PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes commissioning process requirements for Plumbing systems, assemblies, and equipment. Other electrical system testing is required under the direction of the CM.

B. The list of commissioned equipment and systems is found in Section 01 91 13 and the Commissioning Plan.

C. Commissioning requires the participation of Division 22 to ensure that all systems are operating in a manner consistent with the Contract Documents. The general commissioning requirements and coordination are detailed in Division 1. Division 22 shall be familiar with all parts of Division 1 and the commissioning plan issued by the CxA and shall execute all commissioning responsibilities assigned to them in the Contract Documents.

D. Related Sections:

1. Division 01 Section "General Commissioning Requirements" for general commissioning process requirements.

1.3 DEFINITIONS

A. CM: Construction Manager.

B. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.

C. CxA: Commissioning Authority.

D. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

1.4 RESPONSIBILITIES

A. Plumbing Contractors. The commissioning responsibilities applicable to the Plumbing contractor are as follows (all references apply to commissioned equipment only):
1. **Construction and Acceptance Phases**

   a. Include the cost of commissioning in the contract price, if not yet let.

   b. In each purchase order or subcontract written, include requirements for submittal data, O&M data and training.

   c. Attend a commissioning scoping meeting and other necessary meetings scheduled by the CxA to facilitate the Cx process.

   d. Contractors shall provide cut sheets and shop drawing submittals to the CxA of commissioned equipment.

   e. Provide additional requested documentation, prior to normal O&M manual submittals, to the CxA for development of start-up and functional testing procedures.

   1) Typically this will include detailed manufacturer installation and start-up, operating, troubleshooting and maintenance procedures, full details of any owner-contracted tests, fan and pump curves, full factory testing reports, if any, and full warranty information, including all responsibilities of the Owner to keep the warranty in force clearly identified. In addition, the installation and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the Commissioning Agent.

   2) The Commissioning Agent may request further documentation necessary for the commissioning process.

   3) This data request may be made prior to normal submittals.

   f. Provide a copy of the O&M manuals submittals of commissioned equipment, through normal channels, to the CxA for review and approval.

   g. Contractors shall assist (along with the design engineers) 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.

   h. Provide limited assistance to the CxA in preparation of the specific functional performance test procedures listed in the Commissioning Plan. Contractor shall review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests.

   i. Develop a full start-up and initial checkout plan using manufacturer’s start-up procedures and the prefuctional checklists from the CxA. Submit manufacturer’s detailed start-up procedures and the full start-up plan and procedures and other requested equipment documentation to CxA for review.

   j. During the startup and initial checkout process, execute and document the plumbing-related portions of the prefuctional checklists provided by the CxA for all commissioned equipment.

   k. Perform and clearly document all completed startup and system operational checkout procedures, providing a copy to the CxA.

   l. Address current A/E punch list items before functional testing.

   m. Provide skilled technicians to execute starting of equipment and to execute the functional performance tests. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem-solving.
n. Perform functional performance testing under the direction of the CxA for specified equipment in the Commissioning Plan and 01 91 13. Assist the CxA in interpreting the monitoring data, as necessary.
o. Correct deficiencies (differences between specified and observed performance) as interpreted by the CxA, CM and A/E and retest the equipment.
p. Prepare O&M manuals according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built conditions.
q. During construction, maintain as-built red-line drawings for all drawings and provide final record drawings for all owner and contractor-generated coordination drawings. Update after completion of commissioning (excluding deferred testing).
r. Provide training of the Owner’s operating personnel as specified.
s. Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.

2. Warranty Period

a. Execute seasonal or deferred functional performance testing, witnessed by the CxA, according to the specifications.
b. Correct deficiencies and make necessary adjustments to O&M manuals and record drawings for applicable issues identified in any seasonal testing.

B. CxA's RESPONSIBILITIES

1. Provide Project-specific construction pre-functional checklists and commissioning process functional test procedures for actual Plumbing systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.
2. Direct commissioning testing.
3. Verify testing and adjusting of work is complete.

