

23 08 00 – Commissioning of HVAC Systems

1. GENERAL

A. GENERAL PROVISIONS

1. Drawings and general provisions of the Contract, including General Conditions and Division - 1 Specifications Sections, apply to Work of this section.
2. Provisions of Divisions 23 and 26 of the project specifications which are applicable to Commissioning of the HVAC Systems are an integral part of this Section.
3. Commissioning is an important and integral part of the Contractor's Quality Control program.

B. WORK INCLUDED

1. "Active participation" in the Commissioning program as generally outlined in this section.

C. COMMISSIONING PROGRAM

1. Description

- a. The purpose of this section is to specify the Division 23 Contractor's responsibilities and participation in the commissioning process.
- b. Commissioning is primarily the responsibility of the Commissioning Authority and Owner, with support for start-up, testing and commissioning the responsibility of the Division 23 Contractors. The commissioning process does not relieve this Contractor from participation in the process, or diminish the role and obligations to complete all portions of work in a satisfactory and fully operational manner.

2. Work of Division 23 includes:

- a. Testing and start-up of the mechanical equipment.
- b. Assistance in functional testing to verify testing and balancing, and equipment/system performance.
- c. Providing qualified personnel to assist in commissioning tests, including seasonal testing.
- d. Completion and endorsement of pre-functional test checklists provided by the Commissioning Authority to assure that Division 23 equipment and systems are fully operational and ready for functional testing.

- e. Providing equipment, materials, and labor necessary to correct deficiencies found during the commissioning process which fulfill contract and warranty requirements.
 - f. Providing operation and maintenance information and as-built drawings to the Commissioning Authority for their use in developing the Systems Manual.
 - g. Providing assistance to the Commissioning Authority to develop, edit, and document system operation descriptions.
 - h. Providing training for the systems specified in this Division with coordination by the Commissioning Authority. Prior to training, submit a training plan complete with syllabus and sample training material. The Commissioning Authority will review and approve the training plan.
3. Work of Division 23 specific to automation temperature control system includes:
 - a. The Owner will provide the controls, programming, point to point and functional testing. The Commissioning Authority will provide prefunctional checklists and functional test procedures for use by the owner.
 4. Commissioning Coordinators for HVAC
 - a. The Contractors shall assign qualified individuals from each discipline with at least ten (10) years of relevant experience in the installation, testing and start up of HVAC systems.

D. RELATED WORK

1. All testing and start-up procedures and documentation requirements specified within Division 1, Division 23, and related portions of this project.
2. Commissioning procedures that require participation of Division 23 Contractors.
3. Cooperate with the Commissioning Authority in the following manner:
 - a. Install balancing dampers/balancing cocks, access doors, test ports, and P&T taps as required by the Commissioner and/or the Owner for test and balance and functional testing.
 - b. Allow sufficient time before final completion dates so that test and balance and functional testing can be accomplished.
 - c. Provide labor and material to make corrections when required without undue delay.

- d. Put all heating, ventilating, and air conditioning systems and equipment into full operation and continue the operation of the same during each working day of testing and balancing and functional testing.
 - e. Include the costs of dampers, replacement sheaves and belts as required, to obtain satisfactory system performance, as requested by the Owner or the Commissioning Authority.
 - f. Provide test holes in ducts and plenums where directed or necessary for pitot tubes for taking air measurements and to balance the air systems. Test holes shall be provided with an approved removable plug or seal. At each location where ducts or plenums are insulated, test holes shall be provided with an approved extension with plug fitting.
4. Scope: For coordination purposes, the Commissioning scope is generally outlined below:
- a. Review contractor submittals for the systems included in the scope of commissioning.
 - b. Review training materials and agendas provided by the contractor and determine the adequacy of training. Verify training has been completed.
 - c. Document compliance with design intent of the HVAC system
 - d. Verify that equipment and systems have been properly installed in accordance with the contract documents and manufacturer's written installation instructions.
 - e. Verify that equipment has been placed into operation with the appropriate manufacturer's oversight and approval.
 - f. Verify that adjusting, balancing and system testing has properly done.
 - g. Develop a Systems Manual
 - h. Document and review warranty start and end dates.
 - i. Perform an assessment of the first 10 months of building operations and include a plan for resolution and correction of outstanding commissioning items.

2. PRODUCTS

A. TEST EQUIPMENT

1. Standard test equipment for commissioning will be provided by the installing contractor or Owner (for TAB and controls).
2. Division 23 shall provide standard and specialized test equipment as necessary to test and start up the mechanical equipment.

