

SECTION 23 05 93
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. Air Moving and Conditioning Association, Inc. (AMCA): 203, Field Performance Measurement of Fan Systems.
 2. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE): HVAC Applications Handbook.
 3. Associated Air Balance Council (AABC): National Standards for Field Management and Instrumentation Total System Balance.
 4. National Environmental Balancing Bureau (NEBB):
 - a. Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems.
 - b. Procedural Standards for Measuring Sound and Vibration.
 5. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA): HVAC Testing, Adjusting, and Balancing Manual.

1.02 SUBMITTALS

- A. Informational Submittals:
1. Documentation of experience record of testing authority.
 2. Documentation of current AABC or NEBB certifications for those technicians in responsible charge of the work under this Contract.
 3. Submit detailed test and balance procedures, including test conditions for systems to be tested, prior to beginning the Work.
 4. Written verification of calibration of testing and balancing equipment.
 5. Balancing Log Report following completion of system adjustments including test results, adjustments, and rebalancing procedures.

1.03 QUALITY ASSURANCE

- A. Air Balancing and Test Agency Qualifications:
1. Certification by AABC or NEBB for testing, adjusting and balancing of HVAC systems.
 2. Corporately and financially independent organization functioning as an unbiased testing authority.
 3. Professionally independent of manufacturers, suppliers, and installers of HVAC equipment being tested.

4. Have a proven record of at least five similar projects.
5. Employer of engineers and technicians regularly engaged in testing, adjusting and balancing of HVAC equipment and systems.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Provide materials, tools, test equipment, computers and instrumentation required to complete the work included.
- B. Test Hole Plugs: Plug test holes in ducts with plugs made for that purpose and replace any insulation removed to specified conditions.
- C. Drives for Belt-Driven Fans:
 1. Furnish cast iron or flanged steel sheaves.
 2. Sheaves and belt combination shall be capable of providing 150 percent of motor horsepower.

PART 3 EXECUTION

3.01 GENERAL

- A. Adjust and balance air and water systems in accordance with standard procedures and recognized practices of the AABC or SMACNA.
- B. Adjust and balance the following systems:
 1. Supply, return, ventilation and exhaust air systems.
 2. Relocated scrubber system.
 3. Heating, cooling and condenser water systems.

3.02 ADJUSTING AND BALANCING AIR SIDE

- A. Preparation:
 1. Prior to beginning the Work, perform the following activities:
 - a. Review shop drawings and installed system for adequate and accessible balancing devices and test points.
 - b. Recommend to Engineer dampers that need to be added or replaced in order to obtain proper air control.
 - c. Verify proper startup procedures have been completed on the system
 - d. Verify controls installation is complete and system is in stable operation under automatic control.
 - e. Verify test instruments have been calibrated to a recognized standard and are within manufacturer's recommended calibration interval before beginning the Work.

B. General:

1. When adjustments are made to a portion of a fan system, reread other portions of that same system to determine effects imposed by adjustments. Readjust as necessary.
2. Lock and mark final positions of balancing dampers with permanent felt pen.

C. Equipment Data:

1. Collect the following data and included in final report:
 - a. Type of unit.
 - b. Equipment identification number.
 - c. Equipment nameplate data (including manufacturer, model, size, type, and serial number).
 - d. Motor data (frame, hp, volts, FLA rpm, and service factor).
 - e. Sheave manufacturer, size, and bore.
 - f. Belt size and number.
 - g. Sheave centerline distance and adjustment limits.
 - h. Starter and motor overload protection data.
 - i. Include changes made during course of system balancing.

D. Fan Systems:

1. Measure fan system performance in accordance with AMCA 203.
2. In each system at least one airpath from fan to final branch duct termination shall have dampers fully open. Achieve final air quantities by adjusting fan speed.
3. Adjust Fan Air Volumes:
 - a. Adjust fan speeds and motor drives for required equipment air volumes, with allowable variation of plus 10 percent minus 0 percent.
 - b. After final adjustments, do not operate motor above nameplate amperage on any phase.
 - c. After final adjustments, do not operate fan above maximum rated speed.
 - d. Perform airflow test readings under simulated or actual conditions of full cooling, full heating, minimum outside air, full outside air and exhaust, and full return air.
 - e. Provide and make drive and belt changes on motors or fans as required to adjust equipment to specified conditions. Drives shall be able to deliver 150 percent of motor horsepower. Provide written notice to air handling unit manufacturer and **Owner** if drive or belt changes were made.

