SECTION 23 05 90
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1. DESCRIPTION:

A. Testing, adjusting, and balancing (TAB) of heating, ventilating and air conditioning (HVAC) systems. TAB includes the following:
   1. Planning systematic TAB procedures.
   2. Design Review Report.
   3. Systems Inspection report.
   4. Duct Air Leakage test report.
   5. Systems Readiness Report.
   6. Balancing air and water distribution systems; adjustment of total system to provide design performance; and testing performance of equipment and automatic controls.
   7. Vibration and sound measurements.
   8. Recording and reporting results.
   9. Exemptions:
      a. Mechanical supply systems for projects that serve dwelling units and sleeping units in hotels, motels, boarding houses or similar units. Note that outdoor air systems and exhaust systems must still be balanced on all projects to meet the project's enforced mechanical code.

B. Definitions:
   1. Basic TAB used in this Section: Chapter 37, "Testing, Adjusting and Balancing" of 2007 ASHRAE Handbook, "HVAC Applications".
   2. AABC: Associated Air Balance Council.
   3. NEBB: National Environmental Balancing Bureau.
   4. Hydronic Systems: Includes chilled water, condenser water, heating hot water, domestic hot water circulating systems and pumped domestic water supply systems.
   5. Air Systems: Includes all outside air, supply air, return air, exhaust air and relief air systems.

2. QUALITY ASSURANCE:

A. Qualifications:
   1. TAB Agency: The TAB agency shall be a subcontractor of the General Contractor and shall report to and be paid by the General Contractor.
   2. The TAB agency shall be either a certified member of AABC or certified by the NEBB to perform TAB service for HVAC, water balancing and vibrations and sound testing of equipment. The certification shall be maintained for the entire duration of duties specified herein. If, for any reason, the agency loses subject certification during this period, the General Contractor shall immediately notify the Architect and submit another TAB firm for approval. Any agency that has been the subject of disciplinary action by either the AABC or the NEBB within the five years preceding contract award shall not be eligible to perform any work related to the TAB. All work performed in this section and in other related sections by the TAB agency shall be considered invalid if the TAB agency loses

its certification prior to contract completion, and the successor agency's review shows unsatisfactory work performed by the predecessor agency.

3. TAB Specialist: The TAB specialist shall be either a member of AABC or an experienced technician of the agency certified by NEBB. The certification shall be maintained for the entire duration of duties specified herein. If, for any reason, the Specialist loses subject certification during this period, the General Contractor shall immediately notify the Architect and submit another TAB Specialist for approval. Any individual that has been the subject of disciplinary action by either the AABC or the NEBB within the five years preceding contract award shall not be eligible to perform any duties related to the HVAC systems, including TAB. All work specified in this section and in other related sections performed by the TAB Specialist shall be considered invalid if the TAB Specialist loses its certification prior to contract completion and must be performed by an approved successor.
4. TAB Specialist shall be identified by the General Contractor within 60 days after the notice to proceed. The TAB specialist will be coordinating, scheduling and reporting all TAB work and related activities and will provide necessary information as required by the Resident Engineer. The responsibilities would specifically include:
    a. Shall directly supervise all TAB work.
    b. Shall sign the TAB reports that bear the seal of the TAB standard. The reports shall be accompanied by report forms and schematic drawings required by the TAB standard, AABC or NEBB.
    c. Would follow all TAB work through its satisfactory completion.
    d. Shall provide final markings of settings of all HVAC adjustment devices.
    e. Permanently mark location of duct test ports.
5. All TAB technicians performing actual TAB work shall be experienced and must have done satisfactory work on a minimum of 3 projects comparable in size and complexity to this project. Qualifications must be certified by the TAB agency in writing. The lead technician shall be certified by AABC or NEBB.
6. Test Equipment Criteria: The instrumentation shall meet the accuracy/calibration requirements established by AABC National Standards or by NEBB Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems and instrument manufacturer. Provide calibration history of the instruments to be used for test and balance purpose.
7. Tab Criteria:
    a. One or more of the applicable AABC, NEBB or SMACNA publications, supplemented by ASHRAE Handbook "HVAC Applications" Chapter 36, and requirements stated herein shall be the basis for planning, procedures, and reports.
    b. Flow rate tolerance: Following tolerances are allowed. For tolerances not mentioned herein follow ASHRAE Handbook "HVAC Applications", Chapter 36, as a guideline. Air Filter resistance during tests, artificially imposed if necessary, shall be at least 100 percent of manufacturer recommended change over pressure drop values for pre-filters and after-filters.
    c. Air handling unit and all other fans, (cubic feet per minute): Minus 0 percent to plus l0 percent.
    d. Air terminal units (maximum values): Minus 2 percent to plus l0 percent.
    e. Exhaust hoods/cabinets: 0 percent to plus l0 percent.
    f. Minimum outside air: 0 percent to plus 10 percent.

g. Individual room air outlets and inlets, and air flow rates not mentioned above: Minus 5 percent to plus l0 percent except if the air to a space is 100 CFM or less the tolerance would be minus 5 to plus 5 percent.
h. Heating hot water pumps and hot water coils: Minus 5 percent to plus 5 percent.
i. Chilled water and condenser water pumps: Minus 0 percent to plus 5 percent.
j. Chilled water coils: Minus 0 percent to plus 5 percent.
k. Domestic water circulation and booster systems: Minus 5 percent to plus 5 percent.

