PART 1 - GENERAL

1. SUMMARY STATEMENT

The test and balance of HVAC systems (both heating and cooling) and air exhaust systems shall be performed by an independent test and balance agency selected by the Pinellas County School Board (PCSB). This Section of the Specifications, providing for coordination between this Contractor and the test and balance agency, indicates the minimum scope of services to be supplied by, the (mechanical) Contractor, the minimum services to be provided by the test and balance agency as well as the responsibilities of this (mechanical) Contractor.

Upon completion of the Test & Balance work, a narrative shall be written and jointly signed by the Mechanical Engineer and the Test & Balance Agency stating the operational sequences and expectations of the HVAC system performance. This narrative shall be forwarded to the Manager of the Facilities Design & Construction Department (Attn: Manager, Construction Section).

If this project is administered by the Maintenance Department, all reports, correspondence, etc., will be presented to the project leader in that department. All references to FD&C will be construed as meaning the Maintenance Department.

2. RELATED DOCUMENTS

 The requirements set forth in Pinellas County School Board Bidding and Contractual Requirements and general provisions of Section 00 00 00 Procurement and Contracting Requirements shall apply to this Section.

3. GENERAL

A. Scope:

1) Description:

a) The Owner shall, at the Owner's expense, procure the services of an independent testing and balance agency that specializes in the balancing and testing of heating, ventilating and air conditioning systems. This specialty engineering agency shall balance, adjust and test water circulation, air moving equipment, air distribution and/or exhaust systems as herein specified. The test and balance agency shall be an independent agency not affiliated with contractors, engineers or consultants employed on this project.

b) The Contractor shall be notified of the test and balance firm selected as soon as possible after this Construction Contract has been let, to allow the test and balance agency to schedule this work in cooperation with other trades involved and to help comply with the Contract completion date. Test and balance services will be incorporated into the construction schedule with activity time and durations agreed to by the test and balance firm.

c) Test and balance work shall not begin until all systems have been completed and are in full working order to the satisfaction of the Project Architect/Engineer and the Owner. This Contractor shall make all preliminary tests and adjustments as described in PART II - EXECUTION paragraphs A(1), B(1), D(1)(2)(3), (G)(a) before advising in writing that test and balance work is ready to begin. The Project Architect shall then authorize the commencement of Test and Balance work in writing. This Contractor shall place all systems and equipment into full design operation during each working day of testing and balancing.

d) This Contractor (Mechanical) shall certify in writing that the test and balance punch list is complete and all corrections have been made. A letter shall be generated for each test and balance punchlist that is issued (i.e. water, air, controls or phase punchlist for project). The letter will identify each individual test and balance punch list.

 The original test and balance inspection for each portion of the project and one follow-up punch list inspection shall be considered normal service of the test and balance firm. Any and all additional “punch list” follow-up inspections shall be back charged to the Contractor for excessive inspections.

2) Testing and balancing shall be begun and completed during each season, heating and cooling; i.e. -- cooling system during the cooling season and heating system during the heating season. All systems shall be tested and balanced under full load conditions and a report submitted as set forth in paragraph 3C Submittals.

a) The HVAC system shall be started, operated and stopped to determine that it operates according to the design specifications and sequence of operations. Each element in the system shall be systematically and individually started, operated and stopped.

b) The test and balance agency shall perform as a minimum the requirements outlined in PART II EXECUTION Paragraphs A(2), B(2) and C for the applicable season.

c) Notification to perform the opposite season test and balance will be made by the Facilities Design & Construction Department. The work shall then be scheduled by mutual agreement. The report shall be submitted within fifteen (15) days after completion of the work and shall include:

1. Characterization of the system quality of operation.
2. Data and results of test and balance work.
3. Description of system deficiencies found and recommendations.

3) This (mechanical) Contractor shall cooperate with the test and balance agency in establishing a schedule to perform opposite season testing. If changes in the construction schedule affecting test and balance work are necessary, all such changes shall be coordinated with the test and balance agency, by the Contractor, in writing, via the Project Architect.

4) Replacement pulleys (adjustable and non-adjustable), additional balancing dampers, pressure taps, balancing valves, cocks and fittings, trimming, etc., required to effect proper air and water balance shall be furnished and installed by this Contractor at no additional cost to the Owner. The test and balance agency shall furnish this Contractor and the Project Architect/Engineer at the end of each day a list of items that must be repaired, replaced, installed, or adjusted. This (mechanical) Contractor shall do this work within 24 hours so as not to delay the completion of the test and balance work.

5) Systems shall be placed into operation by the Contractor using approved start up procedures. This (mechanical) Contractor shall be responsible for proper specified setting and initial adjustment of HVAC equipment, air handlers, VAV boxes, exhaust fans, etc. furnished and installed by him and shall verify same for the test and balance agency.

6) This (mechanical) Contractor shall provide test openings as required, shall operate HVAC equipment, and shall provide qualified persons from all trades necessary to assist and make adjustments for test and balance during the process. This shall include, but not limited to mechanical, controls and electrical.

7) When the test and balance agency is ready to test according to the established schedule, but is prevented from testing and balancing, making adjustments or taking measurements due to incompleteness of the work, all extra charges for test and balance attributable to the delay may be back charged to this (mechanical) Contractor. The Project Architect/ Engineer shall be the sole judge as to whether a delay has occurred and back charges due the Owner, which, if judged proper, shall be effected through a Change Order or Construction Change Directive reducing the Contract Sum.

