

SECTION 15990 - TESTING AND BALANCING AIR AND WATER SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. The work covered by this section of the specifications includes the furnishing of labor, materials, equipment, transportation, permits, inspections and incidentals and the performing of operations required for testing and balancing the air and water systems.
- B. Alternates: Refer to SECTION 01010 - SUMMARY OF WORK, to determine what extent, work of this section will be affected by any accepted alternates.

1.02 GENERAL REQUIREMENTS

- A. The provisions of Section 15000, "Supplemental Mechanical Requirements", apply to this section.

1.03 DEFINITIONS

- A. Adjust: To regulate the specified fluid flow rate and air patterns at the terminal equipment, (e.g., reduce fan speed, throttling).
- B. Balance: To proportion flows within the distribution system (submains, branches and terminals) in accordance with specified design quantities.
- C. Procedure: Standardize approach and execution of sequence of work operations to yield reproducible results.
- D. Report Forms: Test data sheets arranged for collection of test data in logical order to submission and review. This data should also form the permanent record which shall be used as the basis for any future testing, adjusting, and balancing required.
- E. Test: To determine quantitative performance of equipment.

1.04 SUBMITTALS: Submit the following:

- A. Standards Compliance:
  - Testing Agency
  - Testing Agency Personnel
  - Professional Engineers
  - Instrument Calibration

1.05 TESTING AND BALANCING AGENCY

- A. Air and Water Systems Testing and Balancing: Upon completion of the installation and field testing, performance test and adjust the supply, return, make-up, and exhaust air systems, and heating water systems to provide the air volume and water flow quantities indicated. Accomplish work in accordance with the agenda and procedures specified and AABC 71679 and standards of the NEBB. Correct air and water system performance

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deficiencies disclosed by the test before balancing the systems.

- B. Agency Qualifications: Obtain the services of a qualified testing organization to perform the testing and balancing work as herein specified. Prior to commencing work under this section of the specifications, the testing organization shall have been reviewed by the Architect. The criteria for determining qualifications shall be membership in the AABC, or certification by the NEBB, or the testing organization shall have submitted proof to satisfy the Architect that the organization meets or exceeds the technical standards for membership of the AABC as published in the AABC 71679. The testing organization shall be independent of both the installing contractors and equipment suppliers for this project.

1.06 AGENDA

- A. Preliminary Report: Review drawings and specifications prior to installation of any of the affected system. Submit a written report to the Architect indicating any deficiencies in the system that would preclude the proper adjusting, balancing, and testing of the systems.

1.07 PROCEDURES, GENERAL

- A. Requirements: Adjust systems and components thereof that perform as required by drawings and specifications.
- B. Test Duration: Operating tests of heating and cooling coils, fans and other equipment shall be of not less than 4 hours duration, after stabilized operating conditions have been established. Capacities shall be based on temperatures and air and water quantities measured during such tests.
- C. Instrumentation: Method of application of instrumentation shall be in accordance with the manufacturer's instructions. Furnish personnel, instruments, and equipment for tests specified herein.
- D. Accuracy of Instruments: Instruments used for measurements shall be accurate. Provide calibration histories for each instrument for examination. Calibrate each test instrument by an reviewed laboratory or by the manufacturer. The Architect has the right to request instrument recalibration, or the use of other instruments and test methodology, where accuracy of readings is questionable.
- E. Accuracy of Thermometers: Plus or minus one graduation at the temperatures to be measured. Graduations shall conform with the following schedule:

Medium	Design Temperature Differential (°F)	Maximum Graduation (°F)
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

- F. Flow Rate Tolerance: Values are based on discussion in ASHRAE "HVAC Applications", Chapter 34. Air filter resistance during tests, artificially imposed if necessary, shall be 80

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percent of final values.

1. Air Handling Unit CFM: Minus 0 percent to plus 10 percent.
2. Other Fans: Minus 0 percent to plus 10 percent.
3. Air Terminal Units (VAV Boxes): Minus 5 percent to plus 10 percent.
4. Minimum Outside Air (for manually set dampers): Minus 0 percent to plus 10 percent.
5. Individual Room Air Outlets and Inlets, and Air Flow Rates Not mentioned Above: Minus 10 percent to plus 10 percent.
6. Heating System Pumps GPM: Minus 0 percent to plus 10 percent.
7. Other Pumps GPM: Minus 10 percent to plus 10 percent.
8. Air Handling Unit Coils GPM: Minus 5 percent to plus 10 percent.
9. Terminal Unit Coils/Elements GPM: Minus 10 percent to plus 10 percent.