1.5 COMMISSIONING DOCUMENTATION

A. Provide the following information to the CxA for inclusion in the commissioning plan:

1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.
2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
3. Process and schedule for completing construction pre-functional checklists and manufacturer's prestart and startup checklists for Plumbing systems, assemblies, equipment, and components to be verified and tested.
4. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.
5. Certificate of readiness certifying that Plumbing systems, subsystems, equipment, and associated controls are ready for testing.
6. Test and inspection reports and certificates.
7. Corrective action documents.
8. Verification of testing and adjusting reports.
1.6 SUBMITTALS

A. Shall provide documentation relative to commissioning to the CxA as requested by the CxA. Refer to Division 01 Section “General Commissioning Requirements”.

B. Certificates of readiness.

C. Certificates of completion of installation, prestart, and startup activities.

PART 2 - PRODUCTS (Not Used)

2.1 TEST EQUIPMENT

A. Division 22 shall provide all test equipment necessary to fulfill the testing requirements of this Division.

B. Refer to Section 01 91 13 for additional Division 22 requirements.

PART 3 - EXECUTION

3.1 GENERAL DOCUMENTATION REQUIREMENTS

A. Refer to Division 01 Section “General Commissioning Requirements”

3.2 SYSTEMS TO BE COMMISSIONED

A. Refer to Division 01 Section “General Commissioning Requirements”

3.3 TESTING PREPARATION

A. Certify that Plumbing systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.

B. Certify that Plumbing systems instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.

C. Certify that testing, adjusting and start-up procedures have been completed and that testing, adjusting and start-up reports have been submitted, discrepancies corrected, and corrective work approved.

D. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

E. Inspect and verify the position of each device and interlock identified on checklists.
F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.

G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

3.4 TESTING AND ADJUSTING VERIFICATION

A. Prior to performance of testing and adjusting Work, provide copies of reports, sample forms, checklists, and certificates to the CxA.

B. Notify the CxA at least 15 days in advance of testing and adjusting Work, and provide access for the CxA to witness testing and adjusting Work.

C. Provide technicians, instrumentation, and tools to verify testing and adjusting of Plumbing systems at the direction of the CxA.
   1. The CxA will notify testing and adjusting Contractor 15 days in advance of the date of field verification. Notice will not include data points to be verified.
   2. The testing and adjusting Contractor shall use the same instruments (by model and serial number) that were used when original data were collected.
   3. Failure of an item includes, other than sound, a deviation of more than 10 percent. Failure of more than 10 percent of selected items shall result in rejection of final testing, and adjusting report.
   4. Remedy the deficiency and notify the CxA so verification of failed portions can be performed.

3.5 GENERAL TESTING REQUIREMENTS

A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.

B. Scope of Plumbing testing shall include entire Plumbing installation. Testing shall include measuring capacities and effectiveness of operational and control functions.

C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of controllers and sensors.

D. The CxA along with the Plumbing Contractor shall prepare detailed testing plans, procedures, and checklists for Plumbing systems, subsystems, and equipment.

E. Tests will be performed using design conditions whenever possible.

F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
G. The CxA may direct that set points be altered when simulating conditions is not practical.

H. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.

I. If tests cannot be completed because of a deficiency outside the scope of the Plumbing system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.

J. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.6 DEFICIENCIES/NON-CONFORMANCE, COST OF RETESTING, FAILURE DUE TO MANUFACTURER DEFECT

A. Refer to Division 01 Section “General Commissioning Requirements” for requirements pertaining to deficiencies/non-conformance, cost of retesting, or failure due to manufacturer defect.

