

SECTION 01 91 13 - GENERAL COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This Section specifically identifies the requirements of the Project Commissioning Team, which includes the Commissioning Provider (CxP), Owner, General Contractor, Installation Contractors, Equipment Suppliers and Vendors in the execution of the commissioning process. A Commissioning Plan shall be provided by the CxP early in the Construction Phase to outline the Commissioning Process, including roles and responsibilities of the Project Commissioning Team. The plan shall also identify the logistics, schedules and management protocols associated with the commissioning process. The plan shall be updated by the CxP as required to accommodate project logistical changes.
- B. This Section shall delineate the requirements of the GC and Installation Contractors for the execution of the commissioning process for the following activities:
1. Participation in Commissioning Meetings
 2. Commissioning submittal requirements
 3. Installation verification and start-up for system components.
 4. Functional operational demonstration of system performance
 5. Commissioning field deficiencies and test deficiencies.
 6. The GC and Installation Contractors shall:
 - a. Verify installation and perform quality control.
 - b. Provide project scheduling that coordinates commissioning activities with installation contractors' activities
 - c. Execute the Training Plan
 - d. Perform equipment installation verification and start up. Contractor shall verify the functional readiness of systems to be tested, using pre-functional performance tests, prior to scheduling and demonstrating the functional operational performance in the presence of the CxP.
 - e. Conduct functional performance testing
 - f. Correct deficiencies
 - g. Conduct functional performance retesting, as necessary
 - h. Provide documentation of the effort.
- C. The Owner, Architect/Engineer, and CxP are not responsible for construction means, methods, job safety, or management function related to commissioning on the job site.

1.2 RELATED SECTIONS

- A. Section 01 91 14 – Functional Testing Requirements
- B. Division 14 – Conveying Equipment
- C. Division 21 – Fire Protection
- D. Division 22 – Plumbing
- E. Division 23 – Heating, Ventilation and Air Conditioning
- F. Division 26 – Electrical

G. Division 28 – Electronic Safety and Security

1.3 EQUIPMENT AND SYSTEMS INCLUDED IN COMMISSIONING PROGRAM

A. The following is a list of the equipment and system test requirements included in this section:

1. Division 14 – Conveying Equipment
 - a. Elevators
2. Division 21 – Fire Protection
 - a. Fire Protection System
3. Division 22 - Plumbing
 - a. Sump Systems
 - b. Water Supply Including Circulation Systems & Auto Valves
4. Division 23 - Heating Ventilating and Air Conditioning
 - a. Rooftop Unit With DX Cooling
 - b. Computer Room Air Conditioning Units
 - c. Variable Air Volume Boxes
 - d. Fan Coil Units
 - e. Cabinet Heaters
 - f. Unit Heaters
 - g. Toilet Exhaust
 - h. Gas Fired Rooftop Units
 - i. Boilers
 - j. DDC Building Control System (HVAC System, Security Systems & Emergency Power)
5. Division 26 - Electrical
 - a. Lighting Control Including Time Settings & Sensitivity on Sensors
 - b. Power Monitoring & Control
 - c. Variable Frequency Drives
 - d. Electrical Distribution, Greater Than 400A
 - e. Automatic Transfer Switches
 - f. Photovoltaic System
6. Division 28 – Electronic Safety
 - a. Fire Alarm System

1.4 DEFINITIONS

- A. Acceptance Phase: Phase of construction after startup and initial checkout when Functional Performance Testing, O&M documentation review, and facility and user training occur.
- B. Basis of Design (BOD): Documentation of design criteria and decisions made to meet design intent. Describes systems, components, conditions, and methods chosen to define the intent of the Owner.
- C. Building Automation System (BAS): The system used to control building system in accordance with specifies sequenced of operation.

- D. Commissioning Plan (CP): A manual providing documentation of roles and responsibilities and provides structured means of scheduling, coordination and documentation for the commissioning process.
- E. Commissioning Provider (CxP): The consultant who facilitates the commissioning program and directs and coordinates day-to-day commissioning activities. Acts as the objective advocate for the Owner. The CxP is contracted by the Owner.
- F. Commissioning Team (CT): The Project Team including the Owner, General Contractor, Design Professional, Installation Contractors and equipment manufacturer representatives (as needed).
- G. Deferred Functional Test: Functional performance test performed after substantial completion due to conditions that preclude test from being performed in normal sequential order of project delivery. Also includes seasonal testing of environmental systems.
- H. Deficiency: Condition of a component, piece of equipment, or system that is not in compliance with Contract Documents. The CxP shall conduct a series of construction phase site visits to observe the progress of installation of building systems in the Commissioning Program. Deficiencies identified by the CxP shall be reviewed by the Design Professionals to determine if the deficiency is a non-conformance issue. If the issue is a non-conformance issue, the Design Professionals shall include the issue in their non-conforming issues report to the contractors.
- I. Design Professional (A/E): The design team, generally the Architect, Mechanical Engineer and Electrical Engineer.
- J. Factory Testing: Testing of equipment at factory by the Manufacturer.
- K. Functional Performance Test (FPT): Test of dynamic function and operation of equipment and systems. Systems are tested under various modes, such as during low cooling or heating loads, high loads, component failures, unoccupied, varying outside air temperatures, fire alarm, power failure, etc. Systems are run through all specified sequences of operation. Components are verified to be responding in accordance with contract documents. Functional Performance Tests are witnessed by the CxP and executed by the responsible contractor after installation certification forms and start-ups and Pre-Functional Test documentation.
- L. Functional Performance Test Document: Protocols and instructions provided for and described in the Commissioning Plan and specifications that describe process required to document Functionality Testing process for each system. Also includes the Systems Integration Tests to confirm that various inter-related systems respond as intended. . CxP develops Functional Performance Test procedures in sequential written form, coordinates, oversees and documents actual testing, which is usually performed by installing contractor or vendor.
- M. General Contractor (GC): The prime contractor responsible for the construction of the facility in accordance with contract documents. Responsible for oversight and coordination of all sub-contractor activities to ensure on-time project delivery and compliance with the commissioning program.
- N. Installation Certification Form (ICF): Document used by the GC to certify that they have inspected the work of the installing contractors and determined that it is in full compliance with the contract requirements. This form is required on each piece of equipment or component prior to functionally testing the system. Monitoring: Recording of parameters (flow, current, status, pressure, etc.) of equipment operation using data loggers or trending capabilities of control systems.

- O. Installation Contractor (Sub-Contractor): Contractor who is under contract to General Contractor who provides and/or installs building components and systems.
- P. Phased Commissioning: Commissioning completed in phases due to size of structure, construction phasing, availability of systems, etc.
- Q. Pre-Functional Testing (PFT): Testing performed by the responsible contractor utilizing the functional performance test protocol. This testing is a prerequisite to the Functional Performance Test witnessed and documented by the CxP.
- R. Seasonal Performance Evaluation: Functional Performance evaluation executed at the time of year such that system(s) experience conditions closer to design conditions. Includes a combination of trend log analysis and possibly on-site testing as appropriate.
- S. Specifications: Construction specifications of Contract Documents.
- T. Startup: Initial start or activation of dynamic equipment, including executing the Installation Certification Form and completing a manufacturer's start-up and form where applicable.
- U. Trending: Monitoring controls points of systems as a function of time using building control system.
- V. Vendor: Supplier of equipment.

1.5 COORDINATION

- A. Perform commissioning services to expedite the testing process and minimize unnecessary delays, while not compromising the integrity of the procedures.
- B. CxP shall provide overall coordination and management of the commissioning program as specified herein.
- C. Commissioning Team:
 - 1. The Commissioning Team (CT) is comprised of representatives from the project team who shall be the primary contact for commissioning activities:
 - a. Commissioning Provider (CxP)
 - b. Owner's Representative(s) (OR)
 - c. General Contractor
 - d. Design Professional (A/E)
 - e. Finishes Contractors
 - f. Equipment Installation Contractors
 - g. Mechanical Contractor (MC)
 - h. Electrical Contractor (EC)
 - i. Test and Balance Contractor (TAB)
 - j. Controls Contractor (CC)
 - k. Equipment Suppliers and Vendors
- D. The CxP may witness test activities specified in Division 1 and the technical specifications as well as select construction tests (e.g. piping pressure tests, duct leakage test, etc.) and equipment start-up tests. The OR shall witness commissioning activities as appropriate. Contractors shall provide a minimum five (5) working days advanced notice when tests are scheduled.

- E. Contractor shall provide written timely notice to GC and CxP of any changes in date, time, and location or anticipated duration of start-up and test activities. For the purpose of this paragraph written notice shall be received by a minimum of 48 hours in advance to be considered timely.
- F. Tests that are not performed as scheduled shall be considered a failed test unless notification of cancellation or rescheduling was received by all parties. The notification shall be received 48 hours prior to the scheduled arrival of the CxP on site to witness functional testing. Contractor shall reimburse Owner for actual costs incurred by the Owner as the result of failure to provide timely notice, per preceding paragraph, of changes in date, time, location, or anticipated duration of start-up and test activities. The actual costs incurred by the Owner shall include costs associated with the CxP involvement.
- G. Meeting:
 - 1. Within 90 days after all installation contractors involved in the commissioning program have been awarded a contract for the project, the CxP shall plan, schedule, and conduct a commissioning kickoff meeting with designated project team commissioning representatives in attendance. Responsibilities of the commissioning team shall be clarified at this meeting. The CxP shall distribute meeting minutes to all parties.
 - 2. Commissioning meetings shall be held on a monthly basis as a minimum during the construction installation phase of work. The frequency of these meetings shall increase as construction and acceptance activities require. Designated project team commissioning representatives shall attend the meetings as appropriate based upon the agenda topics to be discussed.
 - 3. Commissioning meetings shall be held weekly during the functional performance testing phase to review status of testing discrepancies and scheduling of retests and back checks.
- H. Scheduling:
 - 1. Once a master construction schedule is issued, the CxP shall provide for incorporation to the schedule, commissioning milestone activities linked to specific predecessor construction activities. As construction progresses, more specific activities and milestones shall be incorporated into the master construction schedule.
 - 2. Approximately 6 to 8 weeks prior to the commencement of equipment start-ups, the CxP shall conduct a commissioning functional testing schedule workshop with all commissioning representatives. The purpose of this workshop is to establish a coordinated approach to the integration of the function testing activities with the master construction schedule to ensure substantial completion can be achieved as scheduled.
 - 3. In cooperation with the CxP, the GC shall integrate commissioning activities into the master construction schedule.
 - 4. Scheduling issues shall be resolved at monthly commissioning meetings.

1.6 SUBMITTALS

- A. General: Submit the following in accordance with requirements of Section 01 33 00.
- B. Start-up plan: For each piece of equipment or system, the GC and Installation Contractors shall submit a start-up plan. Obtain approval of the plan prior to beginning activities. The plan should include, but not be limited to, the following:
 - 1. Start-up schedule
 - 2. Names of firms/individuals required to participate
 - 3. Detailed manufacturer start-up procedures
 - 4. Manufacturer start-up data forms

- C. Installation Certification Form (ICF): Installation contractors shall provide CxP, through the GC a completed ICF and a completed manufacturer's start-up form for each piece of equipment or component of a building system included in the commissioning program. These documents shall be used to determine the readiness of the building system for functional performance testing.
- D. Pre-Functional Performance Test Documentation: Responsible contractor shall execute the pre-functional performance test and document the satisfactory results of the testing. The completed test shall be provided to the CxP through the GC for review and approval. Final scheduling of the functional performance test on a building system shall not be established until the pre-functional performance test documentation is approved.
- E. Temporary Use of Permanent Equipment Operations and Maintenance Plan: Should the contractor receive authorization from the OR to utilize permanent equipment per Section 01 9113-3.2, an Operations and Maintenance Plan shall be submitted for review and approval prior to temporary use of permanent equipment. The Plan shall include a temporary sequence of operations.
- F. Submit the final program logic and as-built control sequences used to control all systems included in the commissioning program. As-built control sequences shall also include all system setpoints and reset schedules.
- G. The CxP shall review submittals for criteria as related to commissioning. Review is primarily intended to aid in development of functional testing procedures and secondarily to verify compliance with equipment specifications. The CxP notifies the GC, OR and A/E of missing items or where issues may exist.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. Installation contractors shall provide all specialized tools, test equipment, and instruments required to execute startup, checkout, field calibration and functional performance testing of equipment under their contract.
- B. Test equipment shall be of sufficient quality and accuracy (greater accuracy than specified for component) to test and/or measure system performance according to specified tolerances. Test equipment is to have been calibrated within the previous 12 months. Calibration shall be NIST traceable. Equipment shall be re-calibrated when dropped or damaged. Calibration tags shall be affixed or certificates be readily available for review by the CxP.
- C. Datalogging equipment or software required to test equipment will be provided by the CxP, but shall not become the property of the Owner.

PART 3 - EXECUTION

3.1 COMMISSIONING OVERVIEW

- A. The following provides a brief overview of typical commissioning tasks during construction and general order in which they occur.
 - 1. Commissioning kick-off meeting held within 90 days after all installation contractors involved in the commissioning program have been awarded a contract for the project.
 - 2. Contractor's submittals for equipment and system components included in the commissioning program are reviewed by the A/E and the CxP as specified and in accordance with the requirements of other sections of this project manual.

