SECTION 23 05 93

TESTING, ADJUSTING AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Work Included:

1. Cleaning
2. Adjusting and Balancing

C. Related Sections:

1. Division 01 -- Commissioning
2. Section 23 00 10 – HVAC General Requirements
3. Section 23 05 00 – Common Work Results for HVAC
4. Section 23 07 00 – HVAC Insulation
5. Section 23 20 00 – HVAC Piping and Pumps
6. Section 23 30 00 – HVAC Air Distribution
7. Section 23 70 00 – Central HVAC Equipment
8. Section 23 80 00 – Decentralized HVAC Equipment

1.2 REFERENCES

A. General: The following publications listed below, form a part of this specification to the extent indicated by the reference thereto.

B. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA):

Balancing and Adjustment Manual

C. Associated Air Balancing Council (AABC):

National Standards for Total System Balance

D. National Environmental Balancing Bureau (NEBB):

Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.

1.3 QUALIFICATIONS

A. For the air conditioning, heating and ventilation systems the Contractor shall obtain the services of a qualified, independent testing organization specializing in total system air and water testing and balancing. The Contractor shall be responsible for making changes in pulleys, belts and dampers where necessary to obtain the required air volume as determined by the Testing and Balancing Contractor. The Testing and Balancing Contractor shall provide all labor, engineering and test equipment required to adjust, test and balance all heating, ventilating, air conditioning and exhaust systems as hereinafter specified. All personnel involved in the execution of the work under the balancing contract shall be experienced and factory trained specifically in the total balancing of mechanical systems, as well as being regular employees of the Balancing Contractor. The Test and Balance Contractor shall work in close coordination with the Controls Contractor to ensure that the system is operating as designed and to aid in adjusting setpoints as necessary for proper system operation.

1.4 TAB COORDINATION AND RESPONSIBILITIES

A. The TAB Agent shall provide the following:

1. All instrumentation used in the course of testing and balancing shall be accurate and shall have been calibrated within the six months prior to commencing test and balance work for this project.
2. The TAB Agent shall conduct a pre-TAB inspection two weeks prior to commencing the test and balance. The TAB Agent shall notify the Contractor in writing of any deficiencies that would affect the ability to successfully complete the test and balance or result in an incomplete or unacceptable report.
3. During the course of the test and balance, the TAB Agent shall immediately notify the Contractor of any equipment or system discrepancies discovered that need to be corrected prior to the satisfactory completio
4. n of the test and balance procedures.
5. Equipment settings, including damper positions, valve positions, fan speed controls, and similar devices shall be marked to show final settings.

B. The Contractor shall provide the following:

1. Prior to the commencement of testing and balancing, the installation of building systems shall be fully complete. Building controls systems shall be complete, operational, and verified by the Contractor.
2. The Contractor shall resolve any discrepancies noted by the TAB Agent in the Pre-TAB Inspection prior to commencing the test and balance. The Contractor shall provide written confirmation of the corrective action that was taken to correct each deficiency.
3. The Contractor shall make available qualified personnel during the period in which the test and balance is being conducted for the purpose of problem resolution and controls support.

4. The Contractor shall resolve any deficiencies noted by the TAB Agent prior to the submission of the report and prior to any subsequent visits required by the TAB Agent.

1.5 SUBMITTALS

A. Prior to commencing work under this section, the Contractor shall submit the name of the testing organization, a proof of certification by the Associated Air Balance Council or National Environmental Balancing Bureau, and a list of five local projects on which testing and balancing has been completed for two years, for approval by the Architect/Engineer. The submittal shall include TAB procedures proposed for the systems specific to this project.

B. As part of the submittal, the Contractor shall provide a list of any conditions where balancing or testing cannot be accomplished due to access or other project conditions.

C. Heating, Air Conditioning and Ventilation Systems Balance and Performance Data: At a time no later than the Substantial Completion Inspection, the Contractor shall provide the Architect/Engineer with two (2) typewritten copies of schedules containing air and water system balance and performance data.

D. Equipment and System Verification: Letters, signed by representatives of boiler, chiller, cooling tower, heat pump, air conditioning unit, and temperature control manufacturers, shall attest that their respective equipment installed on this project has been started, tested and set to operate safely and at the control points required as an integral part of the systems specified herein. The Contractor shall attest by letter that all equipment has been wired and tested to see that the indicated sequence of m

E. otor control is established, that all safety controls function properly, that all motor protective devices are sized correctly and that the systems are operating at the points set on the controls. The Engineers will not conduct a site visit for the purpose of determining the status of final payment until these letters are received.

F. Test data shall be submitted for all equipment and systems where specifically required by this specification and all items identified with [TD] behind the product data.

