

## SECTION 019113.00 - GENERAL COMMISSIONING REQUIREMENTS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Federal Acquisition Regulations, and Division 01 Specification Sections, apply to this Section.
- B. Government's Project Requirements and Basis of Design documents are included by reference for information only.
- C. ASHRAE Guideline 0-2005 "The Commissioning Process".

#### 1.2 DESCRIPTION

- A. Commissioning: Commissioning is a quality-oriented process for achieving, verifying, and documenting that the performance of facilities, systems, and assemblies meet defined objectives and criteria. The Commissioning process begins at project inception (during the pre-design phase) and continues through the life of the facility. The commissioning process includes specific tasks to be conducted during each phase in order to verify that design, construction, and training meets the Government's project requirements.
- B. Commissioning Team: The members of the commissioning team consist of the contracted commissioning authority (CxA), the general contractor (GC), the Contracting Officer (CO), the mechanical contractor (MC), the electrical contractor (EC), the testing and balancing (TAB) contractor, the control contractor (CC), the facility operating staff, and any other installing subcontractors or suppliers of equipment. The contracted commissioning agent is hired by the government directly. The CxA directs and coordinates the project commissioning activities and the reports to the Contracting Officer. All team members work together to fulfill their contracted responsibilities and meet the objectives of the contract documents.
- C. Commissioning shall:
  - 1. Verify that applicable equipment and systems are installed according to the contract documents, manufacturer's recommendations, and industry accepted minimum standards and that they receive adequate operational checkout by installing contractors.
  - 2. Verify and document proper performance of equipment and systems.
  - 3. Verify that O&M documentation left on site is complete.
  - 4. Verify that the government's operating personnel are adequately trained.
- D. The commissioning process does not take away from or reduce the responsibility of the system designers or installing contractors to provide a finished and fully functioning product.

### 1.3 SUMMARY

- A. This section includes general requirements that apply to the implementation of the commissioning process without regard to specific systems, assemblies, and components.
- B. Related sections include the following:
  - 1. Division 1 Section 019113.22 “Commissioning of Plumbing” for commissioning process activities for domestic hot water and circulating pump, and pollution control.
  - 2. Division 1 Section 019113.23 “Commissioning of HVAC” for commissioning process activities for heating, ventilating, air- conditioning, and refrigerating systems, assemblies, equipment, and components.
  - 32. Division 1 Section 019113.26 "Commissioning of Electrical" for commissioning process activities for electrical systems, assemblies, equipment, and components.

### 1.4 DEFINITIONS

- A. Acceptance - A formal action, taken by a person with appropriate provider (which may or may not be contractually defined) to declare that some aspect of the project meets defined requirements, thus permitting subsequent activities to proceed.
- B. Approval - Acceptance that a piece of equipment or system has been properly installed and is functioning in the tested modes according to the contract documents.
- C. Basis of Design - A document that records the concepts, calculations, decisions, and product selections used to meet the government’s project requirements and to satisfy applicable regulatory requirements, standards, and guidelines. The document includes both narrative descriptions and lists of individual items that support the design process.
- D. Checklists - Verification checklists that are developed and used during all phases of the commissioning process to verify that the government’s project requirements are being achieved. This includes checklists for general verification, plus testing, training, and other specific requirements.
- E. Commissioning Authority (CxA) - The entity identified by the Contracting Officer who leads, plans, schedules, and coordinates the commissioning team to implement the commissioning process.
- F. Commissioning Plan - An overall plan developed by the commissioning agent that provides the structure, schedule and coordination planning for the commissioning process.
- G. Commissioning Process - A quality-focused process for enhancing the delivery of a project. The process focuses upon verifying and documenting that the facility and all of its systems and assemblies are planned, designed, installed, tested, operated, and maintained to meet the government's project requirements.
- H. Commissioning Process Activities - Components of the commissioning process.

- I. Commissioning Process Progress Report - A written document that details activities completed as part of the commissioning process and significant findings from those activities that is continuously updated during the course of a project. Usually it is incorporated into the commissioning plan as an ongoing appendix.
- J. Construction Checklist - A form used by the contractor to verify that appropriate components are on-site, ready for installation, correctly installed, and functional. Also see Checklists.
- K. Construction Documents - This includes a wide range of documents, which will vary from project to project, with the government's needs and with regulations, laws, and countries. Construction documents usually include the project manual (specifications), plans (drawings) and general terms and conditions of the contract.
- L. Continuous Commissioning Process - A continuation of the commissioning process well into the occupancy and operations phase to verify that a project continues to meet current and evolving government's project requirements. Continuous commissioning process activities are on-going for the life of the facility. Also see On-Going Commissioning Process.
- M. Contract Documents - This includes a wide range of documents, which will vary from project to project, with the government's needs and with regulations, laws, and countries. Contract documents frequently include price agreements, construction management process, sub-contractor agreements or requirements, requirements and procedures for submittals, changes, and other construction requirements, timeline for completion, and the construction documents.
- N. Coordination Drawings - Drawings showing the work of all trades to illustrate that equipment can be installed in the space allocated without compromising equipment function or access for maintenance and replacement. These drawings graphically illustrate and dimension manufacturers' recommended maintenance clearances.
- O. Control system - A component of environmental, HVAC, security, and fire systems for reporting/monitoring and issuing of commands to/from field devices.
- P. Data logging -The monitoring and recording of flows, currents, status, pressures, etc., of equipment using stand-alone data recorders separate from the control system or the trending capabilities of control systems.
- Q. Deferred Performance Tests (DPTs) - Performance tests that are performed, at the discretion of the CxA, after final acceptance, due to partial occupancy, equipment, seasonal requirements, design, or other site conditions that disallow the test from being performed.
- R. Deficiency - A condition in the installation or function of a component, piece of equipment, or system that is not in compliance with the contract documents.
- S. Factory Testing - Testing of equipment on-site or at the factory, by factory personnel, with or without a Contracting Officer present.
- T. Functional Performance Test Procedures: Commissioning protocols and detailed test procedures and instructions in tabular and script-type format that fully describe system configuration and steps required to determine if the system is performing and functioning properly. Contractor prepares these procedures to document Functional Performance Tests.

- U. Functional Performance Test (FPT): Test of dynamic function and operation of equipment and systems executed by Contractor. Systems are tested under various modes, such as during low cooling or heating loads, high loads, component failures, unoccupied, varying outside air temperatures, life safety conditions, power failure, etc. Systems are run through all specified sequences of operation. Components are verified to be responding in accordance with Contract Documents. Functional Performance Tests are executed after start-ups and Prefunctional Checklists are complete.
- V. Integrated System Test: Test of dynamic function and operation of multiple systems. Integrated System Tests are tested under various modes, such as fire alarm and emergency situations, life safety conditions, power failure, etc. Systems are integrally operated through all specified sequences of operation. Components are verified to be responding in accordance with Contract Documents. Integrated System Tests are executed after Functional Performance Tests are complete and prior to Substantial Completion. Integrated System Tests provide verification that the integrated systems will properly function according to the Contract Documents.
- W. Integrated System Test Procedures: Commissioning protocols and detailed test procedures and instructions in tabular and script-type format that fully describe system configurations and steps required to determine if the interacting systems are performing and functioning properly. Contractor prepares these procedures to document Integrated System Tests.
- X. Prefunctional Checklist: A list of static inspections and material or component tests that verify proper installation of equipment (e.g., belt tension, oil levels, labels affixed, gages in place, sensors calibrated, etc.). The word Prefunctional refers to before Functional tests. Prefunctional Checklists must include the manufacturer's Start-up checklist(s). Contractor shall sign Prefunctional Checklists as complete and submit with the Request for Start-up/Functional Performance Test Form.
- Y. Government's Project Requirements - A written document that details the functional requirements of a project and the expectations of how it will be used and operated. This includes project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, and supporting information. (The term "Project Intent" may be used in lieu of project requirements.)
- Z. Issues Log - A formal and ongoing record of problems or concerns – and their resolution – that have been raised by members of the commissioning team during the course of the commissioning process.
- AA. Nominal Group Technique - A formal, structured brainstorming process used to obtain the maximum possible ranked input from a variety of viewpoints in a short period of time. The typical approach is a workshop session where a question is presented, the attendees each record their responses on a piece of paper, the individual responses are recorded on a flip chart without discussion in a round robin fashion, all of the responses are discussed, and the participants rank their top five responses.
- BB. Non-Compliance - See Deficiency.
- CC. Non-Conformance - See Deficiency.
- DD. On-Going Commissioning Process - A continuation of the commissioning process well into the occupancy and operations phase to verify that a project continues to meet current and evolving government's project requirements. On-going commissioning process activities occur throughout

the life of the facility. Some of these will be close to continuous in implementation, and others will be either scheduled or unscheduled (as needed). Also see Continuous Commissioning Process.

