participate in training sessions for OWNER's operation and maintenance personnel.
10. Provide technicians who are familiar with the construction and operation of installed systems and who shall develop specific test procedures to conduct systems functional performance testing of installed systems.
11. Gather and submit operation and maintenance data for systems, subsystems, and equipment to the CxA, as specified in Division 01 Section "Operation and Maintenance Data."
12. Provide technicians who are familiar with the construction and operation of installed systems and who shall develop specific test procedures and participate in testing of installed systems, subsystems, and equipment.

**1.10 COMMISSIONING AGENT RESPONSIBILITIES**

- A. Organize and lead the commissioning team.
- B. Prepare the construction phase commissioning plan.
- C. Collaborate with the Construction Manager, each Contractor, and with subcontractors to develop test and inspection procedures.
- D. Include scheduled commissioning activities coordinated with overall Project schedule.
- E. Review and comment on selected submittals from the Contractor for general conformance with the Construction Documents. Review and comment on the ability to commission the system and/or equipment, including providing gages, controls and other components required to operate, maintain, and test the system. Review and comment on performance expectations of systems and equipment and interfaces between systems relating to the Construction Documents and Owner's Project Requirements.
- F. At the beginning of the construction phase, conduct an initial construction-phase coordination meeting for the purpose of reviewing the commissioning activities and establishing tentative schedules for operation and maintenance submittals; operation and maintenance training sessions; TAB Work; Systems Readiness Checklists, Systems Functional Performance Testing; and Project completion.
- G. At the beginning of the construction phase, conduct an initial construction-phase coordination meeting for the purpose of reviewing the commissioning activities and establishing tentative schedules for operation and maintenance submittals; operation and maintenance training sessions; TAB Work; System Readiness Checklists, Functional Performance Testing and Project completion.

- H. Convene commissioning team meetings for the purpose of coordination, communication, and conflict resolution; discuss progress of the commissioning processes. Responsibilities include arranging for facilities, preparing agenda and attendance lists, and notifying participants. The Commissioning Agent shall prepare and distribute minutes to commissioning team members and attendees within five workdays of the commissioning meeting.
- I. Observe construction and report progress, observations and issues. Observe systems and equipment installation for adequate accessibility for maintenance and component replacement or repair, and for general conformance with the Construction Documents.
- J. Prepare Project-specific Systems Readiness Checklists and Systems Functional Performance Test procedures.
- K. Coordinate Systems Functional Performance testing schedule with the Contractor. Witness selected systems startups. Verify selected Systems Readiness Checklists completed and submitted by the Contractor. Direct, witness, and document Systems Functional Performance testing.
- L. Compile test data, inspection reports, and certificates and include them in the systems manual and commissioning report.
- M. Review and comment on operation and maintenance (O&M) documentation and systems manual outline for compliance with the Contract Documents. Operation and maintenance documentation requirements are specified in Division 01 Section "GENERAL REQUIREMENTS."
- N. Review operation and maintenance training program developed by the Contractor. Verify training plans provide qualified instructors to conduct operation and maintenance training.
- O. Prepare commissioning reports.
- P. Return to the site at 10 months into the 12 month warranty period and review with facility staff the current building operation and the condition of outstanding issues related to the original and seasonal commissioning. Also interview facility staff and identify problems or concerns they have operating the building as originally intended. Make suggestions for improvements and for recording these changes in the O&M manuals. Identify areas that may come under warranty or under the original construction contract. Assist facility staff in developing reports, documents and requests for services to remedy outstanding problems.
- Q. Assemble the final commissioning documentation, including the Final Commissioning Report and Addendum to the Final Commissioning Report.

1.11 COMMISSIONING DOCUMENTATION

A. Commissioning Plan: A document, prepared by the Commissioning Agent, that outlines the schedule, allocation of resources, and documentation requirements of the commissioning process, and shall include, but is not limited to the following:

1. Plan for delivery and review of submittals, systems manuals, and other documents and reports. Identification of the relationship of these documents to other functions and a detailed description of submittals that are required to support the commissioning processes. Submittal dates shall include the latest date approved submittals must be received without adversely affecting commissioning plan.
2. Description of the organization, layout, and content of commissioning documentation (including systems manual) and a detailed description of documents to be provided along with identification of responsible parties.
3. Identification of systems and equipment to be commissioned.
4. Description of schedules for testing procedures along with identification of parties involved in performing and verifying tests.
5. Identification of items that must be completed before the next operation can proceed.
6. Description of responsibilities of commissioning team members.
7. Description of observations to be made.
8. Description of requirements for operation and maintenance training, including required training materials.
9. Description of expected performance for systems, sub-systems, equipment, and controls.
10. Schedule for commissioning activities with specific dates coordinated with overall construction schedule.
11. Identification of installed systems, sub-systems, and equipment, including design changes that occurred during the construction phase.
12. Process and schedule for documenting changes on a continuous basis to appear in Project Record Documents.
13. Process and schedule for completing prestart and startup checklists for systems, sub-systems, and equipment to be verified and tested.

14. Step-by-step procedures for testing systems, sub-systems, and equipment with descriptions for methods of verifying relevant data, recording the results obtained, and listing parties involved in performing and verifying tests.
- B. Functional Performance Test Procedures: The Commissioning Agent will develop Systems Functional Performance Test Procedures for each system to be commissioned, including sub-systems, or equipment and interfaces or interlocks with other systems. Systems Functional Performance Test Procedures will include a separate entry, with space for comments, for each item to be tested. Preliminary Systems Functional Performance Test Procedures will be provided to the OWNER, Architect/Engineer, and Contractor for review and comment. The Systems Performance Test Procedure will include test procedures for each mode of operation and provide space to indicate whether the mode under test responded as required. Each System Functional Performance Test procedure, regardless of system, sub-system, or equipment being tested, shall include, but not be limited to, the following:
  1. Name and identification code of tested item.
  2. Test number.
  3. Time and date of test.
  4. Indication of whether the record is for a first test or retest following correction of a problem or issue.
  5. Dated signatures of the person performing test and of the witness, if applicable.
  6. Individuals present for test.
  7. Observations and issues.
  8. Issue number, if any, generated as the result of test.
- C. System Readiness Checklists: The Commissioning Agent will prepare Systems Readiness Checklists that describe the minimum conditions necessary prior to testing. System Readiness Checklists shall be completed and signed by the Contractor, verifying that systems, sub-systems, equipment, and associated controls are ready for testing. The Commissioning Agent will spot-check System Readiness Checklists to verify accuracy and readiness for testing. Inaccurate System Readiness Checklists shall be returned to the Contractor for correction and resubmission.
- D. Test and Inspection Reports: The Commissioning Agent will record test data, observations, and measurements on Systems Functional Performance Test Procedure forms. Photographs, forms, and other means appropriate for the application shall be included with data. CxA shall compile

