

SECTION 15996 - TESTING, ADJUSTING AND BALANCING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

All division 15 specification sections, drawings, and general provisions of the contract apply to work of this section, as do other documents referred to in this section.

1.2 SCOPE OF WORK:

1.2.1 The Contractor shall obtain the services of an independent Test and Balance (TAB) Company which specializes in the testing and balancing of heating, ventilating and air conditioning (HVAC) systems to test, adjust and balance all HVAC systems in the building(s).

1.2.2 The work included in this section consists of furnishing labor, instruments, and tools required in testing, adjusting and balancing the HVAC systems as described in these specifications or shown on accompanying drawings. Services shall include checking equipment performance, taking the specified measurements, and recording and reporting the results. The testing, adjusting and balancing agency shall act as a reporting agency; that is, list and report each piece of equipment as to identification number, manufacturer, model number, serial number, proper location, specified performance, and report actual performance of all equipment as found during testing. The report is intended to be used during the life of the building as a ready reference indicating original conditions, equipment components, etc.

1.2.3 Representatives of the Test and Balance Company shall visit the job site during installation of the HVAC equipment, piping and ductwork as required.

1.2.4 Upon completion of the HVAC system installation, the Test and Balance Company shall perform all required testing and balancing with the full cooperation of the Contractor and his Sub-contractors. The Contractor shall make changes and/or adjustments to the HVAC system components that are required by the Test and Balance Company to accomplish proper balancing. The TAB agency shall not supply or install any materials or balancing devices, such as pulleys, drives, belts, etc. All of this work is by the Contractor and shall be performed at no additional cost to the Owner.

1.2.5 The test and balance report complete with a summary page listing all deficiencies shall be submitted to the Architect for review by his Mechanical Engineer. If the Mechanical Engineer agrees with the report, he shall sign it and return it to the Architect. The test and balance report must be complete and must be accepted by the Engineer prior to acceptance of the project. Any outstanding test and balance items shall be placed on the punch list and a monetary value shall be assigned to them.

1.2.6 After all deficiencies have been corrected the Mechanical Engineer shall sign the testing and balancing report, and the Test and Balance Company shall supply four (4) copies of the final and complete report to the Architect for inclusion in the Installation, Operation and Maintenance Manuals. ~~The TAB company shall also submit an additional three (3) copies of the report to the FDA consultant for validation.~~ **Delete the last sentence of paragraph 1.2.6. [Add7-25.a]**

1.2.7 The items requiring testing, adjusting, and balancing include (but are not restricted to) the following:

AIR SYSTEMS:

Supply Fan AHU
Return Fans
Filter Fans
Relief Fans
Exhaust Fans
Zone branch and main ducts
VAV systems
Diffusers, Registers, Grilles and Dampers
Coils (Air Temperatures)
Valves
Vibration Isolators

HYDRONIC SYSTEMS:

Pumps
System Mains and Branches
Chillers
Boilers
Coils

1.3 DEFINITIONS, REFERENCES, STANDARDS:

All work shall be in accordance with the latest standards of the National Environmental Balancing Bureau (NEBB) and shall conform to NIST standards. If these contract documents set forth more stringent requirements than the NEBB Standards, these contract documents shall prevail.

1.4 QUALIFICATIONS:

Agency Qualifications: The TAB Agency shall be a current member of NEBB. ~~Falsification of a TAB report for an FDA validated facility is a federal offense and the firm's actions shall be reported to the appropriate certifications agency.~~ **Delete the final sentence under paragraph 1.4. [Add7-25.b]**

1.5 SUBMITTALS:

1.5.1 Procedures and Agenda: The TAB agency shall submit the TAB procedures and agenda proposed to be used.

1.5.2 Sample Forms: The TAB agency shall submit sample forms, which shall include the minimum data required by the AABC National Standards or the NEBB Standards.

1.6 TAB PREPARATION AND COORDINATION:

1.6.1 Shop drawings, submittal data, up-to-date revisions, change orders, fan curves, pump curves and other data required for planning, preparation, and execution of the TAB work shall be provided

when available and no later than 15 days after the Designer has returned the final approved submittal data to the Contractor. ~~All of the above mentioned data shall be submitted to the FDA consultant for validation.~~ **Delete the final sentence of paragraph 1.6.1. [Add7-25.c]**

1.6.2 System installation and equipment startup shall be complete prior to the TAB agency's being notified to begin.

1.6.3 The building control system (BCS) contractor shall provide and install the control system, including all temperature, pressure and humidity sensors. These shall be calibrated for accurate control. If applicable, the BCS contractor shall install all necessary computers and computer programs, and make these operational. Assistance shall be provided as required for reprogramming, coordination, and problem resolution.