3. Proprietary test equipment required by the manufacturer, whether specified or not, shall be provided by the manufacturer of the equipment. Manufacturer shall provide the test equipment, demonstrate its use, and assist the Commissioning Authority or Owner in the commissioning process. The test equipment will become the property of the Owner.

3. EXECUTION

A. PREPARATION OF COMMISSIONING PROGRAM

1. The Commissioning program shall be prepared by the Commissioning Authority and submitted to the Engineer for approval.

B. COMMISSIONING TEAM

1. The Commissioning Coordinator shall assemble the Commissioning Team which shall consist of the following persons:
 - a. Commissioning Authority
 - b. Plumbing Contractor and Trade Representative(s)
 - c. HVAC Contractor and Trade Representative(s)
 - d. Control System Trade Representative(s) (from Owner)
 - e. Test, Adjust and Balance Trade Representative (from Owner)
 - f. Electrical Contractor's Representative
 - g. Owner's Project Manager
 - h. Owner's Maintenance staff
 - i. Engineer of Record
 - j. The Commissioning Team shall develop and generally follow a schedule of Commissioning events for the project.

C. RESPONSIBILITIES

1. Owner
 - a. Assign appropriate staff and schedule them to participate in the various meetings, training sessions and inspections as follows:
 - b. Pre-commissioning coordination and schedule of events meeting.
 - c. Initial training session at initial placement of major equipment.

- d. Maintenance orientation and inspection at initial placement of major equipment.
 - e. Maintenance orientation and inspection at connection of distribution systems.
 - f. Piping and ductwork test and flushing verification meetings.
 - g. Installation and programming of the BMS system, including point to point.
 - h. Conduct Testing and Balancing of systems.
 - i. Conduct Functional Testing of systems.
 - j. Owners training and demonstration session(s).
 - k. Review of operation and maintenance manuals and submittals for key components of the HVAC systems.
 - l. Participate in final review and acceptance meeting.
2. Commissioning Authority
- a. Review all Commissioning requirements and intent of the Contract Documents. Assure all specialty Trade Subcontractors include their active participation in the Commissioning of HVAC systems.
 - b. Prepare the Commissioning program. Include input from Trade Representatives.
 - c. Coordinate the implementation of the Commissioning program, through organization of all Commissioning meetings, tests, demonstrations, training events and performance verifications described in the Contract Documents and the Commissioning program.
 - d. Review the plans and specifications with respect to their completeness in all areas as they relate to the Commissioning program.
 - e. The plan and specification review by the Commissioning Authority does not include any responsibility for the system evaluation, adequacy of the system to meet design intent, capacity of the system or any of the other elements of the system design which are the strict responsibility of the Engineer of record.
 - f. Schedule a pre-commissioning coordination meeting with the Commissioning Team within 45 days of the award of the contract, at a convenient location. This pre-commissioning meeting will be for the purpose of reviewing the complete Commissioning program and establishing tentative schedules for maintenance orientation and inspections, O&M submittals, training sessions, system flushing and testing, job completion, system start-up and test, adjust and balance work.
 - g. Verify accessibility of equipment for maintenance and component replacement/repair.

- h. Conduct site installation verification visits to observe that equipment and systems are installed per the contract documents and applicable standards.
 - i. Schedule a meeting with the Owner prior to test, adjust and balance (TAB). This meeting should be attended by the Commissioning Team. The Owner's TAB Representative will outline the TAB procedure and get concurrence from the Engineer of Record and Commissioning Coordinator.
 - j. Upon notification from the HVAC Contractor that the HVAC systems have been started, that all air, water and control systems have been started, tested, adjusted and balanced and that the systems and equipment is functioning as designed and specified, schedule the functional testing. Functional testing will be conducted by the Owner. Any Commissioning Team member may witness testing.
 - k. Provide a final Commissioning Report and LEED letters.
3. Engineer of Record
- a. Provide clarification of any design intent questions raised by the Commissioning Team.
 - b. Attend and actively participate in initial pre-commissioning coordination meeting to be scheduled by the Commissioning Authority within 45 days of the award of the contract.
 - c. Review and approve Commissioning program.
 - d. Participate in sessions scheduled in the Commissioning program.
 - e. Receive and review operation and maintenance manuals as submitted by the HVAC Contractor.
 - f. Attend meetings with Owner's TAB Representative as scheduled by Commissioning Authority.
 - g. Attend Owner training sessions as appropriate.
 - h. Review TAB report from Owner against design assumptions and system requirements. Issue a report noting deficiencies requiring correction to the Commissioning Team.
 - i. Prepare record drawings for the project after receipt from the HVAC Contractor.

