

## **SECTION 23 99 50 – COMMISSIONING**

### **PART 1 – GENERAL**

#### **1.1 DESCRIPTION**

- A. This section covers Mechanical, Hot Water Heating and Lighting systems commissioning to make the systems ready for safe and satisfactory operation within the design intent. This work includes:
1. The Owner shall provide a Commissioning Supervisor from an approved agency.
  2. The Commissioning Supervisor is to generate a Commissioning Plan and commissioning schedule, subject to Owner approval. The commissioning plan is intended to document the approach to commissioning of Mechanical, Hot Water Heating and Lighting equipment and systems to verify that they are ready for use and in compliance with the design intent.
  3. Performance of Commissioning Plan. The Commissioning Supervisor and support personnel are to execute the Commissioning Plan. Provide a copy to the owner or owner's authorized agent and made available to the code official upon request.
  4. Generation of a Preliminary Commissioning Report. The Commissioning Supervisor is to prepare a Preliminary Commissioning Report to document the deficiencies found during testing required by this section that have not been corrected at the time of report preparation.
  5. Generation of a Final Commissioning Report. The Commissioning Supervisor is to prepare a Final Commissioning Report to document the results of these tests.
  6. Performance of a Systems Demonstration. The Commissioning Supervisor is to coordinate and perform a Demonstration of Mechanical, Hot Water Heating and Lighting systems operation to the Owner's personnel.

#### **1.2 QUALITY ASSURANCE**

- A. Mechanical, Hot Water Heating and Lighting systems commissioning shall be the direct responsibility of a Commissioning Supervisor who shall have a minimum of ten years experience in the design and construction of building mechanical and lighting systems.

#### **1.3 SEQUENCING AND SCHEDULING**

- A. The commission agent shall provide a commissioning schedule along with the commissioning plan. The schedule shall indicate all trades necessary for completion of the commissioning process.
- B. The work described in this Section shall begin only after work required in related Sections, including Testing and Balancing and Temperature Controls Sections have been successfully completed.
- C. Enlist the aid of the Installing Contractors or equipment suppliers, at no cost to the Owner, whenever such aid is necessary, for the timely and proper performance of commissioning work.
- D. Submit Commissioning Plan for Owner's review within 90 days of Contract Award.
- E. Submit completed Final Commissioning Report, Operation and Maintenance manuals, and Balance Reports and documented performance criteria of installed lighting controls to owner within 90 days of the date of receipt of the certificate of occupancy.
- F. Submit Commissioning Plan for and perform demonstration of Mechanical, Hot Water Heating and Lighting systems operation in the presence of the Owner following completion of commissioning work.

#### **1.4 SUBMITTALS**

- A. The following shall be submitted for approval before work proceeds:
  - 1. Commissioning Plan:
    - a. A narrative description of the activities that will be accomplished during each phase of commissioning, including the personnel intended to accomplish each of the activities.
    - b. A listing of the specific equipment, appliances or systems to be tested and a description of the tests to be performed.
    - c. Functions to be tested including, but not limited to, calibrations and economizer controls.
    - d. Conditions under which the test will be performed. Testing shall affirm winter and summer design conditions and full outside air conditions.
    - e. Measurable criteria for performance.
  - 2. Demonstration of Mechanical, Hot Water Heating and Lighting systems operation Schedule:

- B. The following shall be submitted for approval upon commencement of and prior to the completion of commissioning process.

1. Preliminary Commissioning Report:

- a. A preliminary report of commissioning test procedures and results shall be completed and certified by the Commissioning Supervisor and provided to the building owner or owner's authorized agent. The report shall be organized with mechanical and service hot water findings in separate sections to allow independent review. The report shall be identified as "Preliminary Commissioning Report" and shall identify:
  - i. Itemization of deficiencies found during testing required by this section that have not been corrected at the time of report preparation.
  - ii. Deferred tests that cannot be performed at the time of report preparation because of climatic conditions.
  - iii. Climatic conditions required for performance of the deferred tests.
- b. The Commissioning Manager shall make ready a copy of the Preliminary Commissioning Report be made available for review by the code official if requested.
- c. **Note:** Buildings, or portions thereof, shall not be considered acceptable for a final inspection pursuant to 2015 IECC Section C104.3 until the code official has received a letter of transmittal from the building owner acknowledging that the building owner or owner's authorized agent has received the Preliminary Commissioning Report.