3. CxP completes development of Functional Performance Tests protocols based on submittals and approved sequence of operations and submits to Project Team for review and comment. Final format of testing protocols, based on review comments, are prepared by CxP and distributed in sufficient time to allow the responsible contractor to complete the pre-functional performance test.
4. During the Construction Phase, the CxP shall make periodic site visits to observe installation progress, conduct commissioning meetings and follow-up on open issues from past visits. Frequency of visits shall increase as systems are nearing start-up and functional testing. Observation reports shall be issued after each site visit.
5. The GC and sub-contractors document proper installation and start-up of equipment utilizing the Installation Certification Form (ICF) developed by the CxP. Supplemental start up documentation and manufacturer authorized representatives start up documentation shall also be attached to the ICF.
6. CxP receives the completed ICF along with the completed manufacturer's start-up form for each respective piece of equipment and/or system. During site visits, CxP may conduct random review of equipment included in completed ICF's.
7. Prefunctional Performance Test documentation. After the system components have been properly installed and started in accordance with the ICF and manufacture representative start up activities, the responsible contractor shall perform a prefunctional performance test on the system utilizing the functional performance test protocols. This test shall not be witnessed by the CxP but is required prior to scheduling the FPT.
8. Contractor and Owner develops Training Plan including training agendas in coordination with the OR and GC.
9. Functional Performance Testing for a system shall be scheduled upon completion of the ICF's for each piece of equipment and component in a building system and Prefunctional Performance Testing. The contractor with responsibility for the functionality of a system demonstrates system functionality to CxP. The CxP shall document the results of the testing.
10. CxP recommends acceptance of performance and functionality or recommends remedial action and re-testing.
11. GC and sub-contractors shall be responsible for providing training in accordance with the Training Plan. Training Plan schedule is coordinated with the OR by the GC.
12. Final Commissioning Report.
13. Deferred Testing.
 - a. Unforeseen Deferred Tests.
 - b. Seasonal Testing.
 - c. End-of-Warranty Review.

3.2 TEMPORARY USE OF PERMANENT BUILDING SYSTEMS DURING CONSTRUCTION

- A. Temporary use of permanent building systems shall be authorized only by the Owner in coordination with the A/E and GC.
- B. An Operations and Maintenance Plan shall be developed and submitted for review and approval. Should the temporary operation of the system include a Sequence of Operations that does not conform fully to the contract requirements, this temporary Sequence of Operations shall be in the Operations and Maintenance Plan. The temporary Sequence of Operations shall include all safeties to ensure the permanent equipment is protected against failure or damage. A/E and CxP shall review and approve the temporary Operations and Maintenance Plan prior to the contractor energizing and operating the system in the temporary mode.

- C. As the construction progresses it may be necessary to utilize building systems for temporary environmental control within the building. Should systems be used for temporary environmental control, this activity shall be sequenced into the system delivery process and involve temporary start-up and functional operations testing. Temporary conditions shall not be fully functionally tested to the extent that a duplication of effort must occur for final delivery to the Owner, once the system is fully operational and balanced. Temporary conditions must, at a minimum, meet the intent of the documentation regarding functionality, hydronic flow rates and space pressurization. The sub-contractor shall utilize the ICF for documenting the readiness of the system to be temporarily operated based upon an approved Operations and Maintenance Plan for the temporary use. The contractor shall be responsible to verify that all temporary conditions meet the requirements of the design documents.
- D. A formal verification process for temporary systems will be at the discretion of the Owner and the A/E in the event the need becomes apparent. A formal process is defined as the responsible contractor demonstrating comprehensive functionality to a representative of the Owner, CxP or A/E. The Owner shall not bear additional cost for this demonstration and the demonstration shall occur at the request of the Owner or A/E.
- E. The above applies to systems that serve areas of phased construction. Testing shall occur piecewise as determined prudent by the project team for conditions of a system considered to be permanent. The intent is to not repeat the formal functional testing process on a system except as deemed prudent for effective delivery to the Owner.

3.3 RESPONSIBILITIES

- A. Responsibilities of contractors are provided as follows (the project Commissioning Plan shall include a comprehensive list of responsibilities of all project parties):
 - 1. General Contractor (GC):
 - a. Include requirements for commissioning in each purchase order or subcontract written.
 - b. Ensure acceptable representation, with the means and Provider to assist the CxP in the coordination and execution of the commissioning program.
 - c. Attend commissioning kick-off meeting and other commissioning team meetings. Ensure appropriate representation at these meetings by sub-contractors.
 - d. Incorporate commissioning milestones and activities including functional performance testing into master construction schedule. Maintain and update schedule, as needed, such that it is an accurate representation of construction progress through the completion of functional performance testing and resolution of all punch list issues. Also incorporate durations for scheduled training in the schedule.
 - e. Review and provide comment on the Commissioning Plan and Functional Performance Test protocols developed by CxP.
 - f. Take lead role in coordinating completion and documentation of the Installation Certification Form for equipment and components of building systems included in the Commissioning Program.
 - 1). Coordinate this activity with knowledgeable staff of.
 - 2). Once all ICF's are completed for a building system, GC shall forward them ICF's to CxP as a system package.
 - g. Coordinate the execution of prefunctional performance test documentation with the responsible contractors.
 - h. Coordinate Contractor participation in execution of the Training Plan.
 - i. Provide CxP with required documentation from commissioning activities and submittal requests.

- j. Schedule, coordinate and assist CxP in seasonal or deferred testing and deficiency corrections required by specifications.
2. Installation Contractors:
- a. Ensure acceptable representation on the commissioning team, with the means and Provider to assist the CxP in the coordination and execution of the commissioning program.
 - b. Attend commissioning kick-off meeting and other commissioning team meetings scheduled by CxP.
 - c. Assist CxP with developing a comprehensive commissioning schedule during regularly scheduled commissioning meetings. Participate in the functional test scheduling workshop.
 - d. Complete commissioning activities as scheduled in master construction schedule.
 - e. Complete Installation Certification Form along with respective manufacturer's start-up form and submit with supporting documentation to the GC.
 - f. Address deficiencies identified during construction phase site visits in a timely manner. Within two (2) work days of notification of a deficiency, acknowledge the deficiency and implement action required to address the issue. Within five (5) work days of notification of a deficiency have deficiency corrected.
 - g. Provide certified and calibrated instrumentation to field calibrate all sensors and devices and assist during Functional Performance Testing.
 - h. Ensure installation work is complete, in compliance with Contract Documents, in accordance with approved submittals and meets or exceeds industry standards and ready for Functional Performance Testing.
 - i. Execute the prefunctional performance test successfully. Resolve any performance issues with the A/E.
 - j. Execute inspections, tests, and Functional Performance Tests as described in contract documents and Commissioning Plan. Operate systems and equipment to demonstrate proper sequences of operation.
 - k. Review Commissioning Plan and Functional Performance Test procedures.
 - l. Provide required training for Owner personnel utilizing qualified and experienced instructors.
 - m. Provide documentation according to contract documents.
 - n. Address deficiencies identified during functional testing in a timely manner. Within one (1) work day of notification of a deficiency, acknowledge the deficiency and implement action required to address the issue. Within two (2) work days of notification of a deficiency have deficiency corrected unless an extension is approved by the OR and CxP.
 - o. Execute seasonal or deferred Functional Performance Testing.
3. Controls Contractor:
- a. Ensure acceptable representation, with the means and Provider to assist the CxP in the coordination and execution of the commissioning program.
 - b. Completely install and thoroughly inspect, startup, test, adjust, field calibrate, and document systems, equipment, devices, sensors, etc. controlled by the building automation system. Provided documented point-to-point check out of the system prior to functional performance testing. Field calibration of sensors and devices shall be performed even though factory calibration documentation has been provided.
 - c. Address deficiencies identified during construction phase site visits in a timely manner. Within two (2) work days of notification of a deficiency, acknowledge the deficiency

and implement action required to address the issue. Within five (5) work days of notification of a deficiency have deficiency corrected.

- d. Complete prefunctional performance tests for all sequence of operations controlled by the Building Automation System.
 - e. Assist CxP during Functional Performance Testing. Assistance shall generally include the following:
 - 1). Attend Cx progress and coordination meetings
 - 2). Complete Installation Certification Forms (ICF's) with supporting documentation and submit to the GC.
 - 3). Prepare and submit required draft forms and systems information.
 - 4). Set up trend logs of system operation at discretion of CxP.
 - 5). Demonstrate system operation to the CxP.
 - 6). Address deficiencies identified during functional testing in a timely manner. Within one (1) work day of notification of a deficiency, acknowledge the deficiency and implement action required to address the issue. Within two (2) work days of notification of a deficiency have deficiency corrected unless an extension is approved by the OR and CxP.
 - 7). Provide onsite programmer(s), in addition to those dedicated to functional testing, to correct deficiencies in control sequences during the commissioning period. Minor adjustments to program logic may be made during the functional testing at the discretion of the CxP. All other programming issues shall be completed either after hours or by utilizing additional controls technicians.
 - 8). Provide instrumentation, in calibration, necessary for field verification of all sensors and devices and Functional Performance Testing.
 - 9). Manipulate control systems to facilitate verification and Functional Performance Testing.
 - 10). Provide at least one dedicated controls technician who is totally familiar with the controls installation and program logic on the project to work with the CxP during the functional performance testing.
 - 11). Provide an as-programmed copy of the control logic for each system controlled by the Building Automation System and provide an as-built sequence of operations for each system.
4. Test Adjust Balance (TAB) Subcontractor:
- a. Ensure acceptable representation, with the means and Provider to assist the CxP in the coordination and execution of the commissioning program.
 - b. Attend Commissioning meetings.
 - c. Both air and hydronic balancing of systems supporting a building system shall be completed prior to the functional performance test of the system.
 - d. Once TAB record is completed, coordinate with the CxP to verify up to 10% of the record. Contractor shall utilize equipment used during initial TAB balancing for the TAB verification.
 - e. Rebalance deficient areas identified during commissioning.

3.4 COMMISSIONING TEAM MEETINGS

- A. Commissioning Team Meetings shall be held periodically as determined by CxP with frequency increasing as construction advances and systems become operational. Three days prior to a scheduled meeting the CxP shall issue an Agenda and a list of meeting participants. Not all meetings will require all team members to be present. Attendance is mandatory for Contractors

on the agenda participant list. CxP shall chair Commissioning Team Meetings and issue meeting minutes within two (2) days of the meeting.

- B. Discussions held in Commissioning Team Meetings shall include but not be limited to system / equipment start-up, progress, scheduling, testing, documentation, training, deficiencies, and problem resolution.

3.5 BUILDING SYSTEM MAINTENANCE/SERVICE POINT ACCESS REQUIREMENTS

- A. Each trade contractor shall be responsible for flagging all maintenance points that are located above the ceiling. Construction warning ribbon (1" minimum width) shall be securely attached to the maintenance point and, where applicable, extended down to the ceiling height level such that it is highly visible by all trades. If the location has no ceiling the ribbon shall extend a minimum of 3 feet.
- B. All trades shall ensure that unobstructed access to the maintenance point is maintained from floor level up to the point of service. Unobstructed access shall include full body access to the service point should that be required for maintenance activities. Any trade who installs systems encroaching upon the unobstructed access shall be required to relocate their material, systems and/or equipment at no additional cost to the Owner.

3.6 INSTALLATION CERTIFICATION FORM (ICF)

- A. The purpose of this certification form is to formally document the contractor's quality assurance effort as it relates to the installation and start-up of the specified piece of equipment or system component. The installing contractor responsible for the system shall be responsible for coordinating the completion of this form with the other trades supporting the installation and start-up. The individual signing this certification shall have the Provider to sign on behalf of the contractor and shall have direct personal knowledge of the equipment or system component installation. Any contractor start-up forms or manufacturer specified start-up procedures and documentation shall be attached to this certification form. The completed ICF shall be submitted to the GC.
- B. The GC shall coordinate the effort. When an installing contractor completes an ICF and submits it to the GC, the GC representative shall sign the ICF after inspecting the installation and confirming the equipment/system component, as installed, meets the requirements of the project documents and is ready for functional performance testing. The GC shall compile all ICF's for equipment/system components then submit a system package to the CxP for review.
- C. At appropriate milestones, the GC shall review the status of the completion of the ICF's with each contractor to ensure progress in completing this documentation does not delay the start of functional testing.
- D. Lead Trade Contractor and supporting trade contractors shall execute the ICF and provide the GC with an original signed and dated form. Only individuals with the Provider to sign as the contractor representative and having direct knowledge of the installation and start-up of the equipment or system component shall sign Installation Certification Form. The CxP receives completed ICF's from the GC as system packages. Once all equipment and system component certification forms have been submitted for a building system the contractor shall proceed with the Pre-Functional Performance Testing.
- E. The OR, A/E or CxP reserve the right to witness any startup and preliminary equipment testing.

3.7 FUNCTIONAL PERFORMANCE TESTING

A. General:

1. Refer to Section 01 9114 for additional details regarding the functional performance testing.

B. Objectives and Scope:

1. Each system shall be operated through all modes of operation (normal operation, failure/recovery operation, seasonal, occupied, unoccupied, warm-up, cool-down, part- and full-load, etc.) where there is a specified system response. Verifying each sequence in the specified sequence of operation is required including responses to conditions such as power failure, freeze condition, low oil pressure, no flow, equipment failure, etc. The first step in achieving these objectives is the successful execution of the FPT by the responsible contractor as a prefunctional performance test prior to demonstrating the system operation to the CxP.
2. The contractor responsible for the dynamic operation of a system shall demonstrate comprehensive functionality of that system. All contractors that have contributed to the installation of the same system shall not be required to directly participate in the functional testing activity but shall be required to be immediately available for reconciliation of issues that fall within their scope and responsibility during testing.
3. Functional Performance Testing witnessed by the CxP shall be considered successful when repeatable acceptable outcomes meeting the Basis of Design criteria are achieved.

