

SECTION 15990
TESTING, ADJUSTING, AND BALANCING

PART 1 GENERAL

1.1. RELATED DOCUMENTS:

- A. Drawings & and related documents including the General and Supplementary Conditions and Division 1 Specifications Section and Division 15 Specifications.

1.2. DESCRIPTION:

- A. The Testing and Balancing Agency shall specialize in testing, adjusting, and balancing of heating, ventilating, air-moving equipment, air-conditioning systems and hydronic systems. The testing agency shall have successfully completed at least five projects of similar size and scope, and shall be a certified member of the Testing Adjusting and Balancing Bureau (TABB). *(The Associated Air Balance Council (AABC), or the National Environmental Balancing Bureau (NEBB) may be added to the specifications).*
- B. The TAB Contractor shall furnish all labor, equipment, and services necessary to test and balance all air and hydronic systems on the project.
- C. Testing and balancing shall not begin until the mechanical systems have been completed and are in full working order.
- D. A “team” approach to this construction project is required. The TAB Contractor is expected to cooperate with all parties involved with the construction process.

1.3. SCOPE OF WORK:

- A. The required testing, adjusting, and balancing includes:
 - 1. All air conditioning equipment including air distribution devices, supply ducts, air handling units, condensing units, fans, coils, and related equipment.
 - 2. All hydronic systems including pumps, water distribution systems, chillers, boilers, heat exchangers, coils, and related equipment.

1.4. REFERENCES:

- A. ASHRAE 111 – Practices for Measurement, Testing, Adjusting, and Balancing of Building Heating, Ventilation, Air-conditioning, and Refrigeration Systems.
- B. SMACNA – HVAC Systems Testing, Adjusting, and Balancing.
- C. TABB-International Standards for Environmental Systems Balance

1.5. SUBMITTALS:

- A. Within 30 days after award of Contract, submit name of testing, adjusting, and balancing agency for approval.
- B. Field reports must be submitted indicating deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
- C. Submit four (4) copies of the TAB report in soft cover, letter size, binder manuals, complete with index page and indexing tabs.
- D. The Mechanical Contractor shall provide a copy of the TAB Report within each operating and maintenance manual.

1.6. QUALITY ASSURANCE:

- A. Perform total system balance in accordance with Testing Adjusting and Balancing Bureau (TABB)-Quality Assurance Program for Environmental Systems Balance. (*The AABC National Standards for Field Measurement and Instrumentation, or Total System Balance or NEBB Standards – Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems may be added if desired*).

1.7. QUALIFICATIONS:

- A. Agency Company specializing in the testing, adjusting, and balancing of systems specified in this section will have a minimum of one year's experience.
- B. The TAB Technician shall be certified by a nationally recognized (certification board) certifying agency.

1.8. PROJECT CONDITIONS:

- A. System shall not be balanced until the HVAC system is complete and in full working order, and all areas of general construction are complete (walls, doors, ceilings).

1.9. WARRANTY/GUARANTEE:

- A. The TAB Contractor shall include an extended warranty of 90 days after submission of a completed balancing report, during which time the Owner may request a recheck of no more than 10% of total number of terminals, or resetting of any outlet, coil, or device listed in the test report, and;
- B. Warranty/Guarantee must meet one of the following programs: TABB International Quality Assurance program, AABC national project performance guarantee, NEBB's Conformance Certification.

PART 2 PRODUCTS

2.1. INSTRUMENTS/TOOLS:

- A. Provide all necessary TAB instruments as per instrument schedules from Testing, Adjusting, and Balancing Bureau (TABB), NEBB, or AABC. Instruments shall be used and applied that are best suited to the system function being tested.

PART 3 EXECUTION

3.1. EXAMINATION:

- A. The general, electrical, mechanical, controls, and sheet metal contractor(s) will verify that systems are complete and operable before commencing work. Responsible installing contractors shall ensure the following conditions:
 1. Systems are started and operating in a safe and normal condition.
 2. Temperature control systems are installed, complete, and operable.
 3. All automatic and manual dampers are operable and fully open.
 4. Proper thermal overload protection is in place for all fans, pumps, chillers, etc.
 5. Final filters are clean and in place.
 6. Duct and fan systems are clean of debris.
 7. Fans are rotating correctly.

8. Fire and volume dampers are in place and open.
 9. Air coil fins are cleaned and combed straightened.
 10. Access doors are closed, and duct end caps are in place.
 11. Air outlets are installed and connected.
 12. Hydronic systems are pressure tested, flushed, filled, and properly vented.
 13. Leak testing on duct system has been performed if required.
 14. Pumps are rotating correctly.
 15. Start up or construction strainers have been removed and all other strainers are clean and in place.
 16. Gauges and/or test ports are properly located for balancing.
 17. Service and balance valves are open.
- B. A construction deviation field report must be submitted noting deviation, or deficiencies in the above 3.1a, that would preclude or prevent system balance.

