

## **1. GENERAL**

### **1.1 Commissioning Agency**

- .1 The Commissioning Agency shall be hired and paid for by the Mechanical HVAC Contractor for portions of this project relating to the HVAC systems. The Commissioning Agency has overall responsibility for planning and coordinating the commissioning process. However, commissioning involves all parties to the design and construction process.

### **1.2 Contractor Responsibility**

- .1 Each contractor and sub-contractor shall review this Section, and shall include in their bids for carrying out the work described, as it applies to each Division and Section of these specifications, individually and collectively.

### **1.3 Description of Work**

- .1 The purpose of the commissioning process is to provide the City with assurance that the mechanical systems have been installed according to the Contract Documents, and operate within the performance guidelines set out in the design intent documents and these specifications. The Commissioning Agency will provide an objective view of the system's installation, operation and performance. The commissioning process does not remove or reduce the responsibility of the contractors to provide a finished product, installed and fully functional in accordance with the contract documents.
- .2 Commissioning is intended to enhance the quality of system start-up and aid in the orderly completion and transfer of systems for beneficial use by the City. The Commissioning Agency will be the leader of the commissioning team, planning and coordinating all commissioning activities in conjunction with the Contract Administrator, General Contractor, Subcontractors, manufacturers and equipment suppliers.
- .3 The General Contractor, Mechanical Contractor, all Division 15 subcontractors and the Electrical Contractor shall be responsible for cooperating, and coordinating their work, with the Commissioning Agency. They shall be responsible for carrying out all physical activities required for installation of components and systems, and operating them during the commissioning process as required in this section.

### **1.4 Related Documents**

- .1 Drawings and general provisions of the Contract, including general and supplemental conditions, general mechanical provisions and applicable Division 15 and 16 Specification sections, apply to work of this section.

### **1.5 References**

- .1 Associated Air Balance Council Commissioning Guideline.
- .2 ASHRAE Commissioning Guideline.

## **2. PRODUCTS**

### **2.1 HVAC Systems to be Commissioned**

- .1 HVAC systems installed under this contract are to be inspected, tested, signed off as complete and operational and operated for Commissioning Agency verification as described in Part 3 of this Section. This includes, but is not necessarily limited to the work listed for each system. The foregoing includes all the following:
  - .1 Duct and air-handling systems – work includes installation, inspections and checks; confirmation of flow balancing completion; leak testing as applicable.
  - .2 Refrigeration compressors/condensing units – work includes the installation inspection and checks; checkout and start-up by manufacturer’s representative as specified; documented performance measurements including capacity, evaporator and condenser pressures, motor current draw and control operations.
  - .3 Supply, return, relief and exhaust fans – work includes checks on installation (including dampers and other accessories), rotation, sound levels, motor current draw, airflows and pressures.
  - .4 Air-handling units – work includes installation inspections and checks; checkout and start-up by manufacturer’s representative as specified; documented capacity tests, for cooling, airflow, static pressures; operation of all controls; sound levels.
  - .5 Control systems – work includes inspections and checks of installation and operation of all devices; complete operation of all controls sequences, in coordination with commissioning of all controlled systems.
- .2 The Contractor shall be responsible for carrying out all work required for commissioning these systems that is defined as a Contractor responsibility in Part 3 of this Section.

### **2.2 System Verification Checklists**

- .1 This Specification contains the system verification checklists as listed below:
  - .1 Supply Fan
  - .2 Return Fan
  - .3 Coils
  - .4 Packaged rooftop air-handling unit, DX cooling.

### **2.3 Functional Performance Test Checklists**

- .1 This Specification contains the functional performance checklists as listed below:
  - .1 Constant volume system, package rooftop air-handling unit, DX cooling.

**2.4 Members of the Commissioning Team**

- .1 The Commissioning Team shall consist of representatives of the following:
  - .1 City
  - .2 City’s O&M Staff
  - .3 Contract Administrator (Mechanical)
  - .4 Contract Administrator (Electrical)
  - .5 Commissioning Agency (CA)
  - .6 General Contractor
  - .7 Mechanical Contractor (M)
  - .8 Electrical Contractor (E)
  - .9 Controls Contractor (ATC)
  - .10 Sheet Metal Contractor
  - .11 Testing, Adjusting and Balancing Agency (TAB)
- .2 During the commissioning process, participation of team members will generally be required as noted in the following table. The mechanical contractor, indicated by “M”, includes all mechanical sub-contractors or suppliers whose participation is required for commissioning a particular system or piece of equipment.

