LOOK FOR ADDITIONAL INSTRUCTION THROUGHOUT THIS DOCUMENT
1. VERIFY THAT ALL SECTIONS AND DIVISIONS LISTED THROUGHOUT THIS SECTION ARE INCLUDED IN THE SPECIFICATIONS.
2. BRACKETS AND BOLD WILL BE REMOVED PRIOR TO PRINTING FINAL COPY.
3. EDIT ONLY BOLD TEXT AND TEXT IN BRACKETS.

SECTION 01660 SYSTEMS AND EQUIPMENT START-UP, TESTING AND ADJUSTMENT

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section defines the responsibilities of the Contractor to perform and document start-up testing of all systems and equipment installed including installation checklists and verification. This Section supplements but does not supersede specific testing requirements found elsewhere in the Contract Documents.

1.2 RELATED WORK AND DOCUMENTS

A. Section 01334 Shop Drawings, Product Data and Samples.
B. Section 01662 Commissioning.
C. Section 01664 Demonstration and Training.
D. Section 01830 Operation and Maintenance.
E. Division 2 Site Construction. Consult the University for a copy of site utility installation and start-up checklist.
F. Division 11 Equipment (if used).
G. Division 13 Special Construction (if used).
H. Division 14 Conveying Systems Sections: Individual sections stipulate specific installation and start-up requirements for Elevators (if used).
I. Division 15 Mechanical.
J. Section 15959 DDC/EMS Commissioning.
K. Division 16 Electrical.

1.3 DEFINITIONS AND ABBREVIATIONS

A. Action Item: Any issue that requires an action, response, work, etc. It can be a Request for Information (RFI), a work directive, a clarification, a task to accomplish an identified deficiency, or similar item.

B. Action List: This list is maintained by the Quality Assurance Manager and includes all action items that relate to Commissioning activities. These are categorized as appropriate.
C. ASHRAE: American Society of Heating, Refrigerating, and Air Conditioning Engineers.

D. Commissioning (Cx): The process of ensuring that all building systems are installed and perform interactively according to the contract documents.

E. Quality Assurance Manager: This is an individual selected by the General Contractor to coordinate commissioning activities. See Section 01113 Special Requirements for more information on this role.

F. Commissioning Team: The group of individuals who will collaborate to ensure the facility is fully and completely commissioned. This will include the University’s Representative, the TAB contractor, and a Quality Assurance Manager provided by the Contractor. Generally, the installing contractor, subcontractor, and manufacturer will be integral members of the team for any given system or equipment.

G. Deficiency: An installation or condition that is not in conformance with the Construction Documents.

H. Equipment Performance Testing (EPT): Testing designed to prove the satisfactory operation of system components under operating conditions.

I. Field Test: This test represents field testing on installed equipment at the project site.

J. Functional Completion: A milestone that marks the successful completion of the Functional Performance Testing (FPT).

K. Functional Performance Testing (FPT): Testing designed to prove the satisfactory operation of equipment as a complete system under operating conditions. Testing of some systems may require the concomitant proper functioning of other systems (i.e., the testing of proper performance of air handlers will require the proper operation of chilled water and hot water systems, and thus these water systems must be tested before the air handlers, and they must be in satisfaction operation during the air handler testing.)

L. Operational Test (OT): Testing designed to demonstrate 1) satisfactory system performance over a period of time under different and expected operating conditions, 2) satisfactory recovery of systems from failure conditions (such as a power outage) to normal and satisfactory operating performance, and 3) the correct response of systems to an emergency mode, such as is triggered by the Fire Alarm System.

M. Start-up: The process whereby the contractor verifies the proper installation of a system, device, or equipment item, executes the manufacturer’s start-up and check out procedures, completes the start-up checklist, energizes the device, and verifies it is in proper working order.

N. Start Up Checklist Item: Requires a Yes, No, OK, or Non Response. This is one component of the equipment start up documentation (start up tests being the other).

O. Start up Test: This test verifies equipment start-up. It is a measurement or a sequence of events that must be documented.
P. System: A system shall include all items of equipment, devices and appurtenances connected in such a fashion as their operation or function complements, protects or controls the operation or function of the others. Contractor shall coordinate all the activities to implement the requirements of the Section.