3.2. BALANCING TOLERANCES:

- A. Air Handling Systems: Adjust to within plus 10 percent of outlet total plus allowable leakage rate. If this is not achievable, contact designing engineer on how to proceed.
- B. Air Outlets and Inlets: Adjust total to within plus 10 percent or minus 10 percent of design for the space, or revised design quantities determined value obtained in A.
- C. Hydronic Systems: Adjust to within plus 10 percent of outlet total minus 0 percent. If this is not achievable, contact designing engineer on how to proceed.
- D. Hydronic terminal devices: Adjust total to within plus 10 percent or minus 10 percent of design for the space, or revised design quantities determined value obtained in A.

3.3. ADJUSTING – GENERAL:

- A. Recorded data shall represent actual measured or observed condition.
- B. Permanently mark setting of valves, dampers, and other adjustment devices allowing for settings to be restored. Set and lock memory stops.
- C. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

3.4. AIR SYSTEMS PROCEDURE

- A. Adhere to one of the following procedures:
 1. TABB & SMACNA's HVAC Testing, Adjusting, and Balancing International Standards.
 - a. Chapters on preliminary TAB procedures.
 - b. Chapters on General air systems TAB procedures.
 - c. Chapters on TAB procedures for specific air systems VAV, CAV, Multizone, Dual duct, etc.
 2. NEBB procedural standards for TAB of environmental systems.
 3. AABC National standards for total system balance.

- B. Minimum air procedures should include the following:

1. Test and adjust fan RPM to design requirements.
2. Test and record motor full load nameplate rating and actual ampere draw.
3. Test and record system static pressures, fan suction, and discharge.
4. Adjust all main supply and return air duct to proper design CFM.
5. Test and adjust each diffuser, grille, and register. Reading and tests of diffusers, grilles, and registers shall include design velocity (FPM) and adjusted velocity, design CFM and adjusted CFM.
6. Test and record outside, mixed air, and discharge temperatures (D.B. for heating cycle, D.B. and W.B. for cooling cycle).
7. In coordination with the ATC contractor, set adjustments of automatically operated dampers to operate as specified, indicated and/or noted.
8. Test and adjust air handling and distribution systems to provide required or design supply, return, outside, and exhaust air quantities.
9. Make air quantity measurements in ducts by Pitot tube traverse entire cross sectional area of duct.
10. Measure air quantities at air inlets and outlets.
11. Use volume control devices to regulate air quantities only to the extent (?) that adjustments do not create objectionable air motion or sound levels.
12. Vary total system air quantities by adjustment of fan speeds. Provide drive changes recommendations to installing contractor. Vary branch air quantities by damper regulation.
13. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for loading of filters.
14. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
15. Measure temperature conditions across air, return air, and exhaust dampers to check leakage.
16. Where modulating dampers or economizers are provided, take measurement at full return air, minimum outside air, and 100 percent outside air mode of operation.

3.5. HYDRONIC SYSTEM PROCEDURE:

- A. Adhere to one of the following procedures:
 1. SMACNA's HVAC Testing, Adjusting, and Balancing standards
 - a. Chapters on hydronic TAB procedures.
 2. NEBB procedural standards for TAB of environmental systems.
 3. AABC National standards for total system balance.
- B. The hydronic balancing shall include the minimum data
 1. Prepare itemized equipment schedules, listing all heating and/or cooling elements and equipment in the systems to be balanced. List in order on equipment schedules, by pump or zone according to the design, all heating and/or cooling elements, all zone balancing valves, and circuit pump ending with the last items of equipment or transfer element in the respective zone or circuit. Include on schedule sheet column titles listing the location, type of element or apparatus, design conditions, and measured conditions. Prepare individual pump report sheets for each zone or circuit.

2. Adjust hydronic systems to provide plus 10 percent or minus 10 percent of required design quantities.
3. Use calibrated Venturi tubes, orifices, metered fittings, pressure gages, and direct reading instrumentation to determine flow rates for system balance. Where flow-metering devices are not installed, flow balance on temperature difference across various heat transfer elements in the system is acceptable.
4. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.
5. Effect system balance with automatic control valves fully open to heat transfer elements.
6. Adjust hydronic distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.
7. Test pumps and adjust flow. Record the following on pumps report sheets: (a) suction and discharge pressure, (b) running amps and brake horsepower of pump motor under full flow and no flow conditions, (c) pressure drop across pump in feet of water and total GMP pump is handling under full flow conditions.
8. Where available pump capacity is less than total flow requirements or individual system parts, proportional balancing must be performed.

3.6. REQUIRED REPORTS TO BE SUBMITTED:

- A. Submitted reports shall be on TABB/SMACNA, NEBB or AABC, or forms that contain the previous minimum data and the following information
- B. Reports shall include the following minimum information:
 1. Title Page
 - a. Project Name & Location
 - b. Project Architect & Location
 - c. Project Engineer & Location
 - d. Project Contractors (General, Mechanical, Balancing) & Location
 - e. Page index for all sections of the report
 - f. Report date
 2. Section A. Summary & Certifications
 - a. Deficiency noted where design criteria could not be obtained within specified tolerance
 - b. Design versus final performance
 - c. Quality assurance statement and balancing certification
 - d. Name & address of Certifying Testing, Adjusting, and Balancing Agency
 - e. TAB Supervisor name and certification number
 - f. TAB technician name and certification number
 3. Section B. Air Outlet Test Report: Supply, Return, & Exhaust Air
 - a. Drawing or sketch number
 - b. Air Terminal Number / Air Handling Unit
 - c. Area served (room number / location if available)