## PART 2 - PRODUCTS

NOT USED

## PART 3 - EXECUTION

### 3.01 AIR SYSTEM PROCEDURES

- A. Adjustments: Adjust air handling systems to provide the required design air quantity to, or through, each component. Conduct adjusting and balancing of systems during periods of the year approximating maximum seasonal operation.
- B. 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 specified limits.
- C. Balancing Between Runs (submains, branch mains, and branches): Use flow regulating devices at, or in, the divided - flow fitting. Minimize restriction imposed by flow regulating devices in or at terminals.
- D. Final Measurements of Air Quantity: Make final measurements of air quantity, after the air terminal has been adjusted to provide the optimum air patterns of diffusion.
- E. Fan Adjustment: Total air system quantities, generally, shall be varied by adjustment of fan speeds, or axial-flow fan wheel blade pitch. For systems with direct-connected fans (without adjustable pitch blades), damper restrictions of a system's total flow or variable speed rheostats shall be adjusted as appropriate.

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### F. Air Measurement:

1. Pitot Tube: Except as specifically indicated herein, make pitot tube traverses of each duct to measure air flow therein. Pitot tubes, associated instruments, traverses, and techniques shall conform with the ASHRAE Handbook Fundamentals.
2. Pitot Tube Traverse: Pitot-tube traverse may be omitted if the duct serves only a single room or space and its design volume is less than 2000 cfm. In lieu of Pitot-tube traverse, determine air flow in the duct by totalling volume of individual terminals served, measured as described herein.
3. Measurements of Air Quantity: Where duct's design velocity and air quantity are both less than 1000 (fpm/cfm), air quantity may be determined by measurements at terminals served.

- G. Air Terminal Balancing: Measurement of flow rates by means of velocity meters applied to individual terminals, with or without cones or other adapters, shall be used only for balancing.

## 3.02 WATER SYSTEM PROCEDURES

- A. Adjustment: Adjust heating, water systems to provide required quantity to, or through each component.
- B. Metering: Measure water quantities and pressures with calibrated meters.
- C. Water Measurements and Balancing: Use venturi tubes, orifices, or other metering fittings and pressure gages. Adjust systems to provide the design flow rates through the heat transfer equipment prior to the capacity testing. Perform measurement of temperature differential with the air system, adjusted as described herein, in operation.
- D. Automatic Controls: Position automatic control valves for full flow through the heat transfer equipment of the system during tests.
- E. Flow: Flow through by-pass circuits at three-way valves shall be adjusted to balance that through the supply circuit.
- F. Distribution: Adjust distribution by means of balancing devices (cocks, valves, and fittings) and automatic flow control valves. Do not use service valves for adjustment. Where automatic flow control valves are utilized in lieu of venturi tubes, record only the pressure drop across the valve if within the pressure drop rating on the valve tag.
- G. 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.

## 3.03 SOUND TEST PROCEDURES

- A. Sound Compliances Tests: Tests to demonstrate compliance with sound requirements shall be made as indicated.

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- B. Timing: Take sound level measurements at times when the building is unoccupied, or when activity in surrounding areas and background noise levels in areas tested are at minimum and free from sudden changes in noise levels. Take measurements with equipment secured, except that being tested. Measure sound levels at any point within a room not less than 6 feet from an air terminal or room unit, and not closer than 3 feet from any floor, wall, or ceiling surface.
- C. Meters: Measure sound levels with a sound meter complying with the latest ANSI S1.4. Use the "A" scale to measure overall sound levels. To determine the specified octave band levels, the above sound level meter shall be supplemented by an Octave Band Analyzer complying with ANSI S1.11.
- D. Equipment Components: Determine "equipment components" of room sound (noise) levels for each (of eight) octave bands as follows:
1. Measure room sound pressure level "LPb" with equipment to be tested shut off.
  2. Measure room sound pressure level "LPt" with equipment to be tested turned on.
  3. Calculate LPt-LPb; if this value is less than one, applicable test must be rerun with lower background level (LPb) unless LPt is within sound pressure level specified for equipment.
  4. Determine "C" from table below:

LPt-LPb (dB)	1	2	3	4-4-1/2	5-5-1/2	6-7-1/2	8-12	over 12
C (dB)	7	4	3	2	1-1/2	1	1/2	0
  5. The "equipment component" of room sound level equals LPt-C.

