

SECTION 23 05 93

TESTING, ADJUSTING AND BALANCING

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: requirements for balancing the air and hydronic heating, ventilating and cooling systems to satisfy the project building design conditions.
- B. This contractor shall do the work under the general contractor.

1.02 QUALITY ASSURANCE

- A. Pre-qualified Contractors:
 - 1. Checkpoint
 - 2. Finn & Associates
 - 3. TAB Services
 - 4. Griffith Engineering
 - 5. JPG Engineering
 - 6. Double T Balancing
 - 7. JEDI
- B. Mechanical contractor shall obtain approval in writing from balancing contractor for type and size of balancing devices.
- C. Qualifications:
 - 1. Work under this section shall be executed under the direct supervision of a registered professional engineer having an established professional office in the state of Colorado and having an experience record of not less than five (5) years in the mechanical contracting industry, engaged in testing, balancing and adjusting of air and hydronic mechanical systems for not less than two (2) years of that time.
- D. Calibration and maintenance of instruments shall be in accordance with manufacturer's standards and recommendations, and calibration histories for each instrument available for examination.
- E. Accuracy of measurements in accordance with the applicable measurement means as listed in the chapter on measurement and instruments in the latest edition of ASHRAE Fundamentals Handbook.
 - 1. The TAB Contractor shall have obtained CAD reduced-size drawings from Engineer for the TAB report.
 - 2. The TAB shall return to the site to perform spot checks as directed by the DPS Project Manger during the commissioning process. The TAB shall include a minimum of 2 days on to provide spot checks as required by the commissioning agent.

1.03 STATUS OF SYSTEMS

- A. Air and water testing and balancing shall not begin until the system to be tested has been cleaned and flushed, and is in full working order. Where glycol is used, it shall be installed prior to hydronic balancing.
 - 1. Coordinate scheduling of work with the general contractor and appropriate subcontractors. Schedule TAB work to coincide with testing and verification of control systems.
 - 2. Provide written notification (within 24 hours) to the general contractor, engineer, and owner or his/her representative of any component and/or system deficiencies.
- B. Review available plans and specifications for the project and make visual observations during construction to determine that required balancing devices are being installed properly, and access to them is provided.
- C. Before any air balance work is done, systems shall be checked for:

1. Excessive duct leakage. Excessive duct leakage shall be corrected.
 2. Dirt and debris in ducts and/or air handling units (AHUs).
 3. Filters are installed and changed if they are dirty.
 4. Coil fins are clean and combed where needed.
 5. Verify motor rotation and correct if necessary.
 6. Excessive vibration. Excessive vibration shall be corrected.
 7. Equipment has been lubricated in accordance with manufacturer's recommendations..
 8. Proper operation of automatic control and smoke dampers shall be verified.
 9. Manual control dampers, fire dampers, and air outlet dampers are wide open.
 10. Duct end caps are properly installed and access doors closed.
 11. Grilles, registers, and diffusers are properly installed.
- D. Before any hydronic balancing work is done, the system shall be checked for:
1. Proper cleaning and flushing has been completed; glycol installed when specified.
 2. Dirty strainers have been cleaned.
 3. Correct pump rotation has been verified.
 4. Proper control valve installation and operation.
 5. Proper system static pressure to assure a completely filled system.
 6. Air in system eliminated.
 7. Proper flow meter and check valve installation.
 8. Manual balancing devices, control and shut-off valves are open.
- E. Put heating, ventilating, and air conditioning systems and equipment into full operation and continue operation of same during each working day of testing and balancing.
- F. For remodels and additions, TAB shall include the entire system being worked on. TAB of an extended or modified branch only shall not be accepted.

PART 2 PRODUCTS

PART 3 EXECUTION

3.01 EQUIPMENT

- A. Provide all instruments, tools, scaffolding, and ladders necessary to perform the work.
- B. Provide a set of instruments and tools necessary to balance the hydronic system for the District.

3.02 PERFORMANCE OF WORK

- A. Air Balance:
 1. Balance air supply, return, and exhaust systems and record air quantities for each air device.
 - a) The pilot tube traverse method for determining main duct CFM shall be used and recorded wherever possible; flow hood measurements at registers and diffusers may be totalized for branch duct quantities.
 2. Air diffuser pattern shall be set to minimize objectionable drafts and noise.
 3. The supply, return, and exhaust fan static pressures shall be set by the balancing firm (and the controls contractor if the systems have fan volume control).
 - a) The lowest fan speed resulting in satisfactory system performance shall be determined at full design delivery. Any inlet or outlet fan volume (balancing) dampers shall be in the wide-open position, and one path presenting the greatest resistance to flow shall be fully open and unobstructed.