3. SUBMITTALS

A. Submit names and qualifications of TAB agency and TAB specialists within 60 days after the notice to proceed. Submit information on three recently completed projects and a list of proposed test equipment with calibration reports.

B. Submit Following for Review and Approval:
1. Design Review Report within 90 days for conventional design projects and within 60 days for design-build projects.
2. Systems inspection report on equipment and installation for conformance with design.
3. Duct Air Leakage Test Report.
4. Systems Readiness Report.
5. Intermediate and Final TAB reports covering flow balance and adjustments, performance tests, vibration tests and sound tests.
6. Include in final reports uncorrected installation deficiencies noted during TAB and applicable explanatory comments on test results that differ from design requirements.

.

C. Prior to request for Final or Substantial Completion inspection, submit completed Test and Balance report for the area.

4. APPLICABLE PUBLICATIONS:

A. The following publications form a part of this specification to the extent indicated by the reference thereto. In text the publications are referenced to by the acronym of the organization.

B. American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE): 2007 HVAC Applications ASHRAE Handbook, Chapter 37, Testing, Adjusting, and Balancing and Chapter 47, Sound and Vibration Control.

C. Associated Air Balance Council (AABC): 2002 AABC National Standards for Total System Balance.

D. National Environmental Balancing Bureau (NEBB):
7th Edition 2005 Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems. 2nd Edition 2006 Procedural Standards for the Measurement of Sound and Vibration. 3rd Edition 2009 Procedural Standards for Whole Building Systems Commissioning of New Construction.

E. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):
3rd Edition 2002 HVAC SYSTEMS Testing, Adjusting and Balancing.

PART 2 – PRODUCTS

1. PLUGS:

A. Provide plastic plugs to seal holes drilled in ductwork for test purposes.

PART 3 – EXECUTION

1. GENERAL:

A. Obtain applicable contract documents and copies of approved submittals for HVAC equipment and automatic control systems.

2. DESIGN REVIEW REPORT:

A. The TAB Specialist shall review the Contract Plans and specifications and advise the Architect of any design deficiencies that would prevent the HVAC systems from effectively operating in accordance with the sequence of operation specified or prevent the effective and accurate TAB of the system. The TAB Specialist shall provide a report individually listing each deficiency and the corresponding proposed corrective action necessary for proper system operation.

3. SYSTEMS INSPECTION REPORT:

A. Inspect equipment and installation for conformance with design.

B. The inspection and report is to be done after air distribution equipment is on site and duct installation has begun, but well in advance of performance testing and balancing work. The purpose of the inspection is to identify and report deviations from design and ensure that systems will be ready for TAB at the appropriate time.

C. Reports: Follow check list format developed by AABC, NEBB or SMACNA, supplemented by narrative comments, with emphasis on air handling units and fans. Check for conformance with submittals. Verify that diffuser and register sizes are correct. Check air terminal unit installation including their duct sizes and routing.

4. DUCT AIR LEAKAGE TEST REPORT:

TAB Agency shall perform the leakage test as outlined in the duct system specification for agency's role and responsibilities in witnessing, recording and reporting of deficiencies.

5. SYSTEM READINESS REPORT:

A. The TAB Contractor shall measure existing air and water flow rates associated with existing systems utilized to serve renovated areas as indicated in the drawings. Submit report of findings to Architect

B. Inspect each system to ensure that it is complete, including installation and operation of controls. Submit report to Architect in standard format and forms prepared and or approved by the Commissioning Agent if applicable.

C. Verify that all items such as ductwork, piping, ports, terminals, connectors, etc., that are required for TAB are installed. Provide a report to the Architect.

6. TAB REPORTS:

A. Submit an intermediate report for 25 percent of systems and equipment tested and balanced to establish satisfactory test results.

B. The TAB contractor shall provide raw data in writing to the Architect if there is a problem in achieving intended results before submitting a formal report.

C. If over 20 percent of readings in the intermediate report fall outside the acceptable range, the TAB report shall be considered invalid and all contract TAB work shall be repeated and re-submitted for approval at no additional cost to the owner.

D. Do not proceed with the remaining systems until intermediate report is approved by the Architect.

7. TAB PROCEDURES:

A. Tab shall be performed in accordance with the requirement of the Standard under which TAB agency is certified by either AABC or NEBB.

B. General: During TAB, all related system components shall be in full operation. Fan and pump rotation, motor loads and equipment vibration shall be checked and corrected as necessary before proceeding with TAB. Set controls and/or block off parts of distribution systems to simulate design operation of variable volume air or water systems for test and balance work.