C. Coordination and Scheduling:

1. Functional Performance Testing is conducted following completion of all installation and start-up contractor activities for all equipment and system components associated with the building system. The ICF's for all system equipment/components shall be completed by the installing contractors, submitted by the GC and reviewed by the CxP prior to performing the Pre-Functional Performance Test. Once both of these tasks are complete and reviewed by the CxP, the Functional Performance Test shall be scheduled.
2. Coordination and final scheduling confirmation of Functional Performance Testing shall occur during regularly scheduled commissioning meetings.
3. All commissioning activities shall be fully integrated into the construction activity schedule. This includes milestone deadlines for completion of installation of major system components and the durations for functional testing of a system.
4. The GC shall provide sufficient notice to CxP regarding changes to the coordinated completion schedule for systems testing.
5. CxP shall witness and document Functional Performance Testing of systems. Designated sub-contractor or vendor responsible for dynamic operation of a system or device shall demonstrate system functionality to CxP.
6. Functional Performance Test discrepancies shall be issued upon completion of a system test, or portion thereof should the deficiency preclude continuation of testing.

D. Test Strategy

1. Each contractor shall comprehensively test and document all building systems in the Commissioning Program for which they are responsible utilizing the Pre-Functional Performance Test Document. Any discrepancies or issues identified during the Pre-Functional Performance Test shall be resolved then retested and documented by the installation contractor.
2. Once the successful Pre-Functional Performance Test has been documented, then the CxP shall witness and document the Functional Performance Test for the record.

3. Systems that contain many repeated identical devices may be selected and demonstrated to the project team based on the sampling strategy indication in paragraph 1.3A of this specification.

E. Non-Conformance:

1. CxP shall document results of Functional Performance Test to FPT forms. Deficiency or non-conformance issues shall be noted and reported to commissioning team as a punch list item with specific responsibility indicated.
2. Corrections of minor deficiencies identified may be made during testing at discretion of CxP. In such case, deficiency and resolution shall be documented on procedure form and to punch list as a resolved issue.
3. Every effort shall be made to expedite testing and minimize unnecessary delays, while not compromising integrity of procedures.
4. Deficiencies are handled in the following manner:
 - a. When there is no dispute on deficiency and Contractor accepts responsibility for remedial action:
 - 1). CxP documents deficiency and contractor's response and intention. CxP posts issue to action list. Contractor corrects deficiency and resubmits to CxP. Contractor addresses all issues noted on action list by correcting deficiencies or by posting date for completion of resolution of deficiency.
 - 2). Contractor shall provide a response pertaining to the deficiency within one (1) work day of notification of the deficiency. This response shall include the contractor's intentions for addressing the issue. Contractor shall satisfactorily address the issue including completion of the corrective actions within two (2) work days of the initial notification of the deficiency unless an extension is authorized by the OR and CxP.
 - 3). The GC reschedules test with CxP and contractor. New test time is posted to project schedule.
 - b. When there is a dispute about a deficiency, regarding whether it is a deficiency or who is responsible:
 - 1). CxP documents deficiency and contractor's response and testing proceeds on subsequent test or sequence. CxP posts issue to punch list and distributes to team.
 - 2). The GC facilitates resolution of deficiency. Other parties are brought into discussions as needed. Final interpretive Provider is with A/E. Final acceptance Provider is with the Owner.
 - 3). CxP documents resolution process.
 - 4). Once interpretation and resolution has been decided, appropriate party corrects deficiency, and CxP is given notice to proceed for retest. The GC and CxP reschedule test. New test time is posted to project schedule.

F. Cost of Retesting:

1. Cost to contractor to recheck Installation Certification Form, re-execute the prefunctional performance test or the FPT, if they are responsible for deficiency or failure, shall be theirs. If contractor is not responsible, cost recovery for re-visitation shall be negotiated with the GC. Final determination as to whether the ICF, PFT or FPT was properly executed as it relates to the project documents and the Basis of Design falls with the A/E.
2. Time for CxP to witness and document any retesting required because a specific Installation Certification Form, start-up test item or prefunctional performance test reported to have been successfully completed, but determined during Functional Performance Testing to be faulty, shall be back charged to the contractor.

3. Contractors shall be held responsible for expenses incurred by Owner for retesting due to the contractor's state of reported readiness or lack thereof as represented on the completion of all commissioning documentation required prior to the FPT. Expenses could include, but not be limited to, retesting labor costs, travel expenses, and remobilization for owner and consulting teams.

G. Approval:

1. CxP notes each satisfactorily demonstrated function on test form. CxP, GC, and OR provide formal approval of FPT after review.

3.8 DEFERRED TESTING

A. Unforeseen Deferred Tests:

1. Any testing that is not completed prior to substantial completion due to reasons beyond the control of the GC or at the request of the Owner shall be conducted as soon after substantial completion as possible so as not to disrupt the building occupants when the facility is fully occupied.

- B. Opposite Season Testing: Testing procedures shall be repeated and/or conducted as necessary during appropriate seasons. "Opposite season" testing is primarily for environmental systems and shall be required where scheduling prohibits thorough testing in all modes of operation. Opposite season testing may also be required when conditions have been simulated to observe the response of the system. The CxP shall schedule the opposite season testing during the warranty period to coincide with a design day condition when possible. Alternatively, should the testing during the normal testing period demonstrated the acceptability of the program logic for the opposite season, then trending of the system during the opposite season is also an acceptable means of documenting operational performance.

END OF SECTION

SECTION 01 91 14 - FUNCTIONAL TESTING REQUIREMENTS

PART 1 - GENERAL

1.1 INCLUDED SYSTEMS AND EQUIPMENT

A. The following systems and equipment included in commissioning program. The sampling rate shown indicates what percentage of system components shall be tested during the functional performance period.

1. Division 14 – Conveying Equipment	Sampling Rate
a. Elevators	100%
2. Division 21 – Fire Protection	Sampling Rate
a. Fire Protection System	100%
3. Division 22 - Plumbing	Sampling Rate
a. Sump Systems	100%
b. Water Supply Including Circulation Systems & Auto Valves	100%
4. Division 23 - Heating Ventilating and Air Conditioning	Sampling Rate
a. Rooftop Unit With DX Cooling	100%
b. Computer Room Air Conditioning Units	100%
c. Variable Air Volume Boxes	20%
d. Fan Coil Units	20%
e. Cabinet Unit Heaters	20%
f. Unit Heaters	20%
g. Toilet Exhaust	100%
h. Gas Fired Rooftop Units	100%
i. Boilers	100%
j. DDC Building Control System	100%
k. Test, Adjust and Balance Verification	5%
5. Division 26 - Electrical	Sampling Rate
a. Lighting Control System	100%
b. Power Monitoring & Control	100%
c. Variable Frequency Drives	100%
d. Electrical Distribution, Greater Than 40A	100%
e. Automatic Transfer Switches	100%
f. Photovoltaic System	100%
6. Division 28 – Electronic Safety and Security	Sampling Rate
a. Fire Alarm System	100%

1.2 DESCRIPTION

A. This section specifies the functional testing requirements for, 14, 21, 22, 23, 26, and 28 systems and equipment. From these requirements, the Commissioning Provider (CxP) shall develop step-by-step procedures to be executed by the Subs or the CxP. The general functional testing process,

requirements and test method definitions are described in Section 01 9113. The test requirements for each piece of equipment or system contain the following:

1. The contractors responsible to execute the tests, under the direction of the CxP.
 2. A list of the integral components being tested.
 3. Functions and modes to be tested.
 4. Required conditions of the test for each mode.
 5. Special procedures.
 6. Required methods of testing.
 7. Required monitoring.
 8. Acceptance criteria.
 9. Sampling strategies allowed.
- B. The functional performance testing protocols developed shall be used as follows:
1. The responsible contractor shall perform a Prefunctional Performance Test utilizing the testing protocol. During the execution of test, the contractor may encounter issues or requires clarification to a test procedure that may require coordination with both the A/E and the CxP. Any changes or modifications to the test protocol shall be made by the CxP for use in the final test effort. Any changes to the test protocol that result in changes to the sequence of operation of the system shall require written approval by the A/E. Once written approval is obtained from the A/E, the control sequence changes shall be incorporated into the test protocol by the CxP. The Contractor shall be responsible for performing and documenting the test results should the control sequences be modified.
 2. Upon completion of the prefunctional testing documentation by the contractor, the Functional Performance Test protocol shall be updated to reflect any approved changes or modifications and then used by the CxP to witness and document the final testing by the contractor.

1.3 PREREQUISITES

- A. The first prerequisite for the start of functional performance testing is the completion and acceptance of the Installation Certification Form (ICF) for each system and/or system component. Refer to Section 01 9113 for information regarding the Installation Certification Form (ICF). The second prerequisite for the start of functional performance testing is the prefunctional performance test documentation from the responsible contractor.
- B. The Controls Sub-Contractor shall have completed the BAS network communication for the entire system, verified and completed the BAS graphics package and confirm the availability of a dedicated controls technician knowledgeable with the programming for the project during the functional performance testing.
- C. All test and Balance (TAB) work shall be completed for the respective and associated systems that are to be tested.

1.4 MONITORING

- A. Monitoring is a method of testing as a stand-alone method or to augment manual testing.
- B. All points listed in the required monitoring section of the test requirements that are control system monitored points shall be trended by the Controls Subcontractor. Other points shall be monitored by the CxP using data loggers or other independent stand-alone devices. At the option of the CxP,

some control system monitoring may be replaced with data logger monitoring. At the CxP's request, the Controls Subcontractor shall trend up to 20% more points than listed herein at no extra charge.

- C. Systems not controlled by the integrated automation system: Systems like the fire detection system or prepackaged control systems for boilers or chillers, events logs shall be set up by the contractor to record all events and alarms during the period of testing
- D. Copies of monitored trend data shall also be provided in electronic format in either Microsoft Excel or Word.
- E. Graphical output is desirable, and will be required for all output, if the system can produce it.

PART 2 - PRODUCTS

- A. NOT APPLICABLE

PART 3 - EXECUTION

3.1 DIVISION 14 – CONVEYING SYSTEMS

A. Elevator

- 1. Obtain documentation indicating correct equipment has been provided and installed as specified. Include all manufacturer and installer certifications as specified.
- 2. Perform testing verifying the elevator door operation (open and closing)
- 3. Verify operation under fire alarm conditions.
- 4. Verify operation during emergency power operations.

3.2 DIVISION 21 – FIRE PROTECTION

A. Fire Protection System

- 1. Parties Responsible to Execute Functional Test
 - a. Fire Protection Contractor: to perform testing
 - b. Fire Detection Contractor to assist in testing
 - c. CxP: direct, witness, and document testing
- 2. Integral Components or Related Equipment Being Tested as applicable for the specific unit
 - a. Fire Protection System
- 3. Functions / Modes Required To Be Tested
 - a. Testing requirements for commissioning are in addition to and do not replace any testing requirements elsewhere in this Division.
 - b. Commissioning testing shall include but not be limited to the following:
 - 1). Flow and Tamper Switches
 - 2). Fire Pump
- 4. Required Monitoring
 - a. None

B. Acceptance Criteria (referenced by function or mode ID)

1. For the conditions, sequences and modes tested, the fire protection system, integral components and related equipment respond to changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice.

3.3 DIVISION 22 - PLUMBING

A. Plumbing related systems

1. Parties Responsible to Execute Functional Test
 - a. CxP: perform and document testing.
 - b. Plumbing contractor: operate the controls to activate the equipment.
2. Integral Components or Related Equipment Being Tested as applicable for the specific unit
 - a. Equipment, systems, and associated devices for systems in the commissioning scope of work as listed above in section 1.1
3. Functions / Modes Required To Be Tested
 - a. Testing requirements for commissioning are in addition to and do not replace any testing requirements elsewhere in this Division.
 - b. Commissioning testing shall include but not be limited to the following:
 - 1). Domestic Water Heaters
 - a). Recovery Rate
 - b). Temperature Control
 - c). Staging
 - 2). Potable Hot/Cold Systems
 - a). Pressure Control
 - b). Mixing Valves
 - c). Fixture Sensors
 - d). Temperature
 - 3). Sump Pumps
 - a). Location of Level Floats
 - b). Operation of Pump Staging
 - c). Alarms
4. Required Monitoring
 - a. None
5. Acceptance Criteria (referenced by function or mode ID)
 - a. For the conditions, sequences and modes tested, the heating hot water integral components and related equipment respond to changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice.

B. Sump Pumps

1. Parties Responsible to Execute Functional Test
 - a. Plumbing contractor: operate the controls to activate the equipment.
 - b. Controls Contractor: assist in testing sequences (Monitoring Alarms).
 - c. CxA: direct, witness and document testing

2. Integral Components or Related Equipment Being Tested as applicable for the specific unit
 - a. Sump Pumps
3. Functions / Modes Required To Be Tested
 - a. Testing requirements for commissioning are in addition to and do not replace any testing requirements elsewhere in this Division.
 - b. Test methods shall include manual, auto, emergency operations and monitoring as applicable and feasible.
 - c. Commissioning testing shall include but not be limited to the following:
 - 1). Verify all alarms and safeties
 - 2). Verify sensor calibration checks on any controlling equipment
 - 3). Verify schedules and setpoints to be reasonable and appropriate
 - 4). Verify floats activate the pumps
 - 5). Verify high-level water alarm
 - 6). Verify low-level water alarm
 - 7). Verify the sequencing of the each pump
 - 8). Determine the diversity/recovery rate in system (if any) then test to maximum diversity.
4. Acceptance Criteria
 - a. For the conditions, sequences and modes tested, the sump pumps, integral components and related equipment respond to varying loads and changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice.