test and inspection reports and test and inspection certificates and include them in systems manual and commissioning report.

- E. Corrective Action Documents: The Commissioning Agent will document corrective action taken for systems and equipment that fail tests. The documentation will include any required modifications to systems and equipment and/or revisions to test procedures, if any. The Commissioning Agent will direct and document any retesting of systems and/or equipment requiring corrective action and document retest results.
- F. Issues Log: The Commissioning Agent will prepare and maintain Master Commissioning Issues Log that describes Commissioning Issues and Commissioning Observations that are identified during the Commissioning process. These observations and issues include, but are not limited to, those that are at variance with the Contract Documents. The Master Commissioning Issues Log will identify and track issues as they are encountered, the party responsible for resolution, progress toward resolution, and documenting how the issue was resolved. The Master Commissioning Issues Log will also track the status of unresolved and resolved issues.
1. Creating an Issues Log Entry:
    - a. Identify the issue with unique numeric or alphanumeric identifier by which the issue may be tracked.
    - b. Assign a descriptive title of the issue.
    - c. Identify date and time of the issue.
    - d. Identify test number of test being performed at the time of the observation, if applicable, for cross-reference.
    - e. Identify system, subsystem, and equipment to which the issue applies.
    - f. Identify location of system, subsystem, and equipment.
    - g. Include information that may be helpful in diagnosing or evaluating the issue.
    - h. Note recommended corrective action.
    - i. Identify commissioning team member responsible for corrective action.
    - j. Identify expected date of correction.
    - k. Identify person documenting the issue.

2. Documenting Issue Resolution:

- a. Log date correction is completed or the issue is resolved.
  - b. Describe corrective action or resolution taken. Include description of diagnostic steps taken to determine root cause of the issue, if any.
  - c. Identify changes to the OPR, BoD, or Contract Documents that may require action.
  - d. State that correction was completed and system, subsystem, and equipment is ready for retest, if applicable.
  - e. Identify person(s) who corrected or resolved the issue.
  - f. Identify person(s) documenting the issue resolution.
- G. Final Commissioning Report: The Commissioning Agent will document results of the commissioning process, including unresolved issues, and performance of systems, sub-systems, and equipment. The Commissioning Report will indicate whether systems, sub-systems, and equipment have been completed and are performing according to the Contract Documents. The commissioning report will include, but is not limited to, the following:
- 1. Lists and explanations of substitutions; compromises; variances with the Contract Documents; record of conditions; and, if appropriate, recommendations for resolution. This report will be used by the Department of Veterans Affairs when determining that systems will be accepted. This report will be used to evaluate systems, sub-systems, and equipment and will serve as a future reference document during OWNER occupancy and operation. It shall describe components and performance that exceed requirements of the Contract Documents and those that do not meet requirements of the Contract Documents. It may also include a recommendation for accepting or rejecting systems, sub-systems, and equipment.
  - 2. Owner's Project Requirements prepared by the OWNER
  - 3. Design Narrative documentation prepared and maintained by the A/E.
  - 4. Commissioning plan.
  - 5. System Readiness Checklists completed by the Contractor, with annotation of the Commissioning Agent review and spot-check.
  - 6. Systems Functional Performance Test Procedures, with annotation of test results.
  - 7. Corrective Action Reports with annotation of corrective action taken by the Contractor.

8. Commissioning Master Issues Log.
9. Listing of deferred or off-season test(s) not performed, including the schedule for their completion.
- H. Addendum to Final Commissioning Report: The Commissioning Agent will prepare an Addendum to the Final Commissioning Report near the end of the Warranty Period. The Addendum will indicate whether systems, sub-systems, and equipment are complete and continue to perform according to the Contract Documents. The Addendum to the Final Commissioning Report shall include, but is not limited to, the following:
  1. Documentation of deferred or off-season test(s) results.
  2. Completed Systems Functional Test Procedures for off-season test(s).
  3. Updated status of unresolved issues.
  4. Documentation that unresolved system performance issues have been resolved.
  5. Updated Commissioning Master Issues Log.
  6. Identification of potential Warranty Claims to be corrected by the Contractor.
- I. Systems Manual: The Commissioning Agent will gather required information and compile the Systems Manual. The Systems Manual will include, but is not limited to, the following:
  1. Final version of the Owner's Project Requirements (Owner provided)
  2. Final version of the Basis of Design (A/E provided)
  3. System single-line diagrams (Contractor provided)
  4. Retesting recommendations and blank test forms (CxA provided)
  5. Recommended schedule for calibrating sensors and actuators (Contractor provided)

#### 1.12 SUBMITTALS

- A. Preliminary Construction Commissioning Plan Submittal: The Commissioning Agent will submit the Preliminary Construction Commissioning Plan. Delivery will be through electronic submission. Present submittal in sufficient detail to evaluate data collection and arrangement process. Review comments will be returned to the Commissioning Agent.

