PART 1 - GENERAL

1.1 GENERAL PROVISIONS:

A. Drawings and general provisions of the Contract, including General Conditions and Division 1, Specifications Sections, apply to Work of this section.

1.2 WORK INCLUDED:

A. Contractor shall participate in the Commissioning program as outlined in this section.

1.3 COMMISSIONING PROGRAM CRITERIA:

A. Intent: The intent of HV System Commissioning is to assure delivery to the Owner, HV systems that are fully functioning in accordance with all specifications and which the Owner's personnel are fully trained and equipped to operate, maintain and troubleshoot.

B. Commissioning Authority: The Commissioning Authority shall be a current full member of the Building Commissioning Association and function as the Commissioning Authority and coordinate the Commissioning Program. The Commissioning Authority will be retained by the owner.

C. Scope: For coordination purposes, the entire commissioning scope shall include Division 15 work performed by the contractor and require contractor participation and support throughout the process.

1. Document HV design intent. Review sequence of operation with the owner, engineer, architect and temperature control sub-contractor for the proper sequence, and setpoint control time of day scheduling, set-back temperatures, etc. Submit final written sequence of operation and time of day schedule to the owner and architect for their approval prior to finalization of this item.
2. Verify that equipment and systems have been properly installed in accordance with the contract documents and manufacturer's written installation instructions.
3. Verify that piping systems have been properly cleaned.
4. Verify that hydronic systems have been properly flushed, and start-up strainers in pumps have been removed.
5. Verify all strainers in hydronic systems have been cleaned, and are free of debris.
6. Verify all controls are properly wired and all control devices respond to controllers as specified.
7. Verify all filters are clean, and in their proper place.
8. Verify that duct systems have been properly cleaned.
9. Verify that equipment has been placed into operation with manufacturer's oversight and approval and/or in accordance with the manufacturer's written installation instructions.
10. Verify that system testing adjusting & balancing has been properly done.
11. Assemble contract documents and record drawings.
12. Assemble operation and maintenance instructions and submittal data.
13. Verify the performance of each piece of equipment and each system.

14. Review owner's training for proper instruction on the maintenance and operation of each piece of equipment and each system.
15. Document warranty start and end dates.
16. Assemble all records of Code authority inspections and approvals.
17. Monitor and enforce accessibility of all work vs. maintenance requirements of each piece of equipment.
18. Identify, document and report all deficiencies of the work to the architect vs. contract specifications and performance requirements, for tracking and correction through the commissioning program.

PART 2 - PRODUCTS - NOT APPLICABLE TO THIS SPECIFICATION

PART 3 - EXECUTION

3.1 PREPARATION OF THE COMMISSIONING PROGRAM

A. The Commissioning Program shall be prepared by the Commissioning Authority.

B. The Commissioning Program shall be submitted in writing to the Owner and the Architect for approval.

3.2 COMMISSIONING TEAM

A. The Commissioning Authority shall designate a Commissioning Team consisting of all members needed to execute the approved Commissioning Program. Minimum membership shall include:
1. Commissioning Authority
2. Mechanical Trade Representative
3. Controls and Energy Management Trade Representative
4. Test, Adjust and Balance Trade Representative
5. Electrical Trade Representative
6. Project Consultant (optional)
7. Project Mechanical Engineer (observing only)

B. The Contractor's personnel shall be made available to execute all aspects of the Commissioning Program until the Owner accepts final results.

3.3 RESPONSIBILITIES

A. Commissioning Authority:
1. Execute the Commissioning Program, through organization of all meetings, tests, demonstrations, training events and performance verifications described in the Contract Documents and approved Commissioning Program.
2. Schedule a pre-commissioning coordination meeting for the purpose of reviewing.
3. Schedule the HV Maintenance orientation and inspection at the Pre-final/Start-up stage. The emphasis on this Maintenance orientation and inspection will be an observation of the equipment location with respect to accessibility. The Maintenance orientation and inspection will be attended by the Commissioning Authority, the Mechanical Trade

Representative and the Engineer. Prepare minutes of this meeting, with separate summary of the deficiency findings.