- d. Terminal Type
- e. Terminal Size
- f. Ak factor if applicable
- g. Design Air Flow and velocity if applicable
- h. Final Air Flow of velocity if applicable
- i. Percent of Design Air Flow

4. Section C. Fan Test Data

- a. Designation
- b. Service
- c. Location
- d. Manufacturer
- e. Model/size
- f. Serial number
- g. Design RPM/Actual RPM
- h. Fan sheave size and bore
- i. Motor sheave size and bore
- j. Belts quantity number and size
- k. Bore Center to center distance
- l. Sheave type fixed adjustable (percent open)
- m. Motor manufacturer
- n. Nameplate horsepower
- o. Motor RPM
- p. Nameplate and actual voltage
- q. Nameplate and actual amperage
- r. Design brake horsepower/Actual brake horsepower
- s. Phase
- t. 60 Hertz or Variable frequency drive
- u. Service factor
- v. Frame size
- w. Starter size
- x. Heater size
- y. Design Air Flow/actual airflow
- z. Design total Static Pressure/actual total static pressure
- aa. Actual discharge static pressure
- bb. Actual suction pressure
- cc. Design CFM/Actual CFM

5. Section D. Air handling Unit Test Data additional required data (all readings for section C to be included):

- a. Filter (quantity & size)
- b. Outside Air Flow (specified / actual)
- c. Return Air Flow (specified / actual)
- d. Relief or Spill Air (specified and actual)
- e. Static Pressure Profile for all component parts filters, coils, humidifiers, sound attenuators (traps), etc., and inlet static pressure

6. Section E. Air Terminal Units:

- a. Type (Constant, Variable, Fan, Single, Dual)
 - b. Manufacture/Model.
 - c. Size
 - d. Actual Inlet Static Pressure
 - e. Minimum / Maximum Design Air Flow
 - f. Minimum / Maximum Actual Air Flow
 - g. Actual pressure drop across flow station or sensor
 - h. DDC boxes coefficient multipliers or Cv's
 - i. Address number, or identifying DDC unit number
7. Section F. Duct Traverse Data:
- a. Designation (System zone/branch)
 - b. Duct Size & Area
 - c. Test Readings & Calculations.
 - d. Design & Actual Duct Static Pressure
 - e. Design & Actual Air Flow (CFM).
 - f. Correction factor for altitude density and temperature if applicable.
 - g. Method used
8. Section G. Pump Test Data:
- a. Designation/location
 - b. Manufacture
 - c. Size and type
 - d. Impeller size
 - e. Required NPSH (open system)
 - f. Motor manufacture
 - g. Hoarse power
 - h. Frame size
 - i. Service factor
 - j. Phase
 - k. 60 hertz or Variable Frequency Drive
 - l. Rated amps/actual amps
 - m. Rated volts/actual volts
 - n. Starter size
 - o. Heater size
 - p. Block tight, discharge and suction pressures
 - q. Block tight, total head pressure
 - r. Actual suction Pressure
 - s. Actual discharge Pressure
 - t. Design and actual operating head pressure
 - u. Design and actual BHP
 - v. Design and actual GPM
9. Section H. Chiller, Boiler, Heat Exchanger Test Data:
- a. Service/Designation
 - b. Location
 - c. Manufacturer
 - d. Model Number
 - e. Serial Number

- f. Design and actual entering & leaving water temperature.
- g. Design GPM & pressure drop / Actual GPM & pressure drop.
- h. Condenser data (if applicable).

3.7. HYDRONIC BALANCING:

- A. Terminal unit/coil test data: When balancing hydronic terminal units or hydronic coils choose one of the five alternate methods for achieving design GPM.
 - 1. Balance by unit pressure drop (alternate #1)
 - a. Design pressure drop
 - b. Entering pressure
 - c. Leaving pressure
 - d. Actual pressure differential
 - e. Actual GPM
 - 2. Water temperature differential (alternate #2)
 - a. Design water temperature difference
 - b. Actual entering water temperature
 - c. Actual leaving water temperature
 - d. Actual water temperature differential
 - e. Actual calculated GPM
 - 3. Air temperature differential (alternate #3)
 - a. Design air temperature differential
 - b. Actual entering air temperature
 - c. Actual leaving air temperature
 - d. Actual air temperature differential
 - e. Actual calculated CFM
 - 4. Calibrated balancing valve (flow meter) (alternate #4)
 - a. Manufacture
 - b. Size
 - c. Actual set point
 - d. Actual valve Pd
 - e. Actual valve GPM
 - 5. Ultrasonic/Doppler (alternate #5)
 - a. Pipe size
 - b. Pipe type
 - c. Meter setup
 - d. Sonic velocity
 - e. Actual GPM
- B. All reports contain:
 - 1. Method used
 - 2. Drawing number
 - 3. Location or area served
 - 4. Design GPM
 - 5. Final balance Valve position
 - 6. Actual GPM

END OF SECTION