4. Adjust outside air dampers, return air dampers, relief air dampers, exhaust air dampers, and motorized louvers for maximum and minimum air requirements.
5. Read and record static pressures at unit inlet and discharge, each filter set, coils, dampers, plenums, and mixing dual-duct or adjustable-volume boxes, on every supply, return, and exhaust fan for each test condition.
6. Read and record motor amperage on all phases for each test condition.

E. Air Terminal Devices:

1. Terminal Airflow Calibration: Calibrate and set the flow coefficients in terminal controller units to ensure controller readings are identical to measured values. This shall be a one-point calibration at maximum flow conditions. Record coefficient values.
2. Test each terminal flow device at minimum and maximum flow conditions. Ensure terminal controller is under control at time of each test.
3. If airflow of terminal device is derived from two or more flow streams, the individual air streams shall be measured and recorded independently for each test.
4. In each terminal system at least one airpath from terminal to final duct termination shall have dampers fully open.
5. Adjust air volumes on each terminal to quantity shown, with allowable variation of plus 10 percent minus 0 percent.

F. Air Outlets and Inlets:

1. In each system at least one air path from fan to final branch duct termination shall have dampers fully open.
2. Adjust air volumes on supply diffusers and grilles, and on return and exhaust grilles, to the quantity shown, with allowable variation of plus 10 percent and minus 0 percent.
3. Adjust diffusers and grilles for proper deflection, throw, and coverage. Eliminate drafts and noise where possible.
4. After final adjustments are made secure dampers to prevent movement and mark final positions with permanent felt pen.

G. Building Static Pressure:

1. Measure and record building static pressure relative to outside in perimeter entrances during normal system conditions that would yield widest range in internal building pressure.

H. Zone Differential Pressure:

1. Test and adjust differential pressures by setting design flows to meet required flow direction and pressure differential during worst case conditions of systems serving zone being adjusted and of adjacent zones.
2. Zone differentials for this project include:

- a. Adjust make up air/ventilation air so that office areas and electrical rooms remain slightly positive relative to process areas.
3. Provide written notice to Engineer of zone leakage conditions preventing design differential requirements to be met.

3.03 ADJUSTING AND BALANCING WATER SIDE

A. Preparation: Prior to beginning the Work, perform the following activities:

1. Review shop drawings and installed system for adequate and accessible balancing devices and test ports.
2. Recommend to Engineer devices needed to be added or replaced in order to obtain proper water control.
3. Verify proper startup procedures have been completed on system.
4. Verify controls installation is complete and system is in stable operation under automatic control.
5. Verify hydronic systems have been filled and are clean. Examine a sample of strainers to ensure cleanliness.
6. Verify manual air vents have been bled and expansion tanks and automatic air vents are functioning.
7. Verify control valves and coil connections are complete and properly installed.

B. General:

1. When adjustments are made to a portion of a water system, reread other portions of that same system to determine effects imposed by adjustments. Readjust as necessary.
2. Correctly adjust water flow readings for mixtures other than pure water.
3. Throttling of butterfly and other non-balancing device valves shall not be allowed.
4. Lock and mark final positions of balancing devices with a centerpunch or permanent felt pen.

C. Equipment Data:

1. Collect the following data and include in final report:
 - a. Type of pump.
 - b. Equipment identification number.
 - c. Equipment nameplate data (including manufacturer, model, size, type, impeller size and serial number).
 - d. Pump capacity (flow rate and differential pressure).
 - e. Drive data.
 - f. Motor data (frame, hp, volts, FLA rpm, and service factor).
 - g. Starter and motor overload protection data.
 - h. Include changes made during course of system balancing.