4. Witness the HV piping test and cleaning procedure. Document the results and incorporate the documentation in the O&M Manuals. Prepare report of this observation, with separate summary of deficiency findings.
5. If ductwork testing and cleaning is specified, witness those tests, document the results and incorporate it into the O&M Manuals.
6. Schedule a meeting with the test, adjust and balance (TAB) Trade Representative prior to the start of the test, adjust and balance procedure. This meeting should be attended by the Owner, mechanical Trade Representative, Commissioning Authority, and TAB Trade Representative. The TAB Trade Representative will outline the TAB procedure and get concurrence from the Commissioning Authority. Ensure that the TAB Trade Representative has all forms required for the job database and understands their importance and use.
7. Observe the Owner training sessions. These training sessions are to be attended by the Owner, Commissioning Authority, Contractor, Trade Representatives, and equipment suppliers as necessary. Observe Maintenance orientation and inspection with hands on training as a part of the training program.
8. Upon receipt of notification from the Contractor that the system has 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 verification demonstration. These demonstrations will be conducted by the Contractor and his TAB and controls Trade Representative and witnessed by the Owner and Commissioning Authority. Prepare minutes of verification events and provides summary of deficiency findings.
9. Prepare final commissioning report per Section 3.9 and submit to the Consultant and Engineer. Schedule final review with Consultant and Owner.
10. Review HV system design parameters with the project engineer. Incorporate this data in the appropriate section of the O&M Manuals.
11. Provide sections on system description for inclusion in the O&M Manuals.
12. Review TAB report from Contractor against design requirements. Issue a report noting deficiencies requiring correction to the General Contractor.

B. Contractor:

1. Include commissioning requirements in the mechanical and electrical subcontracts and ensure full cooperation of all parties in the commissioning program.
2. Include requirements for submittal data, O&M data and training in each purchase order or subcontract written.
3. Ensure cooperation and participation of specialty sub-Trade Representatives such as sheet metal and piping, test, adjust and balance, water treatment and refrigeration sub-Trade Representatives.
4. Ensure participation of major equipment manufacturers in their representatives.
5. Gather O&M data on all equipment assemble and submit to Commissioning Authority.
6. Conduct the Maintenance orientation and inspection at the Distribution completion stage. Update drawings to the record condition, to date, and review with the Commissioning Authority prior to the inspection.
7. Notify the Commissioning Authority of the time for the piping system pressure tests and cleaning.

8. Notify the Commissioning Authority of the time for start of the TAB work. Attend the initial TAB meeting for the review of the TAB procedures.
9. Conduct a Maintenance training orientation and inspection with hands on training. Update drawings to the record condition to date and review with the Commissioning Authority prior to the orientation.
10. Provide written certification that the following work has been completed in accordance with the plans and specifications and that they are functioning as designed. Where the work has been subcontracted, the sub-Trade Representative shall be responsible for recertifying that he has inspected the work and that it has been completed and functioning as designed. This certification must be submitted to the Commissioning Authority prior to the final verification.
    a. HV equipment including all fans, air handling units, dust collectors, ductwork, dampers, etc.
    b. Humidification system equipment, piping, and controls.
    c. Boilers, pumping systems and fuel supply systems.
    d. Fire stopping in fire rated construction including fire damper installation.
    e. Dedicated smoke control systems.
    f. Building and automated control systems.
11. Demonstrate the performance of each piece of equipment to the Owner and Commissioning Authority. Schedule the TAB, HV controls, energy management and other sub-Trade Representatives as may apply to demonstrate the performance of the equipment and systems.
12. Turn over the set of record markups to the Engineer of Record for his review.

C. Test, Adjust and Balance Trade Representative
1. Attend the TAB review meeting scheduled by the Commissioning Authority. Be prepared to discuss the TAB procedures that will be followed in testing, adjusting and balancing the HV system.
2. At the completion of the TAB work, notify the Mechanical Trade Representative, and demonstrate to the Commissioning Authority the performance of the equipment covered by the TAB subcontract.
3. Repeat any measurement contained in the TAB report where required by the Commissioning Authority for verification or diagnostic purposes.

D. Temperature Controls Trade Representatives:
1. At the completion of the temperature controls and energy management systems startup and adjustment work, notify the Mechanical Trade Representative, and demonstrate to the Commissioning Authority the performance of the controls and energy management systems.
2. Participate in training sessions as set up by the Commissioning Authority.
3. Provide printed 24-hour and 7-day trend logs of any specific HVAC system operation, or room temperature requested by the commissioning authority.

E. Equipment Suppliers and Miscellaneous Trade Representatives:
1. Perform startup of equipment as applicable.
2. Participate in training sessions as set up by the Commissioning Authority.
3. Demonstrate performance of equipment as applicable.