D. WORK PRIOR TO COMMISSIONING

- 1. Complete all phases of work so the system can be started, tested, balanced, and otherwise commissioned. Division 23 has primary start-up responsibilities with

- obligations to complete systems, including all sub-systems so they are functional. This includes the complete installation of all equipment, materials, pipe, duct, wire, insulation, controls, etc., per the contract documents and related directives, clarifications, change orders, etc.
2. A commissioning plan will be developed by the Commissioning Authority. Upon request of the Commissioning Authority, this Contractor shall provide assistance and consultation. The commissioning plan will be developed prior to completion of the installation. This Contractor is obligated to assist the Commissioning Authority in preparing the commissioning plan by providing all necessary information pertaining to the actual equipment and installation. If system modifications/ clarifications are incorporated to this and related sections of work, commissioning of this work will be made at no additional cost to the Owner. If Contractor-initiated system changes have been made that alter the commissioning process, the Commissioning Authority will notify the Architect, and the Contractor may be obligated to compensate the Commissioner to test the revised product, or confirm the suitability/unsuitability of the substitution or revision.
 3. Specific pre-commissioning responsibilities of Division 23 are as follows:
 - a. Normal start-up services required to bring each system into a fully operational state. This includes motor rotational check, cleaning, filling, purging, control sequences of operation, leak testing, full-load and part-load performance, etc. The Commissioning Authority will not begin the commissioning process until each system is complete, including normal contractor start-up.
 - b. The Contractor shall perform pre-functional tests on the following equipment and systems.
 - Supply/Exhaust Fans**
 - Pressurization Fans**
 - Air Handling Units**
 - Kitchen Fans**
 - Terminal Units**
 - Baseboard Radiation**
 - Chiller Plant**
 - Boiler Plant**
 - Sump pumps**
 - Split Systems**
 - Unitary Heaters**
 - c. Acceptance phase should begin upon completion of all building systems. However, testing of individual systems can begin as long as it has been completely tested by the sub-contractor and it is in the best interests of the

Owner. Commissioning activities and schedule will be coordinated with the Contractor. Start of commissioning before system completion will not relieve the Contractor from completing those systems as per the schedule.

E. PARTICIPATION IN COMMISSIONING

1. Provide skilled technicians to start-up and debug all systems within the division of work. These same technicians shall be made available to assist the Commissioning Authority/Owner in completing the commissioning program as it relates to each system and their technical specialty. Work schedules, time required for testing, etc., will be requested by the Commissioning Authority/Owner and coordinated by the Contractor. Contractor will ensure the qualified technician(s) are available and present during the agreed-upon schedules and of sufficient duration to complete the necessary tests, adjustments, and/or problem resolutions.
2. System problems and discrepancies may require additional technician time, Commissioning Authority/Owner time, redesign and/or reconstruction of systems, and system components. The additional technician time shall be made available for the subsequent commissioning periods until the required system performance is obtained.
3. The Commissioning Authority/Owner reserves the right to judge the appropriateness and qualifications of the technicians relative to each item of equipment, system, and/or sub-system. Qualifications of technicians include expert knowledge relative to the specific equipment involved, adequate documentation and tools to service/commission the equipment, and an attitude/willingness to work with the Commissioning Authority/Owner to get the job done. A liaison or intermediary between the Commissioning Authority/Owner and qualified factory representatives does not constitute the availability of a qualified technician for purposes of this work.

F. WORK TO RESOLVE DEFICIENCIES

1. In some systems, misadjustments, misapplied equipment, and/or deficient performance under varying loads will result in additional work being required to commission the systems. This work will be completed under the direction of the Architect/Engineer of Record, with input from the Contractor, equipment supplier, Owner and Commissioning Authority. Whereas all members will have input and the opportunity to discuss, debate, and work out problems, the Architect/Engineer of Record will have final jurisdiction on the necessary work to be done to achieve performance.
2. Corrective work shall be completed in a timely fashion to permit the timely completion of the commissioning process. Experimentation to render system performance will be permitted. If the Commissioning Authority/Owner deems the

experimentation work to be ineffective or untimely as it relates to the commissioning process, the Commissioning Authority/Owner will notify the Architect/Engineer of Record indicating the nature of the problem, expected steps to be taken, and the deadline for completion of activities. If the deadline(s) passes without resolution of the problem, the Owner reserves the right to obtain supplementary services and/or equipment to resolve the problem. Costs incurred to solve the problems in an expeditious manner will be the Contractor's responsibility.