Equipment / System Description	Team Members				
	CA	M	TAB	ATC	E
Air-handling Unit	X	X	X	X	X
Refrigerant Compressor / Condensing Unit	X	X		X	X

**3. EXECUTION**

**3.1 Commissioning Responsibilities – Non-Contractor Team Members**

- .1 Contract Administrator’s (Mechanical) Responsibilities
  - .1 The Contract Administrator will review the Commissioning Plan, and will participate, as appropriate, in on-site commissioning meetings.
  - .2 During the acceptance phase of the commissioning process, the Contract Administrator may be on site to review commissioning documentation, to witness functional performance tests, and to analyse the installation and its performance.

.2 City's Responsibilities

- .1 The City will ensure the availability of operating staff for all scheduled instruction and demonstration sessions. This staff will possess sufficient skills and knowledge to operate and maintain the installation following attendance at these sessions.
- .2 The City will ensure the appropriate involvement of the Contract Administrator, Architect and any other consultants as required, in the commissioning process.

**3.2 Commissioning Responsibilities – Commissioning Agency**

.1 The Commissioning Agency will:

- .1 Plan, organize and implement the commissioning process as specified herein;
- .2 Prepare the commissioning plan, and ensure its distribution for review and comment;
- .3 Revise the commissioning plan as required during construction;
- .4 Chair commissioning meetings, and prepare and distribute minutes to all commissioning team members, whether or not they attended the meeting;
- .5 In conjunction with the General Contractor, coordinate commissioning activities among all contractors, sub-trades and suppliers;
- .6 Monitor system verification checks, and ensure the results are documented as the checks are done;
- .7 Monitor controls point-to-point checks done by the controls contractor, and ensure the results are documented as the checks are done;
- .8 Observe all start-ups and initial system operations tests and checks;
- .9 Direct the contractors to operate equipment and systems as required to ensure that all required functional performance tests are carried out for verification purposes;
- .10 Witness all functional performance tests and document the results;
- .11 Prepare and submit a Commissioning Report which documents all checks and tests done throughout the commissioning process, and the results obtained from each; and
- .12 Ensure all required O&M manuals, instructions and documentations are provided to the City's designated operating staff.

**3.3 Commissioning Responsibilities – Division 15 (Mechanical) Contractor**

- .1 The Mechanical Contractor, and all the sub-contractors and suppliers within Division 15, shall cooperate with the Commissioning Agency, and other commissioning team members, to facilitate the successful completion of the commissioning process.

- .2 The Contractor shall assign a representative to the commissioning team, and submit the person's name to the commissioning agency, within one (1) month of the award of the Contract. The representative shall have the authority to make decisions on behalf of the Mechanical Contractor as they relate to the organization and scheduling of HVAC commissioning. The representative shall ensure communications between Division 15 subcontractors and suppliers and all other commissioning team members, and shall foster the necessary cooperative action. One specific responsibility shall be to attend commissioning meetings, and ensure all action items arising from them are attended to as required to allow the commissioning process to proceed on schedule.
- .3 The Mechanical Contractor, and all mechanical sub-contractors and suppliers, shall cooperate with the Commissioning Agency in carrying out the HVAC commissioning process. The Mechanical Contractor shall:
  - .1 Each contractor and sub-contractor in this division shall include in their quotes the cost of participating in the commissioning process as specified herein.
  - .2 Ensure the Controls Contractor performs HVAC commissioning responsibilities as specified herein.
  - .3 Ensure the TAB Contractor performs HVAC commissioning responsibilities as specified herein.
  - .4 Ensure that all other sub-contractors perform HVAC commissioning responsibilities as specified herein.
  - .5 Provide instruction and demonstrations for the City's designated operating staff, in conjunction with the Commissioning Agency and the Mechanical Engineer, and with the participation of qualified technicians from major equipment suppliers and the Controls Contractor.
  - .6 Include requirements for submittal data, O&M data, and training information in each purchase order or sub-contract written.
  - .7 Ensure cooperation and participation of specialty sub-contractors such as sheet metal, piping, refrigeration, and water treatment as applicable.
  - .8 Ensure participation of major equipment manufacturing in appropriate start-up, testing and training activities.
  - .9 Attend HVAC commissioning meetings scheduled by the Commissioning Agency.
  - .10 Notify the Commissioning Agency, in written, a minimum of two weeks in advance of scheduled equipment and system start-ups, so that the Commissioning Agency may witness system verifications, and equipment and system start-ups.
  - .11 Provide sufficient personnel to assist the Commissioning Agency, as required, during system verification and functional performance testing.

