

SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

- A. The work required under this Section shall conform to the requirements of "Division 01, General Requirements," "Conditions of the Contract" and "Supplementary Conditions." Specific attention is called to the "Division 23 General Requirements" located in Section 23 00 10.

1.2 SCOPE OF WORK

- A. Provide all testing, balancing, and adjusting of mechanical systems as indicated on the Drawings and as specified herein. Tests shall include but not be limited to the items specified in this Section.
- B. Testing, balancing, and adjusting shall in no way relieve the Contractor of the warranty requirements.
- C. The Contractor shall furnish all fuel, water, and electricity required in performing the testing, balancing, and adjusting of mechanical systems.

1.3 CONTRACTOR REQUIREMENTS

- A. The Air and Water Balancing Contractor will be directly contracted to Loudoun County.
- B. The Air and Water Balancing Subcontractor and the personnel used for this Project shall be certified testing agents of the National Environmental Balancing Bureau (NEBB) or the Associated Air Balance Council (AABC).

PART 2 - NOT USED

PART 3 - EXECUTION

3.1 GENERAL

- A. Testing
  - 1. During the progress of the work, tests shall be made as specified herein and as required by authorities having jurisdiction, including Local Authorities Inspection Department, Owner, Architect, or Engineer. Tests shall be conducted by the Mechanical Contractor as part of the work of this Division and shall include all qualified personnel, equipment apparatus, and services required to perform the tests.
- B. Job Site Reviews
  - 1. The Testing, Balancing and Adjusting Subcontractor shall visit the site at intervals appropriate to the stage of construction to familiarize himself with the progress and quality of work. This Subcontractor shall report directly to the General Contractor in written reports indicating any deficiencies, potential problems areas

and conditions that could adversely affect the building systems and the testing, balancing, adjusting procedures.

C. Testing Procedures and Recording Forms

1. The Contractor shall submit proposed test procedures, recording forms, and test equipment for review prior to the execution of testing.

D. Repairs

1. Leaks, damage, or defects discovered or resulting from tests shall be repaired, or replaced to a like new condition. Leaky pipe joints, ductwork, etc., shall be removed and replaced with acceptable materials.

E. Equipment

1. All equipment and instruments required for tests as well as additional thermometer wells, gauge and instrument connections shall be installed at no additional cost to the Owner.

F. Instrument Calibration

1. All instruments used for testing and balancing must have been calibrated within a period of six months prior to balancing. Instrument calibration shall be certified as specified in Section 23 00 10.

G. Report

1. Submit six copies of each complete testing and balancing report to the Engineer for review.

H. Acoustic Performance

1. The final results of all testing, adjusting and balancing shall achieve the range of indoor design goals for sound control for all occupied spaces as indicated in section 23 00 15. Refer to section 23 00 10 "Equipment Noise and Vibration" for additional requirements.

I. Equipment Identification

1. The Contractors shall coordinate the equipment tag designations and nameplates used to identify each piece of the Division 21, 22, 23, 25, 26 and 28 equipment so as to match and correspond to the equipment tag designations indicated on the contract documents. This includes, but is not limited to, the Contractor's shop drawings; submittals; record drawings; wiring diagrams; testing and balancing reports; Operating and Maintenance (O&M) manuals; Energy Management and Control System (EMCS) documents, software, programming, and graphics.

3.2 TESTING, BALANCING, AND ADJUSTING OF DIVISION 23

A. Vibration and Alignment

1. Vibration and alignment field measurements shall be taken when directed by the Engineer on equipment where vibration appears excessive. Readings shall

include shaft alignment, equipment vibration, bearing housing vibration, foundation vibration, building structure vibration, and other tests as directed by the Engineer. Readings will be made using portable IRD (or approved equal) equipment capable of filtering out various unwanted frequencies and standard reporting forms. Maximum vibration at any point listed above or specified shall not exceed 2 mils on fans and 2 mils on pumps unless otherwise specified.

