

SECTION 15907TESTING AND BALANCING
HEATING AND VENTILATING SYSTEMSPART 1 - GENERAL1.1 DESCRIPTION

- A. Work Included: The testing and balancing Work includes the measurement and setting of air and water flow devices in accordance with the Contract Documents for the systems, recording data, making tests, and preparing reports, all as hereinafter specified. Perform the Work specified in this Section on, and after the completion of, Work on the HVAC systems.
- B. Related Work Specified Elsewhere: "HVAC - General" is specified in this Division.
- C. Qualifications: Obtain the services of a qualified testing organization, approved by the Engineer, to perform the testing and balancing work as herein specified. The criteria for determining qualifications of the testing organization shall be certification by the Associated Air Balance Council (AABC), certification by the National Environmental Balancing Bureau (NEBB), or organization shall have submitted proof to satisfy the Engineer that the organization meets the technical standards for membership of the AABC as published in the AABC "National Standards for Field Measurements and Instrumentation - Total System Balance", Volume Two, No. 12173, except that affiliation with manufacturers, installing contractors, or engineering firms may not preclude their acceptance.
- D. Procedures: Accomplish the Work in accordance with the Agenda specified herein. Follow procedures described herein and, in general, if not specifically described herein, the Work shall be in accordance with the Associated Air Balance Council's "National Standards for Field Measurements and Instrumentation Total System Balance", Volume Two, No. 12173, and standards of NEBB.
- E. Cooperate with the selected test and balance agency in the following manner:
 - 1. Provide sufficient time before final completion date so that tests and balancing can be accomplished.
 - 2. Provide immediate labor and tools to make corrections when required without undue delay. Install balancing dampers as required by test and balance agency.
 - 3. Put all heating, ventilating and air conditioning systems and equipment into full operation and continue the operation of same during each working day of testing and balancing.
 - 4. Keep the testing and balancing agency informed of any major changes made to the system during construction, and provide with a complete set of as-built drawings.
 - 5. Include the costs of dampers, pulley and belt changes and the costs of obtaining the test and balancing agency in the Contract price.
- F. Installation shall not be considered complete until final reports by the testing agency have been submitted to the Engineer and approved.

1.2 SUBMITTALS TO THE ENGINEER

- A. Submit the name of the proposed testing organization to the Engineer for approval within 90 days after Contract award.
- B. Provide all results of all required tests for the Engineer's approval.

1.3 AGENDA

- A. Preliminary Report: Review Drawings and Specifications prior to the installation of any of the affected systems, and submit a written report to the Engineer indicating any deficiencies in the system that would preclude the proper adjusting, balancing, and testing of the systems.
- B. Submit an agenda for approval by the Engineer prior to start of testing and balancing work. The agenda shall include the following:
 - 1. A complete listing of all air and water flow and air terminal measurements to be performed.
 - 2. Specific test procedures and parameters for determining specified quantities, e.g., flow, drafts, etc., from the actual field measurements to establish compliance with the Contract Documents.
 - 3. Samples of forms showing applications of procedures and calculations to typical systems.
- C. Advise the Engineer in advance when the testing will begin so that the testing procedure and techniques can be evaluated and approved or modified.
- D. Procedure Reporting: Specific test procedures for measuring air quantities at terminals shall specify type of instrument to be used, method of instrument application (by sketch), and factors used.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Not applicable in this Section.

PART 3 - EXECUTION

3.1 PROCEDURES AND INSTRUMENTS - GENERAL

- A. Requirements: Adjust all systems and components to perform as required by the Drawings and Specifications.
- B. Test Duration: Perform operating tests of heating coils, fans and other equipment no less than a four hour duration after stabilized operating conditions have been established. Base capacities on temperatures and air and water quantities measured during such tests.
- C. Instrumentation: Use methods of application of instrumentation in accordance with the approved agenda.
- D. Use only instruments used for measurements that are accurate, and calibrated within 6 months of the testing with calibration histories for each instrument available for examination. Have each test instrument calibrated by a laboratory approved by the Engineer or by the manufacturer. The Engineer has the right to request instrument

recalibration, or the use of other instruments and test methodology, where accuracy of readings is questionable.

- E. Apply all instruments in accordance with manufacturer's instructions and recommendations.
- F. Provide all labor, instruments and appliances required. Do not install instruments that are permanent installations used for the tests, e.g., gages, thermometers, etc., until just prior to the tests to avoid damage and changes in calibration.
- G. Accuracy of all thermometers shall be plus or minus 1 graduation at the temperatures to be measured. Graduations shall conform to the following schedule.

