## PART 1 - GENERAL

### 1.1 SCOPE

A. Commissioning is a quality delivery process to provide the Owner with a higher level of assurance that the systems and equipment have been installed in the prescribed manner and will perform according to the design intent. The commissioning process will include the monitoring of the construction process, observation of equipment start-up, review of control software, development of a commissioning plan, review of the testing, performance of functional test procedures on the equipment and systems being commissioned, supervision of organization of the operation and maintenance manuals for the project, and the coordination of the training of the owner's operational and maintenance staff.

### 1.2 SYSTEMS TO BE COMMISSIONED

A. The following shall be commissioned:
   1. HVAC systems (Division 23) including:
      a. Air handling units
      b. Lab exhaust fans
      c. Exhaust fans
      d. Fan coil units
      e. Split systems
      f. Hot and chilled water pumps
      g. Terminal air units and laboratory terminal units
      h. Heating hot water and steam systems
      i. Process cooling water system
      j. Associated controls and laboratory controls
   2. Domestic hot water system and service to the required equipment and fixtures (Division 22).
   3. Lab compressed air and vacuum (Division 22)
   4. Emergency generator and transfer switch (Division 26)
   5. Lighting controls system (Division 26)
   6. Telecom backbone (review of test results) (Division 27)
   7. Landscape irrigation controls (Division 32)

### 1.3 COORDINATION

A. Commissioning Team: The members of the commissioning team consist of the Owner's Representatives, Commissioning Agent, General Contractor, Engineer of Record (Architects and Engineers, or A/E), Mechanical Contractor, Electrical Contractor, Test and Balance (TAB) Representative, Controls Contractor, and any other installing subcontractors or suppliers of equipment.

B. Scheduling: The Commissioning Agent will work with the Owner's Representative and General Contractor (GC) to schedule the commissioning activities.

## 1.4 COMMISSIONING PROCESS

A. Commissioning Process. 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 a kickoff meeting.
   2. Additional meetings may be required throughout construction and will be scheduled by the Commissioning Agent in coordination with the Construction Manager and General Contractor.
   3. The Commissioning Agent provides the Sub-Contractors with pre-functional checklists to be completed during the startup process.
   4. The Sub-Contractors, under their own direction, execute and document the pre-functional checklists and perform startup and initial checkout. The Commissioning Agent documents that the checklists and startup were completed.
   5. The Commissioning Agent develops specific equipment and system functional performance test procedures. The Contractors review the procedures.
   6. The procedures are executed by the installing Contractors, under the direction of, and documented by the Commissioning Agent.
   7. Items of non-compliance in material, installation or setup are corrected at the installing Contractor's expense and the system retested at no additional cost to the Owner.
   8. The Commissioning Agent reviews the O&M documentation for completeness.
   9. Commissioning is completed before Substantial Completion.
   10. The Commissioning Agent reviews and coordinates the training provided by the Sub-Contractors and verifies that it was completed.

## 1.5 RELATED WORK

A. All of the following sections apply to the Work of this section.
   1. Section 230805 – Mechanical Systems Commissioning Requirements
   2. Section 260800 – Electrical Systems Commissioning Requirements

## 1.6 RESPONSIBILITIES

A. The responsibilities of various parties in the commissioning process are provided in this section. Additional responsibilities of the Mechanical Contractor, TAB, Controls Contractor, Plumbing Contractor, and Irrigation/Landscaping Contractor are in Division 23. Additional responsibilities of the Electrical Contractor and Telecom Contractor are in Division 26. All parties shall attend commissioning kickoff meeting and other scheduled commissioning meetings.

B. Commissioning Agent (CxA)
   1. The Commissioning Agent is not responsible for design concept, design criteria, compliance with codes, design or general construction scheduling, cost estimating, or construction management.
   2. The Commissioning Agent may assist with problem-solving non-conformance or deficiencies, but ultimately that responsibility resides with the general contractor and the Architect of Record.
   3. The primary role of the Commissioning Agent is to develop and coordinate the execution of a testing plan, observe and document that systems are functioning in accordance with the design intent.
   4. Coordinates and directs the commissioning activities in a logical, sequential and efficient manner.