- EE. Over-ridden Value -Riding over a sensor value in the equipment's controls to observe the response of the equipment's operation. Also see Simulated Signal.
- FF. Phased Commissioning - Commissioning that is completed in phases as required by the phasing plan as approved for the project and other scheduling issues.
- GG. Quality Based Sampling - A process for evaluating a sub-set (sample) of the total population. The sample is based upon a known or estimated probability distribution of expected values; an assumed statistical distribution based upon data from a similar product, assembly, or system; or a random sampling that has scientific statistical basis.
- HH. Re-Commissioning - An application of the commissioning process requirements to a project that has been delivered using the commissioning process. This may be a scheduled re- commissioning developed as part of an ongoing commissioning process, or it may be triggered by use change, operations problems, or other needs.
- II. Retro-Commissioning -The commissioning process applied to an existing facility that was not previously commissioned. This guideline does not specifically address retro-commissioning. However, the same basic process needs to be followed from pre-design through occupancy and operations to optimize the benefits of implementing the commissioning process philosophy and practice.
- JJ. Seasonal Performance Tests - Performance tests that are deferred until the system(s) will experience conditions closer to their design conditions based on weather conditions.
- KK. Simulated Condition - Condition that is created for the purpose of testing the response of a system (e.g., raising/lowering the setpoint of a thermostat to see the response in a VAV box).
- LL. Simulated Signal - Disconnecting a sensor and using a signal generator to simulate a sensor value for the purpose of testing a full range of conditions.
- MM. Startup - The initial starting or activating of dynamic equipment, including completing construction checklists.
- NN. Systems Manual - A system-focused composite document that includes the operation manual, maintenance manual, and additional information of use to the government during the occupancy and operations phase.
- OO. Test Procedure - A written protocol that defines methods, personnel, and expectations for tests conducted on components, equipment, assemblies, systems, and interfaces among systems. The test procedures are specified in the Technical Specifications sections of the contract documents. Performance testing covers the dynamic functions and operations of equipment and systems using manual or monitoring methods. Performance testing is the dynamic testing of systems under full operation. Systems are tested under various modes, such as during low cooling 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 respond as the sequences state.

- PP. Training Plan - A written document that details the expectations, schedule, budget, and deliverables of commissioning process activities related to training of project operating and maintenance personnel, users, and occupants.
- QQ. Verification - The process by which specific documents, components, equipment, assemblies, systems, and interfaces among systems are confirmed to comply with the criteria described in the Government's Project Requirements.
- RR. Trending – The monitoring, by a building management system or other electronic data gathering equipment, and analyzing of the data gathered over a period of time.
- SS. Vendor - Supplier of equipment.
- TT. Warranty Period - Refer to Section 017823.

## 1.5 COORDINATION

- A. Project Commissioning Team - The members of the project commissioning team will consist of the commissioning authority and any support personnel, the construction manager, the government's facility staff (FS) or designee, the general contractor, subcontractors and/or vendors as required, and the Contracting Officer (CO).
- B. Management - The CxA coordinates the commissioning activities through the construction manager. All members shall work together to fulfill their contracted responsibilities and meet the objectives of the contract documents. Refer to Paragraph 1.6 for additional management details.
- C. Scheduling - The CxA, through the Contracting Officer, will provide sufficient notice to the contractor for scheduling commissioning activities with respect to the government's participation. The contractor will integrate all commissioning activities into the overall project schedule. All parties will address scheduling problems and make necessary notifications in a timely manner in order to expedite the commissioning process.

## 1.6 COMMISSIONING PLAN

- A. The CxA will develop the commissioning plan which shall be included in the project schedule when approved by the Contracting Officer. The following narrative provides a brief overview of the typical commissioning tasks during construction and the general order in which they occur.
  - 1. Commissioning during construction begins with an initial commissioning meeting conducted by the CxA where the commissioning process is reviewed with the project commissioning team members.
  - 2. Additional meetings will be required throughout construction, scheduled by the CxA, through the Contracting Officer, with necessary parties attending to plan, scope, coordinate, schedule future activities and resolve problems.
  - 3. Equipment documentation is submitted to the CxA, through the Contracting Officer, during normal submittals, including detailed startup procedures.
  - 4. The construction checklists are to be completed by the contractor (or its subcontractors), before and during the startup process.

5. Construction checklists, TAB and startup must be completed before performance testing.
6. Items of non-compliance in material, installation, or setup shall be corrected at no expense to the government.
7. The contractor ensures that the subcontractors' construction checklists are executed and documented and that startup and initial checkout are performed. The CxA verifies that the TAB, construction checklists and startup were completed according to the approved plans. This includes the CxA approving TAB, checklists and startup plans. This also includes witnessing startup of selected equipment. Any testing failure is to be corrected at no additional cost to the government, and a re-test is to be performed, observed, and documented.
8. The CxA develops and implements equipment and system performance test procedures. The forms and procedures are approved by the Contracting Officer.
9. The performance tests are executed by the contractor under the direction of the CxA with the assistance of the facility staff. All documentation is by the CxA.
10. The CxA reviews the O&M documentation for completeness and provides the commissioning record for the O&M manuals.
11. Commissioning should be completed before final acceptance.
12. The CxA develops procedures, reviews, pre-approves, coordinates, and implements the training provided by the contractor.
13. Deferred testing is conducted as specified or required.

#### 1.7 COMMISSIONING TEAM

- A. Members appointed by contractor(s): Individuals, 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 each contractor, including project superintendent and subcontractors, installers, suppliers, and specialists deemed appropriate by the CxA.
- B. Members appointed by Contracting Officer:
  1. CxA - An entity identified by the government who leads, plans, schedules, and coordinates the commissioning team to implement the commissioning process. Contracting Officer will engage the CxA under a separate contract.
  2. Representatives of the facility user and operation and maintenance personnel.
  3. Contracting Officer.