2. Lighting System Functional Testing and Verification:

- a. Prior to passing final inspection, the Commissioning Supervisor shall provide evidence that the lighting control systems have been tested to ensure that control hardware and software are calibrated, adjusted, programmed and in proper working condition in accordance with the construction documents and manufacturer's instructions. Functional testing shall be in accordance with Sections below.
- b. **Occupant Sensor Controls:** Where occupant sensor controls are provided, the following procedures shall be performed:

- i. Certify that the occupant sensor has been located and aimed in accordance with manufacturer recommendations.
  - ii. For projects with seven or fewer occupant sensors, each sensor shall be tested.
  - iii. For projects with more than seven occupant sensors, testing shall be done for each unique combination of sensor type and space geometry. Where multiples of each unique combination of sensor type and space geometry are provided, not less than 10 percent, but in no case less than one, of each combination shall be tested unless the code official requires a higher percentage to be tested. Where 30 percent or more of the tested controls fail, all remaining identical combinations shall be tested.
- c. For occupant sensor controls to be tested, verify the following:
- i. Where occupant sensor controls include status indicators, verify correct operation.
  - ii. The controlled lights turn off or down to the permitted level within the required time.
  - iii. For auto-on occupant sensor controls, the lights turn on to the permitted level when an occupant enters the space.
  - iv. For manual-on occupant sensor controls, the lights turn on only when manually activated.
  - v. The lights are not incorrectly turned on by movement in adjacent areas or by HVAC operation.
- d. **Time-switch controls:** Where time-switch controls are provided, the following procedures shall be performed:
- i. Confirm that the time-switch control is programmed with accurate weekday, weekend and holiday schedules.
  - ii. Provide documentation to the owner of time-switch controls programming including weekday, weekend, holiday schedules, and set-up and preference program settings.
  - iii. Verify the correct time and date in the time switch.
  - iv. Verify that any battery back-up is installed and energized.

- v. Verify that the override time limit is set to not more than 2 hours.
- vi. Simulate occupied condition. Verify and document the following:
  - (a) All lights can be turned on and off by their respective area control switch.
  - (b) The switch only operates lighting in the enclosed space in which the switch is located.
- vii. Simulate unoccupied condition. Verify and document the following:
  - (a) Nonexempt lighting turns off.
  - (b) Manual override switch allows only the lights in the enclosed space where the override switch is located to turn on or remain on until the next scheduled shutoff occurs.

**e. Daylight responsive controls:** Where daylight responsive controls are provided, the following shall be verified:

- i. Control devices have been properly located, field calibrated and set for accurate setpoints and threshold light levels.
- ii. Daylight controlled lighting loads adjust to light level set points in response to available daylight.
- iii. The locations of calibration adjustment equipment are readily accessible only to authorized personnel.

**C.** The following shall be submitted for approval upon commencement and completion of commissioning process.

1. Final Commissioning Report:

- a. A report of test procedures and results identified as "Final Commissioning Report" shall be delivered to the building owner or owner's authorized agent. The report shall be organized with mechanical system and service hot water system findings in separate sections to allow independent review. The report shall include the following:
  - i. Results of functional performance tests.

- ii. Disposition of deficiencies found during testing, including details of corrective measures used or proposed.
  - iii. Functional performance test procedures used during the commissioning process including measurable criteria for test acceptance, provided herein for repeatability.
  - iv. Deferred tests that cannot be performed at the time of report preparation due to climatic conditions shall be noted as such.
- b. Submit completed systems startup verification and functional performance test checklists organized by system and by subsystem as one package. The results of failed tests shall be included along with a description of the corrective action taken and subsequent successful retests. The Final Commissioning Report shall signed by the Commissioning Agent.

2. Operation and Maintenance Manuals:

- a. An operating and maintenance manual shall be provided and include all of the following:
- i. Submittal data stating equipment size and selected options for each piece of equipment requiring maintenance.
  - ii. Manufacturer's operation manuals and maintenance manuals for each piece of equipment requiring maintenance, except equipment not furnished as part of the project. Required routine maintenance actions shall be clearly identified.
  - iii. Name and address of at least one service agency.
  - iv. HVAC and service hot water controls system maintenance and calibration information, including wiring diagrams, schematics and control sequence descriptions. Desired or field-determined set points shall be permanently recorded on control drawings at control devices or, for digital control systems, in system programming instructions.
  - v. Submittal data indicating all selected options for each piece of lighting equipment and lighting controls.
  - vi. Operation and maintenance manuals for each piece of lighting equipment. Required routine maintenance actions, cleaning and recommended relamping shall be clearly identified.

- vii. A schedule for inspecting and recalibrating all lighting controls.
- viii. A narrative of how each system is intended to operate, including recommended set points.