3.7 APPROVAL

A. Refer to Division 01 Section “General Commissioning Requirements” for approval procedures.

3.8 DEFERRED TESTING / SEASONAL TESTING

A. Refer to Division 01 Section “General Commissioning Requirements” for requirements pertaining to deferred testing.

3.9 OPERATION AND MAINTENANCE MANUALS

A. The Operation and Maintenance Manuals shall conform to Contract Documents requirements as stated in Division 01.

B. Refer to Division 01 Section “General Commissioning Requirements” for the AE and CxA roles in the Operation and Maintenance Manual contribution, review and approval process.

3.10 SYSTEMS MANUAL REQUIREMENTS

A. The Systems Manual is intended to be a usable information resource containing all of the information related to the systems, assemblies, and Commissioning Process in one place with indexes and cross references. The CM shall include final approved versions of the following information for the Systems Manual:

1. As-Built System Schematics
2. Verified Record Drawings
3. Test Results (not otherwise included in Cx Record)
4. Periodic Maintenance Information
5. Recommendations for recalibration frequency of sensors
6. A list of contractors, subcontractors, suppliers, architects, and engineers involved in the project along with their contact information
7. Training Records, Information on training provided, attendees list, and any on-going training

B. This information shall be organized and arranged by building system, such as fire alarm, chilled water, heating hot water, etc.

C. Information should be provided in an electronic version to the extent possible. Legible, scanned images are acceptable for non-electronic documentation to facilitate this deliverable.

3.11 TRAINING OF OWNER PERSONNEL

A. The CM shall be responsible for training coordination and scheduling and ultimately to ensure that training is completed. Refer to Division 01 Section “General Commissioning Requirements” for additional details.

B. The CxA shall be responsible for overseeing and approving the content and adequacy of the training of Owner personnel for commissioned equipment. Refer to Division 01 Section “General Commissioning Requirements” for additional details.

C. Plumbing Contractor. The plumbing contractor shall have the following training responsibilities:

1. Provide the CxA with a training plan two weeks before the planned training according to the outline described in Division 01 Section “General Commissioning Requirements”.
2. Provide designated Owner personnel with comprehensive training in the understanding of the systems and the operation and maintenance of each major piece of commissioned plumbing equipment or system.
3. Training shall start with classroom sessions, if necessary, followed by hands on training on each piece of equipment, which shall illustrate the various modes of operation, including startup, shutdown, fire/smoke alarm, power failure, etc.
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 will be repaired or adjusted as necessary and the demonstration repeated.
5. The appropriate trade or manufacturer's representative shall provide the instructions on each major piece of equipment. This person may be the start-up technician for the piece of equipment, the installing contractor or manufacturer’s representative. 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 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.
7. Training shall include:

   a. Use the printed installation, operation and maintenance instruction material included in the O&M manuals.
b. Include 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 start-up, operation in all modes possible, shut-down, seasonal changeover and any emergency procedures.

c. Discuss relevant health and safety issues and concerns.

d. Discuss warranties and guarantees.

e. Cover common troubleshooting problems and solutions.

f. Explain information included in the O&M manuals and the location of all plans and manuals in the facility.

g. Discuss any peculiarities of equipment installation or operation.

h. The format and training agenda in The HVAC Commissioning Process, ASHRAE Guideline 1-1996 is recommended.

8. Hands-on training shall include start-up, operation in all modes possible, including manual, shut-down and any emergency procedures and preventative maintenance of all pieces of equipment.

9. The plumbing contractor shall fully explain and demonstrate the operation, function and overrides of any local packaged controls, not controlled by the central control system.

10. Training shall occur after functional testing is complete, unless approved otherwise by the Owner's.

3.12 DEFERRED TESTING

A. Refer to Division 01 Section “General Commissioning Requirements” for requirements of deferred testing.

3.13 WRITTEN WORK PRODUCTS

A. Written work products of Contractors will consist of the startup and initial checkout plan described in Division 01 Section “General Commissioning Requirements” and the filled out startup, initial checkout and prefunctional checklists.

END OF SECTION 220800