#### 1.8 RELATED REQUIREMENTS

- |    |                |                                     |
|----|----------------|-------------------------------------|
| A. | Section 013300 | Submittals                          |
| B. | Section 013100 | Project Management and Coordination |
| C. | Section 013200 | Construction Progress Documentation |
| D. | Section 014500 | Contractor Quality Control          |
| E. | Section 017300 | Execution Requirements              |

F.	Section 017329	Cutting and Patching
G.	Section 017700	Closeout Procedures
H.	Section 017839	Project Record Documents
I.	Section 019113.22	Commissioning of Plumbing
J.	Section 019113.23	Commissioning of HVAC
K.	Section 019113.26	Commissioning of Electrical
L.	Section 079200	Joints Sealants
M.	Section 092900	Gypsum Board
N.	Section 096813	Tile Carpeting
O.	Section 096900	Access Flooring
P.	Section 237433	Packaged, Outdoor, Heating and Cooling Make-up Air Conditioners
Q.	Section 233713	Diffusers, Registers and Grilles
R.	Section 230593	HVAC System Testing, Adjusting, and Balancing

#### 1.9 RESPONSIBILITIES

- A. The general responsibilities of various parties in the commissioning process are provided in this sub-section. The specific responsibilities are in the Technical Specifications.
- B. All Parties
  - 1. Follow the commissioning plan.
- C. Contracting Officer
  - 1. Design Phase
    - a. Provide the NASA's project requirements documentation to the Commissioning Authority and Contractor for use in the developing of the commissioning plan; systems manual; operation and maintenance training plan; testing plans and checklists.
  - 2. Construction Phase
    - a. Attend the commissioning scoping meeting and selected commissioning team meetings.
    - b. Perform normal submittal review, construction observation, as-built drawing preparation, O&M manual preparation, etc., as contracted.
    - c. Provide any design narrative documentation requested by the CxA.

- d. Coordinate resolution of system deficiencies identified during commissioning, according to the contract documents.
- e. Prepare and submit final as-built design intent documentation for inclusion in the O&M manuals. Review and approve the O&M manuals.

D. Mechanical and Electrical Designers/Engineers

1. Construction and **Acceptance** Phase

- a. Perform normal submittal review, construction observation, as-built drawing preparation, etc., as contracted. One site observation should be completed just prior to system startup.
- b. Provide any design narrative and sequences documentation requested by the CxA. The designers shall assist (along with the contractors) in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.
- c. Attend commissioning scoping meetings and other selected commissioning team meetings.
- d. Participate in the resolution of system deficiencies identified during commissioning, according to the contract documents.
- e. Prepare and submit the final as-built design intent and operating parameters documentation for inclusion in the O&M manuals. Review and approve the O&M manuals.
- f. From the contractor's red-line drawings, edit and update one-line diagrams developed as part of the design narrative documentation and those provided by the vendor as shop drawings for the chilled and hot water, condenser water, domestic water, steam and condensate systems; supply, return and exhaust air systems and emergency power system.
- g. Witness testing of selected pieces of equipment and systems

2. Occupancy and Operations Phase

- a. Participate in the resolution of non-compliance, non-conformance and design deficiencies identified during commissioning during warranty-period commissioning.
- b. Attend lessons learned session

E. Commissioning Authority (CxA)

- 1. Organize and lead the commissioning team.
- 2. Prepare a construction-phase commissioning plan. Collaborate with Contractor and with subcontractors to develop test and inspection procedures. Identify commissioning team member responsibilities, by name, firm, and trade specialty, for performance of each commissioning task.
- 3. Review and comment on submittals from Contractor for compliance with the NASA'S Project Requirements, Basis of Design, Contract Documents, and construction-phase commissioning plan. Review and comment on performance expectations of systems and equipment and interfaces between systems relating to the NASA'S Project Requirements and Basis of Design.

4. 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 Authority shall prepare and distribute minutes to commissioning team members and attendees within five workdays of the commissioning meeting.
5. Construction Phase
  - a. Coordinates and directs the commissioning activities in a logical, sequential and efficient manner using consistent protocols and forms, centralized documentation, clear and regular communications and consultations with all necessary parties, frequently updated timelines and schedules and technical expertise.
  - b. Coordinate the commissioning work and, with the GC and Contracting Officer, help integrate commissioning activities into the master schedule.
  - c. Revise the Construction Phase Commissioning Plan as necessary.
  - d. Plan and conduct a commissioning scoping meeting and other commissioning meetings.
  - e. Request and review additional information required to perform commissioning tasks, including O&M materials, contractor startup and checkout procedures.
  - f. Before startup, gather and review the current control sequences and interlocks and work with contractors and design engineers until sufficient clarity has been obtained, in writing, to be able to write detailed testing procedures.
  - g. Review and accept normal contractor submittals applicable to systems being commissioned for compliance with commissioning needs, concurrent with the Contracting Officer reviews.
  - h. Write and distribute construction checklists. Prepare and maintain completed construction checklist log.
  - i. Develop an enhanced startup and initial systems checkout plan with construction team.
  - j. Perform site visits, as necessary, to observe component and system installations. Attend selected planning and job-site meetings to obtain information on construction progress. Review construction meeting minutes for revisions/substitutions relating to the commissioning process. Assist in resolving any discrepancies.
  - k. Witness all or part of the HVAC duct work leakage, piping test and flushing procedure, sufficient to be confident that proper procedures were followed. Document this testing and include the documentation in O&M manuals. Notify Contracting Officer of any deficiencies in results or procedures.
  - l. Approve construction checklist completion by selected site observation and spot checking.
  - m. Review TAB report.
  - n. With necessary assistance and review from installing contractors, write the performance test procedures for equipment and systems, including energy management control system trending, stand-alone data logger monitoring or manual performance testing. Submit to Contracting Officer for review, and for approval if required.
  - o. Analyze any performance trend logs and monitoring data to verify performance.
  - p. Coordinate, witness, and document of manual performance tests performed by installing contractors. Coordinate retesting as necessary until satisfactory performance is achieved
  - q. Maintain a master Issues Log and a separate testing record. Provide the Contracting Officer with written progress reports and test results with recommended actions.

- r. Witness performance testing of smoke control systems by Fire Marshall Division and all other Contracting Officer contracted tests or tests by manufacturer's personnel over which the CxA may not have direct control. Document these tests and include this documentation in Commissioning Record in O&M manuals.
- s. Review equipment warranties to ensure that the government's responsibilities are clearly defined.
- t. Oversee and document the training of the government's operating personnel as provided by the contractors.
- u. Compile and maintain a commissioning record and building systems book(s).
- v. Review the O&M manuals.
- w. Provide a final commissioning report (as described in this section).
- x. Coordinate the development of a systems manual
- y. Prepare a standard trend logging package of primary parameters that will provide the operations staff clear indications of system function in order to identify proper system operation and trouble shoot problems. The CxA shall also provide any needed information on interpreting the trends.

6. Occupancy and Operations Phase

- a. Coordinate and supervise required seasonal or deferred testing and deficiency corrections.
- b. 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.
- c. Assist in the development of a preventative maintenance plan, a detailed operating plan or an energy and resource management plan or as-built documentation.
- d. Attend lessons learned session

F. Government

1. Construction and Acceptance Phase

- a. Facilitate the coordination of the commissioning work by the CxA, and, with the GC and CxA, ensure that commissioning activities are being scheduled into the master schedule.
- b. Review and approve the final Commissioning Plan—Construction Phase.
- c. Attend a commissioning scoping meeting and other commissioning team meetings.
- d. Perform the normal review of contractor submittals.
- e. Furnish a copy of all construction documents, addenda, change orders and approved submittals and shop drawings related to commissioned equipment to the CxA.
- f. Review and approve the performance test procedures submitted by the CxA, prior to testing.
- g. When necessary, observe and witness startup and performance testing of selected equipment.
- h. Review commissioning progress and deficiency reports.