G. ADDITIONAL COMMISSIONING

1. Additional commissioning activities may be required after system adjustments, replacements, etc., are completed. The Contractor, suppliers, and Commissioning Authority shall include a reasonable reserve to complete this work as part of their standard contractual obligations.

H. SEASONAL COMMISSIONING AND OCCUPANCY VARIATIONS

1. Seasonal commissioning pertains to testing under full-load conditions during peak heating and peak cooling seasons, as well as part-load conditions in the spring and fall. Initial commissioning will be done as soon as contract work is completed regardless of season. Subsequent commissioning may be undertaken at any time thereafter to ascertain adequate performance during the different seasons.
2. All equipment and systems will be tested and commissioned in a peak season to observe full-load performance. Heating equipment will be tested during winter design extremes. Cooling equipment will be tested during summer design extremes, with a fully occupied building. Each Contractor and supplier will be responsible to participate in the initial and the alternate peak season test of the systems required to demonstrate performance.
3. Subsequent commissioning may be required under conditions of minimum and/or maximum occupancy or use. All equipment and systems affected by occupancy variations will be tested and commissioned at the minimum and peak loads to observe system performance. Each Contractor and supplier will be responsible to participate in the occupancy sensitive testing of systems to provide verification of adequate performance.
4. At 10 months into the warranty period, the Commissioning Authority and Owner will review the operation to date. The Contractors will be expected to be available to address any warranty related items that come out of this review.

I. TRAINING OF OWNER'S PERSONNEL

1. The Owner's staff shall be given comprehensive training in the operation and maintenance of each major piece of equipment.

2. The Construction Manager in cooperation with the Commissioning Team, will be responsible for scheduling and actively participating in the training. A training plan is to be submitted to the Commissioning Authority for review prior to training being scheduled.
3. Hands on training shall include start-up, operation in all modes possible, shut-down and any emergency procedures.
4. The manufacturer's representative shall provide the instructions on each major piece of equipment. These sessions shall use the printed installation, operation and maintenance instruction material included in the operation and maintenance manuals and shall include a review of the written operation and maintenance manuals. Training will be included for all major pieces of equipment. Equipment training shall be done by qualified service representatives employed by the manufacturers.
5. Contractor will be required to participate in the training of the Owner's engineering and maintenance staff for each mechanical system and the related components. Training may be conducted in a classroom setting, with system and component documentation, and suitable classroom training aids, or in the field with the specific equipment. The type of training will be per the Owner's option.

J. SYSTEMS DOCUMENTATION

1. In addition to the requirements of Division 1, update Contract Documents to incorporate field changes and revisions to system designs to account for actual constructed configurations. All drawings shall be red-lined on two sets. Division 23 as-built drawings shall include updated architectural floor plans, and the individual mechanical systems in relation to actual building layout.
2. Maintain as-built red-lines on the job site as required in Division 1. Given the size and complexity of this project, red-lining of the drawings at completion of construction, based on memory of key personnel, is not satisfactory. Continuous and regular red-lining and/or posting of drawings is considered essential and mandatory.

K. NOTIFICATION OF SYSTEM COMPLETION AND REQUEST FOR FINAL ACCEPTANCE OF THE HVAC SYSTEMS

1. When systems are ready for final acceptance, the Contractor shall certify to the Commissioning Team, in writing, that all systems are complete and fully functional.
2. Should the commissioning tests determine that the equipment is still not performing as specified or control operation is not acceptable on the second inspection, the time and expenses of the Commissioning Authority, Engineer of Record and Owner to make further verification shall be considered as additional cost of the Owner. The

total sum of such costs shall be deducted from the final payment to the HVAC Contractor.

L. REPORT REQUIREMENTS

1. The Commissioning Authority shall document each Commissioning event with meeting minutes or a report. The documents shall separately list deficiencies observed or discovered during the event. The document shall be distributed to Commissioning Team members.
2. The Commissioning Authority shall prepare a final report to the Commissioning Team which will include a narrative in the form of an Executive Summary of the results of program, executed construction checklists/startup documentation, executed functional test procedures, project reports, issues log and other pertinent documents.