1.6 COMMISSIONING OF HVAC SYSTEMS

A. Participate in Commissioning Meetings designated by the Commissioning Agent.

B. Participate in resolving controls issues identified by the Commissioning Agent.

C. Notify Commissioning Agent a minimum of 2 weeks in advance of start-up of Testing, Adjusting and Balancing (TAB) work. Arrange and attend meeting between Commissioning Agent and TAB agency for review of TAB procedures, TAB work plan, and TAB schedule. Refer to Division 1 for complete scope of Commissioning work.

D. Provide Commissioning Agent with a copy of preliminary and final balance reports.

1.7 CONDITIONS

A. Partial Testing: As much as practical, systems shall be tested as complete systems. Tests on portions of a system will be permitted to facilitate proper progress scheduling. When systems are tested in segments, a system diagram indicating portion tested and a separate and complete report including the date of test is required for each segment.

B. Concealed Work:

1. All concealed work shall be tested and approved by the Architect/Engineer prior to the application of insulation or construction of chase walls.
2. Covering shall not be applied to any piping nor shall any piping be concealed or covered until pipes have been tested, all leaks stopped, retested and approved.
3. Where ductwork is inside a shaft or chase, TAB agent shall coordinate with Contractor to make the required traverses before shaft walls are closed in, or shall make provisions to allow for traverse to be done at a later date through fire rated (where required) access door of adequate size for full traverse.

PART 2 - PRODUCTS

2.1 GENERAL

A. All equipment, instruments, materials and utilities required for cleaning, testing and balancing of the air and hydronic systems shall be provided by the Contractor.

2.2 INSTRUMENTATION

A. All instruments used by this Contractor shall be accurately calibrated and maintained in good working condition.

2.3 TESTS OF MATERIALS

A. Manufacturers' certificates will be accepted in lieu of tests of materials. If individual laboratory tests are desired by the Architect-Engineer, they will be secured by this Contractor and paid for by the Owner.

PART 3 - EXECUTION

3.1 CLEANING

A. Each boiler shall be cleaned in accordance with manufacturer's instructions before being connected to the system.

B. Equipment shall be wiped clean to remove all dust, oil, dirt or paint spots. Trash, plaster, mortar or paint shall be removed from all coils, plenums and end pockets.

C. Ductwork shall be thoroughly blown out or flushed and cleaned of all foreign matter before connections are made to equipment. After all construction dirt has been removed from the building, new filters shall be installed in all air units.

3.2 ADJUSTING AND BALANCING:

A. Equipment: Before attempting to adjust and balance the air systems, the Contractor shall verify that the following items have been completed and are correct.

1. Motor and bearings are properly lubricated.
2. Direction of rotation of motors.
3. Belt tension.
4. Electric current flow in each phase of motors and electric heating elements.
5. Motor protective devices are sized to properly protect installed motors.
6. Thermostats, controls, accessories and other items requiring setting or adjustment shall be set as indicated.

B. Air System Balancing Procedure:

1. Place all related supply, exhaust and return air systems in operation with the fans running at design RPM.
2. Establish system conditions for the maximum demand in airflow; generally, a cooling application. Variable volume systems shall be set and balanced such that the systems are operating at minimum static pressure necessary to maintain proper airflow at the terminal devices.
3. Measure supply air volumes by means of the duct traverse method, making a minimum of sixteen (16) readings. Test holes shall be in straight duct as far as possible downstream from elbows, takeoffs, dampers, etc. Seal duct access holes wi
4. th metal snap-in plugs. The use of duct tape to seal access holes will not be permitted.
5. Adjust balancing dampers for required branch duct air quantities. Ducts with multiple branches shall have at least one branch with volume damper(s) completely open.
6. Adjust grilles and diffusers to within deviations listed below of individual requirements specified, and also adjust so as to minimize drafts and sound in all areas. Restriction imposed by flow regulating devices in or at terminals shall be minimal. Final measurement of air quantity shall be made after optimum air pattern has been achieved.

System Type	CFM Range	Allowable Deviation
Supply\Return	0-50	+ or –5 CFM
	50-1,000	+ or – 10%
	>1,000	+ or – 5%
Exhaust	0-50	+ 5 CFM
	50-1,000	+ 10%

	>1,000	+ 5%

7. The total air delivery in any particular fan system shall be obtained by adjustment of the particular fan speed. The drive motor of each fan shall not be loaded over the corrected full load amperage rating of the motor involved. Where belt drive fans are used in conjunction with VFD's, the fan speed shall be adjusted by changing pulleys such that fan speed to achieve design airflow occurs at 60 Hz. These sheave and pulley changes shall be included in the Contractors scope of work.
8. Adjust quantity of air on each zone to the values given in the specifications and/or plans.
9. If the supply fan volume (, return fan volume,) and outdoor air volume are not within plus or minus 5% of the design capacity at design RPM, determine the reason by reviewing all system conditions, procedures and recorded data. Check and record the air pressure drop across filters, coils, eliminators, sound traps, etc., to see if excessive loss is occurring. Particularly study duct and casing conditions at the fan inlet and outlet.
10. Any changes that are required for the final balancing results will be provided for by the respective Contractors who supplied and installed such equipment under their contract
11. ual obligations. Such changes may encompass, but are not necessarily restricted to, the changing of pulleys, belts, dampers or adding dampers or access holes.