- i. Coordinate the resolution of non-compliance and design deficiencies identified in all phases of commissioning.
  - j. Sign-off (final approval) on individual commissioning tests as completed and passing. Recommend completion of the commissioning process to the Project Manager.
  - k. Assist the GC in coordinating the training of government personnel.
  - l. Provide the OPR documentation to the CxA and for information and use.
  - m. Provide the BoD documents, to the CxA and for use in developing the commissioning plan, systems manual, and operation and maintenance training plan.
  - n. Assign operation and maintenance personnel and schedule them to participate in commissioning team activities.
2. Occupancy and Operations Phase
    - a. Assist the CxA as necessary in the seasonal or deferred testing and deficiency corrections required by the specifications.
    - b. Attend lessons learned session
- G. Government's Project Manager (PM)
1. Construction Phase
    - a. Manage the contract of the GC.
    - b. Arrange for facility operating and maintenance personnel to attend various field commissioning activities and field training sessions.
    - c. Provide final approval for the completion of the commissioning work.
  2. Occupancy and Operations Phase
    - a. Ensure that any seasonal or deferred testing and any deficiency issues are addressed.
    - b. Attend lessons learned session
- H. Contractor. Contractor and their subcontractors and vendors shall assign representatives with expertise and authority to act on their behalf and schedule them to participate in and perform commissioning process activities including, but not limited to, the following:
1. Construction Phase
    - a. Facilitate the coordination of the commissioning and incorporate commissioning activities (the Commissioning Plan) into the Overall Project Schedule (OPS).
    - b. Provide detailed startup procedures
    - c. Include the cost of commissioning in the total contract price.
    - d. Ensure that all subcontractors and vendors execute their commissioning responsibilities according to the contract documents and the OPS.
    - e. Provide copies of all submittals as required in Section 013300 including all changes thereto. Attend and participate in commissioning team meetings held biweekly.
    - f. No later than 60 days prior to startup of the first piece of major equipment, meet with the CxA, PM and Contracting Officer to finalize the detailed commissioning procedures/ schedule.
    - g. Provide the training of government personnel.
    - h. Review and accept construction checklists provided by the commissioning authority.

- i. Complete construction checklists as work is completed and provide to the CxA on a weekly basis.
  - j. Accomplish commissioning process test procedures.
  - k. Evaluate performance deficiencies identified in test reports and, in collaboration with entity responsible for system and equipment installation, recommend corrective action.
  - l. Cooperate with the CxA for resolution of issues recorded in the “Issues Log”.
  - m. Prepare O&M manuals, according to the contract documents, including clarifying and updating the original sequences of operation to as-built/as-tested conditions.
2. Occupancy and Operations Phase
    - a. Ensure that subcontractors provide assistance for seasonal or deferred performance testing, performed by the CxA, according to the specifications.
    - b. Ensure that subcontractors correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.
    - c. Perform all guarantee work for materials furnished under the contract for the time specified in the contract, including all warranties and curing all latent defects within the time period provided in the contract.
- I. Vendors/Subcontractors
1. Provide all requested submittal data, including detailed startup procedures and specific responsibilities of the government to keep warranties in force.
  2. Assist in equipment testing per agreements with subcontractors and/or contractor.
  3. Include cost of all special tools and instruments (only available from vendor, specific to a piece of equipment) required for testing, operating, and maintaining equipment according to these contract documents in the base bid price to the contractor.
  4. Analyze specified products and verify that the Contracting Officer has specified the newest, most current equipment reasonable for this project’s scope and budget.
  5. Provide requested information regarding equipment sequence of operation and testing procedures.
  6. Review construction checklists and test procedures for equipment installed by factory representatives.

1.10 EQUIPMENT/SYSTEMS TO BE COMMISSIONED

- A. The following equipment/systems will be commissioned in this project:

1. Building Automation System (BAS)
2. Lighting Control Systems.
3. Domestic Water Systems.
4. All equipment of the Heating, Ventilating and Air Conditioning Systems, including but not limited to the following major elements:
  - a. Central Plants – Heating hot water and chilled water systems.
  - b. Radiant Systems
  - c. Ventilation Systems.

5. Pollution Control: Solid waste control.
6. Renewable Energy Systems.
7. Gray/Black wastewater treatment and landscape irrigation system.

## PART 2 - PRODUCTS

### 2.1 TEST EQUIPMENT

- A. All standard testing equipment required to perform startup and initial checkout and required performance testing shall be provided by the contractor for the equipment being tested. This includes, but is not limited to, two-way radios, meters, and data recorders. Data recorders may be provided by the CxA at the option of the CxA,
- B. Special equipment, tools, and instruments required for testing equipment according to these contract documents shall be included in the contractor's base bid price and shall be turned over to the government at Project close-out. **If specialty software is required to start-up or testing, a digital copy of that software shall be provided to the Government.**
- C. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance within 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 to NIST traceable standards within the past year to an accuracy of 0.5 degree F and a resolution of + or - 0.1 degree 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 MEETINGS

- A. Initial Meeting. Within 10 days of the Notice to Proceed (NTP), the CxA, through the Contracting Officer, will schedule, plan and conduct an initial commissioning meeting. The contractor and its responsible parties are required to attend.
- B. Miscellaneous Meetings. Other meetings will be planned and conducted by the CxA as construction progresses. These meetings will cover coordination, deficiency resolution, and planning issues. These meetings will be held at least monthly, until the final 3 months of construction, when they may be held as frequently as one per week.
- C. The Contractor shall incorporate the commissioning activities into the overall project schedule.

### 3.2 SITE OBSERVATION AND VERIFICATION

- A. The Commissioning Authority will perform routine site visits during the construction period.

- B. The Commissioning Authority site observation reports may include construction issues, access and maintenance issues, safety issues, or other issues. Each observation is intended to improve the project quality and achieve the Government's Project Intent
- C. The Commissioning Authority site observation reports are not "punch lists" in that they focus on systemic problems. Where an issue is identified, not all of the same components will have been verified by the Commissioning Authority.

### 3.3 STARTUP, CONSTRUCTION CHECKLISTS, AND INITIAL CHECKOUT

- A. The following procedures apply to all equipment/systems to be commissioned, according to Paragraph 1.10 Equipment/Systems to be commissioned.
- B. General. Construction checklists are important to verify that the equipment and systems are fully connected and operational. It ensures that performance testing (in-depth system checkout) may proceed without unnecessary delays. The construction checklists for a given system must be successfully completed and approved prior to startup and formal performance testing of equipment or subsystems of the given system.
- C. Startup and Checkout Plan.
  - 1. The intent of the pre-functional construction checklist is to provide a formalized means to easily track construction progress and to provide individual workers the key criteria for a successful installation. Each piece of equipment receives full pre-functional checkout by the Contractor. No sampling strategies are used. In general, the pre-functional testing for a given system must be successfully completed prior to formal functional performance testing.
  - 2. Delivery and Construction checklists are described in detail below.
  - 3. Checklists for piping, ductwork, cable trays, wiring, masonry etc. are different from the Delivery and Installation checklists. Although they are not formally tracked, they will be used by the Commissioning Authority during periodic site observations. These checklist items are reminders to the contractors of some common items that have been problematic on other projects.
- D. Checklist Format
  - 1. Construction checklists for all pieces of equipment typically follow the same format, yet are tailored to the specific equipment being installed.
- E. Checklist Development
  - 1. Construction checklists are developed for each individual piece of equipment and verify equipment from when they are delivered, installed, and started up.
  - 2. Commissioning Authority in collaboration with the HVAC Subcontractor, Test and Balance Subcontractor, and HVAC Instrumentation and Control Subcontractor, shall prepare detailed testing plans, procedures, and checklists for HVAC systems, subsystems, and equipment. The Contractor shall submit installation and startup instructions and checklists provided by the manufacturer. The contractor shall utilize all checklists provided by the manufacturer and the Contracting Officer for each item of equipment or system. Checklists shall include the following:

- a. Pre-Installation Checks: Includes several yes/no or short answer questions to document the condition of the equipment prior to installation and several blank columns to compare delivery items such as manufacturer, model, serial no., etc. to the corresponding submitted/approved items.
- b. Installation and Startup: Includes several yes/no or short answer questions to document that the equipment is installed, electrically wired, controlled and started up according to manufacturer's requirements and balanced according to the contract documents.
- c. Other Checklists: Prefunctional checklists provided by Contracting Officer including steps to verify equipment operation and control system operation as required in contract documents or in instructions from the manufacturer.
- d. A Negative Response: A Negative Responses section is included at the end of the checklist to document the reasons for any "responses or discrepancies in the various sections. A space is included to document the actions taken to correct the problems resulting in "no" responses.

