

SECTION 15990 (23 05 93)

TESTING, ADJUSTING, AND BALANCING

PART 1 DESIGN DIRECTIVE

1.1 SUMMARY

- A. This Section specifies the requirements and procedures for mechanical systems testing, adjusting, and balancing (TAB). Requirements include measurement and establishment of the fluid (hydronic and air) quantities of the mechanical systems as required to meet design specifications, and recording and reporting the results.
- B. Test, adjust, and balance the following mechanical systems:
 - 1. Supply air systems.
 - 2. Return air systems.
 - 3. Exhaust air systems.
 - 4. Outside air systems.
 - 5. Hot water systems.
 - 6. Condenser water systems.
 - 7. Chilled water systems.
 - 8. Domestic hot water recirculation systems.
- C. The Testing and Balancing (TAB) Contractor will work with the commissioning agent as required to commission the building (in accordance with project Commissioning specifications).

1.2 QUALITY ASSURANCE

- A. The contractor shall have one of the following qualifications:
 - 1. Be an independent testing, adjusting, and balancing agency that follow and execute testing balancing procedures per National Environmental Balancing Bureau (NEBB) or Associated Air Balance Council (AABC) standard guidelines required for this project.
 - 2. Be an independent testing, adjusting, and balancing agency with a minimum of ten years experience with similar projects. The contractor shall provide suitable evidence of past performance, including references, justifying the firm's capabilities.
 - 3. Other contractors may be acceptable with prior approval from DC-FOM. The approval process is to be submitted prior to bids being processed. Pre-approved contractors are:
 - a. Boone Testing & Balancing, East Burke, VT
 - b. Tekon Technical Consultants, Inc., Rochester, NH
 - c. Hood T.A.B., LLC., Andover, MA
- B. Codes and Standards:
 - 1. NEBB: "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems".
 - 2. AABC: "National Standards For Total System Balance".
 - 3. ASHRAE:
 - a. ASHRAE 11-2008 (RA 2017).
 - b. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2013

- c. ASHRAE/IESNA 90.1-2007 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2007, Section 6.7.2.3 - "System Balancing."
- C. The balancing contractor shall be hired within four weeks of the mechanical contractor. The balancing contractor shall be named to DC-FO&M. The balancing contractor shall review the drawings to determine where balancing dampers and valves will need to be located. The design team, with the mechanical & general contractors, and DC-FO&M, shall review the modified drawings for locations of access to the dampers and valves.
- D. Prior to beginning of the testing, adjusting, and balancing procedures, schedule and conduct a conference with representatives of the installers of the mechanical systems. The objective of the conference is final coordination and verification of system operation, readiness for testing, adjusting, and balancing, and to establish procedures for mechanics to be available to perform incidental remedial work.

1.3 SUBMITTALS

- A. The first submittal, to be made within thirty days of award of the TAB Contractor Contract, shall consist of the following:
 - 1. Submit a synopsis of the testing, adjusting, and balancing procedures. Submit, if requested the outline of the TAB plan and approach for each system and component to the Cx Authority, Engineer, and the controls contractor six weeks prior to starting the TAB.
 - 2. Submit sample NEBB or AABC forms of each type of equipment required to be tested and balanced.
 - 3. Submit proof that all required instrumentation has been calibrated to tolerances specified in the referenced standards, within a period of two months prior to starting the project.
 - 4. Contractor qualifications:
 - a. NEBB or AABC certificate preferred.
 - b. Project portfolio illustrating ten years of experience; including project names, locations, dates and references
- B. The second submittal, to be made after the first submittal has been satisfactorily reviewed, shall be made after the balancing work has been performed.
 - 1. Submit testing, adjusting, and balancing reports bearing the signature of the test and balance lead technician. The reports shall be certified proof that the systems have been tested, adjusted, and balanced in accordance with the referenced standards; are an accurate representation of how the systems have been installed; are a true representation of how the systems are operating at the completion of the testing, adjusting, and balancing procedures; and are an accurate record of all final quantities measured, to establish normal operating values of the systems. Final reports shall be type written, organized and formatted as specified below

2. Report forms shall be those included in the first submittal for each respective item and system to be tested, adjusted, and balanced. Bind report forms complete with schematic systems diagrams and other data. Divide the contents of the binder into the below listed divisions, separated by divider tabs:
 - a. General Information and Summary
 - b. Air Systems
 - c. Hydronic Systems
 - d. Special Systems

3. Provide the following minimum information, forms and data:
 - a. General Information and Summary: Inside cover sheet to identify testing, adjusting, and balancing agency, Contractor, Owner, Architect, Engineer, and Project; including addresses, contact names, and telephone numbers. Provide a listing of the instruments used for the procedures along with the proof of calibration.
 - b. The remainder of the report shall contain the appropriate forms containing as a minimum, the information indicated on standard report forms for each respective item and system. Prepare a schematic diagram for each item of equipment and system to accompany each respective report form.
 - c. Provide "mark-up floor plans" indicating the location of each air terminal with the reference number clearly indicated.

1.4 PROJECT CONDITIONS

- A. HVAC Systems shall be fully operational prior to beginning TAB procedures.

PART 2 PRODUCTS (Not Used).

PART 3 EXECUTION

3.1 PRELIMINARY PROCEDURES FOR NEW AND EXISTING AIR SYSTEM BALANCING

- A. Before operating the system, perform these steps:
 1. Obtain copies of satisfactorily reviewed shop drawings of all air handling equipment, outlets (supply, return, and exhaust) and temperature control diagrams.
 2. Compare design to installed equipment and field installations.
 3. Walk the system from the system air handling equipment to terminal units to determine variations of installation from design.
 4. Insure new filters are installed.
 5. Check all dampers for correct and locked position, and temperature control for completeness of installation before starting fans. Dampers shall include, but not be limited to, balancing, control, fire and smoke.
 6. Prepare report test sheets for both fans and outlets. Obtain manufacturer's outlet factors and recommended procedures for testing. Prepare a summation of required outlet volumes to permit a crosscheck with required fan volumes.