- .12 Prior to start-up, inspect, check and confirm the correct and complete installation of all equipment and systems for which system verification checklists are included in the commissioning plan. Document the results of all inspections and checks on the checklists and sign them. If deficient or incomplete work is discovered, ensure corrective action is taken and re-check until the results are satisfactory and the system is ready for safe start-up.
- .13 Notify the Commissioning Agency, in written, a minimum of two weeks in advance of the time for start of the TAB work. Attend the initial TAB meeting for review of the TAB procedures.
- .14 Provide equipment and system start-up resources as specified and required. If during an attempted equipment of system start-up, deficient or incomplete work is discovered that would preclude safe operation, the start-up shall be aborted until corrective action has been taken. Ensure such action is taken and verified before rescheduling a new start-up. Those responsible for deficient or incomplete work will be responsible for costs in accordance with 3.3 in this section.
- .15 Carry out performance checks to ensure that all equipment and systems are fully functional and ready for the Commissioning Agency to witness formal functional performance tests.
- .16 Operate equipment and systems for functional performance tests in accordance with the commissioning plan and as directed by the Commissioning Agency. If improper functionality, incomplete work, or other deficiencies affecting system performance are discovered, the functional performance tests will be stopped by the Commissioning Agency or Contract Administrator. Those responsible for the deficient or incomplete work will be responsible for the costs in accordance with 3.3 of this Section. Ensure that all corrections necessary for full and complete system operation as specified are completed; then with the Controls Contractor and other applicable sub-contractors, carry out the functional performance checks to confirm correct operation before applying to the Commissioning Agency to reschedule the functional performance tests for the system in question.
- .17 Prepare preliminary schedule for mechanical system orientation and inspections. O&M manual submission, training sessions, pipe and duct system testing, flushing and cleaning, equipment start-up TAB, and task completion for use the Commissioning Agency. Update schedule as appropriate throughout the construction period.
- .18 Attend initial operation and maintenance staff training session.
- .19 Conduct mechanical system orientation and inspection at the equipment placement completion stage.
- .20 Update drawings to as-built condition and review with the Commissioning Agency and the Contract Administrator.

- .21 Gather O&M data on all equipment, and assemble in manuals as required in Division 01300 – Submittals. Submit to Commissioning Agency prior to completion of construction.
- .22 Participate in, and schedule vendors and contractors to participate in the O&M staff training sessions as set up by the Commissioning Agency.
- .23 Provide written notification to the General Contractor and the Commissioning Agency that the following work has been completed in accordance with the contract documents and the equipment, systems and sub-systems are operating as required.
  - .1 HVAC equipment including all fans, air handling units, dehumidification units, ductwork, dampers, terminals and all Division 15 equipment.
  - .2 Refrigeration equipment, pumping systems and heat rejection equipment.
  - .3 Fire stopping in the fire rated construction, including fire and smoke damper installation, caulking, gasketing and sealing of smoke barriers.
  - .4 Dedicated smoke control systems.
  - .5 Non-dedicated systems using the air-handling units for smoke control.
  - .6 Fire detection and smoke detection devices furnished other divisions of the specification as they affect the operation of the smoke control systems.
  - .7 That the building control system is functioning to control mechanical equipment and smoke control systems as specified.
- .24 Provide a complete set of as-built drawings and O&M manuals to the Commissioning Agency.
- .25 In the event that any scheduled equipment or system start-ups or functional performance tests are terminated because the Commissioning Agency or the Contract Administrator discover deficient or incomplete work, or due to non-attendance of required contractor or supplier personnel, the contractor or subcontractor responsible for the termination shall be responsible for paying reasonable costs of time and travel expenses of any or all of the following representatives who were physically present for the purpose of witnessing the start-up or the function performance test: the Commissioning Agency, the Contract Administrator and the City. The Contract Administrator may provide a statement to the General Contractor identifying the specific activity that was terminated, the scheduled date and a list of those in attendance, along with their reasonable time and travel expense costs.

### **3.4 Commissioning Responsibilities – TAB Contractor**

- .1 The TAB Contractor shall provide the following for HVAC commissioning:
  - .1 Include costs for HVAC commissioning requirements in the quoted price.