5. Coordinate the commissioning work with the General Contractor and Owner's Representative so that commissioning activities are being scheduled into the master schedule.
6. Plan and conduct a commissioning kickoff meeting and other commissioning meetings.
7. 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.
8. Review Contractor submittals applicable to systems being commissioned for compliance with commissioning needs.
9. Write and distribute pre-functional checklists.
10. Review construction meeting minutes for revisions/substitutions relating to the commissioning process. Assist in resolving any discrepancies.
11. Verify pre-functional tests and checklist completion by reviewing pre-functional checklist reports and by selected site observation and spot checking.
12. Verify systems startup by reviewing start-up reports and by selected site observation.
13. Verify systems balancing by reviewing completed reports.
14. Write the functional performance test procedures for equipment and systems.
15. Coordinate and witness functional performance tests performed by installing contractors.
16. Maintain a master deficiency and resolution log and a separate testing record.
17. Review contractor's systems training plan.
18. Compile and maintain a commissioning record.
19. Review the preparation of the O&M manuals.
20. Provide a final commissioning report.

C. Owner's Representative
1. Facilitate the coordination of the commissioning work by the Commissioning Agent.
2. Attend a commissioning kickoff meeting and other commissioning team meetings.
3. Arrange for facility operating and maintenance personnel to attend various field commissioning activities and field training sessions.
4. Furnish a copy of all construction documents, addenda, change orders and approved submittals and shop drawings to the Commissioning Agent.
5. Coordinate the resolution of non-compliance and design deficiencies identified in all phases of commissioning with A/E.
6. Assist the General Contractor in coordinating the training of personnel.
7. Assist the Commissioning Agent as necessary in deficiency corrections.
8. Provide final approval for the completion of the commissioning work.

D. Mechanical, Electrical Designers/Engineers (A/E)
1. Perform normal submittal review, construction observation, as-built drawing preparation, etc., as contracted.
2. Provide any design narrative and sequences documentation requested by the CxA.
3. Participate in the resolution of system deficiencies identified during commissioning.
4. Review and approve the O&M manuals.

E. General Contractor (GC): 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. Facilitate the coordination of the commissioning work by the Commissioning Agent.
2. Include the cost of commissioning in the total contract price.
3. In each purchase order or subcontract written, include requirements for submittal data, O&M data, commissioning tasks and training.
4. Provide copies of all submittals including all changes thereto.
5. Review and accept prefunctional checklists provided by the Commissioning Agent.

6. Ensure that all Sub-Contractors execute their commissioning responsibilities.
7. A representative shall attend a commissioning kickoff meeting and other necessary meetings scheduled by the Commissioning Agent.
8. Accomplish commissioning process test procedures.
9. Cooperate with the CxA for resolution of issues recorded in the “Issues Log”.
10. Provide the training of Owner personnel.
11. Prepare O&M manuals including clarifying and updating the original sequences of operation to as-built conditions.
12. Ensure that subcontractors correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings.
13. Perform all guarantee work for materials furnished under the contract for the time specified in the contract.

F. Equipment Suppliers
1. Provide all requested submittal data.
2. Assist in equipment testing per agreements with Sub-Contractors.
3. Include all special tools and instruments required for testing equipment according to these Contract Documents.
4. Provide information requested by Commissioning Agent regarding equipment sequence of operation and testing procedures.

## PART 2 - PRODUCTS

### 2.1 TEST EQUIPMENT

A. All standard testing equipment required to perform start-up and initial checkout and required functional performance testing shall be provided by the Division contractor for equipment being tested.

## PART 3 - EXECUTION

### 3.1 MEETINGS

A. Commissioning Kickoff Meeting: Within 90 days of commencement of construction, the Commissioning Agent will schedule, plan and conduct a commissioning kickoff meeting with the entire commissioning team in attendance.

B. Miscellaneous Meetings: Additional meeting as required will be scheduled during the course of the commissioning process.