- B. Construction Commissioning Plan Final Submittal: The Commissioning Agent will submit electronically formatted information of final commissioning plan. The final submittal must address previous review comments. The final submittal shall include a copy of the preliminary submittal review comments along with a response to each item.
- C. Functional Test Procedures and Report Forms: The Commissioning Agent will submit preliminary functional test procedures and forms to the Contractor, the OWNER, and the Architect/Engineer for review and comment. The Contractor shall return review comments to the OWNER and the Commissioning Agent. The OWNER and Architect/Engineer will also return review comments to the Commissioning Agent. The Commissioning Agent will incorporate review comments into the Final Functional Test Procedures to be used in Systems Functional Performance Testing.
- D. System Readiness Checklists: The Commissioning Agent will submit System Readiness Checklists to be completed by the Construction Manager and Contractors.
- E. Test and Observation Reports: The Commissioning Agent will submit test and observation reports to the OWNER with copies to the Contractor and the Architect/Engineer.
- F. Corrective Action Documents: The Commissioning Agent will submit corrective action documents to the OWNER with copies to the Contractor and Architect.
- G. Preliminary Commissioning Report Submittal: The Commissioning Agent will submit electronic copies of the preliminary commissioning report. The OWNER shall review and comment on the Preliminary Commissioning Report. Review comments will be returned to the Commissioning Agent for preparation of the final submittal.
- H. Final Commissioning Report Submittal: The Commissioning Agent will submit one hard copy and two sets of electronically formatted information of the final commissioning report to the OWNER.
- I. Data for Commissioning:
1. The Commissioning Agent will request from the Contractor specific information needed about each piece of commissioned equipment or system to fulfill requirements of the Commissioning Plan.
  2. Typically this information will include manufacturer and model number, detailed manufacturer installation and start-up, operating, troubleshooting and maintenance procedures, full details of any required testing, fan and pump curves, full factory testing reports, if any, and full warranty information, including all responsibilities of the OWNER to keep the warranty in force clearly identified. In addition, the installation and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the

factory or field technicians shall be completed and submitted to the Commissioning Agent.

3. The Commissioning Agent may request further documentation as is necessary for the commissioning process.
4. Much of this information will also be included with the O&M manual submittals normally submitted for the project. Typically, this information is required to be used in the commissioning process prior to the formal O&M manual submittals.

#### 1.13 COMMISSIONING PROCESS

- A. The Commissioning Agent shall be responsible for the overall management of the commissioning process as well as the specific scheduling of all procedures.
- B. Prior to the start of mechanical or electrical system installation, the Contractor shall designate a specific individual as the Commissioning Manager (CxM) to manage and lead the commissioning effort on behalf of the Contractor. The CxM shall provide a single point of contact and communications for all commissioning related services.
- C. Prior to the start of mechanical or electrical system installation, the Contractor shall designate specific individuals as commissioning representatives (CxR) for each Subcontractor to be associated with commissioning work. The commissioning representatives shall participate in the commissioning process as team members providing commissioning testing services, equipment operation, adjustments, and corrections if necessary. All CR's shall be selected as individuals having sufficient authority to direct their respective staff to provide the services required, accept and provide minor changes to the work on behalf of the sub-contractors or various organizations involved, and to speak on behalf of their organizations in all commissioning related contractual matters

#### 1.14 QUALITY ASSURANCE

- A. Instructor Qualifications: Factory-authorized service representatives experienced in training, operation, and maintenance procedures for installed systems, subsystems, and equipment.
- B. Test Equipment Calibration: Comply with test equipment manufacturer's calibration procedures and intervals. Recalibrate test instruments immediately whenever instruments have been repaired following damage or dropping. Affix calibration tags to test instruments. Instruments shall have been calibrated within six months prior to use.

**1.15 COORDINATION**

- A. Management: The Commissioning Agent will direct and coordinate the commissioning activities and the commissioning reports to the OWNER. All commissioning team members shall work together to fulfill their contracted responsibilities and meet the objectives of the contract documents.
- B. Scheduling: The Commissioning Agent will work with the Contractor and the OWNER to schedule the commissioning activities. The Commissioning Agent will provide sufficient notice to the Contractor and the OWNER for scheduling commissioning activities. The Contractor shall integrate all commissioning activities into the master schedule. All parties will address scheduling problems and make necessary notifications in a timely manner in order to expedite the commissioning process.
- C. Coordinating Meetings: The Commissioning Agent will conduct monthly coordination meetings of the commissioning team to review progress on commissioning activities, to discuss scheduling conflicts, and to discuss upcoming commissioning process activities.
- D. Pretesting Meetings: The Commissioning Agent will conduct pretest meetings of the commissioning team to review startup reports, System Readiness Checklist results, Systems Functional Performance Testing procedures, testing personnel and instrumentation requirements.
- E. Systems Functional Performance Testing Coordination: The Commissioning Agent will coordinate the sequence of testing activities to accommodate required quality-assurance and -control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting. The Commissioning Agent will coordinate the schedule times for tests, inspections, obtaining samples, and similar activities.

**PART 2 - PRODUCTS**

**2.1 TEST EQUIPMENT**

- A. The Contractor shall provide all standard and specialized testing equipment required to perform startup and initial checkout and Systems Functional Performance Testing. Required test equipment will be identified in the detailed System Performance Test Procedure checklists prepared by the Commissioning Agent.
- B. Data logging equipment and software required to test equipment shall be provided by the Contractor.
- C. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified

in the Specifications. If not otherwise noted, the following minimum requirements apply: Temperature sensors and digital thermometers shall have a certified calibration within the past year to an accuracy of 0.5 C (1.0 F) and a resolution of + or - 0.1 C (0.2 F). Pressure sensors shall have an accuracy of + or - 2.0% of the value range being measured (not full range of meter) and have been calibrated within the last year. All equipment shall be calibrated according to the manufacturer's recommended intervals and when dropped or damaged. Calibration tags shall be affixed or certificates readily available.