3.3 BALANCE AND PERFORMANCE DATA REPORT [TD]:

A. General: Each heating, ventilating and air conditioning system shall be operated and tested continuously for at least two consecutive days to verify that the system is operating satisfactorily and safely and that all equipment is producing the required capacity. To be successful, this test must be conducted with all controls in automatic position and all lights on or off to simulate day time or night time use of the building. Submit two typewritten copies of reports covering air and water system balance and performance. Reports must be received by the Architect-Engineer at least one week prior to the Contractor's request for a substantial completion inspection. Reports that contain deficiencies related to incomplete or improper system installation will be rejected by the Engineer without further review.

B. Calibration Data: The report shall include a list of all instrumentation used and the date of the most recent calibration for each instrument.

C. Balance Data: The following balance data shall be provided. Design and actual air flows shall be provided in tabular form.

1. All Air Handling and Air Conditioning Equipment Used for Heating, Cooling and Ventilating:

a. System nomenclature and identification.
b. Nameplate information: Manufacturer, model and serial number, horsepower, rpm, voltage, phase, maximum amperage.

c. Fan speed.
d. Static pressure profile – reading between all components and total external static pressure.
e. Outside, return, and supply air quantities.
f. Actual running motor amperage.
g. For all VAV units, provide location of downstream static pressure sensor, set point (if applicable), and reading.
h. For all VAV units, provide VFD speed setting (Hz) at both minimum and maximum flow (at final balanced condition).
i. Final fan operating point plotted on appropriate fan curve.

2. Fans:

a. System nomenclature and identification.
b. Nameplate information: Manufacturer, model and serial number, horsepower, rpm, voltage, phase, maximum amperage.
c. Fan speed.
d. Total external static pressure.
e. Air quantity.
f. Actual running motor amperage.
g. Final fan operating point plotted on appropriate fan curve.

3. Air Outlet and Inlet:

a. Room identification.
b. Manufacturer.
c. Size.
d. Free area factor.
e. Air quantity.
f. Velocity.

D. Performance Data: The following information shall be recorded twice each day and twice each night during the performance test. Reading shall be taken for each item at a different time each succeeding day at least two hours later than the time the reading was taken on the preceding day.

1. All Air Handling and Air Conditioning Equipment Used for Heating, Cooling and Ventilating (except for unit heaters):

a. System nomenclature and identification.
b. Dry bulb and wet bulb temperatures entering and leaving all coils.
c. Water flow through all coils.
d. Water temperatures entering and leaving all coils.
e. Water pressure drop through all coils.
f. (Test all electric heating coils for operation of low airflow interlock.)

2. Space Pressurization:

a. Measure and record space pressurization in corridor served by each major air handling unit.
b. Coordinate with Controls Contactor for fan speed adjustments to achieve space pressurization setpoint of 0.05” w.c. (adjustable).

3. Temperature: Each Room in Building. Temperature measurements shall be taken with the Contractor’s calibrated equipment. Trended data from the temperature control system is not acceptable.

E. Control Setting: During the performance and balance tests, control settings may require adjustment, and if so, shall be adjusted to produce the best balanced system operation. The final setting of each operating and safety control shall be recorded. This shall include, but not be limited to, thermostats, limit controls, damper position switches, firestats, freezestats, humidistats, aquastats and other similar items.

3.4 HVAC SYSTEMS FINAL TESTS:

A. Upon completion of the work, in accordance with these drawings and specifications, the Contractor shall make a final test in the presence of the Architect-Engineer. With all equipment energized and all controls in automatic position, the systems and equipment specified herein shall be proven to operate safely and to heat and cool the structure uniformly. If not, adjustments and corrections shall be made until satisfactory operation is achieved.

B. At the time of final inspection, the Contractor shall recheck, in the presence of the Engineer and Owner, random selections of water and air quantities, and air motion recorded in the certified report. In general, selections for recheck will not exceed 25 percent of the total number tabulated in the report.

3.5 HVAC SYSTEM POST ACCEPTANCE TESTS:

A. Should completion of the building occur at such time that the required performance test must be conducted and test data recorded and submitted during a season when both heating and cooling system performance cannot be checked, the Contractor shall perform the tests and record all such data as is available with system operating automatically under the prevailing weather conditions. That part of the system portion which cannot be recorded because of the prevailing weather shall be delayed until the weather is appropriate at which time the remaining part of the required tests shall be conducted and data recorded accordingly. Portions of the tests may not be delayed without written consent of the Engineer.

END OF SECTION 23 05 93

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