3.4 DIVISION 23 - HEATING VENTILATING AND AIR CONDITIONING

A. General

1. Required Monitoring
 - a. All controlled parameters, respective setpoints, and output points/values for controlling devices shall be trended at a sampling rate specified by the Owner. The controls contractor shall program the respective trend logs in the BAS. All other points that are control system monitored points shall be made available for trending and respective trend logs shall be programmed by the Controls Contractor if owner or CxP require these (any or all) points to be (historically) trended. Other points may be monitored by the CxP using data loggers. During Functional Testing, trend log sampling rates may be increased to monitor responses to various control sequences and failure scenarios.
2. Acceptance Criteria for Air Handling Systems
 - a. For the conditions, sequences and modes tested, the HVAC equipment and/or other building systems, integral components and related equipment respond to varying loads and changing conditions and parameters appropriately as expected, as specified, and according to acceptable operating practice.
 - b. HVAC equipment and supporting systems shall be able to maintain the respective controlled temperature and humidity within specified tolerances either side of the current setpoint without excessive hunting.

- c. HVAC equipment and controls shall control the duct static pressure and/or air flows to maintain the controlled parameter within specified tolerances either side of the setpoint value without excessive hunting.
- 3. Acceptance Criteria for Hydronic Systems
 - a. For the conditions, sequences and modes tested, the chilled water system, integral components and related equipment respond to varying loads and changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice.
 - b. Chiller shall maintain the chilled water supply setpoint to within +/- 1.0F of setpoint deadband without excessive hunting.
 - c. Pumping system and controls shall maintain the current desired pressure setpoint to within an amount equal to [5%] of the setpoint value either side of the deadband without excessive hunting.
- 4. Acceptance Criteria for Building Automation System(BAS) and Test and Balance (TAB) Report
 - a. A failure of more than 10% of the randomly selected items shall result in the failure of acceptance of the BAS system or the TAB report.
- 5. BAS contractor shall be responsible for performing a new point-to-point verification check, provide documentation and repeat the random verifications of the system
- 6. TAB contractor shall be responsible to rebalance the system, provide a new system TAB report and repeat random verifications of the new TAB report.

B. Humidifiers

- 1. Parties Responsible to Execute Functional Test
 - a. Controls contractor: operate the controls to activate the equipment as needed.
 - b. HVAC mechanical contractor: assist in testing sequences as needed.
 - c. CxP: to witness, direct and document testing.
- 2. Integral Components or Related Equipment Being Tested as applicable for the specific unit
 - a. Air Handling Units
- 3. Functions / Modes Required To Be Tested
 - a. Testing requirements for commissioning are in addition to and do not replace any testing requirements elsewhere in this Division.
 - b. Test methods shall include manual, auto, emergency operations and monitoring as applicable and feasible.
 - c. Commissioning testing shall include but not be limited to the following:
 - 1). Test each sequence in the sequence of operations, and other significant modes and sequences not mentioned; including startup, shutdown, component failure, unoccupied & manual modes and power failure. Test functionality of this piece of equipment or system in all control strategies or interlocks with which it is associated. This testing shall include the following as applicable:
 - a). Sensor activator calibration checks
 - b). Device and actuator calibration and stroke checks
 - c). Control parameters and setpoints are reasonable and appropriate
 - 2). Control loops are tuned to eliminate hunting or significant overshoot

3). Alarms

C. Exhaust Fans

1. Parties Responsible to Execute Functional Test
 - a. Controls contractor: operate the controls to activate the equipment as needed.
 - b. HVAC mechanical contractor: assist in testing sequences as needed.
 - c. CxP: to witness, direct and document testing.
2. Integral Components or Related Equipment Being Tested
 - a. Exhaust fans
3. Functions / Modes Required To Be Tested
 - a. Testing requirements for commissioning are in addition to and do not replace any testing requirements elsewhere in this Division.
 - b. Test methods shall include manual, auto, emergency operations and monitoring as applicable and feasible.
 - c. Commissioning testing shall include but not be limited to the following:
 - 1). Test each sequence in the sequence of operations, and other significant modes and sequences not mentioned; including startup, shutdown, component failure, unoccupied & manual modes and power failure. Test functionality of this piece of equipment or system in all control strategies or interlocks with which it is associated. This testing shall include the following as applicable:
 - a). Schedules and setpoints are reasonable and appropriate
 - b). Interlocks to building pressurization control
 - 2). Sensor and actuator calibration checks: Sensor and actuator calibration completed by contractor in ICF Calibration document. Random sampling checks by CxP during functional testing. (BAS readout against hand-held calibrated instrument or observation must be within specified tolerances)

D. Fan Coil

1. Parties Responsible to Execute Functional Test
 - a. Controls contractor: operate the controls to activate the equipment as needed.
 - b. CxP: to witness, direct and document testing.
2. Integral Components or Related Equipment Being Tested as applicable for the specific unit
 - a. Fan Coil
3. Functions / Modes Required To Be Tested
 - a. Testing requirements for commissioning are in addition to and do not replace any testing requirements elsewhere in this Division.
 - b. Test methods shall include manual, auto, emergency operations and monitoring as applicable and feasible.
 - c. Commissioning testing shall include but not be limited to the following:
 - 1). Test each sequence in the sequence of operations, and other significant modes and sequences not mentioned; including startup, shutdown, component failure, unoccupied & manual modes and power failure. Test functionality of this piece of equipment or system in all control strategies or interlocks with which it is associated. This testing shall include the following as applicable:

- a). Monitor and trend room temperature data
- 2). Alarms

E. Unit Heaters

- 1. Parties Responsible to Execute Functional Test
 - a. Controls contractor: operate the controls to activate the equipment as needed.
 - b. CxP: to witness, direct and document testing.
- 2. Integral Components or Related Equipment Being Tested as applicable for the specific unit
 - a. Unit Heaters
- 3. Functions / Modes Required To Be Tested
 - a. Testing requirements for commissioning are in addition to and do not replace any testing requirements elsewhere in this Division.
 - b. Test methods shall include manual, auto, emergency operations and monitoring as applicable and feasible.
 - c. Commissioning testing shall include but not be limited to the following:
 - 1). Test each sequence in the sequence of operations, and other significant modes and sequences not mentioned; including startup, shutdown, component failure, unoccupied & manual modes and power failure. Test functionality of this piece of equipment or system in all control strategies or interlocks with which it is associated. This testing shall include the following as applicable:
 - a). Monitor and trend room temperature data
 - 2). Alarms

F. Cabinet Unit Heaters

- 1. Parties Responsible to Execute Functional Test
 - a. Controls contractor: operate the controls to activate the equipment as needed.
 - b. CxA: direct, witness and document testing
- 2. Integral Components or Related Equipment Being Tested as applicable for the specific unit
 - a. Cabinet Unit Heaters
- 3. Functions / Modes Required To Be Tested
 - a. Testing requirements for commissioning are in addition to and do not replace any testing requirements elsewhere in this Division.
 - b. Commissioning testing shall include but not be limited to testing each sequence in the sequence of operations, and other significant modes and sequences not mentioned; including startup, shutdown, component failure, unoccupied & manual modes and power failure. Test functionality of this piece of equipment or system in all control strategies or interlocks with which it is associated. Test methods shall include manual, auto, emergency operations and monitoring as applicable and feasible. Testing shall include but not be limited to the following:
 - 1). Verify that airflow is as per schedule
 - 2). Manipulate terminal devices through all sequences of operation and verify proper operation.
 - 3). Monitor and trend room temperature sensors.
 - 4). All alarms

G. Heat Pumps

1. Parties Responsible to Execute Functional Test
 - a. Controls contractor: operate the controls to activate the equipment as needed.
 - b. CxP: to witness, direct and document testing.
2. Integral Components or Related Equipment Being Tested as applicable for the specific unit
 - a. Dedicated Outside Air Handling Unit
3. Functions / Modes Required To Be Tested
 - a. Testing requirements for commissioning are in addition to and do not replace any testing requirements elsewhere in this Division.
 - b. Test methods shall include manual, auto, emergency operations and monitoring as applicable and feasible.
 - c. Commissioning testing shall include but not be limited to the following:
 - 1). Test each sequence in the sequence of operations, and other significant modes and sequences not mentioned; including startup, shutdown, component failure, unoccupied & manual modes and power failure. Test functionality of this piece of equipment or system in all control strategies or interlocks with which it is associated. This testing shall include the following as applicable:
 - a). Monitor and trend room temperature data
 - b). Device and actuator calibration and stroke checks
 - c). Control parameters and setpoints are reasonable and appropriate
 - 2). Control loops are tuned to eliminate hunting or significant overshoot
 - 3). Alarms

H. Air Terminal Boxes

1. Parties Responsible to Execute Functional Test
 - a. Controls contractor: operate the controls to activate the equipment as needed.
 - b. CxP: to witness, direct and document testing.
2. Integral Components or Related Equipment Being Tested as applicable for the specific unit
 - a. Air Terminal Boxes – Office
3. Functions / Modes Required To Be Tested
 - a. Testing requirements for commissioning are in addition to and do not replace any testing requirements elsewhere in this Division.
 - b. Test methods shall include manual, auto, emergency operations and monitoring as applicable and feasible.
 - c. Commissioning testing shall include but not be limited to the following:
 - 1). Test each sequence in the sequence of operations, and other significant modes and sequences not mentioned; including startup, shutdown, component failure, unoccupied & manual modes and power failure. Test functionality of this piece of equipment or system in all control strategies or interlocks with which it is associated. This testing shall include the following as applicable:
 - a). Monitor and trend room temperature data
 - b). Device and actuator calibration and stroke checks
 - c). Control parameters and setpoints are reasonable and appropriate

- 2). Control loops are tuned to eliminate hunting or significant overshoot
- 3). Alarms

I. Water Cooled Computer Room Air Conditioning Units

1. Parties Responsible to Execute Functional Test
 - a. Controls contractor: operate the controls to activate the equipment as needed.
 - b. CxA: direct, witness and document testing
2. Integral Components or Related Equipment Being Tested as applicable for the specific unit
 - a. Water-Cooled Computer Room Air Conditioning Units
3. Functions / Modes Required To Be Tested
 - a. Testing requirements for commissioning are in addition to and do not replace any testing requirements elsewhere in this Division.
 - b. Commissioning testing shall include but not be limited to testing each sequence in the sequence of operations, and other significant modes and sequences not mentioned; including startup, shutdown, component failure, unoccupied & manual modes and power failure. Test functionality of this piece of equipment or system in all control strategies or interlocks with which it is associated. Test methods shall include manual, auto, emergency operations and monitoring as applicable and feasible. Testing shall include but not be limited to the following:
 - 1). Activate air conditioning unit using remote wall mounted microprocessor control keypad.
 - 2). Check that all dampers modulate freely
 - 3). Verify that condensate drain is functioning properly.
 - 4). Verify cooling capacity
 - 5). Verify smoke detector operation

J. Chilled Water System

1. The cooling tower can be tested integrally with the chiller testing. The cooling tower test requirements are listed elsewhere.
2. Parties Responsible to Execute Functional Test
 - a. Controls subcontractor: operate the controls as needed.
 - b. HVAC mechanical contractor or vendor: assist in testing sequences as needed.
 - c. CxP: to witness, direct and document testing.
3. Integral Components or Related Equipment Being Tested
 - a. Chilled water piping system
 - b. Pumps
 - c. Variable Frequency Drives
4. Functions / Modes Required To Be Tested
 - a. Testing requirements for commissioning are in addition to and do not replace any testing requirements elsewhere in this Division.
 - b. Test methods shall include manual, auto, emergency operations and monitoring as applicable and feasible.
 - c. Commissioning testing shall include but not be limited to the following:

- 1). Test each sequence in the sequence of operations, and other significant modes and sequences not mentioned; including startup, shutdown, component failure, unoccupied & manual modes and power failure. Test functionality of this piece of equipment or system in all control strategies or interlocks with which it is associated. This testing shall include the following as applicable:
 - a). Failure and recovery scenarios for pumps
 - b). Device and actuator calibration and stroke checks
 - c). Control parameters and setpoints are reasonable and appropriate
- 2). Control loops are tuned to eliminate hunting or significant overshoot on system pressure and temperature
- 3). Alarms

K. Heating Hot Water System

1. Parties Responsible to Execute Functional Test
 - a. Controls Subcontractor: operate the controls, to activate the equipment as needed.
 - b. HVAC Mechanical Contractor or vendor: assist in testing sequences as needed.
 - c. CxP: to witness, direct and document testing.
2. Integral Components or Related Equipment Being Tested as applicable:
 - a. Heat Exchanger
 - b. Supply pumps
 - c. Heating water piping system
 - d. Variable Frequency Drives
3. Functions / Modes Required To Be Tested
 - a. Testing requirements for commissioning are in addition to and do not replace any testing requirements elsewhere in this Division.
 - b. Test methods shall include manual, auto, emergency operations and monitoring as applicable and feasible.
 - c. Commissioning testing shall include but not be limited to the following:
 - 1). Test each sequence in the sequence of operations, and other significant modes and sequences not mentioned; including startup, shutdown, component failure, unoccupied & manual modes and power failure. Test functionality of this piece of equipment or system in all control strategies or interlocks with which it is associated. This testing shall include the following as applicable:
 - a). Failure and recovery scenarios for pumps
 - b). Staging on and off heat exchangers
 - c). Device and actuator calibration and stroke checks
 - d). Control parameters and setpoints are reasonable and appropriate
 - e). Supply water temperature reset
 - 2). Control loops are tuned to eliminate hunting or significant overshoot on system pressure and temperature
 - 3). Alarms

