

PART 1 – GENERAL

1.1 DESCRIPTION

- A. The purpose of functional performance testing (FPT) is to assure the Owner that all work has been completed as specified and that systems are functioning in the manner intended, within the limits of the design and the contract documents. It will serve as a tool to minimize post-occupancy systems operational difficulty or failure. It will assist operations staff familiarization and training with new systems. It will also be used to develop test protocols and record associated test data in an effort to advance the building systems from a state of substantial completion to full dynamic operation. Functional performance testing will commence as systems startup and startup documentation is completed and reviewed and TAB work is completed. Functional performance testing will be done on a system-by-system basis. The results of these tests will be documented and handed over to the Commissioning Agent and Owner for final system acceptance.
- B. Substantial Completion requires that:
 - 1. All functional performance testing be complete and approved.
 - 2. O&M manuals are complete (not in process).
 - 3. All training is complete.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Related Sections:
 - 1. Division 23.

1.3 CODES AND STANDARDS

- A. Codes and Standards shall be the current version adopted by the Authority Having Jurisdiction.

1.4 SYSTEMS TO BE TESTED

- A. FPT will be performed on all energy-consuming systems and equipment and those mechanical systems that affect the performance of the dynamic functioning of the building. Those systems shall include the following:
 - 1. HVAC
 - a. Steam System
 - b. Heating Hot Water System
 - c. Chilled Water System
 - d. Chemical Treatment Systems
 - e. Glycol Systems
 - f. Make-up Water Systems
 - g. Pressure Relief Devices
 - h. HHW Convertors
 - i. Steam Condensate Receivers/Pumps
 - j. Water-Cooled Chillers

- k. Open Cooling Towers
 - l. Chilled Water Pumps
 - m. Condenser Water Pumps
 - n. Heating Hot Water Pumps
 - o. Air Handling Units
 - p. Air Terminal Units
 - q. Exhaust Fans
 - r. Chiller Room Refrigerant Gas Detection and Purge System
 - s. Elevator Pressurization Fans
 - t. Unit Heaters
 - u. Air Conditioning Units
 - v. Fan Coil Units
 - w. Variable Frequency Drives
2. Plumbing
- a. Domestic Hot Water Heaters
 - b. Domestic Hot Water Pump
 - c. Domestic Hot Water Recirculation System
 - d. No-Touch Automatic Lavatory Faucets
 - e. Trap Primer Systems
 - f. Drinking Fountains
 - g. Reduced-Pressure Backflow Preventers (may be satisfied by City Inspection Reports)
3. Fire Sprinkler System
- a. Seattle Fire Department Testing and Inspections
4. Controls
- a. DDC Sequences of Operation
 - b. DDC Graphics including demonstration of correct mapping for each graphic point
 - c. DDC Sensors and Calibration
 - d. DDC Trend Logging
 - e. DDC Report Generation
 - f. DDC Alarm Generation at Operator's Station, Campus Loop, and Dial-out Communications
 - g. DDC Remote Access from Campus Control Loop and Dial-In Communications
 - h. DDC Security Password Access
 - i. DDC Control Loop Stability for Each PI or PID Sequence Loop
 - j. DDC System Under Loss of Power and Recover
 - k. Unitary Controls Sequences of Operation and Alarming
 - l. Unitary Control Loop Stability for Each PI or PID Loop
 - m. Unitary Controls Safety Features
5. Inter-system Interfaces
- a. Fire Dampers, Smoke Dampers, Combination Fire/Smoke Dampers
 - b. General Fire Alarm System Alarm Status Monitoring
 - c. Fire Alarm System Fan Shutdown and DDC Complimentary AHU Shutdown
 - d. HVAC Bypass Switches at Fire Alarm Control Panel

- e. Fire Alarm Control Panel Fan Over-ride Switches
- f. Elevator Pressurization Fans under Emergency Power
- g. Chiller Room Refrigerant Purge System under Emergency Power
- h. Recovery of HVAC Fan Systems after Shutdown from Fire Alarm Control Panel

PART 2 – PRODUCTS

Not applicable to this section

PART 3 – EXECUTION

3.1 GENERAL

- A. The Contractor and subcontractors shall be responsible for performing all procedures presented in the specification and contract drawings, unless otherwise specified. The Test Engineer and Commissioning Agent will witness system start up and functional performance for all systems listed in this division.

3.2 FUNCTIONAL PERFORMANCE TESTING

- A. Functional performance testing begins after the systems have been completed by the contractors, the system description and training sessions have been completed, and the O&M manuals have been completed.
- B. The objective of functional performance testing is to advance the building systems from a state of installation and startup completion to full dynamic operation in accordance with the specified design requirements and design intent.
- C. The Test Engineer shall attain this objective by developing individual system-testing protocols which, when implemented by the Contractor, will allow the Test Engineer to observe, evaluate, identify deficiencies, recommend modifications, tune, and document the systems and systems' equipment performance over a range of load and functional levels.
- D. Functional performance testing shall be conducted with the systems in full automatic operation, except as noted in the test procedures. Unless otherwise noted in the testing procedures, motor starter HOA switches shall be in the AUTO position, VFD DRIVE/OFF/MANUAL switches shall be in the DRIVE position, VFD/BYPASS switches shall be in the VFD position, and the DDC control system shall not have any software over-rides.
- E. Safety shutdowns (static pressure, freeze protection, etc.) for air handling unit systems shall be tested with the motor starter HOA switches in both the AUTO and HAND positions. For motors with VFD's, safety shutdowns shall be tested in each configuration of the DRIVE/OFF/MANUAL switch and the VFD/BYPASS switch.
- F. Equipment and control sequences shall be tested for equipment under every operating mode (e.g. – warmup, occupied, unoccupied, night setback, unoccupied over-ride to occupied, off, fire alarm mode, etc.)
- G. All equipment safety devices shall be tested (e.g. – chiller low suction pressure cutout, chiller high head pressure cutout, chiller no flow shutdown, boiler no flow shutdown, boiler low/high gas pressure cut-out, boiler no draft airflow cut-out, boiler not flame sensor cutout, pressure

- relief valves, etc.). Coordinate with equipment vendors for safe procedures to test safety devices.
- H. Testing of air terminal units shall be by statistical method. The Contractor shall still be required to perform complete startup and submit startup completion forms for each air terminal unit. For functional testing, the Test Engineer and Commissioning Agent will choose, at random, a sampling of 20% of the air terminal units for functional performance testing. If 90% of the functions for this representative sampling pass, then all of the air terminal units will be accepted. If less than 90% of the functions pass, then all of the air terminal units will fail. Upon failure of the first test, the Contractor shall be required to perform startup on all the air terminal units again. After startup is completed again, another 20% random sampling of the air terminal units shall be functionally tested again. The process shall be repeated until a 20% random sampling is found to pass the 90% functional criteria.
 - I. Air Handling Unit coil capacity tests shall be performed, using dry bulb and wet bulb temperatures for cooling coils. This testing may require seasonal testing in order to obtain the design entering air conditions to the coils.
 - J. Domestic Water Heaters shall be tested for recovery time and for effectiveness of the recirculation system.
 - K. Chemical Treatment systems shall be tested for effectiveness by post startup site visits and reports from the chemical treatment company.
 - L. A two-week trending process shall occur after all individual functional test procedures have been completed and passed. This trend shall be used to demonstrate the functioning of mechanical systems under complete automatic control. The Contractor shall correct all deficiencies found during this trending process.

END OF SECTION