1.6.4 All test points, balancing devices, identification tags, etc., shall be accessible and clear of insulation and other obstructions that would impede TAB procedures.

1.6.5 Qualified installation or startup personnel shall be readily available for the operation and adjustment of the systems. Assistance shall be provided as required for coordination and problem resolution.

1.7 REPORTS:

Delete the requirements for FDA review in paragraphs 1.7.1, 1.7.2 and 1.7.3. [Add7-25.d]

~~1.7.1 Documentation - The TAB agency shall submit proposed documentation format for review by FDA consultant prior to execution of work.~~

1.7.2 Final TAB Report - The TAB agency shall submit the final TAB report for review by the Architect and FDA consultant. On plans provided, all outlets, devices, HVAC equipment, etc., shall be identified (including manufacturer, model number, serial number, motor manufacturer, HP, drive type, fan and motor sheaves and belt number), along with a numbering system corresponding to report unit identification. The TAB agency shall submit a NEBB Project Performance Guaranty assuring that the project systems were tested, adjusted and balanced in accordance with the project specifications and NEBB Standards. The Designer shall certify his approval on the Performance Guaranty.

1.7.3 Submit 4 copies of the Final TAB Report to the Architect for inclusion in the Installation, Operation and Maintenance Manuals and submit three (3) copies to the FDA consultant for validation.

PART 2 - INSTRUMENTATION

All instruments used for measurements shall be accurate and calibrated. Calibration and maintenance of all instruments shall be in accordance with the requirements of NEBB National Standards. Provide NIST calibration documents for each instrument used for measurements. Include this documentation with TAB report.

PART 3 - EXECUTION

3.1 GENERAL:

3.1.1 The specified systems shall be reviewed and inspected for conformance to design documents. Testing, adjusting and balancing on each identified system shall be performed. The accuracy of measurements shall be in accordance with AABC National Standards (or similar NEBB Standards). Adjustment tolerances shall be + or - 10% unless otherwise stated.

3.1.2 Equipment settings, including manual damper quadrant positions, valve indicators, fan speed control levers, and similar controls and devices shall be marked to show final settings.

3.1.3 All information necessary to complete a proper TAB project and report shall be per AABC or NEBB standards unless otherwise noted. The descriptions of work required, as listed in this section, are a guide to the minimum information needed.

3.1.4 TAB contractor shall cut insulation, ductwork and piping for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. Upon completion, patch insulation, ductwork, and housings using materials identical to those removed. Seal insulation to reestablish integrity of the vapor barrier.

3.1.5 TAB work shall include additional inspection and adjustment of components during the season following the initial balance to include re-balance of any items influenced by seasonal changes or as directed by the Owner.

3.2 AIR SYSTEMS:

Delete the testing requirements for filter fans, HEPA filters, filter housing leakage rates, and process room particle count from paragraph 3.2. [Add7-25.e]

3.2.1 The TAB agency shall verify that all ductwork, splitters, extractors, dampers, grilles, registers, and diffusers have been installed per design, are functional and set full open. Any leakage in the ductwork shall be repaired prior to the test. The TAB agency shall perform the following TAB procedures in accordance with the AABC National Standards or NEBB Standards:

For supply fans:

1. Fan Speeds - Test and adjust fan RPM to achieve design CFM requirements.
2. Current and Voltage - Test and record motor voltage and amperage, and compare data with the nameplate limits to ensure fan motor is not in or above the service factor.
3. Pitot-Tube Traverse - Perform a Pitot-tube traverse of main supply and return ducts, as applicable to obtain total CFM. If a Pitot-tube traverse is not practical, an explanation of why a traverse was not made must appear on the appropriate data sheet.
4. Outside Air - Test and adjust the outside air on applicable equipment using a Pitot-tube traverse. If a traverse is not practical, an explanation of why a traverse was not made must appear on the appropriate data sheet. If a traverse is not practical use the mixed-air temperature method if the inside and outside temperature differences is at least 20°

Fahrenheit or use the difference between Pitot-tube traverse of the supply and return air ducts.

5. Static Pressure - Test and record system static pressure, including the static pressure profile of each supply fan.

For return fans:

1. Fan Speeds - Test and adjust fan RPM to achieve design CFM requirements.
2. Current and Voltage - Test and record motor voltage and amperage, and compare data with the nameplate limits to ensure fan motor is not in or above the service factor.
3. Pitot-Tube Traverse - Perform Pitot-tube traverse of the main return ducts to obtain total CFM. If a Pitot-tube traverse is not practical, an explanation of why a traverse was not made must appear on the appropriate data sheet.
4. Static Pressure - Test and record system static pressure, including the static pressure profile of each return fan.