<u>Medium</u>	<u>Design Temperature Differential (°F)</u>	<u>Maximum Graduation (°F)</u>
Air	10 or less	1/2
Air	over 10	1
Water	10 or less	1/10
Water	10-20	1/2
Water	over 20	1

3.2 AIR SYSTEM PROCEDURES

- A. Adjustments: Adjust all air handling systems to provide the required design air quantity to, or through, each component. Conduct adjustment and balancing of all systems during the period of the year approximating maximum seasonal operation, unless otherwise directed or approved by the Engineer.
- B. Equalizers: Adjust equalizing devices to provide uniform velocity across the inlets (duct side for supply) of terminals prior to measuring flow rates.
- C. Balance: Use flow adjusting (volume control) devices to balance air quantities only, i.e., proportion flow between various terminals comprising system, and only to the extent that their adjustments do not create objectionable air motion or sound, i.e., in excess of normal limits.
- D. Accomplish balancing between runs (submains, branch mains and branches) generally by flow regulating devices at, or in, the divided flow fitting.
- E. Restriction imposed by flow regulating devices in or at terminals shall be minimal. Make final measurements of air quantity after the air terminal has been adjusted to provide the optimum air patterns of diffusion.
- F. Fan Adjustment: Generally vary the total air system quantities, by adjusting fan speeds, or axial-flow fan wheel blade pitch. Use damper restriction of a system's total flow only for systems with direct connected fans (without adjustable pitch blades), provided system pressure is less than 1/2 inch w.g.
- G. Except as specified herein, make pitot tube traverses of each duct to measure air flow therein. Pitot tubes, associated instruments, traverses, and techniques shall conform to the ASHRAE Handbook of Fundamentals.
- H. Omit pitot tubes traverse when the duct serves only a single room of space and its design volume is less than 200 cfm. In lieu of Pitot tube traverse, determine air flow in the duct by totaling volume of individual terminals served, measured as specified herein.

- I. Where duct's design velocity and air quantity are both less than 1000 (fpm/cfm), determine air quantity by measurements at terminals served.
- J. Test Holes: Provide test holes, in straight ducts, as far as possible downstream from elbows, bends, take-offs, and other turbulence generating devices, to optimize reliability of flow measurements.
- K. Air Terminal Balancing.
- L. Air Motion: Air motion and distribution shall be as specified and as shown on Drawings. In addition to air motion measurements, make smoke tests wherever requested by the Engineer, to demonstrate the air distribution from air terminals, at no additional cost to the Owner.
- M. Changes in the specified agenda due to field conditions, will be considered for approval by the Engineer.

3.3 WATER SYSTEM PROCEDURES

- A. Adjustment: Adjust all heating, bypass, and transfer systems to provide the required quantity to, or through each component.
- B. Metering: Measure water quantities and pressures with calibrated meters.
- C. Use venturi tubes, orifices, or other metering fittings installed in system and pressure gages to measure water flow rates and balance the systems.
- D. Adjust the systems to provide the approved pressure drops through the heat transfer equipment (coils, converters, etc.) prior to the capacity testing.
- E. Where flow metering fittings are not installed, determine flow balance by measuring temperature differential across the heater transfer equipment.
- F. Perform measurement of temperature differential with the air system, adjusted as described herein, in operation.
- G. Automatic Controls: Position automatic control valves for full flow through the heat transfer equipment of the system during tests.
- H. Flow: Adjust the flow through bypass circuits at three-way valves to balance that through the supply circuit.
- I. Distribution: Adjust distribution by balancing devices (cocks, valves, and fittings) and automatic flow control valves as provided. Do not use service valves.
- J. Only record pressure differential where automatic flow control valves are utilized in lieu of venturi tubes, provided the pressure is at least the minimum applicable to the tag rating.
- K. Special Procedures: Where available pump capacity (as designed) is less than total flow requirements of individual heat transfer units of system served, full flow may be simulated by the temporary restriction of flow to portions of the system; specific procedures shall be delineated in the agenda.

3.4 TEST RECORDS

- A. Submittal: Submit three (3) copies of the reports described herein, covering air and water system performance, and air motion (fpm), to the Engineer prior to final tests and inspection.
- B. Instrument Records: Include types, serial numbers, and dates of calibration of all instruments.

- C. Reports: Identify conspicuous items not conforming to Contract requirements in the reports.