### **PART 3 - EXECUTION**

#### **3.1 START-UP, SYSTEM READINESS CHECKLISTS AND INITIAL CHECKOUT**

- A. The following procedures shall apply to all equipment and systems to be commissioned, according to Part 1, Systems To Be Commissioned.
  - 1. System Readiness Checklists are important to ensure that the equipment and systems are hooked up and operational. These ensure that functional performance testing (in-depth system checkout) may proceed without unnecessary delays. Each piece of equipment shall receive a full System Readiness Checklist checkout. No sampling strategies are used. The System Readiness Checklist for a given system must be successfully completed prior to formal functional performance testing of equipment or subsystems of the given system.
    - a. The Commissioning Agent shall develop System Readiness Checklists and procedures after final approval of equipment submittals. These checklists indicate required procedures to be executed as part of startup and initial checkout of the systems and the party responsible for their execution.
    - b. The Contractor shall determine which trade is responsible for executing and documenting each of the line item tasks and notes that trade on the form. Each form may have more than one trade responsible for its execution.
  - 2. Start-up and Initial Checkout Plan: The Contractor shall develop detailed start-up plans for all equipment. The primary role of the Contractor in this process is to ensure that there is written documentation that each of the manufacturer-recommended procedures have been completed. Parties responsible for System Readiness Checklists and startup shall be identified in coordination meetings and in the checklist forms.
    - a. The Commissioning Agent will assist the contractor in development of the full start-up plan. The Contractor shall combine the checklists with the manufacturer's detailed start-up and checkout procedures from the O&M manual data and the normally used field checkout sheets. The plan shall include checklists and procedures with specific boxes or

lines for recording and documenting the checking and inspections of each procedure and a summary statement with a signature block at the end of the plan.

- b. The full start-up plan shall at a minimum consist of the following items:

- 1) The System Readiness Checklists.
- 2) The manufacturer's standard written start-up procedures copied from the installation manuals with check boxes by each procedure and a signature block added by hand at the end.
- 3) The manufacturer's normally used field checkout sheets.
- 4) The Contractor shall submit the full startup plan to the Commissioning Agent for review and approval.
- 5) The Contractor shall review and evaluate the procedures and the format for documenting them, noting any procedures that need to be revised or added.

3. Sensor and Actuator Calibration

- a. All factory calibrated temperature, relative humidity, CO2 and pressure sensors calibration shall be checked against the automation system and calibrated as needed by the Contractor.
- b. All factory calibrated temperature, relative humidity, CO2 and pressure sensors calibration shall be checked against the automation system and calibrated as needed by the Contractor.
- c. All procedures used shall be fully documented on the System Readiness Checklists or other suitable forms, clearly referencing the procedures followed and written documentation of initial, intermediate and final results.

4. Execution of System Readiness Checklists and Startup

- a. Four weeks prior to startup, the Contractor shall schedule startup and checkout with the Owner and CxA. The performance of the System Readiness Checklists, startup and checkout shall be directed and executed by the Contractor.
- b. The Commissioning Agent will observe the startup procedures for selected pieces of primary equipment.
- c. The Contractor shall execute startup and provide the OWNER and Commissioning Agent with a signed and dated copy of the completed start-up, System Readiness Checklists, and initial tests.

- d. Only individuals that have direct knowledge and witnessed that a line item task on the System Readiness Checklist was actually performed shall initial or check that item off. It is not acceptable for witnessing supervisors to fill out these forms.

### 3.2 PHASED COMMISSIONING

- A. The project may require startup and initial checkout to be executed in phases. This phasing shall be planned and scheduled in a coordination meeting of the OWNER, Commissioning Agent, and the Contractor. Results will be added to the master construction schedule and the commissioning schedule.

### 3.3 FUNCTIONAL PERFORMANCE TESTING

- A. This paragraph applies to commissioning Systems Functional Performance Testing of equipment and systems for all referenced specification Divisions.
- B. Objectives and Scope: The objective of functional performance testing is to demonstrate that each system is operating according to the documented design intent and Contract Documents. Successful Completion of Functional Testing is a Prerequisite to Substantial Completion. Additionally, during the testing process, areas of deficient performance are identified and corrected, improving the operation and functioning of the systems. In general, each system shall be operated through all modes of operation where there is a specified system response. The Contractor shall verify each sequence in the sequences of operation.
- C. Development of Functional Performance Test Procedures: Before Systems Functional Performance Test procedures are written, the Contractor shall submit all requested documentation and a current list of change orders affecting equipment or systems, including an updated points list, program code, control sequences and parameters. Using the testing parameters and requirements found in the Contract Documents and approved submittals and shop drawings, the Commissioning Agent will develop specific systems functional test procedures and forms to verify and document proper operation of each piece of equipment and system to be commissioned. The Contractor shall assist the Commissioning Agent in developing the Systems Functional Performance Test procedures as requested by the Commissioning Agent i.e. by answering questions about equipment, operation, sequences, etc. Prior to execution, the Commissioning Agent will provide a copy of the Systems Functional Performance Test procedures to the OWNER, the Architect/Engineer, and the Contractor, who shall review the tests for feasibility, safety, equipment and warranty protection.
- D. Purpose of Test Procedures: The purpose of each specific Systems Functional Performance Test is to verify and document compliance with

the stated criteria of acceptance given on the test form. Representative test formats and examples are found in the Commissioning Plan for this project. (The Commissioning Plan is issued as a separate document and is available for review.)