F. Checklist Distribution

1. The construction checklists shall be distributed by the supervisor to individual workers (teams) before work begins for the equipment or system to be installed and at the start of each day for the equipment or system to be installed or worked on that day.

G. Checklist Completion

1. The checklist shall be completed and signed by the individual actually completing the work. The checklist shall not be filled out by a supervisor or other individual who did not work on the equipment.
2. Prior to the start of any work, the checklist for an individual item of equipment shall be reviewed by the individual contractor with the commissioning authority to insure they understand the use of the checklist. As work proceeds, the checklist shall be completed to track installation, startup and testing. Any negative responses on the checklist shall be corrected and explained/documented on the checklist.
3. When all work is completed on an item of equipment and checklists are completed, they shall be reviewed with the Commissioning Authority and signed. Checklists shall be submitted to the Contracting Officer for approval. Contracting Officers' approval shall indicate Government's acknowledgment of receipt of installation and testing documentation. The completion of the checklist shall not eliminate the contractor's responsibility for meeting other requirements in contract documents.

H. Checklist Verification

1. The Commissioning Authority will periodically verify the accuracy, completeness and tracking of the checklists. If consistent errors are found, the responsible contractor shall re-validate 100% of the checklists for the problem equipment or system type.
2. The Checklists are designed to detect and eliminate delivery, installation and startup problems, and problems with miscommunication. This process also serves as a convenient way to document the progress of the work.

- I. Sensor and Actuator Calibration. All field-installed temperature, relative humidity, CO, CO<sub>2</sub>, refrigerant, O<sub>2</sub>, and/or pressure sensors and gages, and all actuators (dampers and valves) on all equipment shall be calibrated. Verify that all locations are appropriate and away from causes of

erratic operation. Submit to the CxA through the Contracting Officer the calibration methods and results. All test instruments shall have had a certified calibration within the last 6 months to NIST traceable standards, and comply with all local, state and/or federal requirements/certifications, as required. Sensors installed in the unit at the factory with calibration certification provided need not be field calibrated. Provide bench testing as required at the direction of the CxA.

J. Execution of Construction Checklists and Startup.

1. Four weeks prior to the scheduled startup, the contractor shall coordinate startup and checkout with the CM, Contracting Officer, and CxA. The execution and approval of the construction checklists, startup, and checkout shall be directed and performed by the contractor, subcontractor or vendor. Signatures are required of the applicable subcontractors for verification of completion of their work.
2. The Contracting Officer shall observe, at minimum, the procedures for each piece of primary equipment, unless there are multiple units, in which case a sampling strategy may be used. The CxA will observe all testing.
3. For lower-level components of equipment, (e.g., sensors, controllers), the CxA shall observe a sampling of the startup procedures.
4. The subcontractors and vendors shall execute startup and provide the CxA, through the Contracting Officer, with a signed and dated copy of the completed startup and construction checklists.
5. Only individuals of the contractor (technicians, engineers, tradesmen, vendors, etc.) who have direct knowledge and witnessed that a line item task on the construction checklist was actually performed shall check off that item. It is not acceptable for witnessing supervisors to fill out these forms.

K. Deficiencies, Non-Conformance, and Approval in Checklists and Startup (Master Issues Log).

1. The contractor shall ensure that the subcontractors clearly list any outstanding items of the initial startup and construction checklist procedures that were not completed successfully, on an attached sheet. The form and any outstanding deficiencies shall be provided, through the Contracting Officer, to the CxA within two days of test completion.
2. The CxA will review the report and issue either a non-compliance report or an approval form, through the Contracting Officer, to the contractor. The installing subcontractors or vendors shall correct all areas that are deficient or incomplete in the checklists and tests in a timely manner, shall notify the Contracting Officer as soon as outstanding items have been corrected, and resubmit an updated startup report with a Statement of Correction on the original non-compliance report. When satisfactorily completed, the CxA will recommend approval of the execution of the checklists and startup of each system.
3. Items left incomplete, which later cause deficiencies or delays during performance may result in back charges to the contractor. Refer to Paragraph 3.5, herein, for details.

### 3.3 SUBMITTALS

- A. The Commissioning Authority shall review submittals concurrent to Contracting Officer's review. The intent of this review is to identify long-term issues of submitted equipment and to ensure the original project intent is maintained throughout the design and construction. Comments of the Commissioning Authority will be coordinated through Contracting Officer.

- B. The Contractor shall forward a copy of each submittal to the Commissioning Authority for review, in addition to the copies sent to the Contracting Officer. The Commissioning Authority will review the submittals parallel to the Contracting Officer review. The focus of the Commissioning Authority review will be:
  - 1. Verify that the equipment or system meets the NASA's Project Intent.
  - 2. Verify that equipment or system includes provisions for access and maintenance.
- C. The Contracting Officer will receive the Commissioning Authority comments and return a combined or collective list of comments to the Contractor. Copies of the Commissioning Authority comments will be provided to the Contracting Officer.
  - 1. Submittals reviewed by the Commissioning Authority will be returned to the Contracting Officer for final disposition.
  - 2. The Contracting Officer will incorporate the comments, or attach them to their comments, and return a single comment list to the Contractor. A copy of the Contracting Officer comments will also go to the Commissioning Authority.
- D. Within 30 days of submittal approval, the Contractor shall submit the following additional information:
  - 1. Manufacturer's installation instructions.
  - 2. Operation and maintenance manuals.
  - 3. Part load performance information. This shall include all ranges of operation (i.e. 0 to 100% load) for the entire range of expected performance characteristics (outdoor air temperature, supply air temperatures, etc.).

### 3.4 PHASED COMMISSIONING (IF REQUIRED)

- A. The project requires TAB, startup and performance testing to be executed in phases. Phasing shall be coordinated with the Contracting Officer and CxA and be reflected in the overall project schedule and commissioning schedule by the contractor. Final performance testing of all systems will be as required by the phasing plan. The performance testing of the "systems as a whole" will be performed before final turnover of the entire project.

### 3.5 PERFORMANCE TESTING

- A. Requirements. The performance testing shall demonstrate that each system is operating according to the documented design intent and contract documents. Performance testing facilitates bringing the systems from a state of individual final acceptance to full dynamic operation. Additionally, during the testing process, areas of deficient performance are identified and corrected, improving the operation and functioning of the systems.
- B. Coordination and Scheduling. The contractor shall provide sufficient notice, regarding their completion schedule for the construction checklists and startup of all equipment and systems to allow the performance testing to be scheduled. The commissioning team shall oversee, witness, and document the performance all equipment and systems. The CxA in association with the contractor/subcontractors and facility staff shall execute the tests. Performance testing shall be

conducted after the construction checklists, and startup has been satisfactorily completed. The control system shall be sufficiently tested and approved by the CxA before it is used, to verify performance of other components or systems. The air balancing and water balancing shall be completed before performance testing of air or water-related equipment or systems. Testing proceeds from components to sub-systems to systems. When the proper performance of all interacting individual systems has been achieved, the interface or coordinated responses between systems shall be checked.