3.4 OPERATION AND MAINTENANCE MANUALS

A. General Requirements:
1. Initial preparation shall be the responsibility of the mechanical Trade Representative.
2. Format: 3" thick, 8-1/2" x 11 loose leaf binders. Use as many as required. Do not overload binders.
3. Content:
   a. Cover sheet.
   b. Table of Contents (as follows):
      1) Description of systems.
      2) Design parameters.
      3) Section 15000 – Mechanical General Provisions through Section 15995 – Commissioning.
4. Section 15990 – Testing, Adjusting and Balancing shall contain the following sections:
   a. Specifications
   b. Submittal
   c. TAB Data
5. Section 15995 – Commissioning of HV System shall contain the following sections:
   a. Specifications
   b. Approved Commissioning Plan for HV Systems
   c. Final Report of the Commissioning Authority on HV Systems.

B. Submittal Requirement:
1. The O&M manuals shall be submitted at the equipment placement completion stage, which shall be defined as that time in the project when the major pieces of equipment have been set in place ready for connection to piping and duct systems.

3.5 TRAINING OF OWNER'S OPERATORS

A. The Owner's operators shall be given comprehensive training in the understanding of the systems and the operation and maintenance of each major piece of equipment.

B. Each training session shall be followed by an inspection, explanation and demonstration of the equipment. The start-up and shutdown modes of operation shall be demonstrated.

C. The temperature controls Trade Representative shall attend all sessions and be prepared to conduct the controls portion of the training as it relates to each equipment section.

D. The temperature controls Trade Representative shall conduct the training session on the controls system hardware and software.

3.6 NOTIFICATION OF SYSTEM COMPLETION AND REQUEST FOR FINAL HV SYSTEM COMMISSIONING VERIFICATION

A. When systems are ready for final commissioning verification, the mechanical Trade Representative shall notify the Commissioning Authority in writing. Commissioning data sheets must be complete through the column labeled "Balanced" and included with the request.

B. Should the verification test reveal that the equipment is not performing as specified or control operation is not acceptable, the Contractor shall notify the Commissioning Authority as soon as the deficiency is found.

3.7 VERIFICATION OF COMPLETION AND PERFORMANCE

A. Verification of completion and performance will take place after certification of the completion of the construction. Demonstration shall be done by the mechanical Trade Representative or the TAB Trade Representative and shall be witnessed by the Commissioning Authority and the Owner's Representative.

B. Results of verification tests will be documented on the Commissioning data sheets (CDS). The following demonstrations will be required:
   1. Major duct flow and pressure checks:
      a. The TAB Trade Representative shall identify all places where temperature, pressure and/or velocity readings were taken. On 10% of the locations, performance, as listed in the TAB Report, shall be demonstrated.
   2. Fire damper installation and operation:
      a. All dampers shall be inspected. Smoke detectors shall be checked for proper performance. Fire damper operation shall be checked by removing fusible link and demonstrating closure.
   3. Control damper operation:
      a. Damper Performance
      b. Demonstrate operation on shutdown, start-up and simulated economizer operation. Dampers shall close tightly and operate smoothly.
   4. Pump performance:
      a. Pump Schedule
      b. Demonstrate shutoff and full flow conditions.
   5. Boiler Performance:
      a. Boiler Schedule
      b. Prefer test during heating season.
   6. Exhaust Fan Performance:
      a. Fan Schedule
      b. Demonstrate during normal operation.
   7. Air Handling Unit Performance:
      a. Air handling unit Schedule
      b. Demonstrate during normal operation.
   8. Energy Management and HV Controls System:
      a. ON/OFF control of each applicable piece of equipment.
      b. Sequential operation of dampers over temperature range of economizer operations.
      c. All control loops:
         1) Demonstrate control to setpoint.
      d. Demonstrate tracking of supply and return fans to maintain building pressurization.

3.8 COMMISSIONING DATA SHEETS

A. The following Commissioning Data Sheets apply to this contract. They are to be completed as described in Para. 3.7 – Verification of Performance.

1. Pumps
2. Boiler
3. Air Handling Units
4. Fans
5. Duct Traverse
6. Air Outlet Schedule
7. Room temperature (all rooms with thermostats):
   a. Minimum
   b. Maximum
   c. Heating Mode
   d. Economizer Mode

3.9 REPORT REQUIREMENTS

A. 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.

B. The Commissioning Authority shall prepare a final formal report to the Owner, which will include a narrative in the form of an Executive Summary of the results of program.

C. Transmitted with the report shall be Edited Operation and Maintenance Manuals including:
   1. Commissioning Data Sheets
   2. Warranties
   3. Permits, tests and Inspection Reports
   4. TAB Balancing Reports

END OF SECTION 15995