- E. Test Methods: Systems Functional Performance Testing shall be achieved by manual testing (i.e. persons manipulate the equipment and observe performance) and/or by monitoring the performance and analyzing the results using the control system's trend log capabilities or by stand-alone data loggers. The Commissioning Agent shall determine which method is most appropriate for tests that do not have a method specified.
1. Simulated Conditions: Simulating conditions (not by an overwritten value) shall be allowed as determined by the CxA, though timing the testing to experience actual conditions is encouraged wherever practical.
  2. Overwritten Values: Overwriting sensor values to simulate a condition, such as overwriting the outside air temperature reading in a control system to be something other than it really is, shall be allowed as determined by the Commissioning Agent, but shall be used with caution and avoided when possible. Such testing methods often can only test a part of a system, as the interactions and responses of other systems will be erroneous or not applicable. Simulating a condition is preferable. e.g., for the above case, by heating the outside air sensor with a hair blower rather than overwriting the value or by altering the appropriate setpoint to see the desired response. Before simulating conditions or overwriting values, sensors, transducers and devices shall have been calibrated.
  3. Simulated Signals: Using a signal generator which creates a simulated signal to test and calibrate transducers and DDC constants is generally recommended over using the sensor to act as the signal generator via simulated conditions or overwritten values.
  4. Altering Setpoints: Rather than overwriting sensor values, and when simulating conditions is difficult, altering setpoints to test a sequence is acceptable. For example, to see the Air Conditioning compressor lockout initiate at an outside air temperature below 12 C (54 F), when the outside air temperature is above 12 C (54 F), temporarily change the lockout setpoint to be 2 C (4 F) above the current outside air temperature.
  5. Indirect Indicators: Relying on indirect indicators for responses or performance shall be allowed only after visually and directly verifying and documenting, over the range of the tested parameters, that the indirect readings through the control system represent actual conditions and responses. Much of this verification shall be completed during system readiness testing.

- F. Setup: Each function and test shall be performed under conditions that simulate actual conditions as close as is practically possible. The Contractor shall provide all necessary materials, system modifications, etc. to produce the necessary flows, pressures, temperatures, etc. necessary to execute the test according to the specified conditions. At completion of the test, the Contractor shall return all affected building equipment and systems, due to these temporary modifications, to their pre-test condition.
- G. Sampling: No sampling is allowed in completing System Readiness Checklists. Sampling is allowed for functional test procedures execution. The CxA shall determine the sampling rate. If at any point, frequent failures are occurring and testing is becoming more troubleshooting than verification, the CxA may stop the testing and require the Contractor to perform and document a checkout of the remaining units, prior to continuing with functionally testing the remaining units. Costs associated with testing expanded samples and/or all equipment or systems of the specified type are the responsibility of the Contractor.
- H. Cost of Expanded Sample Testing: The costs for expanded sample System Functional Performance Test shall be solely the responsibility of the Contractor. Any required expanded sample testing by the Contractor shall not be considered a justified reason for a claim of delay or for a time extension by the Contractor.
- I. Coordination and Scheduling: The Contractor shall provide sufficient notice to the CxA and Owner regarding the completion schedule for the System Readiness Checklists and startup of all equipment and systems. The CxA shall schedule functional tests through the Contractor and Owner. The CxA shall direct, witness and document the functional testing of equipment and systems. The Contractor shall execute the tests.
- J. Testing Pre-Requisites: In general, functional testing shall be conducted after system readiness testing and startup has been satisfactorily completed. The control system shall be sufficiently tested and approved by the Commissioning Agent and the Owner before it is used for TAB or to verify performance of other components or systems. The air balancing and water balancing shall be completed and debugged before functional testing of air-related or water-related equipment or systems. Testing shall proceed from components to subsystems to systems. When the proper performance of all interacting individual systems has been achieved, the interface or coordinated responses between systems shall be checked.
- K. Problem Solving: The Commissioning Agent shall recommend solutions to problems found, however the burden of responsibility to solve, correct and retest problems is with the Contractor.

3.4 DOCUMENTATION, NON-CONFORMANCE AND APPROVAL OF TESTS

- A. Documentation: The Commissioning Agent will direct, witness, and document the results of all Systems Functional Performance Tests using the specific procedural forms developed by the Commissioning Agent for that purpose. Prior to testing, the Commissioning Agent will provide these forms to the OWNER and the Contractor for review and approval. The Contractor shall include the filled out forms with the O&M manual data.
- B. Non-Conformance: The Commissioning Agent will record the results of the Systems Functional Performance Tests on the procedure or test form. All items of non-conformance issues will be noted and reported to the OWNER on Commissioning Field Reports and/or the Commissioning Master Issues Log.
1. Corrections of minor items of non-compliance identified may be made during the tests at the discretion of the Commissioning Agent. In such cases, the item of non-compliance and resolution shall be documented on the Systems Functional Test Procedure form.
  2. Every effort shall be made to expedite the systems functional performance testing process and minimize unnecessary delays, while not compromising the integrity of the procedures. However, the Commissioning Agent will not be pressured into overlooking non-compliant work or loosening acceptance criteria to satisfy scheduling or cost issues, unless there is an overriding reason to do so by direction from the OWNER.
  3. As the systems functional performance tests progress and an item of non-compliance is identified, the Commissioning Agent shall discuss the issue with the Contractor and the OWNER.
  4. When there is no dispute on an item of non-compliance, and the Contractor accepts responsibility to correct it:
    - a. The Commissioning Agent will document the item of non-compliance and the Contractor's response and/or intentions. The Systems Functional Performance Test then continues or proceeds to another test or sequence. After the day's work is complete, the Commissioning Agent will submit a Commissioning Field Report to the OWNER. The Commissioning Agent will also note items of non-compliance and the Contractor's response in the Master Commissioning Issues Log. The Contractor shall correct the item of non-compliance and report completion to the OWNER and the Commissioning Agent.
    - b. The need for retesting will be determined by the Commissioning Agent. If retesting is required, the Commissioning Agent and the Contractor shall reschedule the test and the test shall be repeated.