L. Steam and Condensate System

1. Parties Responsible to Execute Functional Test

- a. Controls Contractor: operate the controls, as needed.
 - b. HVAC Mechanical Contractor or vendor: assist in testing sequences.
 - c. CxP: to witness, direct and document testing.
2. Integral Components or Related Equipment Being Tested as applicable:
- a. Steam/condensate piping system
 - b. Steam/condensate piping specialties
 - c. Heat Exchangers
3. Functions / Modes Required To Be Tested
- a. Testing requirements for commissioning are in addition to and do not replace any testing requirements elsewhere in this Division.
 - b. Test methods shall include manual, auto, emergency operations and monitoring as applicable and feasible.
 - c. Commissioning testing shall include but not be limited to the following:
 - 1). Test each sequence in the sequence of operations, and other significant modes and sequences not mentioned; including startup, shutdown, component failure, unoccupied & manual modes and power failure. Test functionality of this piece of equipment or system in all control strategies or interlocks with which it is associated. This testing shall include the following as applicable:
 - a). Staging steam valves based on steam demand
 - b). Staging on and off heat exchangers
 - c). Testing steam traps and condensate return pumping units
 - d). Steam pressure control
 - 2). Control loops are tuned to eliminate hunting or significant overshoot on system pressure and temperature
 - 3). Alarms

M. Building Automation System (BAS)

- 1. Parties Responsible to Execute Functional Test
 - a. Controls Subcontractor: operate the controls to activate the equipment.
 - b. CxP: to witness, direct and document testing.
- 2. Integral Components or Related Equipment Being Tested as applicable:
 - a. Building Automation System
 - b. Calibration Certification Documents
- 3. Functions / Modes Required To Be Tested and Test Methods.
 - a. A significant part of the BAS functional testing requirements is the successful completion of the functional tests of equipment the BAS controls or interlocks with. Uncompleted equipment functional tests or outstanding deficiencies shall be completed prior to conclusion of the functional testing of the BAS.
 - b. Integral or stand-alone controls are functionally tested with the equipment they are attached to, including any interlocks with other equipment or systems and thus are not covered under the BAS testing requirements, except for any integrated functions or interlocks listed below.

- c. Testing requirements for commissioning are in addition to and do not replace any testing requirements elsewhere in this Division.
- d. Test methods shall include manual, auto, emergency operations and monitoring as applicable and feasible.
- e. Commissioning testing shall include but not be limited to the following:
 - 1). Power failure and battery backup and power-up restart functions
 - 2). Global commands features
 - 3). Security and access codes
 - 4). Occupant over-rides (manual, telephone, key, keypad, etc.)
 - 5). Scheduling features fully functional and setup, including holidays
 - 6). Date and time setting in central computer and verify field panels read the same time
 - 7). All graphic screens and value readouts completed
 - 8). Communications to remote sites
 - 9). Final as-builts or redlines (per spec) control drawings, final points list, program code, setpoints, schedules, warranties, etc. per specs, submitted for O&M's
 - 10). Alarm notification system and alarm priorities
 - 11). Optimum start-stop functions
 - 12). Auto-tuning disabled

N. Test, Adjust and Balance Verification

- 1. Parties Responsible to Execute Functional Test
 - a. TAB contractor: perform checks using test instruments
 - b. Controls subcontractor: operate the controls to activate the equipment.
 - c. CxP: to witness, direct and document testing.
- 2. Integral Components or Related Equipment Being Tested as applicable for the specific unit
 - a. TAB water-side
 - b. TAB air-side
- 3. Functions / Modes Required To Be Tested
 - a. Testing requirements for commissioning are in addition to and do not replace any testing requirements elsewhere in this Division.
 - b. Test methods shall include manual, auto, emergency operations and monitoring as applicable and feasible.
 - c. Commissioning testing shall include but not be limited to the following:
 - 1). A random sample of up to 15% the TAB report data shall be selected for verification (air velocity, air or water flow rate, pressure differential, electrical or sound measurement, etc.). The original TAB contractor will execute the checks, witnessed by the CxP. The TAB contractor will use the same test instruments as used in the original TAB work

3.5 DIVISION 26 - ELECTRICAL

A. Normal Power Electric Service Distribution

- 1. Parties Responsible to Execute Functional Test
 - a. Electrical Subcontractor: assist in testing sequences, as needed.

- b. CxP: to witness, direct and document testing.
 - 2. Integral Components or Related Equipment Being Tested
 - a. Switchgear
 - b. Unit Substations
 - c. Distribution Panelboards
 - 3. Functions / Modes Required To Be Tested
 - a. Testing requirements for commissioning are in addition to and do not replace any testing requirements elsewhere in this Division.
 - b. Test methods shall include manual, auto, emergency operations and monitoring as applicable and feasible.
 - c. Commissioning testing shall include but not be limited to the following:
 - 1). Infrared scan of connections of select components and connections. Any PPE required for the CxP to comply with arc-flash requirements shall be provided by the contractor. Contractor shall also open and reclose all equipment being scanned.
 - 2). Randomly check trip settings on breakers to confirm they match the settings in the short circuit coordination study
 - 3). Test the power management control sequence for the switchgear
 - 4). Spot check phase balance at panelboards after system is under load. Ensure proper, thorough and accurate identification of load. Trip breakers and validate load identified. Test GFI breakers
 - 5). Spot check circuit labeling by de-energizing circuits while circuit tester is in the receptacle. Labeling shall be checked on the load/receptacle and at the breaker
 - 6). Receptacle Polarity Test: Spot check receptacles installed or reconnected under this contract with a receptacle circuit tester. Tester shall test for open ground, reverse polarity, open hot, open neutral, hot and ground reversed, hot or neutral and hot open
 - 4. Required Monitoring
 - a. None
 - 5. Acceptance Criteria
 - a. The normal power system, integral components and related equipment respond to varying parameters appropriately as expected, as specified and according to acceptable operating practice.
- B. Emergency Power Distribution
- 1. Parties Responsible to Execute Functional Test
 - a. Controls Subcontractor: operate the controls
 - b. Electrical Subcontractor: Provide load banks and all testing instruments and assist in testing sequences and debugging.
 - c. Mechanical Subcontractor: assist in testing sequences and debugging
 - d. CxP: to coordinate, witness, direct and document testing.
 - 2. Integral Components or Related Equipment Being Tested
 - a. Emergency generator
 - b. Automatic transfer switches

- c. Emergency Power distribution panelboards and circuits
 - d. Emergency Lighting
 - e. Building Automation System
 - f. Fire Alarm System
3. Functions / Modes Required To Be Tested
- a. Testing requirements for commissioning are in addition to and do not replace any testing requirements elsewhere in this Division.
 - b. Test methods shall include manual, auto, emergency operations and monitoring as applicable and feasible.
 - 1). Load banks for testing automatic transfer switches shall be provided by the electrical contractor. The load bank shall be sufficiently sized for the maximum load specified for the automatic transfer switch. One load bank can be used and relocated for each individual test if multiple transfer switches are installed
 - 2). Contractor shall provide all necessary labor and material to connect the load bank to the load side of the transfer switch and then after testing removing same from the project site.
 - c. Commissioning testing shall include but not be limited to the following:
 - 1). Generator safeties and alarms (including high and low oil pressure, high temperature, over-speed, etc.) and interface with BAS
 - 2). Power management control sequence test for loss of normal power, transfer to emergency power then return back to normal power. If authorized by Owner, phase loss scenarios will also be included to confirm specified equipment have phase loss protection.
 - 3). Infrared scan of connections of select components and connections. Any PPE required for the CxP to comply with arc-flash requirements shall be provided by the contractor. Contractor shall also open and reclose all equipment being scanned.
 - 4). Spot check phase balance at panelboards after system is under load. Ensure proper, thorough and accurate identification of load. Trip breakers and validate load identified. Test GFI breakers
 - 5). Spot check circuit labeling by de-energizing circuits while circuit tester is in the receptacle. Labeling shall be checked on the load/receptacle and at the breaker
 - 6). Receptacle Polarity Test: Spot check receptacles installed or reconnected under this contract with a receptacle circuit tester. Tester shall test for open ground, reverse polarity, open hot, open neutral, hot and ground reversed, hot or neutral and hot open
 - 7). BAS sequencing of equipment start-up upon loss and return of power
 - 8). Emergency lighting adequacy for egress routes. Lighting levels for egress paths shall be recorded. Lighting levels for egress paths shall be done at night.
4. Acceptance Criteria
- a. For the conditions, sequences and modes tested, the emergency generator, integral components and related equipment respond to changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice.

C. Lighting Control System

1. Parties Responsible to Execute Functional Test
 - a. Electrical Contractor: assist in testing sequences, as needed.
 - b. CxP: to witness, direct and document testing.
2. Integral Components or Related Equipment Being Tested
 - a. Lighting Control System
3. Functions / Modes Required To Be Tested
 - a. Testing requirements for commissioning are in addition to and do not replace any testing requirements elsewhere in this Division.
 - b. Test methods shall include manual, auto, emergency operations and monitoring as applicable and feasible.
 - c. Commissioning testing shall include but not be limited to the following:
 - 1). Spot check occupancy sensor placement and sensitivity for activation/deactivation
 - 2). Spot check lighting schedules to ensure they are programmed per the owner direction
 - 3). Check lighting levels
 - 4). For exterior fixtures, simulate night mode to validate function. Measure and record light level to ensure they meet the requirements and are generally provide adequate security. Check for excessive light level fluctuations or dark spots

3.6 DIVISION 28 - FIRE ALARM SYSTEM

- A. Parties Responsible to Execute Functional Test
 1. Fire Alarm contractor: operate the controls to activate the equipment
 2. CxP: to witness, direct and document testing
 3. Fire Marshal: to witness, direct and document testing
- B. Integral Components or Related Equipment Being Tested
 1. Fire Pump, Alarm System & Components
- C. Functions / Modes Required To Be Tested
 1. Testing requirements for commissioning are in addition to and do not replace any testing requirements elsewhere in this Division.
 2. Test methods shall include manual, auto, emergency operations and monitoring as applicable and feasible.
 3. Testing will be performed concurrent with testing witnessed by Fire Marshal
 4. Commissioning testing shall include but not be limited to the following:
 - a. Test equipment shutdown and restart sequence for trouble and supervisory alarms
 - b. Test backup battery capacity per requirements
- D. Required Monitoring
 1. None
- E. Acceptance Criteria

1. For the conditions, sequences and modes tested, the fire alarm system, integral components and relate equipment respond to changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice.

END OF SECTION

SECTION 14 08 00 - COMMISSIONING OF CONVEYING EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Commissioning is the process for ensuring that the Conveying Systems is installed and performs interactively according to the basis of design criteria and meets the building operational performance expectations as defined in the sequences of operations. The process also provides adequate documentation of installation, start-up and functional testing and ensures that the Owner's maintenance personnel are adequately trained. It provides for discovery of system operational performance deficiencies prior to substantial completion while the responsible contractors can provide a timely response. It establishes testing and communication protocols in an effort to advance the Conveying Systems from installation to complete dynamic operation and optimization.
- B. The commissioning process involves all the parties involved in the design and construction process as well as the Owner and the Commissioning Provider (CxP). Primary elements of Commissioning during the construction, acceptance and warranty phases of the project include:
 - 1. Verify applicable equipment and systems are installed in accordance with manufacturers' instructions and contract documents and receive adequate operational start-up checkout by installing contractors.
 - 2. Demonstrate functional operational performance of equipment and systems in the commissioning program.
 - 3. Verify O&M documentation submitted is complete. Provide required documentation and information to the Construction Manager. Verify Owner's maintenance personnel are adequately trained in accordance with specified training plan requirements.
 - 4. Verify Owner's maintenance personnel are adequately trained in accordance with specified training plan requirements.
 - 5. Verify systems are interacting and performing optimally in accordance with the system sequence of operations.
 - 6. Furnish labor and material to accomplish conveying systems commissioning and systems' testing as specified herein and other related sections.

1.2 RELATED SECTIONS

- A. Section 01 9113 - General Commissioning Requirements.
- B. Section 01 9114 – Functional Testing Requirements.
- C. Division 14 Sections pertaining to the equipment/systems included in the commissioning program.

1.3 SUBMITTALS

- A. Refer to Section 01 9113 for commissioning submittal requirements. Provide copies of commissioning submittal requirements to the Commissioning Provider, in addition to the copies required by the Owner and Design Professional.

1.4 COORDINATION

- A. The installation schedule for the components, equipment & systems included in the commissioning program shall be such that the commissioning requirements can be met without

impacting the construction schedule. Commissioning Functional Performance Testing is a requirement for Substantial Completion.