~~For filter fans:~~

- ~~1. Fan Speeds - Test and adjust fan RPM to achieve design CFM requirements.~~
- ~~2. Current and Voltage - Test and record motor voltage and amperage, and compare data with the nameplate limits to ensure motor is not in or above the service factor.~~
- ~~3. Pitot Tube Traverse - Perform a Pitot-tube traverse of main transfer ducts to obtain total CFM. If a Pitot-tube traverse is not practical, utilize a flow hood to obtain total CFM.~~
- ~~4. Static Pressure - Test and record system static pressure, including the static pressure profile of each fan with and without filters in place.~~

For exhaust fans:

1. Fan Speeds - Test and adjust fan RPM to achieve design CFM requirements.
2. Current and Voltage - Test and record motor voltage and amperage, and compare data with the nameplate limits to ensure motor is not in or above the service factor.
3. Pitot-Tube Traverse - Perform a Pitot-tube traverse of main exhaust ducts to obtain total CFM. If a Pitot-tube traverse is not practical, an explanation of why a traverse was not made must appear on the appropriate data sheet.
4. Static Pressure - Test and record system static pressure, including the static pressure profile of each exhaust fan.

For zone, branch and main ducts:

1. Adjust ducts to within design CFM requirements. As applicable, at least one zone balancing damper shall be completely open. Multi-diffuser branch ducts shall have at least one outlet or inlet volume damper completely open.

For VAV systems:

1. Identify the type, location, and size of each terminal box. This information shall be recorded on terminal box data sheets.
2. Test, adjust and record the maximum and minimum box air quantities for each VAV box.
3. Set volume regulators on all terminal boxes and associated return or exhaust air valves to meet design maximum and minimum CFM requirements.
4. Test and record entering and leaving air temperature of hot water coils with full heating air flow and water flow.
5. Insure the entering static pressure is sufficient for normal, proper box operation.

For diffusers, registers and grilles:

1. Tolerances - Test, adjust, and balance each diffuser, grille, and register to within 10% of design requirements. Minimize drafts. Include required CFM, initial test CFM and final CFM.
2. Identification - Identify the type, location, and size of each grille, diffuser, and register. This information shall be recorded on air outlet data sheets.

For coils:

1. Air Temperature - Once air flows are set to acceptable limits, take wet bulb and dry bulb air temperatures on the entering and leaving side of each cooling coil. Dry-bulb temperature shall be taken on the entering and leaving side of each heating coil.

~~For filters:~~

1. ~~Filter Integrity - Test each and every high efficiency particulate air (HEPA) filter integrity with approved pinhole scan test and document results for each filter.~~
2. ~~Static Pressure - Test and record static pressure drop across each HEPA filter and across each filter bank.~~
3. ~~Process Room Particulate Count - Test and record process room particulate count after installation of HEPA filters over time as required for FDA validation.~~
4. ~~Leak Testing - Test and record airflow leakage rate through housings/frames around individual HEPA filters and around medium (30%) and high (95%) efficiency filter banks.~~

3.3 HYDRONIC SYSTEMS:

3.3.1 The TAB agency shall, as applicable, verify that all hydronic equipment, piping, and coils have been filled and purged; that strainers have been cleaned; and that all balancing valves (except bypass valves) are set full open. Examine water in system and determine if it has been treated and cleaned. As applicable, it shall check air vents and expansion or compression tank for proper operation. The TAB agency shall perform the following testing and balancing functions in accordance with the AABC National Standards (or similar NEBB Standards):

For pumps:

1. Test and adjust chilled water, hot water, and condenser water pumps to meet design GPM requirements. Check pump rotation and verify impeller size. Check pumps for proper operation. Pumps shall be free of vibration and cavitation. Record appropriate gauge readings for final TDH and Block-Off/Dead head calculations. List pump N.P.S.H. (as applies).
2. Current and Voltage - Test and record motor voltage and amperage, and compare data with the nameplate limits to ensure pump motor is not in or above the service factor.

For system mains and branches:

1. Adjust water flow in pipes to within design GPM requirements. As applicable, at least one branch balancing valve shall be completely open.

For chillers:

1. Verify that chillers have been started by others and are in operation. Test and adjust chiller water flows to within 10% of design requirements by observing differential pressure gauge and setting balance valves.
2. Current and Voltage - Test and record motor voltage and amperage, and compare data with the nameplate limits to ensure compressor motor is not in or above the service factor.
3. Test and record entering and leaving temperature and pressure profiles of chillers.

For boilers:

1. Verify that boilers have been filled and started by others, and are in operation.
2. Current and Voltage - As applicable, test and record motor voltage and amperage, and compare data with the nameplate limits to ensure motor is not in or above the service factor.
3. Test and adjust water flow through water boilers.
4. Test and record entering and leaving temperature and pressure profiles of water or steam boilers.