Q. TAB: Testing, Adjusting, and Balancing.

R. Trending: Monitoring and recording a history of performance and parameters using the facility management system.

1.4 CONTRACTOR RESPONSIBILITIES

A. Remedy any deficiencies identified throughout construction.

B. Documentation Plan for Review: Prepare and submit draft equipment installation checklist, equipment and system pre-start-up and start-up checklists along with the manufacturer’s start-up instructions, as defined below, for all installed systems and equipment. Checklist general format shall be similar to sample checklist forms as shown in the samples following this section.

C. Inspection of the Installation: Complete and inspect installation of systems and equipment as detailed throughout Contract Documents, as required by reference, industry standards, manufacturer recommendation and requirement, and as specifically indicated in this Section.

D. Submit a Schedule: Provide University’s Representative with a schedule establishing the expected time period (using calendar days) when the Contractor plans to start specific systems, along with a description of any temporary systems or installations planned to allow start-up and testing to take place. In addition to system start-ups, this schedule must show delivery dates of the various Operation and Maintenance manuals required by this project.

E. Start-up, Test, Adjust and Balance: Start-up, test, adjust, and balance equipment and system as applicable. Start-up procedures shall be in accordance with Contract Documents, individual related specification sections as outlined above, manufacturer requirement, reference or industry standards, and Part 3 Execution of this Section.

F. Complete Approved Checklists: Complete the approved start-up checklists and submit along with other installation certification. Each checklist form shall be signed and dated by the individual responsible for the start-up or test and initialed by University’s Representative witnessing the test.

G. Provide the services of a Factory authorized Service Representative to perform equipment/device start-up. System testing and adjustment shall be performed by a qualified Factory authorized Service Representative or where required, certified Independent Testing Agency.
1.5 PRESTART / START-UP CHECKLISTS AND MANUFACTURER’S START-UP INSTRUCTIONS

A. Checklists for each type of equipment and system shall be submitted to the University’s Representative for approval prior to start-up. Contractor shall have appropriate subcontractors and vendors design the forms meeting the requirements of the Contract Documents. Forms shall be developed for the systems and equipment being installed for this project.

B. All checklists shall identify:

1. Project name and location.
2. All pertinent nameplate data including equipment or device serial number, horsepower rating, and related electrical data.
3. Name of party performing the test.
4. Place for signature of the technician performing the work along with the date.
5. Clear explanation of the inspection, test, measurement and the like with a pass or fail indication, and a record of measured parameters.
6. Checklist format shall be similar to sample form Pre-Start-Up/Start-Up Checklist Air Handler Unit
7. and adapted for each piece of pertinent equipment

C. Prestart portion of the checklist shall:

1. Identify electrical and maintenance clearance requirements.
2. Identify equipment location (i.e. room and floor number in building).
3. Include installation requirements identified in the equipment operation and maintenance manual. A copy of the Operation & Maintenance manual is not acceptable. Contractor shall extract installation information from the manual and include requirements in a checklist format in this form.
4. Include the equipment installation requirement identified in contract requirements in a checklist format including supports, flashing, electrical, piping and other associated accessories.

D. Start up portion of the checklists shall include:

1. Start-up procedures shall be in accordance with the Contract Documents, reference or industry standards, manufacture requirement. Contractor shall compile the start-up and check out procedures indicated in the manufacturer’s documentation prior to designing the forms. As applicable, include acceptance criteria specified therein. The manufacturer’s start-up and check out procedures shall be submitted to the University’s Representative along with the draft start-up checklists.
2. A checklist item indicating that all installation requirements defined in this article have been completed.
3. A checklist item indicating that required prerequisite equipment and systems were successfully started.
4. Actual field measured electrical start-up data.
5. Instrumentation calibration.
6. Motor information and all control device settings.
7. Manufacturer start-up requirements, if applicable.

E. Approved documentation forms for all systems and items of equipment shall be produced for review by the University’s Representative as a condition precedent to progress payments in excess of 50 percent of the Contract Sum. Once the University’s Representative has reviewed and taken no exception to the forms proposed by the Contractor, the Contractor shall produce sufficient forms to provide documentation of all testing work to be conducted as a part of this contract. Tests shall be witnessed by University’s Representative.