- B. All maintenance points for components installed by the contractor (or sub-contractors) for building systems servicing shall be flagged utilizing construction marker ribbons if the maintenance point is located where multiple trades will be installing systems, unobstructed access from floor level shall be maintained. Refer to Section 01 9113 for additional information on maintenance/service point access.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. Trade contractors shall provide all specialized tools, test equipment, and instruments required to execute startup, checkout, field calibration and functional performance testing of equipment under their contract.
- B. Test equipment shall be of sufficient quality and accuracy (great accuracy than specified for component) to test and/or measure system performance according to specified tolerances. Test equipment is to have calibrated within the previous 12 months. Calibration shall be NIST traceable. Equipment shall be re-calibrated when dropped or damaged. Calibration tags shall be affixed or certificates be readily available.
- C. Datalogging equipment or software required to test equipment will be provided by the CxP, but shall not become the property of the Owner.

PART 3 - EXECUTION

3.1 COMMISSIONING

- A. General Requirements. For additional information regarding general commissioning requirements refer to Section 01 9113.
- B. Installation contractors shall be responsible for executing and documenting equipment installation, start-up and check out for systems and equipment. Contractors shall also be responsible for executing and documenting prefunctional performance tests. Both of these documents are required prior to the Commissioning Provider scheduling the functional performance test. Contractors shall also be responsible for providing training for the Owner's maintenance personnel in accordance with project requirements.
- C. Installation Certification Forms (ICF) for each type of equipment and system shall be provided to the installation contractors by the Commissioning Provider for use by the contractors in documenting the installation and start-up of equipment in the commissioning program.
- D. For equipment and system components requiring a manufacturer's representative for installation verification and start-up, manufacturer documentation of these activities shall be attached to the checklists provided by the Commissioning Provider.
- E. Prefunctional Performance Test procedures for each type of equipment and system shall be provided to the installation contractors by the Commissioning Provider for use by the contractor in documenting the performance of the prefunctional performance test. Refer to Section 01 9114 for further information.

- F. Completed Start-up checklists and prefunctional performance test documentation for all pieces of equipment shall be submitted by contractors to the Commissioning Provider through the Construction Manager prior to the scheduling of the final Functional Performance Test that is witnessed by the CxP.

3.2 TRAINING

- A. Contractor responsible for the installation of the system shall coordinate the participation of other sub-contractors and manufacturer's representatives in the training program in accordance with requirements of other sections of the project specifications.

3.3 OPERATIONS AND MAINTENANCE DATA

- A. Contractor responsible for the installation of the system shall provide operations and maintenance manuals in accordance with requirements of other sections of the project specifications

3.4 GENERAL SYSTEM TESTING CRITERIA

- A. Functional Performance Testing
 - 1. Refer to Sections 01 9113 - General Commissioning Requirements and 01 9114 - Functional Testing Requirements. Installation contractor shall be responsible for providing authorized manufacturer's representatives to demonstrate the operational capabilities of the equipment's systems.

END OF SECTION

SECTION 21 08 00 - COMMISSIONING OF FIRE PROTECTION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Commissioning is the process for ensuring that the Fire Protection System is installed and performs interactively according to the basis of design criteria and meets the building operational performance expectations as defined in the sequences of operations. The process also provides adequate documentation of installation, start-up and functional testing and ensures that the Owner's maintenance personnel are adequately trained. It provides for discovery of system operational performance deficiencies prior to substantial completion while the responsible contractors can provide a timely response. It establishes testing and communication protocols in an effort to advance the Fire Protection System from installation to complete dynamic operation and optimization.
- B. The commissioning process involves all the parties involved in the design and construction process as well as the Owner and the Commissioning Provider (CxP). Primary elements of Commissioning during the construction, acceptance and warranty phases of the project include:
 - 1. Verify applicable equipment and systems are installed in accordance with manufacturers' instructions and contract documents and receive adequate operational start-up checkout by installing contractors.
 - 2. Demonstrate functional operational performance of equipment and systems in the commissioning program.
 - 3. Verify O&M documentation submitted is complete.
 - 4. Verify Owner's maintenance personnel are adequately trained in accordance with specified training plan requirements.
 - 5. Verify systems are interacting and performing optimally in accordance with the system sequence of operations.
 - 6. Furnish labor and material to accomplish fire protection system commissioning and systems' testing as specified herein and other related sections.

1.2 RELATED SECTIONS

- A. Section 01 9113 – General Commissioning Requirements.
- B. Section 01 9114 – Functional Testing Requirements
- C. Division 21 Sections pertaining to the Fire Protection Systems included in the commissioning program.

1.3 SUBMITTALS

- A. Refer to Section 01 91 13 for commissioning submittal requirements. Provide copies of commissioning submittal requirements to the CxP, in addition to the copies required by the Owner and Design Professional.

1.4 COORDINATION

- A. The installation schedule for the components, equipment & systems included in the commissioning program shall be such that the commissioning requirements can be met without impacting the construction schedule. Commissioning Functional Performance Testing and/or

Functional Performance Testing and report from the Provider having jurisdiction is a requirement for Substantial Completion.

- B. All maintenance points for components installed by the contractor (or sub-contractors) for building systems servicing shall be flagged utilizing construction marker ribbons if the maintenance point is located where multiple trades will be installing systems, unobstructed access from floor level shall be maintained. Refer to Section 01 9113 for additional information on maintenance/service point access.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. Trade contractors shall provide all specialized tools, test equipment, and instruments required to execute startup, checkout, field calibration and functional performance testing of equipment under their contract.
- B. Test equipment shall be of sufficient quality and accuracy (great accuracy than specified for component) to test and/or measure system performance according to specified tolerances. Test equipment is to have calibrated within the previous 12 months. Calibration shall be NIST traceable. Equipment shall be re-calibrated when dropped or damaged. Calibration tags shall be affixed or certificates be readily available.
- C. Datalogging equipment or software required to test equipment will be provided by the CxP, but shall not become the property of the Owner.

PART 3 - EXECUTION

3.1 COMMISSIONING

- A. General Requirements. For additional information regarding general commissioning requirements refer to Section 01 91 13.
- B. Installation contractors shall be responsible for executing and documenting equipment installation, start-up and check out for systems and equipment. Contractors shall also be responsible for executing and documenting prefunctional performance tests. Both of these documents are required prior to the CxP scheduling the functional performance test. Contractors shall also be responsible for providing training for the Owner's maintenance personnel in accordance with project requirements.
- C. Installation Certification Forms (ICF) for each type of equipment and system shall be provided to the installation contractors by the CxP for use by the contractors in documenting the installation and start-up of equipment in the commissioning program.
- D. For equipment and system components requiring a manufacturer's representative for installation verification and start-up, manufacturer documentation of these activities shall be attached to the checklists provided by the CxP.
- E. Prefunctional Performance Test procedures for each type of equipment and system shall be provided to the installation contractors by the CxP for use by the contractor in documenting the performance of the prefunctional performance test. Refer to Section 01 9114 for further information.

- F. Completed Start-up checklists and prefunctional performance test documentation for all pieces of equipment shall be submitted by contractors to the CxP through the General Contractor prior to the scheduling of the final Functional Performance Test that is witnessed by the Fire Marshal. The CxP may elect to witness the test along with the Fire Marshal or separately.

3.2 TRAINING

- A. Contractor responsible for the installation of the system shall coordinate the participation of other sub-contractors and manufacturer's representatives in the training program in accordance with requirements of other sections of the project specifications.

3.3 OPERATIONS AND MAINTENANCE DATA

- A. Contractor responsible for the installation of the system shall provide operations and maintenance manuals in accordance with requirements of other sections of the project specifications.

3.4 GENERAL SYSTEM TESTING CRITERIA

- A. Functional Performance Testing
 - 1. Refer to Sections 01 91 13 - General Commissioning Requirements and 01 91 14 - Functional Testing Requirements. Installation contractor shall be responsible for providing authorized manufacturer's representatives to demonstrate the operational capabilities of the equipment & systems.

END OF SECTION

SECTION 22 08 00 - COMMISSIONING OF PLUMBING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Commissioning is the process for ensuring that the Plumbing System is installed and performs interactively according to the basis of design criteria and meets the building operational performance expectations as defined in the sequences of operations. The process also provides adequate documentation of installation, start-up and functional testing and ensures that the Owner's maintenance personnel are adequately trained. It provides for discovery of system operational performance deficiencies prior to substantial completion while the responsible contractors can provide a timely response. It establishes testing and communication protocols in an effort to advance the Plumbing System from installation to complete dynamic operation and optimization.
- B. The commissioning process involves all the parties involved in the design and construction process as well as the Owner and the Commissioning Provider (CxP). Primary elements of Commissioning during the construction, acceptance and warranty phases of the project include:
 - 1. Verify applicable equipment and systems are installed in accordance with manufacturers' instructions and contract documents and receive adequate operational start-up checkout by installing contractors.
 - 2. Demonstrate functional operational performance of equipment and systems in the commissioning program.
 - 3. Verify O&M documentation submitted is complete. Verify Owner's maintenance personnel are adequately trained in accordance with specified training plan requirements.
 - 4. Verify systems are interacting and performing optimally in accordance with the system sequence of operations.
 - 5. Furnish labor and material to accomplish plumbing system commissioning and systems' testing as specified herein and other related sections.

1.2 RELATED SECTIONS

- A. Section 01 91 13 – General Commissioning Requirements.
- B. Section 01 91 14 – Functional Testing Requirements
- C. Division 22 Sections pertaining to the Plumbing Systems included in the commissioning program.

1.3 SUBMITTALS

- A. Refer to Section 01 91 13 for commissioning submittal requirements. Provide copies of commissioning submittal requirements to the CxP, in addition to the copies required by the Owner and Design Professional.

1.4 COORDINATION

- A. The installation schedule for the components, equipment & systems included in the commissioning program shall be such that the commissioning requirements can be met without impacting the construction schedule. Commissioning Functional Performance Testing is a requirement for Substantial Completion.

- B. All maintenance points for components installed by the contractor (or sub-contractors) for building systems servicing shall be flagged utilizing construction marker ribbons if the maintenance point is located where multiple trades will be installing systems, unobstructed access from floor level shall be maintained. Refer to Section 01 91 13 for additional information on maintenance/service point access.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. Trade contractors shall provide all specialized tools, test equipment, and instruments required to execute startup, checkout, field calibration and functional performance testing of equipment under their contract.
- B. Test equipment shall be of sufficient quality and accuracy (great accuracy than specified for component) to test and/or measure system performance according to specified tolerances. Test equipment is to have calibrated within the previous 12 months. Calibration shall be NIST traceable. Equipment shall be re-calibrated when dropped or damaged. Calibration tags shall be affixed or certificates be readily available.
- C. Datalogging equipment or software required to test equipment will be provided by the CxP, but shall not become the property of the Owner.

PART 3 - EXECUTION

3.1 COMMISSIONING

- A. General Requirements. For additional information regarding general commissioning requirements refer to Section 01 91 13.
- B. Installation contractors shall be responsible for executing and documenting equipment installation, start-up and check out for systems and equipment. Contractors shall also be responsible for executing and documenting prefunctional performance tests. Both of these documents are required prior to the CxP scheduling the functional performance test. Contractors shall also be responsible for providing training for the Owner's maintenance personnel in accordance with project requirements.
- C. Installation Certification Forms (ICF) for each type of equipment and system shall be provided to the installation contractors by the CxP for use by the contractors in documenting the installation and start-up of equipment in the commissioning program.
- D. For equipment and system components requiring a manufacturer's representative for installation verification and start-up, manufacturer documentation of these activities shall be attached to the checklists provided by the CxP.
- E. Prefunctional Performance Test procedures for each type of equipment and system shall be provided to the installation contractors by the CxP for use by the contractor in documenting the performance of the prefunctional performance test. Refer to Section 01 9114 for further information.
- F. Completed Start-up checklists and prefunctional performance test documentation for all pieces of equipment shall be submitted by contractors to the CxP through the General Contractor prior to the scheduling of the final Functional Performance Test that is witnessed by the CxP.

3.2 TRAINING

- A. Contractor responsible for the installation of the system shall coordinate the participation of other sub-contractors and manufacturer's representatives in the training program in accordance with requirements of other sections of the project specifications.

3.3 OPERATIONS AND MAINTENANCE DATA

- A. Contractor responsible for the installation of the system shall provide operations and maintenance manuals in accordance with requirements of other sections of the project specifications

3.4 GENERAL SYSTEM TESTING CRITERIA

A. Functional Performance Testing

1. Refer to Sections 01 91 13 - General Commissioning Requirements and 01 9114 - Functional Testing Requirements. Installation contractor shall be responsible for providing authorized manufacturer's representatives to demonstrate the operational capabilities of the equipment & systems.

END OF SECTION

SECTION 23 08 00 - COMMISSIONING OF HVAC SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Commissioning is the process for ensuring that the HVAC System is installed and performs interactively according to the basis of design criteria and meets the building operational performance expectations as defined in the sequences of operations. The process also provides adequate documentation of installation, start-up and functional testing and ensures that the Owner's maintenance personnel are adequately trained. It provides for discovery of system operational performance deficiencies prior to substantial completion while the responsible contractors can provide a timely response. It establishes testing and communication protocols in an effort to advance the HVAC System from installation to complete dynamic operation and optimization.
- B. The commissioning process involves all the parties involved in the design and construction process as well as the Owner and the Commissioning Provider (CxP). Primary elements of Commissioning during the construction, acceptance and warranty phases of the project include:
 - 1. Verify applicable equipment and systems are installed in accordance with manufacturers' instructions and contract documents and receive adequate operational start-up checkout by installing contractors.
 - 2. Demonstrate functional operational performance of equipment and systems in the commissioning program.
 - 3. Verify O&M documentation submitted is complete. Provide required documentation and information to the General Contractor. Verify Owner's maintenance personnel are adequately trained in accordance with specified training plan requirements.
 - 4. Verify systems are interacting and performing optimally in accordance with the system sequence of operations.
 - 5. Furnish labor and material to accomplish HVAC system commissioning and systems' testing as specified herein and other related sections.