C. Coordinate TAB procedures with existing systems and any phased construction completion requirements for the project. Provide TAB reports for pre-construction air and water flow rate and for each phase of the project prior to partial final inspections of each phase of the project. Return existing areas outside the work area to preconstructed conditions.

D. Air Balance and Equipment Test: Include air handling units, fans, terminal units, fan coil units, room diffusers/outlets/inlets, computer room AC units, and laboratory fume hoods and biological safety cabinets. Include all supply, return and exhaust systems as well as outdoor air systems. Kitchen exhaust and make-up systems shall be balanced as well.
    1. Artificially load air filters by partial blanking to produce air pressure drop of manufacturer’s recommended pressure drop.

2. Adjust fan speeds to provide design air flow. Provide belt and sheave replacements as required to achieve design flow rates.
3. Test and balance systems in all specified modes of operation, including variable volume, economizer, and fire emergency modes. Verify that dampers and other controls function properly.
4. Variable air volume (VAV) systems:
    a. Coordinate TAB, including system volumetric controls, with controls contractor to ensure equipment can be operated under all operating conditions and that all equipment is ready for operation.
    b. The VAV box schedule specifies that maximum and minimum flow rates for VAV boxes. Check and readjust VAV flow rates if necessary. Balance air distribution from VAV on full cooling maximum scheduled flow. Reset room thermostats and check VAV operation from maximum to minimum cooling, to the heating mode, and back to cooling. Record and report the heating coil leaving air temperature when the VAV is in the maximum heating mode. Record and report outdoor air flow rates under all operating conditions (The test shall demonstrate that the minimum outdoor air ventilation rate shall remain constant under all operating conditions).
    c. Adjust operating pressure control setpoint to maintain the design flow to each space with the lowest setpoint.
    d. Record final measurements for air handling equipment performance data sheets.

E. Water Balance and Equipment Test: Include chillers, pumps, convertors, coils, coolers and condensers:
1. Adjust flow rates for equipment. Set coils and evaporator to values on equipment submittals, if different from values on contract drawings.
2. Variable Volume Systems: Balance systems design water flow and verify that variable flow controls function as designed.
3. Record final measurements for hydronic equipment on performance data sheets. Include entering and leaving water temperatures for heating and cooling coils, and for converters. Include flow rates, pressure drops, filter differential pressure and entering and leaving air temperatures (DB/WB for cooling coils) for air handling units and reheat coils. Make air and water temperature measurements at the same time.

8. VIBRATION TESTING:

A. Furnish instruments and perform vibration measurements as specified. Provide measurements for all rotating HVAC equipment of 1/2 horsepower and larger, including centrifugal/screw compressors, cooling towers, pumps, fans and motors.

B. Record initial measurements for each unit of equipment on test forms and submit a report to the Architect. Where vibration readings exceed the allowable tolerance, Contractor shall be directed to correct the problem. The TAB agency shall verify that the corrections are done and submit a final report to the Architect.

9. SOUND TESTING:

A. Perform and record required sound measurements as indicated herein.

B. Take readings in rooms, approximately ten percent of all rooms. The Architect may designate the specific rooms to be tested.

C. Provide cooling tower sound measurements as indicated.

D. Take measurements with a calibrated sound level meter and octave band analyzer of the accuracy required by AABC or NEBB.

E. Sound reference levels, formulas and coefficients shall be according to ASHRAE Handbook, "HVAC Applications", Chapter 46, SOUND AND VIBRATION CONTROL.

F. Where measured sound levels exceed specified level, the installing contractor or equipment manufacturer shall take remedial action approved by the Architect and the necessary sound tests shall be repeated.

G. Test readings for sound testing could go higher than 10 percent if determination is made by the Architect based on the recorded sound data.

10. MARKING OF SETTINGS:

A. Following approval of Tab final Report, the setting of all HVAC adjustment devices including valves and dampers shall be permanently marked by the TAB Specialist so that adjustment can be restored if disturbed at any time. Style and colors used for markings shall be high contrast in color and permanent.

11. IDENTIFICATION OF TEST PORTS:

A. The TAB Specialist shall permanently and legibly identify the location points of duct test ports. If the ductwork has exterior insulation, the identification shall be made on the exterior side of the insulation. All penetrations through ductwork and ductwork insulation shall be sealed to prevent air leaks and maintain integrity of vapor barrier.

12. PHASING:

A. Phased Projects: Testing and Balancing Work to follow project with areas shall be completed per the project phasing. Upon completion of the project all areas shall have been tested and balanced per the contract documents.

B. Existing Areas: Systems that serve areas outside of the project scope shall not be adversely affected. Measure existing parameters where shown to document system capacity.

13. COMMISSIONING:

A. Provide commissioning documentation in accordance with the requirements of the commissioning plan for all inspection, start up, and contractor testing required above and required by the Commissioning Agent.

END OF SECTION 23 05 90