3.5 AIR SYSTEM DATA

- A. Report: Include in the certified report, for each air-handling system, the following data (as applicable):
1. Equipment (fan or factory fabricated station unit):
 - a. Installation Data:
 - (1) Manufacturer and Model.
 - (2) Size.
 - (3) Arrangement, Discharge, and Class.
 - (4) Motor H.P., Voltage, Phase, Cycles and Full Load Amps.
 - (5) Location and Local Identification Data.
 - b. Design Data: Data listed in schedules on the Drawings and in the Specifications.
 - c. Fan Recorded (Test) Data:
 - (1) C.F.M.: Discharge CFM and % of OA under minimum conditions.
 - (2) Static Pressure: S.P. total, S.P. suction and S.P. discharge.
 - (3) R.P.M.: Fan and motor.
 - (4) Motor Operating Amps.
 - (5) Motor Operating B.H.P.
 - (6) Motor Sheave Size and Make.
 - (7) Fan Sheave Size and Make.
 - (8) Number of Belts Size and Make.
 2. Duct Systems:
 - a. Duct Air Quantities (Maximum and Minimum) - Main, Submains, Branches, Outdoor (Outside) Air, Total-Air, and Exhaust:
 - (1) Duct size(s)
 - (2) Number of Pitot tube (Pressure) Measurements.
 - (3) Sum of Velocity Measurements (Note: Do not add pressure measurements).
 - (4) Average Velocity.
 - (5) Recorded (Test) C.F.M.
 - (6) Design C.F.M.
 - b. Individual Air Terminals:
 - (1) Terminal Identification (Supply or Exhaust, Location and Number designation).
 - (2) Type, Size, Manufacturer and Catalog Identification.
 - (3) Applicable Factor for Application, Velocity, Area, etc., and Designated Area.
 - (4) Design and Recorded Velocities - F.P.M. (State "core", "inlet", etc., as applicable). Record data for three readings and average.
 - (5) Design and Recorded Quantities - C.F.M. Record data for three readings and average.
 - (6) Deflector Vane or Diffusion Cone Settings.

3.6 WATER SYSTEM DATA

A. Report: Include in the certified report, for each water system, the following data:

1. Pumps:
 - a. Installation Data:
 - (1) Manufacturer and Model.
 - (2) Size.
 - (3) Type Drive.
 - (4) Motor H.P., Voltage, Phase, and Full Load Amps.
 - b. Design Data:
 - (1) G.P.M.
 - (2) Head.
 - (3) R.P.M.
 - (4) B.H.P and Amps.
 - c. Recorded Data:
 - (1) Discharge Pressure (Full-Flow and No-Flow).
 - (2) Suction Pressures (Full-Flow and No-Flow).
 - (3) Operating Head.
 - (4) Operating G.P.M. (From pump curves if metering is not provided).
 - (5) No-Load Amps. (where possible).
 - (6) Full-Flow Amps.
 - (7) No-Flow Amps.
2. Converters and Heat Exchangers:
 - a. Installation Data:
 - (1) Manufacturer, Model and Type.
 - (2) G.P.M.
 - (3) Inlet (entering) and Outlet (leaving) Temperatures.
 - (4) Water pressure drop.
 - b. Recorded Data:
 - (1) G.P.M. (if metered).
 - (2) Entering and Leaving Water Temperatures - System.
 - (3) Water Pressure drop.
 - (4) Heating (or Cooling) Media - Conditions Steam Pressure and Temperature and Condensate Temperature, or Entering and Leaving Water Temperature.
 - (5) Heating (or Cooling) Media - Flow (G.P.M. or lbs per hour).
3. Air Heating Equipment:
 - a. Design Data:
 - (1) Load in BTUH or MBH.
 - (3) Entering and Leaving Water Temperature.
 - (5) C.F.M.
 - (6) Water Pressure Drop.
 - b. Recorded Data:
 - (1) Type of Equipment and Identification (location or number designation).
 - (2) Entering and Leaving Air Conditions (D.B. and W.B).
 - (3) Entering and Leaving Water Temperatures.

TESTING AND BALANCING HEATING AND VENTILATING SYSTEMS

- (4) G.P.M. (if metered).
- (5) Temperature Rise or Drop.

3.7 FINAL TESTS, INSPECTION AND ACCEPTANCE

- A. General: Make tests to demonstrate that the capacities and general performance of air and water systems comply with the Contract Documents.
- B. At the time of final inspection, recheck, in the presence of the Engineer, random selections of data (water and air quantities and air motion) recorded in the Certified Report.
- C. Points and areas for recheck will be selected by the Engineer.
- D. Measurement and test procedures shall be the same as approved by the Engineer for the Work forming basis of report.
- E. Selections for recheck (specific plus random), in general, will not exceed 15 percent of the total number tabulated in the report.
- F. Retests: If random tests elicit a measured flow deviation of ten percent or more from that recorded in the Balance Report listings, at ten percent or more of the rechecked selections, the report shall be automatically rejected. In the event the report is rejected, readjust all systems and re-test. Submit new data recorded, new Balance Reports and make new inspection tests, all at no additional cost to the Owner.
- G. Marking of Settings: Following final acceptance of Balance Reports by the Engineer, permanently mark the settings of all valves, splitters, dampers, and other adjustment devices so that adjustment can be restored if disturbed at any time. Do not mark devices until after final acceptance.

END OF SECTION