5. If there is a dispute about item of non-compliance, regarding whether it is an item of non-compliance, or who is responsible:
  - a. The item of non-compliance shall be documented on the test form with the Contractor's response. The item of non-compliance with the Contractor's response shall also be reported on a Commissioning Field Report and on the Master Commissioning Issues Log.
  - b. Resolutions shall be made at the lowest management level possible. Other parties are brought into the discussions as needed. Final interpretive and acceptance authority is with the Department of Veterans Affairs.
  - c. The Commissioning Agent will document the resolution process.
  - d. Once the interpretation and resolution have been decided, the Contractor shall correct the item of non-compliance, report it to the Commissioning Agent. The requirement for retesting will be determined by the Commissioning Agent. If retesting is required, the Commissioning Agent and the Contractor shall reschedule the test. Retesting shall be repeated until satisfactory performance is achieved.
- C. Cost of Retesting: The cost to retest any portion of a Functional Performance Test shall be solely the responsibility of the Contractor including the costs for the Commissioning Agent. Any required retesting by the Contractor shall not be considered a justified reason for a claim of delay or for a time extension by the Contractor.
- D. Failure Due to Manufacturer Defect: If 10%, or three, whichever is greater, of identical pieces (size alone does not constitute a difference) of equipment fail to perform to the Contract Documents (mechanically or substantively) due to manufacturing defect, not allowing it to meet its submitted performance spec, all identical units may be considered unacceptable by the Owner. In such case, the Contractor shall provide the OWNER with the following:
  1. Within one week of notification from the OWNER, the Contractor or manufacturer's representative shall examine all other identical units making a record of the findings. The findings shall be provided to the Owner within two weeks of the original notice.
  2. Within two weeks of the original notification, the Contractor or manufacturer shall provide a signed and dated, written explanation of the problem, cause of failures, etc. and all proposed solutions which shall include full equipment submittals. The proposed solutions shall not significantly exceed the specification requirements of the original installation.
  3. The OWNER shall determine whether a replacement of all identical units or a repair is acceptable.

4. Two examples of the proposed solution shall be installed by the Contractor and the OWNER shall be allowed to test the installations for up to one week, upon which the OWNER will decide whether to accept the solution.
  5. Upon acceptance, the Contractor and/or manufacturer shall replace or repair all identical items, at their expense and extend the warranty accordingly, if the original equipment warranty had begun. The replacement/repair work shall proceed with reasonable speed beginning within one week from when parts can be obtained.
- E. Approval: The CxA shall note each satisfactorily demonstrated function on the test form. Formal approval of the functional test shall be made later after review by the CxA and by the Owner. The CxA shall evaluate each test and report to the Owner using a standard form. The Owner shall give final approval on each test using the same form, and provide signed copies to the CxA and the Contractor.

### 3.5 DEFERRED TESTING

- A. Unforeseen Deferred Functional Performance Tests: If any check or Functional Performance Test cannot be completed due to the building structure, required occupancy condition or other deficiency, execution of checklists and functional testing may be delayed upon approval of the Owner. These tests shall be conducted in the same manner as the seasonal tests as soon as possible.
- B. Seasonal Functional Performance Testing: Deferred Seasonal Systems Functional Performance Tests are those that must be deferred until weather conditions are closer to the systems design parameters. The Commissioning Agent will review systems parameters and recommend which Systems Functional Performance Tests should be deferred until weather conditions more closely match systems parameters. The Contractor shall review and comment on the proposed schedule for Deferred Seasonal Testing. The OWNER will review and approve the schedule for Deferred Seasonal Testing. Deferred Seasonal Systems Functional Performances Tests shall be directed, witnessed, and documented by the Commissioning Agent. Deferred Seasonal Systems Functional Performance Tests shall be executed by the Contractor in accordance with these specifications.

### 3.6 OPERATION AND MAINTENANCE TRAINING REQUIREMENTS

- A. Training Preparation Conference: Before operation and maintenance training, the Commissioning Agent will convene a training preparation conference to include OWNER, OWNER's Operations and Maintenance personnel, and the Contractor. The purpose of this conference will be to discuss and plan for Training and Demonstration of OWNER Operations and Maintenance personnel.

- B. The Contractor shall provide training and demonstration as required throughout the Contract Documents. The Training and Demonstration shall include, but is not limited to, the following:
1. Review the Contract Documents
  2. Review installed systems, subsystems, and equipment.
  3. Review instructor qualifications.
  4. Review instructional methods and procedures.
  5. Review training module outlines and contents.
  6. Review course materials (including operation and maintenance manuals).
  7. Inspect and discuss locations and other facilities required for instruction.
  8. Review and finalize training schedule and verify availability of educational materials, instructors, audiovisual equipment, and facilities needed to avoid delays.
  9. For instruction that must occur outside, review weather and forecasted weather conditions and procedures to follow if conditions are unfavorable.
- C. Training Modules: The Contractor shall submit the following information to the OWNER and the Commissioning Agent:
1. Instruction Program: Submit two copies of outline of instructional program for demonstration and training, including a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module. At completion of training, submit two complete training manuals for OWNER's use.
  2. Qualification Data: Submit qualifications for facilitator and/or instructor.
  3. Attendance Record: For each training module, submit list of participants and length of instruction time.
  4. Evaluations: For each participant and for each training module, submit results and documentation of performance-based test.
  5. Demonstration and Training Videotapes: All training modules shall be videotaped by the Contractor. Submit two copies within seven days of end of each training module.

- a. Identification: On each copy, provide an applied label with the following information:

- 1) Name of Project.
- 2) Name and address of photographer
- 3) Name of Contractor.
- 4) Date videotape was recorded.
- 5) Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.

6. Transcript: Prepared on 8-1/2-by-11-inch paper, punched and bound in heavy-duty, 3-ring, vinyl-covered binders. Mark appropriate identification on front and spine of each binder. Include a cover sheet with same label information as the corresponding videotape. Include name of Project and date of videotape on each page.

D. Quality Insurance:

1. Facilitator Qualifications: A firm or individual experienced in training or educating maintenance personnel in a training program similar in content and extent to that indicated for this Project, and whose work has resulted in training or education with a record of successful learning performance.
2. Instructor Qualifications: A factory-authorized service representative, complying with requirements in Division 01 Section "Quality Requirements," experienced in operation and maintenance procedures and training.
3. Photographer Qualifications: A professional photographer who is experienced photographing construction projects.

E. Coordination:

1. Coordinate instruction schedule with OWNER's operations. Adjust schedule as required to minimize disrupting OWNER's operations.
2. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.
3. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data has been reviewed and approved by the OWNER.