B. Water Chilling Units

1. The water chilling unit refrigeration systems shall be tested for refrigerant and air leaks at least two times approximately six months after start-up and at the end of the warranty period. The Contractor shall certify the condition of the refrigeration system in writing after test. Any leaks detected shall be properly sealed and the above test period repeated. Soap suds and halide torch or electronic refrigerant detector shall be used for leak detection. Replace refrigerant and oil lost during warranty period at no cost to the Owner. See Division 01 for warranty period.

C. Sound Levels

1. Sound level readings shall be taken at ten locations in the building as selected by the Engineer. The readings shall be taken on an octave band analyzer in a manner acceptable to the Engineer. The Contractor shall submit test equipment data and reporting forms to the Engineer for review. In order to reduce the ambient noise level, the readings shall be taken at night. All tests shall be performed in the presence of the Engineer, if Engineer so desires.

D. Fire Protection Systems

1. Fire protection system, sprinkler system, and valve threads shall be tested as specified in Section 21 10 00. Fire pumps shall be tested as specified in Section 21 31 00.

E. Air and Water Flow Measurements

1. Air and water flow measurements shall be made in conjunction with air and water balancing procedures as specified in this Section. Air and water balance procedures shall be performed by National Environmental Balancing Bureau or Associated Air Balance Council certified, independent Testing and Balancing Contractor(s) in accordance with the latest edition of the NEBB "Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems" or the latest edition of the AABC National Standards.

F. Piping Leak Testing

1. Leak tests shall be conducted in accordance with ANSI B31.1 "Power Piping Code" and as specified herein in Section 23 21 13 and 23 11 00 before piping of various systems has been covered or furred-in. Note: Equipment not rated at or above the specified test pressure plus all sensitive system controls and instrumentation, excluding control valves, shall be valved off or removed and the connections plugged prior to hydrostatic testing. Removed items shall be replaced after testing has been completed. Controls and instrumentation shall be calibrated and tested after reinstallation.

G. Pumps

1. Pumps shall be tested to check impeller trim and operating characteristics. The pump manufacturer or a certified technician as recommended by the pump manufacturer shall perform a laser or dial indicator alignment of all pumps mounted on inertia bases to ensure the pump and motor are properly aligned and submit certified alignment test reports to the engineer for review. In addition, the following data shall be recorded and submitted to the Engineer for review. See Section 23 00 10 for requirements.
  - a. Flow at operating conditions where flow venturi or orifices are installed in the system.
  - b. Shut off pressure required to check impeller trim.
  - c. Discharge pressure at operating conditions.
  - d. Suction pressure at operating conditions.
  - e. Motor amperage and voltage on each phase at operating conditions.
- H. HVAC Water Piping
  1. The HVAC water piping and equipment shall be cleaned and flushed until the systems are clean as specified in Section 23 21 13. Strainers shall be removed and cleaned as often as required. The Contractor shall not start water balancing until the flushing procedures as specified in Section 23 21 13 have been completed.
- I. Field Capacity and Performance Testing
  1. The Contractor shall prove the capacity and performance of each piece of equipment by field tests as specified herein in various Sections or as required by the Engineer. All equipment and instruments required for tests as well as additional thermowells or gauge connections shall be installed at no additional cost to the Owner. A qualified representative of the equipment manufacturer shall be present at the test. These test requirements specifically include the water chilling units, cooling towers, self-contained air handling units, and pumps. The Engineer may witness tests, if Engineer so desires. The Contractor shall notify the Engineer, in writing, at least two weeks prior to the day of the test. See Section 23 00 10 for additional requirements.
- J. Fan Powered Terminal Device Temporary Filter Media Removal
  1. If temporary filter media is installed on the fan-powered terminal devices during the construction period, unless otherwise indicated in the Filter and Fan Powered Terminal Device specification sections, the temporary filter media on the fan powered terminal units shall be removed during the air balancing of the fan powered terminal units and replaced after the completion of the balancing by the Mechanical Subcontractor. After the construction period and the contractors have obtained the Certificate of Substantial Completion issued by the Owner, all temporary filter media shall be removed by the Mechanical Subcontractor after the Owner is given a two (2) week written notice the filter media is to be removed. If the temporary construction filter media is not maintained properly and regularly changed and the internal surfaces of the fan powered terminal devices become contaminated with dust and debris, the terminal units shall be thoroughly cleaned

at no additional cost to the Owner.