### 3.2 SUBMITTALS

A. The Commissioning Agent will provide one review of submittals related to the commissioned equipment.

B. The Commissioning Agent may request additional design narrative from the Engineer of Record and installing Contractors, depending on the completeness of the design intent documentation.

3.3 OPERATION AND MAINTENANCE (O&M) MANUALS

A. Commissioning Agent Review: Prior to substantial completion, the Commissioning Agent shall review the O&M manuals. This work does not supersede the Engineer of Record's review of the O&Ms.

3.4 START-UP, PREFUNCTIONAL INSPECTION CHECKLISTS

A. The following procedures apply to all equipment to be commissioned.

B. The pre-functional testing for a given system must be successfully completed prior to formal functional performance testing of equipment.

C. Manufacturer's Field Checkout Sheets: The contractor is responsible for obtaining all manufacturers' field checkout sheets for the equipment that is being furnished, completing the checkout sheets in their entirety and providing to the Commissioning Agent for review and comment.

D. Sensor and Actuator Calibration.
   1. All field-installed sensors and gages, and all actuators (dampers and valves) on all equipment shall be calibrated.
   2. All test instruments shall have had a certified calibration within the last 12 months.
   3. Sensors installed in the unit at the factory with calibration certification provided need not be field calibrated.

E. Valve and Damper Stroke Setup and Check.
   1. EMS Readout:
      a. For all valve and damper actuator positions checked, verify the actual position against the BAS readout.
      b. Command valve or damper closed, open and to intermediate positions and visually verify that the device goes to the position as commanded.
      c. If actual valve or damper position doesn't reasonably correspond, replace actuator.

F. Execution of Prefunctional Checklists and Startup: The Sub-Contractors and vendors shall execute startup and provide the Commissioning Agent with a signed and dated copy of the completed start-up and pre-functional tests and checklists.

3.5 FUNCTIONAL PERFORMANCE TESTING

A. The following procedures apply to all equipment to be commissioned. This sub-section applies to all commissioning functional performance testing for all Divisions.

B. Objectives and Scope
   1. The objective of functional performance testing is to demonstrate that each system is operating according to the Construction Documents.
   2. Functional performance testing comprises a full range of tests to verify that all components, equipment, systems, and interfaces between systems operate correctly.
   3. This includes all operating modes, interlocks, control sequences, and responses to emergency conditions.

C. Development of Test Procedures
   1. The CxA develops specific test procedures and forms.

2. Prior to execution, the CxA provides the test procedures to the Contractor who reviews the tests for feasibility, safety, equipment and warranty protection.

D. Execution of Functional Performance Tests
1. Setup
a. Each test procedure is performed under conditions that simulate normal operating conditions as closely as possible.
b. The Contractor executing the test provides all necessary system modifications to produce the specified conditions (flows, pressures, temperatures, etc.), necessary to execute the test.
c. At completion of the test, the Contractor returns all affected building equipment and systems to their pre-test conditions.

E. Coordination and Scheduling
1. The Contractor shall provide sufficient notice to the CxA regarding their completion schedule for the pre-functional checklists and startup of all equipment and systems. The Contractor schedules and executes the functional tests in coordination with the CxA. The Contractor shall inform the CxA of the schedule for execution of Functional Performance Tests at least two weeks prior to execution of any tests. The following sequential priorities are followed:
a. Functional performance testing does not begin until pre-functional, start-up, TAB, and controls point-to-point wring-out is completed for a given system.
b. The controls system and equipment it controls are not functionally tested until all points have been calibrated and pre-functional checklists are completed.

F. Problem Solving: The CxA may recommend solutions to deficiencies identified during functional testing. However, the burden of responsibility to solve, correct and retest deficiencies is with the Contractor and Engineer.

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

A. Documentation
1. The Commissioning Agent shall witness and document the results of all functional performance tests using the forms developed for that purpose.
2. The Commissioning Agent will include the filled out forms in the commissioning report.