F. Instruction Program:

1. Program Structure: Develop an instruction program that includes individual training modules for each system and equipment not part of a system, as required by individual Specification Sections, and as follows:
  - a. Fire-protection systems, including fire alarm, fire pumps, and fire suppression systems.
  - b. Intrusion detection systems.
  - c. Conveying systems, including elevators, wheelchair lifts, escalators, and automated materials handling systems.
  - d. Medical equipment, including medical gas equipment and piping.
  - e. Laboratory equipment, including laboratory air and vacuum equipment and piping.
  - f. Heat generation, including boilers, feedwater equipment, pumps, steam distribution piping, condensate return systems, heating hot water heat exchangers, and heating hot water distribution piping.
  - g. Refrigeration systems, including chillers, cooling towers, condensers, pumps, and distribution piping.
  - h. HVAC systems, including air-handling equipment, air distribution systems, and terminal equipment and devices.
  - i. HVAC instrumentation and controls.
  - j. Electrical service and distribution, including switchgear, transformers, switchboards, panelboards, uninterruptible power supplies, and motor controls.
  - k. Packaged engine generators, including synchronizing switchgear/switchboards, and transfer switches.
  - l. Lighting equipment and controls.
  - m. Communication systems, including intercommunication, surveillance, nurse call systems, public address, mass evacuation, voice and data, and entertainment television equipment.
  - n. Site utilities including lift stations, condensate pumping and return systems, and storm water pumping systems.

- G. Training Modules Content: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participants are expected to master. For each module, include instruction for the following:
1. Basis of System Design, Operational Requirements, and Criteria: Include the following:
    - a. System, sub-system, and equipment descriptions.
    - b. Performance and design criteria if Contractor is delegated design responsibility.
    - c. Operating standards.
    - d. Regulatory requirements.
    - e. Equipment function.
    - f. Operating characteristics.
    - g. Limiting conditions.
    - h. Performance curves.
  2. Documentation: Review the following items in detail:
    - a. Emergency manuals.
    - b. Operations manuals.
    - c. Maintenance manuals.
    - d. Project Record Documents.
    - e. Identification systems.
    - f. Warranties and bonds.
    - g. Maintenance service agreements and similar continuing commitments.
  3. Emergencies: Include the following, as applicable:
    - a. Instructions on meaning of warnings, trouble indications, and error messages.
    - b. Instructions on stopping.
    - c. Shutdown instructions for each type of emergency.
    - d. Operating instructions for conditions outside of normal operating limits.
    - e. Sequences for electric or electronic systems.
    - f. Special operating instructions and procedures.
  4. Operations: Include the following, as applicable:
    - a. Startup procedures.
    - b. Equipment or system break-in procedures.

- c. Routine and normal operating instructions.
  - d. Regulation and control procedures.
  - e. Control sequences.
  - f. Safety procedures.
  - g. Instructions on stopping.
  - h. Normal shutdown instructions.
  - i. Operating procedures for emergencies.
  - j. Operating procedures for system, sub-system, or equipment failure.
  - k. Seasonal and weekend operating instructions.
  - l. Required sequences for electric or electronic systems.
  - m. Special operating instructions and procedures.
5. Adjustments: Include the following:
- a. Alignments.
  - b. Checking adjustments.
  - c. Noise and vibration adjustments.
  - d. Economy and efficiency adjustments.
6. Troubleshooting: Include the following:
- a. Diagnostic instructions.
  - b. Test and inspection procedures.
7. Maintenance: Include the following:
- a. Inspection procedures.
  - b. Types of cleaning agents to be used and methods of cleaning.
  - c. List of cleaning agents and methods of cleaning detrimental to product.
  - d. Procedures for routine cleaning
  - e. Procedures for preventive maintenance.
  - f. Procedures for routine maintenance.
  - g. Instruction on use of special tools.
8. Repairs: Include the following:
- a. Diagnosis instructions.
  - b. Repair instructions.
  - c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
  - d. Instructions for identifying parts and components.

- e. Review of spare parts needed for operation and maintenance.

H. Training Execution:

1. Preparation: Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a combined training manual. Set up instructional equipment at instruction location.
2. Instruction:
  - a. Facilitator: Engage a qualified facilitator to prepare instruction program and training modules, to coordinate instructors, and to coordinate between Contractor and Department of Veterans Affairs for number of participants, instruction times, and location.
  - b. Instructor: Engage qualified instructors to instruct OWNER's personnel to adjust, operate, and maintain systems, sub-systems, and equipment not part of a system.
    - 1) The Commissioning Agent will furnish an instructor to describe basis of system design, operational requirements, criteria, and regulatory requirements.
    - 2) The OWNER will furnish an instructor to describe OWNER's operational philosophy.
    - 3) The OWNER will furnish the Contractor with names and positions of participants.
3. Scheduling: Provide instruction at mutually agreed times. For equipment that requires seasonal operation, provide similar instruction at start of each season. Schedule training with the OWNER and the Commissioning Agent with at least seven days' advance notice.
4. Evaluation: At conclusion of each training module, assess and document each participant's mastery of module by use of **an oral, or a written**, performance-based test.
5. Cleanup: Collect used and leftover educational materials and remove from Project site. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

I. Demonstration and Training Recording:

1. General: Engage a qualified commercial photographer to record demonstration and training. Record each training module separately. Include classroom instructions and demonstrations, board diagrams, and other visual aids, but not student practice.

At beginning of each training module, record each chart containing learning objective and lesson outline.

2. Videotape Format: Provide high-quality color DVD on standard-size DVD disks.
3. Recording: Mount camera on tripod before starting recording, unless otherwise necessary to show area of demonstration and training. Display continuous running time.
4. Narration: Describe scenes on videotape by audio narration by microphone while demonstration and training is recorded. Include description of items being viewed. Describe vantage point, indicating location, direction (by compass point), and elevation or story of construction.