For coils:

1. Tolerances - Test, adjust, and balance all chilled-water and hot-water coils within 10% of design requirements.

2. Verification - Verify the type, location, final pressure drop and GPM of each coil. This information shall be recorded on coil data sheets.

For control valves:

1. Check operation of automatic valves.
2. Test and record pressure drop and flow across control valves at full flow.

3.4 SOUND TESTING:

3.4.1 The TAB agency shall conduct sound testing in the following areas per AABC National Standards or NEBB Standards and to the criteria listed, using sound meter with octave band analyzer:

Delete requirement for sound testing in process rooms under paragraph 3.4. [Add7-25.f]

TEST AREA	NUMBER OF LOCATIONS	ACCEPTABLE NC LEVEL
General Offices	2	30-35
Computer/Equipment Rooms	2	40-45
Process Rooms	6	40-45
Warehouse/Storage	3	40-45

3.5 VIBRATION TESTING:

3.5.1 The TAB agency shall conduct vibration testing on the following equipment per AABC National Standards (or similar NEBB Standards). Test deflection in mils and velocity in inches per second shall be measured and the results compared to requirements in equipment specification sections.

EQUIPMENT:

- Air Handling Units
- Fans
- Pumps

3.6 INDOOR AIR QUALITY VERIFICATION:

3.6.1 The TAB agency shall take measurements at minimum outside air. It shall measure temperature and humidity uniformity throughout the space, check filter installation for proper fit, seal, and operation, and verify condensate drain operation. The TAB agency shall note any water damage or obvious contamination sources from inside or outside.

Under paragraph 3.6.1, the TAB agency shall take an IAQ measurement for one space served by each air-handling unit (6 total). [Add7-25.g]

3.6.2 The TAB agency shall conduct the following air sampling tests using TWA limits shown in ASHRAE Standard 62-1989, Table C-1:

1. Carbon dioxide
2. Carbon monoxide
3. Ozone

4. Nitrogen oxides
5. Formaldehyde

3.6.3 The TAB agency shall prepare a short report showing the results and location of each test, a summary of the HVAC operating conditions, and a listing of any discrepancies.

3.7 ADDITIONAL TAB SERVICES:

3.7.1 Job Site Inspections:

During construction, the TAB agency shall inspect the installation of pipe systems, sheet metal work, temperature controls, and other component parts of the HVAC systems as required.

3.7.2 Verification of HVAC Controls:

The TAB agency shall be assisted by the building control systems Contractor in verifying the operation and calibration of all HVAC and temperature control systems. The following tests shall be conducted:

1. Verify that all control components are installed in accordance with project requirements and are functional, including all electrical interlocks, damper sequences, air and water resets, fire and freeze stats, and other safety devices.
2. Verify that all controlling instruments are calibrated and set for design operating conditions.
3. Perform all calibrations in accordance with NIST standards and provide complete documentation of calibrations to FDA consultant for validation.

3.7.3 Temperature Testing:

To verify system control and operation, a series of three temperature tests shall be taken at approximately two hour intervals in each separately controlled zone. The resulting temperatures shall not vary more than two degrees Fahrenheit from the thermostat or control set point during the tests. Outside temperature and humidity shall also be recorded during the testing periods.

3.7.4 Tab Report Verification:

At the time of final inspection, the TAB agency may be required to recheck, in the presence of the owner's representative, specific and random selections of data, air quantities, and air motion recorded in the certified report. Points and areas for recheck shall be selected by the owner's representative. Measurements and test procedures shall be the same as approved for the initial work for the certified report. Selections for recheck, specific plus random, will not exceed 10% of the total number tabulated in the report.

3.7.5 Building/Zone Pressurization:

The TAB agency shall test and adjust building/zone pressurization by setting the design flow to meet the required flow direction and pressure differential. For positive pressure areas, it shall set the supply air to design flow, and gradually reduce the exhaust air rate to obtain the required flow or pressure difference. For negative pressure areas, it shall set the supply air to design flow, and gradually increase the exhaust air rate to obtain the required flow or pressure difference.

3.7.6 Fire and Smoke Testing:

The Contractor shall test fire/smoke dampers in the presence of the TAB agency to assure proper operation. They shall verify that an access door has been installed for each fire and smoke damper. For each fire damper, the Contractor shall open the access door, disconnect the fusible link, and allow

the damper to close. Operation should be smooth and the damper must close completely. The Contractor shall then reset the damper. For each smoke damper, the Contractor shall open the access door, activate the damper, and observe operation. The damper must close quickly and completely. The Contractor shall then reset the damper and observe its complete opening.

END OF SECTION