- C. Development of Test Procedures. Before test procedures are finalized, the contractor shall provide to the Contracting Officer and the CxA all requested documentation and a current list of changes affecting equipment or systems, including an updated points list, program code, control sequences, and testing parameters. Using the testing parameters and requirements in the technical specifications, the CxA shall update/develop specific test procedures and forms to verify and document proper operation of each piece of equipment and system. Each contractor/subcontractor or vendor, as appropriate, shall provide assistance to the CxA in developing the final procedures. Prior to finalization, the Contracting Officer shall review and concur with the test procedure.
- D. Mechanical Testing.
  - 1. General
    - a. Functional performance testing is the dynamic testing of systems (rather than just components) under full operation. The systems are run through all of the control system's sequence of operation and components are verified to be responding as the sequence states.
    - b. Functional performance testing of systems and intersystem performance should occur only after pre-functional checklists for systems, subsystems, and equipment have been approved.
    - c. Refer to Section 019113.23 for additional related documents.
  - 2. Tests
    - a. Perform tests using design conditions whenever possible.
    - b. Simulate conditions by imposing an artificial load when it is not practical to test under design conditions and when written approval for simulated conditions is received from CxA. Before simulating conditions, calibrate testing instruments. Set and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
  - 3. Scope of HVAC Subcontractor Testing
    - a. Testing scope shall include entire HVAC installation, from central equipment for heat generation and refrigeration through distribution systems to each conditioned space. It shall include measuring capacities and effectiveness of operational and control functions.
    - b. Test all operating modes, interlocks, control responses, responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.

4. Detailed Testing Procedures
  - a. CxA, with HVAC Subcontractor, TAB Subcontractor, and HVAC Instrumentation and Control Subcontractor, shall prepare detailed testing plans, procedures, and checklists for HVAC systems, subsystems, and equipment.
5. HVAC Instrumentation and Control System Testing
  - a. Field testing plans and testing requirements are specified in Division 23. The CxA, HVAC Subcontractor, and the HVAC Instrumentation and Control Subcontractor shall collaborate to prepare testing plans.
  - b. CxA shall convene a meeting of appropriate entities to review test report of HVAC instrumentation and control systems.
6. Pipe Cleaning
  - a. Pipe cleaning, flushing, hydrostatic tests, and chemical treatment requirements are specified in Division 15 piping Sections. HVAC Subcontractor shall prepare pipe system cleaning, flushing, and hydrostatic testing. CxA shall review and comment on plan and final reports. Contractor shall certify that pipe cleaning, flushing, hydrostatic tests, and chemical treatment have been completed. Plan shall include the following:
    - 1) Sequence of testing and testing procedures for each section of pipe to be tested, identified by pipe zone or sector identification marker. Markers shall be keyed Drawings for each pipe sector showing the physical location of each designated pipe test section. Drawings keyed to pipe zones or sectors shall be formatted to allow each section of piping to be physically located and identified when referred to in pipe system cleaning, flushing, hydrostatic testing, and chemical treatment plan.
    - 2) Description of equipment for flushing operations.
    - 3) Minimum flushing water velocity.
    - 4) Tracking checklist for managing and ensuring that all pipe sections have been cleaned, flushed, hydrostatically tested, and chemically treated.
7. Energy Supply System Testing:
  - a. HVAC Subcontractor shall prepare a testing plan to verify performance of gas systems and equipment. Plan shall include the following:
    - 1) Sequence of testing and testing procedures for each equipment item and pipe section to be tested, identified by pipe zone or sector identification marker. Markers shall be keyed to Drawings for each pipe sector showing the physical location of each designated pipe test section. Drawings keyed to pipe zones or sectors shall be formatted to allow each section of piping to be physically located and identified when referred to in system testing plan.
    - 2) Tracking checklist for managing and ensuring that all pipe sections have been tested.

8. Heat-Generation System Testing

- a. HVAC Subcontractor shall prepare a testing plan to verify performance of hot water equipment and auxiliary equipment. Plan shall include the following:
  - 1) Sequence of testing and testing procedures for each item of equipment and section of pipe to be tested, identified by identification marker. Markers shall be keyed to Drawings for each pipe sector showing the physical location of each item of equipment and pipe test section. Drawings shall be formatted to allow each item of equipment and section of piping to be physically located and identified when referred to in the system testing plan.
  - 2) Tracking checklist for managing and ensuring that all pipe sections have been tested.

9. Refrigeration System Testing

- a. HVAC Subcontractor shall prepare a testing plan to verify performance of refrigerant compressors and condensers, heat pumps, and other refrigeration systems. Plan shall include the following:
  - 1) Sequence of testing and testing procedures for each item of equipment and section of pipe to be tested, identified by identification marker. Markers shall be keyed to Drawings showing the physical location of each item of equipment and pipe test section. Drawings shall be formatted to allow each item of equipment and section of piping to be physically located and identified when referred to in the system testing plan.
  - 2) Tracking checklist for managing and ensuring that all pipe sections have been tested.

10. HVAC Distribution System Testing:

- a. HVAC Subcontractor shall prepare a testing plan to verify performance of air, steam, and hydronic distribution systems; special exhaust; and other distribution systems. Include HVAC terminal equipment and unitary equipment. Plan shall include the following:
  - 1) Sequence of testing and testing procedures for each item of equipment and section of pipe to be tested, identified by identification marker. Markers shall be keyed to Drawings showing the physical location of each item of equipment and pipe test section. Drawings shall be formatted to allow each item of equipment and section of piping to be physically located and identified when referred to in the system testing plan.
  - 2) Tracking checklist for managing and ensuring that all pipe sections have been tested.
  - 3) The HVAC system employs an underfloor air distribution system. To ensure the success of the underfloor system, HVAC Subcontractor shall test and verify that all underfloor penetrations, wall enclosures, exterior walls and conduits are sealed from the underfloor air plenum to prevent unwanted air leakage.

11. Vibration and Sound Tests
  - a. HVAC Subcontractor shall prepare testing plans to verify performance of vibration isolation and seismic controls. CxA shall witness tests and inspections.
12. Deferred Testing
  - a. If tests cannot be completed because of a deficiency outside the scope of the HVAC system, the deficiency shall be documented and reported to Contracting Officer. Deficiencies shall be resolved and corrected by appropriate parties and test rescheduled.
  - b. If the testing plan indicates specific seasonal testing, appropriate initial performance tests shall be completed and documented and additional tests scheduled.

E. Electrical Testing

1. Perform prefunctional checks according to the steps identified in the pre-functional checklists provided in other sections of this specification. With or in addition to those checks, perform inspections and tests as shown below and in other sections of this specification.
2. Lighting Fixtures and Lighting controls/277/120V lighting
  - a. General: Provide the services of a factory-trained manufacturer's representative to assist the contractor in the installation and start-up service of the lighting control system and train NASA's maintenance personnel as specified below. Representative will confirm the proper installation and operation of all system components.
  - b. Train NASA's maintenance personnel on the operation and programming of the lighting control system. Up to two days of training shall be provided for up to 5 users.
  - c. Start-up checklists: Perform the following final checks before startup
    - 1) Ensure all labeling is affixed and accurate
    - 2) Ensure all terminations are tight.
    - 3) Check sensor placement is adequate for required duty.
    - 4) Ensure adequate access is provided to all panels and that documentation of that panel is provided in it.
    - 5) Ensure all circuits for the loads are energized and ready for testing.
3. Starting Procedures: Follow the manufacturer's written procedures and the following as a minimum:
  - a. Test, calibrate, and set all digital and analog sensing, and actuating devices. Calibrate each instrumentation device by making a comparison between the graphic display and the reading at the device, using an instrument traceable to the National Bureau of Standards, which shall be at least twice as accurate as the device to be calibrated (e.g., if field device is +/-0.5% accurate, test equipment shall be +/-0.25% accurate over same range). Record the measured value and displayed value for each device in the Start Up Report.
  - b. Check each digital control point by making a comparison between the control command at the control panel and the status of the controlled device. Check each digital input point by making a comparison of the state of the sensing device and the OI display. Record the results for each device in the ATC/FMS Start-Up Report.

- c. Check loads on all breakers to ensure that the breaker is properly sized.
  - d. Enter all schedules per occupant's direction.
- F. Test Equipment. Refer to Part 2 for test equipment requirements.
- G. Problem Solving. The burden of responsibility to solve, correct, and retest malfunctions/failures is with the contractor, with Contracting Officer approval as required.