1.2 RELATED SECTIONS

- A. Section 01 91 13 – General Commissioning Requirements
- B. Section 01 91 14 – Functional Testing Requirements
- C. Division 23 Sections pertaining to the HVAC Systems included in the commissioning program.

1.3 SUBMITTALS

- A. Refer to Section 01 91 13 for commissioning submittal requirements. Provide copies of commissioning submittal requirements to the CxP, in addition to the copies required by the Owner and Design Professional.

1.4 COORDINATION

- A. The installation schedule for the components, equipment & systems included in the commissioning program shall be such that the commissioning requirements can be met without impacting the construction schedule. Commissioning Functional Performance Testing is a requirement for Substantial Completion.

- B. All maintenance points for components installed by the contractor (or sub-contractors) for building systems servicing shall be flagged utilizing construction marker ribbons if the maintenance point is located where multiple trades will be installing systems, unobstructed access from floor level shall be maintained. Refer to Section 01 9113 for additional information on maintenance/service point access.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. Trade contractors shall provide all specialized tools, test equipment, and instruments required to execute startup, checkout, field calibration and functional performance testing of equipment under their contract.
- B. Test equipment shall be of sufficient quality and accuracy (great accuracy than specified for component) to test and/or measure system performance according to specified tolerances. Test equipment is to have calibrated within the previous 12 months. Calibration shall be NIST traceable. Equipment shall be re-calibrated when dropped or damaged. Calibration tags shall be affixed or certificates be readily available.
- C. Datalogging equipment or software required to test equipment will be provided by the CxP, but shall not become the property of the Owner.

PART 3 - EXECUTION

3.1 COMMISSIONING

- A. General Requirements. For additional information regarding general commissioning requirements refer to Section 01 91 13.
- B. Installation contractors shall be responsible for executing and documenting equipment installation, start-up and check out for systems and equipment. Contractors shall also be responsible for executing and documenting prefunctional performance tests. All of these documents are required prior to the CxP scheduling the functional performance test. Contractors shall also be responsible for providing training for the Owner's maintenance personnel in accordance with project requirements.
- C. Installation Certification Form (ICF) for each type of equipment and system shall be provided to the installation contractors by the CxP for use by the contractors in documenting the installation and start-up of equipment in the commissioning program.
- D. For equipment and system components requiring a manufacturer's representative for installation verification and start-up, manufacturer documentation of these activities shall be attached to the checklists provided by the CxP.
- E. Prefunctional Performance Test procedures for each type of equipment and system shall be provided to the installation contractors by the CxP for use by the contractor in documenting the performance of the prefunctional performance test. Refer to Section 01 9114 for further information.
- F. Completed Installation Certification Forms along with completed respective manufacturer's Start-up forms and prefunctional performance test documentation for all pieces of equipment shall be submitted by contractors to the CxP through the General Contractor prior to the scheduling of the final Functional Performance Test that is witnessed by the CxP. The CxP

will not schedule any testing until all of these documents have been received, reviewed, and approved.

3.2 TRAINING

- A. Contractor responsible for the installation of the system shall coordinate the participation of other sub-contractors and manufacturer's representatives in the training program in accordance with requirements of other sections of the project specifications.

3.3 OPERATIONS AND MAINTENANCE DATA

- A. Contractor responsible for the installation of the system shall provide operations and maintenance manuals in accordance with requirements of other sections of the project specifications.

3.4 GENERAL SYSTEM TESTING CRITERIA

- A. Functional Performance Testing
 - 1. Refer to Sections 01 91 13 - General Commissioning Requirements and 01 91 14 - Functional Testing Requirements. Installation contractor shall be responsible for providing authorized manufacturer's representatives to demonstrate the operational capabilities of the equipment & systems.

END OF SECTION

SECTION 23 08 01 - COMMISSIONING OF BUILDING CONTROLS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Commissioning is the process for ensuring that the Building Automation System (BAS) is installed and performs interactively according to the basis of design criteria and meets the building operational performance expectations as defined in the sequences of operations. The process also provides adequate documentation of installation, start-up and functional testing and ensures that the Owner's maintenance personnel are adequately trained. It provides for discovery of system operational performance deficiencies prior to substantial completion while the responsible contractors can provide a timely response. It establishes testing and communication protocols in an effort to advance the BAS from installation to complete dynamic operation and optimization.
- B. The commissioning process involves all the parties involved in the design and construction process as well as the Owner and the Commissioning Provider (CxP). Primary elements of Commissioning during the construction, acceptance and warranty phases of the project include:
1. Verify applicable equipment and systems are installed in accordance with manufacturers' instructions and contract documents and receive adequate operational start-up checkout by installing contractors.
 2. Demonstrate functional operational performance of equipment and systems in the commissioning program.
 3. Verify O&M documentation submitted is complete. Provide required documentation and information to the General Contractor. Verify Owner's maintenance personnel are adequately trained in accordance with specified training plan requirements.
 4. Verify systems are interacting and performing optimally in accordance with the system sequence of operations.
 5. Furnish labor and material to accomplish Building Automation System commissioning and systems' testing as specified herein and other related sections.
- C. Primary elements of BAS Commissioning during the construction, acceptance and warranty phases of the project shall include:
1. BAS and equipment testing and start-up.
 2. Verification of complete and thorough installation of BAS and equipment.
 3. BAS performance verification.
 4. Sensor checkout and calibration.
 5. Control valve leak check.
 6. Valve/Damper Stroke Setup and Check.
 7. Verification of BAS system and equipment graphics and proper representation and point mapping and display.
 8. BAS Demonstration.
 9. BAS Acceptance Period.
 10. Trend logs and graphs.
 11. Functional testing of BAS.
 12. Documentation of tests, procedures, and installations.
 13. Provision and coordination of BAS training.
 14. Documentation of BAS Operation and Maintenance materials.
 15. Warranty Phase BAS Opposite Season Trending and Evaluation.

1.2 RELATED SECTIONS

- A. Section 01 91 13 – General Commissioning Requirements
- B. Section 01 91 14 – Functional Testing Requirements
- C. Division 23 Sections pertaining to the Building Automation Systems included in the commissioning program.

1.3 SUBMITTALS

- A. Refer to Section 01 91 13 for commissioning submittal requirements. Provide copies of commissioning submittal requirements to the Commissioning Provider, in addition to the copies required by the Owner and Design Professional.
- B. Point-to-Point verification documentation shall be submitted to the CxP prior to scheduling the final functional performance test of the BAS system.

1.4 COORDINATION

- A. The installation schedule for the components, equipment & systems included in the commissioning program shall be such that the commissioning requirements can be met without impacting the construction schedule. Commissioning Functional Performance Testing is a requirement for Substantial Completion.
- B. All maintenance points for components installed by the contractor (or sub-contractors) for building systems servicing shall be flagged utilizing construction marker ribbons if the maintenance point is located where multiple trades will be installing systems, unobstructed access from floor level shall be maintained. Refer to Section 01 91 13 for additional information on maintenance/service point access.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. Trade contractors shall provide all specialized tools, test equipment, and instruments required to execute startup, checkout, field calibration and functional performance testing of equipment under their contract.
- B. Test equipment shall be of sufficient quality and accuracy (great accuracy than specified for component) to test and/or measure system performance according to specified tolerances. Test equipment is to have calibrated within the previous 12 months. Calibration shall be NIST traceable. Equipment shall be re-calibrated when dropped or damaged. Calibration tags shall be affixed or certificates be readily available.
- C. Datalogging equipment or software required to test equipment will be provided by the CxP, but shall not become the property of the Owner.
- D. BAS contractor shall provide a portable operator's terminal or hand held device to facilitate the checking of sensor calibration. This device shall support all functions and allow querying and editing of all parameters required for proper calibration and start up. Connections shall be provided local to the device being calibrated. For instance, for VAV boxes, connection of the operator's terminal shall be either at the thermostat or the box.

PART 3 - EXECUTION

3.1 COMMISSIONING PROCEDURES AND REQUIREMENTS

- A. The Contractor is responsible for field calibration of all sensors and devices.
- B. Through the commissioning process, the Contractor shall, to the satisfaction of the CxP:
 - 1. Verify the installation, operation and functional performance of BAS systems hardware and software for compliance with design intent and the Contract Documents.
 - 2. Document the data generated by tests and inspections. This documentation shall primarily be done in the ICF form and the prefunctional performance test.
 - 3. Verify accuracy and logical organization of Operation and Maintenance Manuals, as-built control sequences, and as-built program logic and setpoints.
- C. A complete static and dynamic commissioning test program shall be implemented for all hardware and software points, all BAS panels and for all devices by the Contractor.
 - 1. Static tests: Commissioning tests shall consist of a full range of static tests carried out to verify that all hardware points, software, panels, transducers, all devices and other components, function in accordance with the specifications.
 - 2. Dynamic tests: System performance shall be checked under dynamic conditions that simulate varying load and operating modes, including pre-conditioning, start-up, normal operating, emergency and fail-safe modes, shut-down interlocks and lock-outs defined in the Control Sequences.
- D. The Contractor shall provide all commissioning test equipment required.
- E. The CxP shall be given written notice and all required pre-requisite documentation at least seven (7) days in advance of the dates of all tests. The BAS graphics package must have been completed and must be available for testing. Detail the locations and parts of system(s) being tested, the test procedures proposed and the anticipated results. The CxP shall witness testing to the level necessary to ensure testing protocols are acceptable and being followed.
- F. Acceptance by the CxP of test procedures outlined in this Section shall not relieve the Contractor of responsibility for the complete system meeting the requirements of these Specifications after installation.
- G. Final functional performance tests shall be performed for the BAS system as a whole and witnessed by the CxP.
 - 1. Upon complete installation of the BAS system, the Contractor shall start up the system and perform all necessary testing and run diagnostics to ensure proper operation.
 - 2. Pertinent sections of the Installation Certification Form (ICF) and a documented prefunctional performance test for the system shall be completed by the contractor prior to scheduling of the acceptance test.
 - 3. A functional performance test, witnessed by the CxP, or designated representative, shall be performed for each system that includes integrated automation.
- H. All testing, including the final functional performance test, shall be completed prior to substantial completion. If any check or test cannot be accomplished for seasonal reasons, lack of occupancy, or for other reasons, this fact shall be noted along with an indication of when the test shall be rescheduled.

3.2 STATIC COMMISSIONING OF THE INPUT AND OUTPUT HARDWARE

The Contractor shall complete a point-to-point check of the BAS system and provide documentation of same. The point-to-point checks and field sensor/device calibration shall be completed during the Contractor's own testing and verification. The documentation of field calibration of sensors and devices shall be recorded in the Installation Certification Form (ICF) specific system/equipment/component. Factory calibration of sensors shall not be accepted in lieu of field calibration. The completed point-to-point documentation shall then be submitted to the CxP for review and approval. The CxP shall repeat a random sample (20% minimum) of the point-to-point checks during the commissioning process to corroborate accuracy of the documentation. The Contractor shall be present on site with test equipment to repeat a random sample of the point-to-point checks and field calibrations. The procedures shall include the following:

1. Binary Input (BI) :
 - a. BI status shall be verified at the Front End, local BAS control panel and equipment location for ON status and OFF status.
 - b. All binary alarm inputs shall be proven using actual conditions where possible or be jumpered for testing with approval by the CxP at the field device to test for correct notification at the equipment location, local BAS control panel and front end.
2. Binary Output (BO)
 - a. Status shall be verified at the equipment location. Verification at the Front End shall be completed for ON status, OFF status, software DISABLE indicator and OVERRIDDEN indicator.
3. Analog Input (AI)
 - a. All temperature sensors shall be verified by conducting an equivalence test using a digital hand-held meter with equal or better accuracy.
 - b. Selected temperature sensors chosen by the CxP shall be verified by spraying with a "cold-spray" or other means to ensure response and to test the low temperature alarm condition.
 - c. All pressure sensing devices and analog output feedback shall be verified using a device with equal or better accuracy to ensure correct calibration. Calibration must be per Manufacturers' recommendations and to the CxP's satisfaction.
 - d. All humidity sensing devices must be verified using a psychrometer with equal or better accuracy to ensure correct calibration. Calibration shall be per Manufacturer's recommendations and to the CxP's satisfaction.
 - e. All CTs shall be set to accurately reflect motor status.
 - f. All other sensing devices shall be verified using an appropriate device with equal accuracy or better to ensure correct calibration. Calibration shall be per Manufacturer's recommendations and to the CxP's satisfaction.
 - g. Adjust span on feedback points so the analog input matches the end device output.
4. Analog Output (AO)
 - a. AO's shall be tested by sending a command from the front end to incrementally stroke the field device from full CLOSED to full OPEN and measuring the signal at the field device. The increments of the test shall be no larger than 10% of output span.
 - b. The AO feedback requirement shall also be tested by failing the field device and verifying that the alarm registers.
 - c. Each output shall be exercised over the full output capability of the panel.
 - d. Field device hysteresis shall be measured at a minimum of three output levels for each direction of travel. Output increments shall not exceed 2% of span for this test.