## **PART 2 – PRODUCTS**

Non-applicable

## **PART 3 – EXECUTION**

### **3.1 TESTS**

- A. Testing and verification required by this Section shall be performed during the Commissioning phase. Requirements in other Sections are independent for the requirements of this Section and shall not be used to satisfy any of the requirements of this Section. The Contractor shall provide all materials, services, and labor required to perform the functional performance tests and the demonstration to the Owner.
  - 1. System Startup Verification.
  - 2. Prior to functional performance testing of HVAC equipment and systems, the commissioning team shall verify that all items to be commissioned have been substantially installed and balanced in accordance with the contract documents.
- B. Checklists for each piece of equipment shall be generated by the commissioning team and be included as part of the Final Commissioning report.
  - 1. Functional Performance Tests
  - 2. Following performance of systems startup verification, system functional performance tests will begin. Tests shall prove all modes of the sequences of operation and shall verify all other relevant contract requirements for the following HVAC equipment and systems:
    - i. Air Handling Units (DOAS Units)
    - ii. Boilers
    - iii. Boiler Pumps
    - iv. Building Automation and Temperature Control System
    - v. Cabinet Unit Heaters
    - vi. Chemical Treatment Systems
    - vii. Condensing Units
    - viii. Dehumidifiers
    - ix. Domestic Hot Water Heaters

- x. Fans
    - xi. Furnaces
    - xii. Hot Water Systems
    - xiii. Hot Water Pumps
    - xiv. Lighting Systems and Lighting Controls
    - xv. VRF Indoor and Outdoor Units
    - xvi. Unit Heaters
  - 3. Tests shall begin with equipment or components and shall progress through subsystems to complete systems. Equipment functional performance testing shall demonstrate the installation and operation of components, systems, and system-to-system interfacing relationships in accordance with plans and specifications such that operation, function, and maintenance serviceability for each of the commissioned systems is confirmed. Testing shall include all modes and sequence of operation, including under full-load, part-load and the following emergency conditions:
    - a. All modes as described in the sequence of operation.
    - b. Redundant or automatic back-up mode.
    - c. Performance of alarms.
    - d. Mode of operation upon a loss of power and restoration of power.
    - e. Exception: Unitary or packaged HVAC equipment listed in Tables 2015 IECC Sections C403.2.3(1) through C403.2.3(3) that do not require supply air economizers.
  - 4. In addition to equipment installed by the HVAC contractor coordination with other contractors will be required. The schedule will indicate the requirements for other trade participation. A copy of the schedule shall be forwarded to all trades involved. The HVAC contractor shall include in the commissioning report, start-up check lists of components functional to the operation of the mechanical equipment although not necessarily provided by the HVAC contractor including starters and variable frequency drives.
- C. Pre-start and start-up checklists for each piece of equipment and system, as requires, shall be generated by the commissioning team.
- 1. System Demonstration
    - a. Following completion of all functional performance tests, the Commissioning Supervisor shall notify the Owner. The Commissioning supervisor shall generate an schedule for the Demonstration of HVAC Systems Operation, and forward it to the Owner for review. The demonstration shall take place within two weeks of Owner approval.



- b. The Commissioning Supervisor shall be responsible for coordinating this formal system demonstration to the Owner to include provision of all necessary equipment (thermometers, pressure gauges, tools, ladders, flashlights, access keys, etc.) and personnel (controls field technician, etc)
  - c. The schedule shall include demonstration of the sequence of operation for the following:
    - 2. Chilled Water System, to include staging of chillers, towers, pumps and pump speed control.
    - 3. Hot Water system, to include staging of boilers, pumps and pump speed control.
    - 4. Air Handling and Smoke Control systems shall include sequencing of fans and dampers.
      - a. Air economizers shall undergo a functional test to determine that they operate in accordance with manufacturer's specifications.
    - 5. Representative sampling of Terminal units, specific units to be selected by the Owner or Owner's rep.
- D. In addition, compliance of the DDC equipment and software (to include all graphics) with the Contract requirements will be provided.
  - 1. HVAC and service water-heating control systems shall be tested to document that control devices, components, equipment and systems are calibrated and adjusted and operate in accordance with approved plans and specifications. Sequences of operation shall be functionally tested to document they operate in accordance with approved plans and specifications
  - 2. Demonstration of mechanical System Operation will typically be attended by the following: A/E mechanical engineer (system designer), Facilities Personnel (2), Temperature Control contractor, heating contractor, electrical contractor.
  - 3. Systems are expected to be in full compliance with the design intent by the Demonstration of Mechanical System Operation phase. Presence of obviously incomplete work or systems exhibiting problems related to lack of completion shall require retest. The Contractor shall be responsible for all costs associated with re-testing.

**END OF SECTION**