### 3.7 OPERATION AND MAINTENANCE MANUALS

- A. Submission of Operations and Maintenance Data: Submit Operation and Maintenance (O&M) Data specifically applicable to this contract and a complete and concise depiction of the provided equipment, product, or system. Organize and present information in sufficient detail to clearly explain O&M requirements at the system, equipment, component, and subassembly level. Include an index preceding each submittal. Submit in accordance with this section and SUBMITTAL PROCEDURES.

1. Package Quality: Documents must be fully legible. Poor quality copies and material with hole-punches obliterating the text or drawings will not be accepted. Documents shall be written in English language.
2. Package Content: Data package content shall be as shown in the paragraph titled "Schedule of Operation and Maintenance Data Packages." Comply with the data package requirements specified in the individual technical sections, including the content of the packages and addressing each product, component, and system designated for data package submission.
3. Changes to Submittals: Manufacturer-originated changes or revisions to submitted data shall be furnished by the Contractor if a component of an item is so affected subsequent to acceptance of the O&M Data. Changes, additions, or revisions required by the Contracting Officer for final acceptance of submitted data, shall be submitted by the Contractor within 30 calendar days of the notification of this change requirement.
4. Commissioning Record and Testing Data: Provide a separate manual dedicated to documenting the commissioning process which shall include all certifications and testing data and some repeating of O&M data. Description of this manual is found in Section 17100 "Commissioning Requirements" and shall be prepared by the Commissioning Authority.

- B. Schedule of Operations and Maintenance Manual Packages: Furnish the O&M data packages specified in individual technical sections. The required information for each O&M data package is as follows:
- a. First Submission: The first submission of O&M Manuals shall be made within 4 weeks after approval of equipment submittals. This submission shall include the Table of Contents, divider tabs, and approved submittal data arranged in accordance with the requirements provided in paragraph C above.
  - b. Second Submission: The second submission shall be made at least 6 weeks prior to scheduled functional performance testing and/or scheduled contractor's training, whichever is earlier. The second submission shall include all required Operations & Maintenance data as described in the specifications.
- C. CxA Review and Approval: Prior to substantial completion, the CxA shall review the O&M manual data, documentation and redlined as-builds for equipment and systems that were commissioned to verify compliance with the O&M documentation requirements of the specifications. The CxA shall communicate deficiencies in the manuals to the Owner. Upon a successful review of the corrections, the CxA shall recommend approval and acceptance of these sections of the O&M manuals to the Owner. The CxA shall also review each equipment warranty and verify that all requirements to keep the warranty valid are clearly stated. This work does not supersede the normal review requirement of the O&M manual data as indicated elsewhere in the specifications.

### 3.8 MAINTENANCE AND OPERATIONS ACCEPTANCE

- A. The Commissioning Functional Performance Tests shall be successfully completed prior to Substantial Completion. However, should mechanical and electrical systems be in use prior to Substantial Completion:
- 1. The Contractor shall be responsible for the operation of all systems and all adjustments necessary to successfully pass the Functional Performance Test Procedures.
  - 2. The Contractor shall document and respond to all concerns and questions from building occupants in a timely and professional manner.
  - 3. Maintenance and operational acceptance is a requirement of final completion and must be documented prior to submitting the Final Application for Payment.

PART 4 - COMMISSIONING DOCUMENTATION ATTACHMENTS

- A. Training Cover Page: Training agendas shall be submitted for review and approval with this cover page completed.
  
- B. Static Tests and Startup Cover Page: Contractor's static test reports and startup reports shall be submitted for review with this cover page completed.
  
- C. The System Readiness Checklists and Functional Performance Test Procedures attached are included to illustrate level of rigor and general execution techniques. The attached checklists and procedures will be utilized where possible as the starting point or preliminary documents. Modifications, additions and deletions will be performed to customize these documents for the field installed equipment and systems. Additional checklists and test procedures will be incorporated during the project based on the systems being commissioned as defined in section 1.6. These incorporations will not be considered an additional service or basis for change orders nor will modifications to the preliminary checklists and test procedures which are included for the bidding contractors benefit.
  - 1. Sample System Readiness Checklists
    - 1) Chillers
    - 2) Air Handling Units
    - 3) Condensate Return Package
    - 4) Fans
    - 5) Pumps
    - 6) Steam to Water Heat Exchangers
    - 7) Unit Heaters
    - 8) Sump Pump
    - 9) Terminal Units
    - 10) Domestic Hot Water Heaters
    - 11) Lighting Controls
  
  - 2. Sample Functional Performance Test Procedures
    - 1) Chiller
    - 2) Air Handling Unit
    - 3) Heating Hot Water System
    - 4) Terminal Units
    - 5) Unit Heaters
    - 6) Domestic Hot Water
    - 7) Lighting Controls

**O&M TRAINING PLAN COVER**

<b>System/Equipment Identification:</b>	
Training Plan (by contractor):	
Training to be conducted by:	
Name:	Date:
Company:	Title:
Phone:	Fax:
Specification Section Reference:	
Duration of Training:	
List Materials Provided:	
Number of pages attached (agenda):	
Agenda Approval (by Commissioning Authority) Approved? <input type="checkbox"/> Yes <input type="checkbox"/> No	Agenda Approval (by CM Representative) Approved? <input type="checkbox"/> Yes <input type="checkbox"/> No
Comments:	
Attendees (Owner's operations & maintenance staff)	
Name/Affiliation:	Name/Affiliation:
Acceptance of the Training	
The training has satisfactorily provided the Owner's personnel with the knowledge to operate and maintain the equipment discussed during the training session?	
Owner's Cx Coord. <input type="checkbox"/> Yes <input type="checkbox"/> No Name:	Date:
Comments:	
List all Attachments:	



**LSH / T&M ASSOCIATES / GRAEF**

**EXPAND OUTPATIENT CLINICS - BUILDING 30, 2<sup>ND</sup> FLOOR ADDITION**

**JESSE BROWN VA MEDICAL CENTER**

**CHICAGO, ILLINOIS**

**GENERAL COMMISSIONING REQUIREMENTS**

**SECTION 01 91 13**