- .2 Attend commissioning meetings scheduled by the Commissioning Agency prior to, and during, on-site TAB work being done.
- .3 Submit the proposed TAB procedures to the Commissioning Agency and the Contract Administrator for review and acceptance.
- .4 Attend the TAB planning meeting scheduled by the Commissioning Agency. Be prepared to discuss the procedures that shall be followed in testing, adjusting and balancing the HVAC system.
- .5 At the completion of the TAB work submit the final TAB report to the Mechanical Contractor, with the General Contractor, Commissioning Agency and the Contract Administrator notified in writing.
- .6 Participate in verification of the TAB report by the Commissioning Agency for verification or diagnostic purposes. This will consist of repeating a sample (normally 10% to 20%) of the measurements contained in the TAB report as directed by the Commissioning Agency.
- .7 Participate in O&M personnel training sessions as scheduled by the Commissioning Agency.

### **3.5 Commissioning Responsibilities – Controls Contractor**

- .1 The Controls Contractor shall provide the following for HVAC commissioning:
  - .1 Include the cost for commissioning requirements in the quoted price.
  - .2 Review design for controllability with respect to equipment selected for the project;
    - .1 Review and confirm in writing that a proper hardware specification exists to permit functional performance testing as required by the specification and sequence of operation.
    - .2 Review and confirm in writing that proper safeties and interlocks are included in the design.
    - .3 Ensure the proper selection of sensor ranges, and include data with submittal to Contract Administrator.
    - .4 Clarify all questions concerning sequences of operation with the Contract Administrator.
  - .3 Attend commissioning meetings scheduled by the Commissioning Agency.
  - .4 Provide the following submittals to the Commissioning Agency for review;
    - .1 Hardware and software submittals.

- .2 Control panel construction drawings.
- .3 Diagrams showing all control points, sensor locations, point names, actuators, controllers and where necessary, points of access, all superimposed on diagrams of the physical equipment.
- .4 Narrative description of all control sequences for each piece of equipment controlled.
- .5 A list of all control points, including analog input, analog outputs, digital inputs and digital outputs. Include the values of all parameters for each system point. Provide a separate list for each stand-alone control unit.
- .6 A complete control language program listing including all software routines employed in operating the control system. Also provide a program write-up, organized in the same manner as the control software. This narrative shall describe the logic flow of the software and functions of each routine and sub-routine. It should also explain individual math or logic operations that are not clear from reading the software listing.
- .7 Hardware operation and maintenance submittals.
- .8 Application software and project applications code manuals.
- .5 Inspect, check, and confirm the proper installation and performance of controls/BAS hardware and software provided by others.
- .6 Integrate installation and programming scheduling with construction and commissioning schedules.
- .7 Inspect, check and confirm the correct installation and operation of input and output field points and devices through documented and signed off point-to-point checkouts.
- .8 Provide thorough training to operating personnel on hardware operations and programming, and the application program for the system, in accordance with the O&M staff training program in the commissioning plan.
- .9 In conjunction with the Mechanical Contractor, demonstrate system performance to the Commissioning Agency including all modes of system operation (e.g. occupied, unoccupied, emergency) during the functional performance tests. If improper functionality, incomplete work, or other deficiencies affecting system performance are discovered the functional performance tests shall be stopped by the Commissioning Agency or the Contract Administrator. Ensure such action is taken and verified before rescheduling a new functional performance tests. Those responsible for deficient or incomplete work will be responsible for costs in accordance with 3.3 in this section.
- .10 Provide control system technician to assist during system verification and functional performance testing.

- .11 Provide support and coordination with TAB contractor on all interfaces between controls and TAB scopes of work. Provide, at no additional cost to the TAB and Commissioning Agency, all devices, such as portable operator's terminals and all software for the TAB contractor to use in completing TAB procedures.

### **3.6 Commissioning Responsibilities – Electrical (Division 16) Contractor**

- .1 The Electrical Contractor shall provide the following for HVAC commissioning:
  - .1 Include the cost for commissioning requirements in the quoted price.
  - .2 Review design with respect to providing power to the HVAC equipment;
    - .1 Verify the proper hardware specifications exist for the functional performance and sequence of operation required by the specification.
    - .2 Verify that the proper safeties and interlocks are included in the design of electrical connections for the HVAC equipment.
  - .3 Attend commissioning meetings scheduled by the Commissioning Agency.
  - .4 Schedule work so that the required electrical installations are completed, and systems verification checks and functional performance tests can be carried out on schedule.
  - .5 Inspect, check and confirm in writing the proper installation and performance of all electrical services provided.
  - .6 Provide electrical system technicians to assist during system verification and functional performance testing as required by the Commissioning Agency.

**END OF SECTION**