### 3.6 DOCUMENTATION, NON-CONFORMANCE, AND APPROVAL OF TESTS

- A. Documentation. The CxA shall witness and verify/pre-approve the documentation of the results of all performance tests. The CxA shall complete all documentation for performance testing.
- B. Non-Conformance.
- 1. Corrections of minor deficiencies identified may be made during the tests at the discretion of the CxA. In such cases the deficiency and resolution will be documented on the procedure form or on an attached sheet.
  - 2. As tests progress and a deficiency is identified, the CxA shall discuss the issue with the commissioning team, and the contractor.
    - a. When there is no dispute on the deficiency and the contractor accepts responsibility to correct it:
      - 1) The CxA will document the deficiency and the contractor's response and intentions. After the day's work, the CxA will submit the non-compliance reports to the Contracting Officer. The contractor corrects the deficiency, signs the statement of correction at the bottom of the non-compliance form certifying that the equipment is ready to be retested and sends it back to the CxA.
      - 2) The contractor shall reschedule the test; and the test repeated.
    - b. If there is a dispute about a deficiency, regarding whether or not it is a deficiency:
      - 1) The dispute shall be documented on the non-compliance form with the contractor's response.
      - 2) Resolutions are made at the lowest management level possible. Other parties are brought into the discussions as needed. Final interpretive authority is with the Contracting Officer. Final acceptance authority is with the construction manager.
      - 3) The CxA documents the resolution process.
      - 4) Once the interpretation and resolution have been decided, the contractor corrects the deficiency, signs the statement of correction on the non-compliance form and provides it to the CxA, through the Contracting Officer. The contractor shall reschedule the test and the test repeated until satisfactory performance is achieved.

3. The contractor shall submit in writing to the Contracting Officer at least as often as commissioning meetings are being scheduled, the status of each outstanding discrepancy identified during commissioning. Discussion shall cover explanations of any disagreement and proposals for their resolutions.
  - a. The CxA retains the original non-conformance forms until the end of the project.
  - b. Retesting shall not be considered a justified reason for a claim of delay or for a time extension by the contractor.
  
- C. Failure Due to Manufacturer Defect. If 10% (or three, whichever is greater) of identical pieces of equipment fail to perform to the contract documents (mechanically or substantively) due to a manufacturing defect, not allowing it to meet its submitted performance specification, all identical units may be considered unacceptable by the Contracting Officer or CxA. In such case, the contractor shall provide the government with the following:
  1. Within one week of notification from the Contracting Officer, 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 Contracting Officer 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. The proposed solutions shall not significantly exceed the specification requirements of the original installation.
  3. The Contracting Officer will determine whether a replacement of all identical units or a repair is acceptable.
  4. Two examples, where applicable, of the proposed solution shall be installed by the contractor and the Contracting Officer shall be allowed to test the installations for up to one week, upon which the Contracting Officer 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. The replacement/repair work shall proceed with reasonable speed beginning within one week from when parts can be obtained.
  
- D. Approval. The CxA notes each satisfactorily demonstrated function on the test form. Final approval of the performance test by the Contracting Officer is made after review by the CxA.

### 3.7 DEFERRED TESTING

- A. Unforeseen Deferred Tests. If any check or test cannot be completed due to the project completion level, required occupancy condition or other deficiency, execution of checklists and performance testing may be delayed upon approval of the CxA and Contracting Officer. These tests will be conducted in the same manner as the seasonal tests as soon as possible. Services of necessary parties will be negotiated.
  
- B. Seasonal Testing. During the warranty period, seasonal testing (tests delayed until weather conditions are closer to the system's design) shall be completed as part of this contract. The CxA shall coordinate this activity through the Contracting Officer. Tests will be executed, documented by the CxA and deficiencies should be corrected by the appropriate contractor/ subcontractors with the CxA witnessing. Any final adjustments to the O&M manuals and as-builts due to the testing shall be made by the contractor.

3.8 TRAINING OF GOVERNMENT PERSONNEL

- A. The contractor shall provide training coordination, scheduling of subcontractors, and ensure that training is completed. All training shall be coordinated, through the Contracting Officer, with the CxA.
- B. The contractor shall ensure that each subcontractor and vendor (mechanical, plumbing, fire, electrical, specialty, etc.) shall have the following responsibilities:
  - 1. Provide, to the CxA through the Contracting Officer, a training plan sixty days before the planned training covering the following elements:
    - a. Equipment
    - b. Intended audience
    - c. Location of training
    - d. Objectives
    - e. Subjects covered (description, duration of discussion, special methods, etc.)
    - f. Duration of training on each subject
    - g. Instructor for each subject
    - h. Methods (classroom lecture, manufacturer's quality video, site walk-through, actual operational demonstrations, written handouts, etc.).
  - 2. Provide designated government personnel with comprehensive orientation and training in the understanding of the systems and the operation and maintenance of each piece of equipment that makes up the system.
  - 3. Training shall normally start with classroom sessions followed by hands-on demonstration/training on each piece of equipment.
  - 4. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system shall be repaired or adjusted as necessary and the demonstration repeated at another scheduled time, if necessary.
  - 5. The appropriate trade or manufacturer's representative shall provide the instructions on each major piece of equipment. Practical building operating expertise as well as in-depth knowledge of all modes of operation of the specific piece of equipment are required. More than one party may be required to execute the training.
  - 6. The controls contractor shall attend sessions other than the controls training, as specified, to discuss the interaction of the controls system as it relates to the equipment being discussed.
  - 7. The training sessions shall follow the outline in the table of contents of the operation and maintenance manual and illustrate whenever possible the use of the O&M manuals for reference.
  - 8. Training shall include:
    - a. Use of the printed installation, operation and maintenance instruction material included in the O&M manuals.
    - b. A review of the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance, special tools needed and spare parts inventory suggestions. The training shall include startup, operation in all modes possible, shutdown, seasonal changeover and any emergency procedures.
    - c. Discussion of relevant health and safety issues and concerns.
    - d. Discussion of warranties and guarantees.
    - e. Common troubleshooting problems and solutions.
    - f. Explanatory information included in the O&M manuals.

- g. Discussion of any peculiarities of equipment installation or operation.
  - h. Classroom sessions shall include the use of overhead projections, slides, video/audio-taped material as might be appropriate.
  - i. Hands-on training shall include startup, operation in all modes possible, including manual, shut-down, alarms, power failure and any emergency procedures, and preventative maintenance for all pieces of equipment.
9. The contractor shall fully explain and demonstrate the operation, function and overrides of any local packaged controls not controlled by the central control system.
- C. At the discretion of the CxA, training may occur before performance testing is complete if required by the facility operators to assist the CxA in the performance testing.
  - D. Video-recording of the training sessions will be provided by the contractor and added to the O&M manuals. In addition, factory training videos identifying key troubleshooting, repair, service and/or replacement techniques shall be provided and reviewed with the Contracting Officer.
  - E. The CxA at the beginning of each training session presents the overall system narrative and the design concept of each equipment section.
  - F. Refer to Section 09113.22, 09113.23 and 019113.26 for related documents.

### 3.9 OPERATIONS AND MAINTENANCE MANUALS/DATA

- A. The commissioning process requires detailed O&M documentation as identified in this section and technical specifications.
- B. Contractor shall submit two draft copies of the complete operating and maintenance manual to the CM for review by the Contracting Officer and CxA within 60 calendar days after review of equipment shop drawings. One copy will be returned to the contractor within 30 days after receipt by the Contracting Officer.
- C. Contractor shall submit corrected final approved manuals prior to final acceptance. Prior to final submittal, the CxA shall review the O&M manuals (in addition to the initial draft O&M manual), and documentation, with redline as-builts, for systems that were commissioned to verify compliance with the specifications. The CxA will communicate, through the Contracting Officer, deficiencies in the manuals to the contractor or Contracting Officer, as requested. Upon a successful review of the corrections, the CxA will recommend approval and acceptance of these sections of the O&M manuals to the Contracting Officer. The CxA will also review each equipment warranty and verify that all requirements to keep the warranty valid are clearly stated. This work does not supersede the Contracting Officer's review of the O&M manuals according to the Contracting Officer's contract.
- D. The contractor shall compile O&M manuals for every piece of equipment and building operating or electrical system being commissioned with the following format:
  - 1. Quantity: 6 (Unless more are required by the technical specifications).