1.6 QUALITY ASSURANCE

A. Quality Assurance Manager:

1. The Contractor shall appoint an on-site Quality Assurance Manager to manage, coordinate, and supervise the installation, start-up, testing, commissioning and Contractor’s quality assurance program. Refer to Section 01113 Special Requirements for Quality Assurance Manager qualification requirements.

B. Quality Assurance program shall include:

1. A testing plan setting forth the sequence in which all testing work required under the Contract Documents will be implemented.
2. A documentation plan to record the results of all equipment and system tests.
3. An installed performance testing plan for all mechanical, electrical, instrumentation, [laboratory equipment and other building equipment including, but not limited to autoclaves, sterilizers, environmental rooms, generators, emergency power system, elevators, fume hoods, bio-safety cabinets, fire related items, HVAC and electrical equipment and systems installed].
4. A calibration plan for all building instruments, meters, monitors, gauges, and thermometers installed.
5. A testing schedule conforming to the requirements specified in Section 01329 Contract Schedules.

C. Calibration:

1. All test equipment (gauges, meters, thermometers, analysis instruments, and other equipment) used for calibrating or verifying the performance of equipment installed shall be calibrated to within plus or minus 2 percent of actual value at full scale. Test equipment employed for individual test runs shall be selected so that expected values as indicated by the respective section shall fall between 60 and 85 percent of full scale. Pressure gauges shall be calibrated in accordance with ANSI/ASME B40.1. Thermometers shall be calibrated in accordance with ASTM E77 and shall be furnished with a certified calibration curve.
2. If instrumentation calibration was performed at the factory by Manufacturer, Contractor shall provide factory calibration certification specific for that
instrument. Factory calibration sheet shall identify device serial number on the certification.

3. Field calibration procedure shall be submitted by contractor and accepted by University’s Representative prior to proceeding.

1.7 SUBMITTALS

A. Submit in accordance with Section 01334 Shop Drawings, Product Data and Samples, the following:

1. The credentials and certification of the testing laboratory proposed by the Contractor for calibration of all test equipment per this section.
2. Manufacturer’s pre-operational checkout procedures per this section.
3. Detailed testing plans per this section.
4. A schedule per this section. Quality Assurance Manager's qualifications per this section and Section 01113 Special Requirements.
5. Submit documentation in accordance with Section 01662 Commissioning, Contractor Responsibilities.

PART 2 - PRODUCTS

2.1 INSTRUMENTATION AND METERS

A. Contractor shall provide instrumentation required to complete start-up testing.

B. All equipment used for testing and calibration shall be National Institute of Standards and Technology/National Bureau of Standards (NIST/NBS) traceable and calibrated within the current 12-month period. Current certificates of calibration shall be made available for verification by University’s Representative during test.

2.2 TEST KITS FOR METERS AND GAUGES

A. Test kits for meters and gauges shall be provided to the University new and in good condition. Previously used kits are unacceptable. Kits shall be submitted prior to beginning testing. Kits included shall be as a minimum:

1. Digital indication of pressure and temperature (PT) with associated probes to work with the test ports.
2. Companion readout kit (with fittings and hoses) for calibrated balancing valve with ranges as required by all devices.

PART 3 - EXECUTION

3.1 GENERAL

A. All pieces of equipment that act, either by themselves or in conjunction with other devices, as systems are subject to the requirements of start-up and commissioning as described above and in Section 01662 Commissioning. These requirements, along with those specified in the respective sections, provide a minimum requirement and guideline for development of start-up checklists. In some cases, testing requirements are described
in those sections that deal with specific systems or general trades. Contractors providing such equipment shall use the same requirements and provide start-up and testing requirements for all systems and equipment.

B. These procedures and their assembly into a common document are the direct responsibility of the Contractor as a basic element to determine and validate that the installations of equipment are correct. The Contractor shall use these requirements along with applicable Specification Sections, the manufacturer’s requirements, and applicable codes and standards to develop specific and itemized start-up procedures specific to the equipment, as defined above.

C. For all electrical equipment, components and systems, in addition to Division 1 General Requirements and Division 16 Electrical requirements, comply with the requirements of the latest version of Acceptance Testing Specification by the International Electrical Testing Association, Inc. (NETA). Include NETA requirements in the checklist.

END OF SECTION 01660