3.3 STATIC COMMISSIONING OF THE BAS SYSTEM SOFTWARE

- A. The CxP shall review the final versions of all BAS system software to ensure that the software complies with the Control Sequences in every respect. The Contractor shall provide assistance and technical manuals as required.
- B. The Contractor and the CxP shall commission the Front End graphics and reports.

3.4 STATIC COMMISSIONING OF THE BAS SYSTEM PANEL NETWORK AND DEVICES

- A. Each BAS panel and/or controller shall be checked for compliance with standalone and fail-safe requirements, proper grounding and other features. All features listed in Section 23 09 00 shall be checked and verified by the Contractor in the presence of the CxP. Panels that do not pass the standalone tests shall be replaced at no cost to the Owner. In this context, “standalone” means that the panel, with the network cable disconnected, shall accurately maintain reference time, continue trending data, maintain communications with any panels connected to it and control the equipment connected to the panel.

3.5 DYNAMIC COMMISSIONING OF THE WORK AS A WHOLE

A. Functional Performance Testing

- 1. Refer to Sections 01 91 13 - General Commissioning Requirements and 01 9114 - Functional Testing Requirements. Installation contractor shall be responsible for providing qualified manufacturer’s representatives to demonstrate the operational capabilities of the integrated automation systems.

B. Seven(7) Day Acceptance Test

- 1. The Seven (7) Day Acceptance Test shall be scheduled after successful completion of the functional performance test. This test shall occur after substantial completion to limit the contractor activities while the test is being performed.
- 2. With all points enabled and automatically controlled, all systems and associated programs shall operate for seven (7) consecutive days on history/trend logs to verify all types of conditions that occurred in the period.
- 3. All history/trend logs shall be set up by the Contractor and shall be submitted to the CxP for review and approval.
- 4. During the Acceptance Test period, the CxP may generate various failure scenarios to ensure the repeatable and acceptable recovery scenarios are achieved. This will focus primarily on the production areas of the facility.
- 5. The Contractor shall provide a minimum of seven days’ worth of trend data to verify that the following functions:
 - a. Systems operate in accordance with sequence of operations without manual intervention
 - b. Reset schedules for setpoints are met
 - c. Control loop stability without hunting
 - d. Acceptable failure and recovery scenarios so as to maintain pressure cascades
 - e. Contractor shall provide trend data at intervals and duration specified by the CxP at the start of the acceptance test period to determine that the above Control Sequences functions perform to his satisfaction.
- 6. This condition of the commissioning process is met when all alarms and system values are appropriate for the defined Control Sequences. The Acceptance Test is considered a “PASS” if no unexpected outcomes are generated during the period. If unexpected outcomes do occur the test shall be considered a “FAIL”. Depending on the criticality of the unexpected outcome, the contractor may be allowed to continue testing after

modifications are made to complete the test period or may be required to start the acceptance test over.

3.6 WARRANTY PHASE BAS OPPOSITE SEASON TRENDING AND EVALUATION:

- A. Opposite Season Evaluation: Within 6 months of completion of the Acceptance Phase, CxP shall schedule and conduct Opposite Season functional performance evaluation. BAS contractor shall participate in this evaluation and possible testing, if required, and remedy any deficiencies identified.

3.7 TRAINING

- A. Contractor responsible for the installation of the system shall coordinate the participation of other sub-contractors and manufacturer's representatives in the training program in accordance with requirements of other sections of the project specifications.

3.8 OPERATIONS AND MAINTENANCE DATA

- A. Contractor responsible for the installation of the system shall provide operations and maintenance manuals in accordance with requirements of other sections of the project specifications.

END OF SECTION

SECTION 26 08 00 - COMMISSIONING OF ELECTRICAL SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Commissioning is the process for ensuring that the Electrical System is installed and performs interactively according to the basis of design criteria and meets the building operational performance expectations as defined in the sequences of operations. The process also provides adequate documentation of installation, start-up and functional testing and ensures that the Owner's maintenance personnel are adequately trained. It provides for discovery of system operational performance deficiencies prior to substantial completion while the responsible contractors can provide a timely response. It establishes testing and communication protocols in an effort to advance the Electrical System from installation to complete dynamic operation and optimization.
- B. The commissioning process involves all the parties involved in the design and construction process as well as the Owner and the Commissioning Provider (CxP). Primary elements of Commissioning during the construction, acceptance and warranty phases of the project include:
 - 1. Verify applicable equipment and systems are installed in accordance with manufacturers' instructions and contract documents and receive adequate operational start-up checkout by installing contractors.
 - 2. Demonstrate functional operational performance of equipment and systems in the commissioning program.
 - 3. Verify O&M documentation submitted is complete. Provide required documentation and information to the General Contractor. Verify Owner's maintenance personnel are adequately trained in accordance with specified training plan requirements.
 - 4. Verify systems are interacting and performing optimally in accordance with the system sequence of operations.
 - 5. Furnish labor and material to accomplish electrical system commissioning and systems' testing as specified herein and other related sections.

1.2 RELATED SECTIONS

- A. Section 01 91 13 - General Commissioning Requirements.
- B. Section 01 91 14 – Functional Testing Requirements
- C. Division 26 Sections pertaining to the electrical systems included in the commissioning program.

1.3 SUBMITTALS

- A. Refer to Section 01 91 13 for commissioning submittal requirements. Provide copies of commissioning submittal requirements to the CxP, in addition to the copies required by the Owner and Design Professional.

1.4 COORDINATION

- A. The installation schedule for the components, equipment & systems included in the commissioning program shall be such that the commissioning requirements can be met without impacting the construction schedule. Commissioning Functional Performance Testing is a requirement for Substantial Completion.

- B. All maintenance points for components installed by the contractor (or sub-contractors) for building systems servicing shall be flagged utilizing construction marker ribbons if the maintenance point is located where multiple trades will be installing systems, unobstructed access from floor level shall be maintained. Refer to Section 01 91 13 for additional information on maintenance/service point access.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. Trade contractors shall provide all specialized tools, test equipment, and instruments required to execute startup, checkout, field calibration and functional performance testing of equipment under their contract.
- B. Test equipment shall be of sufficient quality and accuracy (great accuracy than specified for component) to test and/or measure system performance according to specified tolerances. Test equipment is to have calibrated within the previous 12 months. Calibration shall be NIST traceable. Equipment shall be re-calibrated when dropped or damaged. Calibration tags shall be affixed or certificates be readily available.
- C. Datalogging equipment or software required to test equipment will be provided by the CxP, but shall not become the property of the Owner.

PART 3 - EXECUTION

3.1 COMMISSIONING

- A. General Requirements. For additional information regarding general commissioning requirements refer to Section 01 91 13.
- B. Installation contractors shall be responsible for executing and documenting equipment installation, start-up and check out for systems and equipment. Contractors shall also be responsible for executing and documenting prefunctional performance tests. Both of these documents are required prior to the CxP scheduling the functional performance test. Contractors shall also be responsible for providing training for the Owner's maintenance personnel in accordance with project requirements.
- C. Installation Certification Forms (ICF) for each type of equipment and system shall be provided to the installation contractors by the CxP for use by the contractors in documenting the installation and start-up of equipment in the commissioning program.
- D. For equipment and system components requiring a manufacturer's representative for installation verification and start-up, manufacturer documentation of these activities shall be attached to the installation certification forms provided by the CxP.
- E. Prefunctional Performance Test procedures for each type of equipment and system shall be provided to the installation contractors by the CxP for use by the contractor in documenting the performance of the prefunctional performance test. Refer to Section 01 9114 for further information.
- F. Completed Start-up checklists and prefunctional performance test documentation for all pieces of equipment shall be submitted by contractors to the CxP through the General Contractor prior to the scheduling of the final Functional Performance Test that is witnessed by the CxP.

3.2 TRAINING

- A. Contractor responsible for the installation of the system shall coordinate the participation of other sub-contractors and manufacturer's representatives in the training program in accordance with requirements of other sections of the project specifications.

3.3 OPERATIONS AND MAINTENANCE DATA

- A. Contractor responsible for the installation of the system shall provide operations and maintenance manuals in accordance with requirements of other sections of the project specifications.

3.4 GENERAL SYSTEM TESTING CRITERIA

A. Functional Performance Testing

1. Refer to Sections 01 91 13 - General Commissioning Requirements and 01 9114 - Functional Testing Requirements. Installation contractor shall be responsible for providing authorized manufacturer's representatives to demonstrate the operational capabilities of the equipment & systems.

END OF SECTION

SECTION 28 08 00 - COMMISSIONING OF ELECTRONIC SAFETY

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Commissioning is the process for ensuring that the electronic safety system is installed and performs interactively according to the basis of design criteria and meets the building operational performance expectations as defined in the sequences of operations. The process also provides adequate documentation of installation, start-up and functional testing and ensures that the Owner's maintenance personnel are adequately trained. It provides for discovery of system operational performance deficiencies prior to substantial completion while the responsible contractors can provide a timely response. It establishes testing and communication protocols in an effort to advance the Fire Alarm System from installation to complete dynamic operation and optimization.
- B. The commissioning process involves all the parties involved in the design and construction process as well as the Owner and the Commissioning Provider (CxP). Primary elements of Commissioning during the construction, acceptance and warranty phases of the project include:
 - 1. Verify applicable equipment and systems are installed in accordance with manufacturers' instructions and contract documents and receive adequate operational start-up checkout by installing contractors.
 - 2. Demonstrate functional operational performance of equipment and systems in the commissioning program.
 - 3. Verify O&M documentation submitted is complete. Provide required documentation and information to the General Contractor. Verify Owner's maintenance personnel are adequately trained in accordance with specified training plan requirements.
 - 4. Verify systems are interacting and performing optimally in accordance with the system sequence of operations.
 - 5. Furnish labor and material to accomplish electronic safety system commissioning and systems' testing as specified herein and other related sections.

1.2 RELATED SECTIONS

- A. Section 01 9113 - General Commissioning Requirements.
- B. Section 01 9114 - Functional Testing Requirements
- C. Division 28 Sections pertaining to the Electronic Safety systems included in the commissioning program.

1.3 SUBMITTALS

- A. Refer to Section 01 91 13 for commissioning submittal requirements. Provide copies of commissioning submittal requirements to the CxP, in addition to the copies required by the Owner and Design Professional.

1.4 COORDINATION

- A. The installation schedule for the components, equipment & systems included in the commissioning program shall be such that the commissioning requirements can be met without impacting the construction schedule. Commissioning Functional Performance Testing is a requirement for Substantial Completion.

- B. All maintenance points for components installed by the contractor (or sub-contractors) for building systems servicing shall be flagged utilizing construction marker ribbons if the maintenance point is located where multiple trades will be installing systems, unobstructed access from floor level shall be maintained. Refer to Section 01 91 13 for additional information on maintenance/service point access.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. Trade contractors shall provide all specialized tools, test equipment, and instruments required to execute startup, checkout, field calibration and functional performance testing of equipment under their contract.
- B. Test equipment shall be of sufficient quality and accuracy (great accuracy than specified for component) to test and/or measure system performance according to specified tolerances. Test equipment is to have calibrated within the previous 12 months. Calibration shall be NIST traceable. Equipment shall be re-calibrated when dropped or damaged. Calibration tags shall be affixed or certificates be readily available.
- C. Datalogging equipment or software required to test equipment will be provided by the CxP, but shall not become the property of the Owner.

PART 3 - EXECUTION

3.1 COMMISSIONING

- A. General Requirements. For additional information regarding general commissioning requirements refer to Section 01 91 13.
- B. Installation contractors shall be responsible for executing and documenting equipment installation, start-up and check out for systems and equipment. Contractors shall also be responsible for executing and documenting prefunctional performance tests. Both of these documents are required prior to the CxP scheduling the functional performance test. Contractors shall also be responsible for providing training for the Owner's maintenance personnel in accordance with project requirements.
- C. Installation Certification Forms (ICF) for each type of equipment and system shall be provided to the installation contractors by the CxP for use by the contractors in documenting the installation and start-up of equipment in the commissioning program.
- D. For equipment and system components requiring a manufacturer's representative for installation verification and start-up, manufacturer documentation of these activities shall be attached to the installation certification forms provided by the CxP.
- E. Prefunctional Performance Test procedures for each type of equipment and system shall be provided to the installation contractors by the CxP for use by the contractor in documenting the performance of the prefunctional performance test. Refer to Section 01 9114 for further information.
- F. Completed Start-up checklists and prefunctional performance test documentation for all pieces of equipment shall be submitted by contractors to the CxP through the General Contractor prior to the scheduling of the final Functional Performance Test that is witnessed by the Fire Marshal. The CxP may elect to witness the test along with the Fire Marshal or separately.

3.2 TRAINING

- A. Contractor responsible for the installation of the system shall coordinate the participation of other sub-contractors and manufacturer's representatives in the training program in accordance with requirements of other sections of the project specifications.

3.3 OPERATIONS AND MAINTENANCE DATA

- A. Contractor responsible for the installation of the system shall provide operations and maintenance manuals in accordance with requirements of other sections of the project specifications.

3.4 GENERAL SYSTEM TESTING CRITERIA

A. Functional Performance Testing

1. Refer to Sections 01 91 13 - General Commissioning Requirements and 01 9114 - Functional Testing Requirements. Installation contractor shall be responsible for providing authorized manufacturer's representatives to demonstrate the operational capabilities of the equipment & systems.

END OF SECTION