- b) Fan RPMs shall not be increased by more than 10 percent without prior authorization from the engineer.
 - c) All adjustable speed sheaves on multiple-belt systems shall be replaced with fixed-speed sheaves by the balancing contractor. Sheaves shall be provided by mechanical contractor.
4. Provide system static pressure profiles that identify pressure differences across all components of air handling units and built-up systems. Pressure drops shall be individually measured and recorded for intake and exhaust vents, hoods, louvers, manual and auto control dampers, filters, coils, evaporative coolers, fans, etc.
 - a) On systems with OSA economizers, pressure drop values shall be recorded for both minimum and 100 percent OSA modes.
 5. Building static pressure adjacent to entries shall be measured and recorded. Adjust systems to maintain a positive pressure of 0.05" w.c. where possible. Note any discrepancies.
 6. When air balancing is done and manual dampers are set, all test holes shall be plugged and all manual damper positions shall be marked.
- B. Hydronic Balance:
1. Converters: record all steam and/or water inlet and outlet temperatures, pressure drops, and flows.
 2. Record inlet and outlet water temperatures of all AHU coils, unit heaters, convectors, finned tube radiation, and other heat release equipment, as well as the corresponding media flows and pressure drops.
 3. Boilers: provide data for boiler operating conditions and thermal efficiencies. (Provide a copy of the independent testing agency report if testing is not performed by the TAB Contractor.) The TAB Contractor shall measure water side temperatures, pressures, and flow rates if so requested by owner and/or boiler testing agency.
 4. Chilled water systems: measure and record chilled and condenser inlet and outlet fluid temperatures, evaporator and condenser fluid pressure drops and flows, full-load motor running voltage and amperage, chiller refrigerant pressures and temperatures.
 5. DX cooling systems: record condensing unit full and part-load amperages, condenser fan(s) rotation and running amperage(s), high and low side refrigerant pressures, coil inlet and outlet air temperatures at full-load condition. Verify operation of condenser fan and head pressure controls.
 6. Hydronic pumps: record flow rates, pressures, running amperage, and full-load amperage at design flow and shutoff conditions. Verify and record impeller size and shutoff head.
 7. When all hydronic balancing is done, all balancing valve positions shall be marked and the locking devices set. Control valve bypass loops (where used) shall be set with the balancing valve to provide equal flow in either mode.
 8. Domestic Water Balance
 - a) Domestic pumps: record flow rates, pressures, running amperage, and full-load amperage at design flow and shutoff conditions. Verify and record impeller size and shutoff head.
 - b) When all domestic balancing is done, all balancing valve positions shall be marked and the locking devices set. Control valve bypass loops (where used) shall be set with the balancing valve to provide equal flow in either mode.
- C. Electric Heat:
1. Record full-load and part-load (when staged) amperage and voltage of all electric heating elements.
 2. Verify that electric heat is locked out when the flow rate drops below minimum requirements.
- D. Smoke Systems:
1. Test all smoke management systems per Chapter 4 of the latest version of NFPA 92A.
 2. Refer to Division 23 Controls, for smoke management sequences.

3. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

3.03 SYSTEM TOLERANCES

- A. Allowable tolerances:
 1. Tolerances of adjustment for air handling systems: \pm 5 percent for supply systems and \pm 10 percent for return and exhaust systems from figures shown on drawings.
 2. Tolerances of adjustment for hydronic systems: \pm 10 percent of design conditions shown on drawings.

3.04 TAB REPORT

- A. The report shall include all test and balance data, as well as information on any discrepancy from specifications or performance standards. All discrepancies shall be included in a separate section. As a minimum, the following items shall be included:
 1. Belt and drive sheave information (as installed and as changed), fan nameplate information, motor nameplate information, and amperage and voltage to all motors (in various operating modes where applicable). Also, maximum and minimum RPM settings on VFD units.
 2. Static pressure drops across all components of the air systems. Static pressure profile for each AHU system.
 3. Required and final balanced CFM at each system terminal unit. Include the terminal size, inlet static pressure, temperature, and velocities read to attain the required CFM.
 4. Pump and motor nameplate information, amperage and voltage to all motors, flow and pressure drop across all system terminals, pressure rise across the pump in psi and feet of head, both operating and shut-off, and maximum operating GPM.
 5. Refrigerant system operating amperages, pressures, and temperatures.
 6. Overload protection data for all motors shall be recorded. Starter and/or VFD brand, model, enclosure type, installed overload devices, original ratings and set points (and revised device ratings and set points when applicable) shall be recorded. If the starters (and/or VFDs) were furnished by the mechanical contractor, the overloads shall be verified and changed to the correct size when necessary, and so noted in the report. If the starters were furnished by the electrical contractor, the correct overload device sizes and settings shall be noted in the report and the electrical contractor shall be advised of all discrepancies.
- B. A reduced set of drawings (11" x 17") shall be included in the report with all terminals (VAV boxes, air outlets, inlets, coils, unit heaters, finned tube loops, radiant panel loops, etc.) clearly marked, all equipment designated, and all referenced to the device test reports. The contract drawings may be reduced and used for this purpose, if they remain legible. Otherwise, CAD reduced-size drawings shall be obtained from the engineer.
- C. The TAB contractor shall submit bound copies of the final TAB report to the owner or his/her representative at least 15 days prior to the mechanical contractor's request for final inspection. The report shall include all operating data as previously listed, a list of all equipment used in TAB work, and shall be signed by the supervising professional engineer or certified TAB supervisor and certified TAB technician, and affixed with his certification seal. Final acceptance of this project will not take place until a satisfactory report is received.

3.05 FIELD VERIFICATION

- A. Upon request of the owner or engineer, a representative of the balancing firm performing the work shall demonstrate fluid flow quantities shown in the report by reading back outlets or terminals selected at random. It is understood that the operating mode of the system shall be the same for the readback as it was during balancing, and the number of readings verified will not exceed 10 percent of the total in the report.
- B. When deemed necessary by the owner or engineer, the balancing firm shall run temperature, pressure, and/or humidity recordings, and shall be prepared to verify any of the report test results in the presence of the owner and/or engineer when requested.

END OF SECTION 23 05 93