K. Air Balance and Adjusting

1. Supply air systems installed in finished areas of the building shall be balanced and adjusted as follows:
  - a. After duct systems have been installed complete with all VAV boxes, terminal devices, grilles, dampers, ducts, coils, and other items hereinafter specified the Contractor shall make adjustments, as required, to deliver the volume of air at each air outlet within 10% of design flow as shown on the Drawings. After the finished area is occupied, the air volumes shall be readjusted, if required, to properly balance the cooling and heating loads throughout the conditioned areas.
  - b. Air outlets shall be balanced with air pattern as shown on the Drawings.
2. After all supply and exhaust air systems have been installed complete with all duct, grilles, dampers, fans, and other items as hereinafter specified, the Contractor shall make adjustments, as required to deliver the volumes of air at each inlet or outlet within 10% of design flow.
3. In addition to the other testing, adjusting, and balancing requirements; the overall pressurization of the project and the overall pressurization of individual areas of the project shall be adjusted to maintain the difference between sources of outside air supply into the building and exhaust air relieved from the building as indicated on the drawings and in the specifications. Pressurization may be of a positive pressure or negative pressure. Contractor shall make adjustments, as required to deliver the set point difference between supply air quantities and exhaust air quantities of related systems within 10% of design flow. Unless otherwise indicated on the drawings, the total set point difference between the outside air supply quantities and the exhaust air quantities on the typical floor of the building shall be 500 cubic feet per minute (cfm). Unless otherwise indicated on the drawings, the total set point difference between the outside air supply quantities and the exhaust air quantities on the ground level floor of the building shall be 1500 cfm.
4. After all miscellaneous ventilation systems have been installed complete with all duct, grilles, louvers, dampers, fans, and other items as hereinafter specified, the Contractor shall make adjustments as required to deliver the volumes of air, or differential static pressures in the case of the pressurization fans, at each air inlet and/or outlet within 10% of design flow. Differential pressure within the stairwell at any location shall not exceed 0.25 W.G. with all doors closed. The pressurization system shall provide a minimum pressure differential of 0.15" of water column between the stairway shaft and the adjacent occupied areas with all doors closed.
5. Additional Requirements for Code Required Systems and Life Safety Systems: For all Code Required Systems and Life Safety Systems, the quantities indicated in the contract documents shall be the minimum values required. It shall not be acceptable to balance each of these systems below its minimum value. Air balance tolerance for each of these systems shall be between the minimum value up to 110% of the minimum value. In addition to this tolerance, systems that require a negative or positive pressurization shall be balanced to provide the

necessary level of positive or negative pressurization by maintaining the relative difference in supply and exhaust air quantities. Code Required Systems and Life Safety Systems shall include but not be limited to smoke exhaust systems, smoke control systems, stairwell pressurization systems, parking area ventilation systems, refrigerant exhaust systems, elevator pressurization systems, and kitchen exhaust systems. These systems shall include the supply, make-up, exhaust, and relief air systems related to the applicable Code Required System and Life Safety System. All Code Required Systems and Life Safety Systems shall be installed and performance tested in accordance with the applicable codes and the requirements of the Local Code Authority. Adjustments to these systems as required by the Local Code Authority during the performance testing, adjusting, and balancing shall be provided by the Contractor without additional cost to the Owner.