B. Non-Conformance
1. The Commissioning Agent will record the results of the functional test on the procedure or test form. All deficiencies or non-conformance issues shall be noted and reported.
2. Corrections of minor deficiencies identified may be made during the tests at the discretion of the Commissioning Agent.
3. Contractor shall expedite the testing process and minimize unnecessary delays.
a. If there is a dispute about a deficiency, regarding whether it is a deficiency or who is responsible:
1) The deficiency shall be documented on the Issues Log and assigned to the party assumed to be responsible.
2) Resolutions are made at the lowest management level possible.
3) The Commissioning Agent documents the resolution process.
4) Once the interpretation and resolution have been decided the test is repeated until satisfactory performance is achieved.
4. Cost of Retesting.
a. The cost for the responsible Sub-Contractor to retest a pre-functional or functional test shall be theirs.

b. The Commissioning Agent and Owner's Representative will direct the retesting of the equipment once at no “charge” to the General Contractor for their time. Additional retests will be charged to the General Contractor.
c. Any required retesting by any contractor shall not be considered a justified reason for a claim of delay or for a time extension.

C. Failure Due to Manufacturer Defect: If equipment fails to perform due to manufacturing defect, all identical units may be considered unacceptable by the Owner's Representative. In such case, the General Contractor shall provide the Owner's Representative with the following:
1. Within one week of notification from the Owner's Representative, the Contractor or manufacturer’s representative shall examine all other identical units making a record of the findings.
2. Within two weeks of the original notification, the Contractor or manufacturer shall provide a signed and dated, written explanation of the problem and all proposed solutions which shall include full equipment submittals.
3. The Owner's Representative will determine whether a replacement of the unit and of all identical units or a repair is acceptable.
4. Any construction delays arising out of this process shall be the sole responsibility of the General Contractor.

D. Approval: The Commissioning Agent recommends acceptance of each test to the Owner’s Representative. The Owner's Representative gives final approval on each test.

## 3.7 TRAINING OF OWNER'S REPRESENTATIVE PERSONNEL

A. The General Contractor shall be responsible to ensure that training is completed.

B. The Commissioning Agent shall be responsible for reviewing the content and adequacy of the training of Owner’s Representative personnel for commissioned equipment.

C. Mechanical Contractor. The mechanical contractor shall have the following training responsibilities:
1. Provide the Commissioning Agent and A/E with a training plan at least two weeks before the planned training.
2. Provide designated Owner personnel with comprehensive orientation and training in the understanding of the systems and the operation and maintenance of each piece of equipment.
3. The appropriate trade or manufacturer's representative shall provide the instructions on each major piece of equipment.
4. The controls contractor shall attend sessions other than the controls training, as requested, to discuss the interaction of the controls system as it relates to the equipment being discussed.
5. Training shall include:
   a. Use of the printed installation, operation and maintenance instruction material included in the O&M manuals.
   b. Classroom sessions shall include the use of overhead projections, slides, video/audio-taped material as might be appropriate.
6. Hands-on training shall include start-up, operation in all modes possible, including manual, shut-down and any emergency procedures and preventative maintenance for all pieces of equipment.
7. The mechanical contractor shall fully explain and demonstrate the operation, function and overrides of any local packaged controls, not controlled by the central control system.
8. Training shall occur after functional testing is complete, unless approved otherwise by the Owner’s Representative.

D. Controls Contractor. The controls contractor shall have the following training responsibilities:
   1. Provide the Commissioning Agent with a training plan four weeks before the planned training session(s).
   2. The controls contractor shall provide designated Owner personnel training on the control system in this facility. The intent is to clearly and completely instruct the Owner personnel on all the capabilities of the control system.
   3. Training manuals. The standard operating manual for the system and any special training manuals will be provided for each trainee, with three extra copies left for the O&M manuals.
   4. The training will be tailored to the needs and skill-level of the trainees.
   5. The trainers will be knowledgeable on the system and its use in buildings.
   6. The controls contractor shall attend sessions other than the controls training, as requested, to discuss the interaction of the controls system as it relates to the equipment being discussed.

E. TAB. The TAB contractor shall have the following training responsibilities:
   1. TAB shall meet with facility staff after completion of TAB and instruct them on the following:
      a. Go over the final TAB report, explaining the layout and meanings of each data type.
      b. Other salient information that may be useful for facility operations, relative to TAB.

END OF SECTION