### 3.04 CERTIFIED REPORTS

- A. Submittal: Submit three copies of the reports described herein, covering air and water system performance, air motion (fpm), to the Architect prior to final tests and inspection.
- B. Instrument Records: Include types, serial numbers, and dates calibration of instruments.
- C. Reports: Reports shall identify conspicuously items not conforming to contract requirements, or obvious maloperation and deficiencies.
- D. Certification: The reports shall be certified by an independent Registered Professional Engineer who is versed in the field of air and water balancing and who is not affiliated with any firm involved in the design or construction phases of the project.

### 3.05 AIR SYSTEM DATA

- A. Report: The certified report shall include for each air-handling system the data listed below:
1. Equipment (fan or factory fabricated station unit):

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- 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 drawings and specifications.
- c. Fan Recorded (Test) Data
  - 1) C.F.M.
  - 2) Static Pressure
  - 3) R.P.M.
  - 4) Motor Operating Amps.
  - 5) Motor Operating B.H.P.

### 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 Measurement, excluding 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) Design and Recorded Quantities - C.F.M.
  - 4) Deflector Vane or Diffusion Cone Settings
  - 5) Applicable Factor for Application, Velocity, Area
  - 6) Design and Recorded Velocities - F.P.M. (State "core" "inlet," as applicable)

### 3.06 WATER SYSTEM DATA

#### A. Report: Include data listed below:

##### 1. Pumps:

- a. Installation Data:

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- 1) Manufacturer and Model
- 2) Size
- 3) Type Drive
- 4) Motor H.P., Voltage, Phase, and Full Load Amps.
- 5) Design Data:

- a) G.P.M.
- b) Head
- c) R.P.M.
- d) B.H.P. and Amps.

b. Recorded Data:

- 1) Discharge Pressures (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. Air Heating and Cooling Equipment:

a. Design Data:

- 1) Load in Btu per hr
- 2) G.P.M.
- 3) Entering and Leaving Water Temperature
- 4) Entering and Leaving Air Conditions (D.B. and W.B.)
- 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
- 4) G.P.M. (if metered)
- 5) Temperature Rise or Drop

### 3.07 SOUND LEVEL DATA

- A. Sound level tests shall be performed in the gymnasium and auditorium.
- B. Report: The certified report shall record data on sound levels, taken at each selected location, as follows:

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1. Source of sound and location
  2. Diagram or description of relationship of sound source to measuring instrument.
  3. "A" scale readings:
    - a. Equipment being tested turned off (ambient) (2) Equipment being tested turned on (operating conditions)
  4. Reading at each specified octave band frequency:
    - a. Equipment being tested turned off (ambient) (2) Equipment being tested turned on (operating condition)
  5. "Equipment components" of sound (noise) levels with applicable calculations per "Sound Test Procedure."
  6. Graph showing relationship between pressure levels specified and recorded readings.
- C. Retest: Subsequent to any correctional construction work, such as acoustic corrections, make measurements to verify that associated air and water quantities, as previously measured, have not been disrupted.
- D. Certified Report: Record sound data, and their locations, after final adjustments of air and water systems involved.

### 3.08 FINAL TESTS, REVIEW, AND ACCEPTANCE

- A. Capacity and Performance Tests: Make tests to demonstrate that capacities and general performance of air and water systems comply with contract requirements.
- B. Final Inspection: At the time of final review, 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: As selected by the Architect.
- D. Measurement and Test Procedures: As reviewed for work forming basis of certified report.
- E. Selections for Recheck (specific plus random): In general, selections for recheck will not exceed 25 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, or a sound level of 2 Db or more greater than that recorded in the certified report listings, at ten percent or more of the rechecked selections, the report shall be automatically rejected. In the event the report is rejected, systems shall be readjusted and tested, new data recorded, new certified reports submitted, and new inspection tests made.
- G. Marking of Settings: Following final acceptance of certified reports by the Architect, the settings of valves, dampers, and other adjustment devices shall be permanently marked, so that adjustment can be restored if disturbed at any time. Do not mark devices until after final review.



\*\*\* END OF SECTION \*\*\*