7. Determine best locations in main and branch ductwork for most accurate duct traverses.
8. Place outlet dampers in the full open position.
9. Prepare schematic diagrams of system “as-built” ductwork and piping layouts to facilitate reporting.
10. Check lubrication of all motors and bearings.
11. Check fan belt tension.
12. Check fan rotation.
13. Prepare individual schematic drawings of each air handling unit. Perform an air handler profile report.

3.2 PRELIMINARY PROCEDURES FOR HYDRONIC SYSTEM BALANCING

- A. Before operating the system perform these steps:
1. Open valves to full open position. Close coil bypass valves.
 2. Verify all strainers have been cleaned.
 3. Examine hydronic systems and determine if water has been treated and cleaned.
 4. Check pump rotation.
 5. Set automatic fill valves for required system pressure.
 6. Check expansion tanks to determine that they are not air bound.
 7. Check that the system is completely full of water.
 8. Check air vents at high points of systems and determine if all are installed and operating freely (automatic type) or to bleed air completely (manual type).
 9. Set temperature controls so all coils are calling for full flow.
 10. Check operation of automatic bypass valves.
 11. Check and set operating temperatures of chillers to design requirements.
 12. Check lubrication of all motors and bearings.

3.3 MEASUREMENTS

- A. Provide all required instrumentation to obtain proper measurements, calibrated to the tolerances specified in the referenced standards. Instruments shall be properly maintained and protected against damage.
- B. Provide instruments meeting the specifications of the referenced standards.
- C. Use only those instruments that have the maximum field measuring accuracy and are best suited to the function being measured. All testing equipment shall be of sufficient quality and accuracy to

test and/or measure system performance within the tolerances specified in the specifications. If not otherwise noted, the following minimum requirements apply: Temperature sensors and digital thermometers shall have a certified calibration to NIST traceable standards within the past 2-years to an accuracy of 0.5 degree F and a resolution of + or - 0.1 degree F. Pressure sensors shall have an accuracy of + or - 2.0% of the value range being measured (not full range of meter) and have been calibrated within the last year. All equipment shall be calibrated according to the manufacturer's recommended intervals and when dropped or damaged. Calibration tags shall be affixed or certificates readily available.

- D. Apply instrument as recommended by the manufacturer.
- E. Use instruments with minimum scale and maximum subdivisions and with scale ranges proper for the value being measured.
- F. When averaging values, take a sufficient quantity of readings that will result in a repeatability error of less than 5%. When measuring a single point, repeat readings until 2 consecutive identical values are obtained.
- G. Take all reading with the eye at the level of the indicated value to prevent parallax.
- H. Use pulsation dampeners where necessary to eliminate error involved in estimating average of rapidly fluctuation readings.
- I. Take measurements in the system where best suited to the task.
- J. Perform a system profile of all air handlers indicating on the previously developed sketch the pressure drop of each air handler component, including the inlet and discharge plenums.

3.4 PERFORMING TESTING, ADJUSTING, AND BALANCING

- A. Perform testing and balancing procedures on each system identified, in accordance with the detailed procedures outlined in the referenced standards.
 - 1. With respect to ceiling & ceiling inline fans, verify the airflow of each fan, and report the physical data of each.
 - 2. With respect to automatic balancing valves, verify fluid flow of each valve, and report the physical data of each.
- B. Artificially load the air filters in air handling units to simulate the midpoint resistance. Balance the duct distribution system when in this mode.
- C. Balance the low pressure side of the VAV boxes after insuring there is sufficient pressure at the box inlet. Obtain from the design consultant the diversity taken for the air handler. After all of the low pressure systems have been balanced, adjust the ATC system to open the diversity amount of the VAV boxes to the maximum airflow. Insure the variable frequency drive will maintain appropriate pressure levels to satisfy the design intent. Record sound power measurements where noise levels are suspect to exceed design criteria.
- D. Cut insulation, ductwork, and piping for installation of test probes to the minimum extent necessary to allow adequate performance of procedures.
- E. Patch insulation, ductwork, and housings, using materials identical to those removed.
- F. Seal ducts and piping, and test for and repair leaks. Seal insulation to reestablish integrity of the vapor barrier.

- G. Mark equipment settings, including damper control positions, valve indicators, fan speed control levers, and similar controls and devices, to show final settings. Mark with paint or other suitable, permanent identification materials.
- H. As part of the scope of this specification section, the contractor shall make any changes in the pulleys, belts, or sheaves, as required, for correct balance at no additional cost to the owner.
- I. Retest, adjust, and balance systems subsequent to significant system modifications, and resubmit test results.

3.5 RECORD AND REPORT DATA

- A. Record all data obtained during testing, adjusting, and balancing in accordance with, and on the forms recommended by the referenced standards, and as approved on the sample report forms.
- B. Prepare report of recommendations for correcting unsatisfactory mechanical performances when system cannot be successfully balanced.
- C. Assist in collecting equipment nameplate (make, model, serial number) and performance data (capacity, airflow, pressure, amps, voltage, horsepower) for Dartmouth's computerized maintenance management system. Provide "mark-up floor plans" indicating the location of each piece of equipment with the reference number clearly indicated.

END OF SECTION 15990 (23 05 93)