6. All balancing must be accomplished with diffuser air patterns as indicated on the Drawings.
7. Adjust or replace the fan belt drives, motor sheaves, and belts on air handling units and fans as required to achieve the specified air volumes indicated on the contract documents. Air handling unit manufacturers and the fan manufacturers shall provide the fan belt drives, motor sheaves, and belts necessary to achieve the specified air volumes as indicated on the contract documents for their respective equipment. Refer to specification sections 23 34 00 and 23 73 00 for additional requirements. Do not make fan speed adjustments that result in motor overload. Consult with the equipment manufacturers concerning fan speed safety factors. Modulate dampers and operate air handling units and fans through all modes of operation while measuring fan motor amperage to ensure no motor overload will occur.
8. The Contractor shall submit detailed balancing procedures and recording forms for the Engineer's review, prior to commencing any air balance work.
9. Submit six copies of complete reports to the Architect for review and comment.

L. Water Balancing and Adjusting

1. After piping systems have been installed complete with all pumps, piping, valves, coils, and other items as herein specified, the Contractor shall make adjustments as required to deliver the water volumes at each coil and piece of equipment to within 5% of design flow as shown on the Drawings or as indicated in Section 23 06 00, or as required to properly balance the cooling load throughout the conditioned areas. Each air handling unit with multiple coils shall have the flow through each coil balanced. Adjustments in water volumes shall be made in a manner satisfactory to the Engineer. The Contractor shall submit detailed balancing procedure and recording forms for the Engineer's review prior to commencing any water balancing work.
2. Submit six copies of complete comprehensive bound reports of the performance of the systems to the Architect for review and comments. Identify all data completely. Identify the manufacturer, size, type, location, room number, and zone of each coil and piece of equipment reported. Give design and actual water flow. Give complete nameplate data for each piece of equipment reported.
3. Automatic Balancing Pressure Independent Control Valves: Water balancing and

adjusting shall not be required on devices where automatic balancing pressure independent control valves are installed.

M. Final Water and Air Balance Readings

1. After water and air flow are balanced, and with the temperature controls set to produce design cooling, measure and record all data necessary to compile a complete report to demonstrate the acceptability of the various mechanical systems. Include at least the following data in the report:
  - a. Outside dry bulb and wet bulb temperature.
  - b. Inside dry bulb and wet bulb temperatures in six selected areas of the conditioned space, room or area selected by the Engineer.
  - c. Dry bulb temperatures of air entering and leaving all coils.
  - d. Temperature of water entering and leaving each water coil.
  - e. Temperatures at all thermometer well locations.
  - f. Temperature of water entering and leaving each water chilling unit condenser and evaporator.
  - g. Temperature of water entering and leaving each boiler.
  - h. Temperature of water entering and leaving each heat exchanger.
  - i. Suction and discharge pressure and shut off head of each circulating water pump.
  - j. Record control voltage range and set points for all adjustable fans typical to (VAV) Fan Powered Terminals, Exhaust and Supply Fans, etc.
  - k. Record min. / max. primary air values.
  - l. Record primary air control valve co-efficient (calibration factor) value.
2. With controls set for design heating, repeat applicable procedures specified in the immediately preceding subparagraph. Data concerning dry bulb temperatures of air entering and leaving coils applies to all duct mounted electric heating coils, air handling unit electric heating coils, and fan powered terminal device electric heating coils.
3. The balanced position of each controlling valve and damper shall be permanently marked on the pipe, insulation, or ductwork.

N. Temperature Control Adjusting

1. Automatic temperature controls shall be calibrated and all thermostats, dampers, etc., adjusted so that control system is in the proper operating condition, subject to review by the Engineer. See Section 25 00 90 for additional requirements.

O. Drainage Piping System Tests

1. Refer to section 22 13 16 and 22 14 13 for additional requirements.

P. Ductwork Leakage Testing

1. Refer to section 23 30 01 for additional information.

3.3 FUNDAMENTAL BUILDING COMMISSIONING GENERAL REQUIREMENTS - LEED

- A. Refer to specification Section 23 08 02 and the alternate pricing requirements indicated in Section 23 00 00 for additional fundamental building commissioning general requirements for LEED.

END OF SECTION 23 05 93