2. Format: 8 1/2 x 11 3 ring loose-leaf binders, 3-inch maximum, and electronic format that is compatible with government's system. Each binder shall be clearly labeled on the spine. Use as many binders as required. Do not overload binders. Dividers with permanently marked tabs of card stock shall separate each section and sub section. Tab labels shall not be handwritten. A separate manual or chapter shall be provided for each applicable system as follows:
  - a. Chilled Water Systems
  - b. Heating Systems
  - c. Pumps
  - d. Air Handling Units (include sequence of operation, one line diagram and area served in a plastic pouch for mounting on equipment or in equipment room)
  - e. Exhaust Fans
  - f. Supply Air Fans (excluding Air Handling Units)
  - g. Plumbing and Drainage Systems/Equipment
  - h. Water Treatment System
  - i. Lighting Systems and Controls (interior, exterior and airfield)
  - j. Building Management/Temperature Control System
  - k. HVAC, Testing Adjusting, and Balancing
3. There shall be a title page and table of contents in the front of each binder for each binder's contents. In each binder, there shall be a main tab for each specification section. Behind the section number tab there shall be the equipment ID tag sub-tab for each piece of major equipment (or group, if small or numerous). These sub-tabs shall be similar to the specification number tabs but of a different color. Behind each equipment name tab shall be the following sections, in the given order, divided by a double weight colored sheet labeled with the title of the section.
  - a. Contractor. The first page behind the equipment tab shall contain the name, address and telephone number of the manufacturer and installing contractor and the 24-hour number for emergency service for all equipment in this section, identified by equipment.
  - b. Submittal and Product Data. This section shall include all approved submittal data, cut sheets, data base sheets and appropriate shop drawings. If submittal was not required for approval, descriptive product data shall be included.
  - c. Operation and Maintenance Instructions. These shall be the written manufacturer's data with the model and features of this installation clearly marked and edited to omit reference to products or data not applicable to this installation. This section shall include data on the following:
    - 1) Model number, serial number and nameplate data for each piece of equipment and any subcomponent.
    - 2) Installation, startup and break-in instructions.
    - 3) All starting, normal shutdown, emergency shutdown, manual operation and normal and emergency operating procedures and data, including any special limitations.
      - i. Step-by-step procedure for system startup, including a pre-start checklist. Refer to controls and indicators by nomenclature consistent with that used on panels and in control diagrams.

- ii. Sequence of operation, with detailed instruction in proper sequence, for each mode of operation (i.e., day-night; staging of equipment).
  - iii. Emergency operation: If some functions of the equipment can be operated while other functions are disabled, give instructions for operations under these conditions. Include here only those alternate methods of operations (from normal) which the operator can follow when there is a partial failure or malfunctioning of components, or other unusual condition.
  - iv. Shutdown procedure: Include instructions for stopping and securing the equipment after operation. If a particular sequence is required, give step-by-step instructions in that order.
- 4) O&M and installation instructions that were shipped with the unit.
  - 5) Preventative and corrective maintenance, with service procedures and schedules:
    - i. Provide a schedule for preventive maintenance in a printed format and an electronic format compatible with government's system. State, preferably in tabular form, the recommended frequency of performance for each preventive maintenance task, cleaning, inspection and scheduled overhauls.
    - ii. Cleaning: Provide instructions and schedules for all routine cleaning and inspection with recommended lubricants.
    - iii. Inspection: If periodic inspection of equipment is required for operation, cleaning or other reasons, indicate the items to be inspected and give the inspection criteria for: motors; controls; filters and any other maintenance items.
    - iv. Provide instructions for minor repairs or adjustments required for preventive maintenance routines. Identify test points and give values for each. Include sensor calibration requirements and methods by sensor type.
    - v. Corrective maintenance instructions shall be predicated upon a logical effect-to-cause troubleshooting philosophy and a rapid replacement procedure to minimize equipment downtime.
    - vi. Troubleshooting: Troubleshooting tables, charts, or diagrams shall be used to present specified procedures. A guide to this type shall be a three-column chart. The columns shall be titled: malfunction, probable cause and recommended action.
    - vii. Repair and Replacement: Indicate repair and replacement procedures most likely to be required in the maintenance of the equipment.
  - 6) Safety Precautions: This subsection shall comprise a listing of safety precautions and instructions to be followed before, during and after making repairs, adjustments or routine maintenance.
  - 7) Manufacturers' brochures (including controls): Manufacturers' descriptive literature covering devices and equipment used in the system, together with illustrations, exploded views and renewal parts lists. Manufacturers' standard brochures and parts list shall be corrected so that information applying to the actual installed equipment is clearly defined.
  - 8) Supply any special tools required to service or maintain the equipment.
  - 9) Performance data, ratings and curves.

- 10) Warranty and guarantee, which clearly lists conditions to be maintained to keep warranty in effect and conditions that would affect the validity of the warranty.
  - 11) Any service contracts issued.
- d. Supplemental Data. Prepare written text and/or special drawings to provide necessary information, where manufacturer's standard printed data is not available and information is necessary for a proper understanding and operation and maintenance of equipment or systems, or where it is necessary to provide additional information to supplement data included in the manual or project documents.
  - e. Control Diagrams/Drawings. Include the as-built control diagrams/drawings for the piece of equipment and its components, including full points list, full print out of all schedules and set points after testing and acceptance of the system, and copies of all checkout tests and calibrations performed by the contractor (not commissioning tests).
  - f. Specifications. This section is comprised of the component or system specification section copied and inserted complete with all addenda.
  - g. System Description. This section shall include the individual equipment portion of the overall system Design Basis Narrative.
- E. Commissioning Record in O&M Manuals.
1. The CxA is responsible to compile, organize and index the following commissioning data by equipment into labeled, indexed and tabbed, three-ring binders and deliver it to the GC, to be included with the O&M manuals.
    - a. Commissioning Plan
    - b. System reports including design narratives and criteria including sequences. Each system shall contain the startup plan and report, approvals, corrections, construction checklists, completed performance tests, trending and analysis, training plan and recommended recommissioning schedule.
    - c. Final Commissioning Report including an executive summary, list of participants and roles, brief building description, overview of commissioning and testing scope and a general description of testing and verification methods. For each piece of commissioned equipment, the report should contain the disposition of the commissioning authority regarding the adequacy of the equipment, documentation and training meeting the contract documents in the following areas:
      - 1) Equipment meeting the equipment specifications
      - 2) Equipment installation
      - 3) Performance and efficiency
      - 4) Equipment documentation and design intent
      - 5) Operator training.
    - d. All outstanding non-compliance items shall be specifically listed. Recommendations for improvement to equipment or operations, future actions, commissioning process changes, etc. shall also be listed. Each non-compliance issue shall be referenced to the specific performance test, inspection, trend log, etc. where the deficiency is documented. The performance and efficiency section for each piece of equipment shall include a brief description of the verification method used (manual testing, BAS trend logs, data loggers, etc.) and include observations and conclusions from the testing.

- F. O&M Manuals in digitized format using Adobe PDF software may be submitted in lieu of paper copies provided they meet all other requirements specified in Paragraph 3.9 of this Section.

END OF SECTION 019113.00