D. Pumps:

1. Verify impeller size through a “dead-head” test. Do not perform on positive displacement pumps.
2. Adjust water to achieve design flows at all modes of operation during single and multiple pump operation.
3. Test redundant and stand-by pumps.
4. After final adjustments, do not operate motor above nameplate amperage on any phase.
5. Read and record pressures at pump inlet and discharge for each test condition.
6. Read and record motor amperage on all phases for each test condition.
7. Record and mark final position of balancing cocks, valves, and operators with a permanent felt pen or centerpunch.

E. Terminal Flow Devices:

1. Adjust water systems for required flow rates at each coil, connection, and terminal device.
2. Provide proper flow through individual fin tube sections, evaporator and condenser circuits, each boiler loop, each pump, and recirculation loops.
3. Measure and adjust flow through valves and valve bypass lines.
4. Record and mark final position of balancing cocks, valves, and operators with a permanent felt pen or centerpunch.
5. Read and record differential pressures across coils, control valves, chiller bundles, boilers, and heat exchanges.

F. Tolerances:

1. Heating Water Flow Rate: Plus 10 percent to minus 0 percent.
2. Condenser Water Flow Rate: Plus 10 percent to minus 0 percent.

3.04 FIELD QUALITY CONTROL

A. General: Perform functional tests as required by Section 01 91 14, Equipment Testing and Facility Startup.

B. Performance Testing:

1. Heating or Sensible Cooling Coil Testing:
 - a. Adjust system as required to achieve design flow conditions for both air and water sides of coil.
 - b. Measure and record airflow rate, water flow rate, entering air temperature, entering water temperature, leaving air temperature and leaving water temperature.
2. Cooling or Dehumidification Coil Testing:
 - a. Adjust system as required to achieve design flow conditions for both air and water sides of coil.
 - b. Measure and record airflow rate, water flow rate, entering air dry bulb and wet bulb temperatures, entering water temperature,

leaving air dry bulb and wet bulb temperatures and leaving water temperature.

3. Vibration Testing:

- a. Upon completion of air and water system balance, perform vibration testing as specified below for the following rotating or reciprocating equipment:
 - 1) **Existing Scrubber System**
- b. Test Procedures:
 - 1) Identify maximum vibration velocity limits as specified for each piece of equipment to be tested.
 - 2) Take measurements at each bearing housing using calibrated electronic analyzer.
 - 3) Measure velocity in direction parallel to rotating shaft, and in two directions perpendicular to shaft and to each other. Align measurement directions where possible to the horizontal and vertical planes.
 - 4) Record log shall include equipment symbol or tag, location, identification, specified vibration velocity limits, and maximum measured velocity in each direction.
 - 5) Notify Engineer if amplitude exceeds upper limit specified.

C. Balancing Log Report Requirements:

1. Include narrative description for each system explaining TAB methodology and assumptions used. Clearly identify test conditions for tests performed. Include control setpoint.
2. Log and record operational information from every test for each system, as necessary to accomplish services described.
3. Include equipment data for units tested.
4. Include reduced set of HVAC Drawings or system schematic diagrams with each element uniquely identified and indexed to balance log.
5. Indicate recorded site values, and velocity and mass correction factors used to provide equivalent standard air quantities.
6. Include separate section in log, if necessary, describing operating difficulties in air or water systems that could not be eliminated by specified procedures. Identify these problems by system and location within building; include outline or summary of condition and its effect on building, and describe corrective actions attempted and recommended.

D. Quality Control Verification:

1. After adjustments have been completed and balance logs submitted, balancing and testing agency shall be available to demonstrate the following:

- a. Air and water balancing procedures, vibration tests, and verification of test results.
- b. Perform spot tests on a maximum of 20 percent of total diffusers and grilles, on two air handling fan devices per building, and on 10 percent of total water balance fittings, with measuring equipment used in original tests, at random points selected by Engineer.
- c. Results of these spot tests shall agree with balance logs within plus or minus 10 percent. Where this accuracy cannot be verified, rebalance portions of system as requested by Engineer.
- d. At completion of rebalance procedures, perform another spot test if required to verify results.

END OF SECTION