8) The test and balance agency shall periodically visit the site during construction of the HVAC system. No less than two visits will be made. After each visit, the test and balance agency shall report in writing to the FD&C Department (copies to PA/E, to this (mechanical) Contractor and to the Contractor) its observations from the visit and potential problem areas. Should methods, materials or workmanship being used adversely affect balancing and adjusting work, the test and balance agency shall report its findings in the report to the Owner (copy to the Project Architect/Engineer) with recommendations for correction.

9) The test and balance agency executing this test and balance work shall hold a valid Certificate of Authorization from the State of Florida Board of Professional Engineers to provide professional engineering services under the firm name.

10) The test and balance agency has agreed or shall agree to carry out the test and balance in accordance with the AABC National Standards for Total Systems Balance, 1982 or the NEBB Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems, Fourth edition, and in conformance with ASHRAE Handbook, 1986, Chapter 37, Testing, Adjusting and Balancing and as outlined in this Specification Section.

11) This (mechanical) Contractor shall furnish to the testing and balancing agency a complete set of plans and specifications, addenda, shop drawings, submittals, field orders, schedules, and change orders as may be required.

12) The test and balance agency shall witness any duct leakage tests required by the Contract Documents.

B. Quality Assurance:

1) The final result of balancing shall be to provide uniform air temperatures within a two (2) degree F. spread in the conditioned space at peak load conditions. All results shall be in complete conformance with State Requirements for Educational Facilities (SREF).

2) All instruments used shall be accurately calibrated within six months of testing and balancing and shall be maintained in good working order. If requested, a calibration test shall be conducted in the presence of the Project Architect/Engineer and/or the Owner's Inspector.

3) Gages and thermometers installed as part of the project are not to be used for test and balance. The test and balance agency shall calibrate all such gages and thermometers and shall affix a permanent tag to each stating the corrections to be applied.

4) In event of dispute, the Owner or Contractor or Project Architect/Engineer may choose to provide verification of test and balance reports, and such verification shall be by a second independent test and balance agency selected by the Project Architect/Engineer or the Owner. Reports found to be inaccurate will be disallowed, and the test and balance agency will be required to repeat operations under the supervision of the second independent agency until accurate reports are complete and agreed upon. The cost of the initial test and balance agency's portion of the original test and balance work will be borne by the Owner. The cost of verification test and balance work shall be borne by the Owner or Contractor. If the original reports are found to be accurate after being disputed by this (mechanical) Contractor or the Contractor, the cost of the verification testing shall be borne by them. If the original test and balance reports are found inaccurate and subsequent costs of supervision are necessary in order to secure acceptable reports, such will be borne by the original test and balance agency, as directed by the Project Architect/Engineer. In event differences between the reports of the two agencies cannot be resolved between themselves, the Project Architect/Engineer shall be the sole judge of the resolution of the differences and no third testing shall be required.

C. Submittals:

1) The test and balance agency will submit two (2) copies of data for the testing and balancing for the approval of the Project Architect/Engineer and three (3) file copies to the Owner and two (2) copies to the General Contractor (one for the mechanical Contractor).

2) All data and information shall be compiled in a neat, orderly format on 8-1/2" x 11" test forms and shall be signed and sealed by a professional engineer registered in Florida whose field of expertise is in HVAC. A statement to that effect shall be placed with this engineer's signature.

3) Reports shall be submitted within fifteen (15) days of completion of each part of the test and balance; i.e. initial visits, test and balance proper, opposite season test, third month check, eleven month inspection, etc.

D. Guarantee:

1) The test and balance agency shall include extended services for six months after completion of test and balance work, during which time the Project Architect/Engineer and/or Owner, at their discretion, may request a recheck or resetting of any piece of equipment listed in the test report believed to not be performing properly. This (mechanical) Contractor shall assist in this extended service.

2) The test and balance agency shall provide technicians to assist in making any tests required. Should the system be found to not work properly any time during the first year of operation it shall then be required to be rebalanced.

3) The test and balance agency shall provide to the Owner three (3) copies of a certified statement that the HVAC systems have been balanced to optimum performance capabilities in accordance with the intent of the Drawings and Specifications. Such statement shall be signed by a Professional Engineer registered in Florida whose discipline is HVAC with copies to the Project Architect/Engineer and two (2) copies to this (mechanical) Contractor via the Contractor.

PART 2 - EXECUTION

A. Air Balance:

1) This (mechanical) Contractor shall prepare the air systems for balancing and verify same in writing for test and balance agency as follows:

a) Mechanically and electrically check fans, blowers and air handling equipment and make such available to operate under design conditions, and within nameplate data.

b) Set volume dampers, air dampers and vanes in their designed position.

c) Set grilles, diffusers, etc. installed with vanes, blades in their designed position.

d) Mechanically and electrically check controls, whether they are electronic, electric or pneumatic or a combination thereof, and insure operation under design conditions.

e) Mark damper shafts and locking devices to accurately represent the position of their respective dampers when in optimum position. Verify proper operation of all automatically operated dampers.

f) All air filters will be replaced prior to the beginning of the test and balance with new filters of the specified quality.

2) The test and balance agency shall perform the following tests and balance as follows:

a) Test and adjust fan RPM to design requirements.

b) Test and record motor full load amperes.

c) Make Pitot tube traverse of main supply and return ducts and obtain design CFM at fans.

d) Test and record system total pressures, suction and discharge.

e) Test and adjust system for design CFM recirculated air.

f) Test and adjust system for design CFM outside air.

g) Test and record entering air temperatures (D.B. heating and cooling, W.B. cooling).

h) Test and record leaving air temperatures. (D.B. heating and cooling, W.B. cooling).

i) Adjust all main supply and return air ducts to proper design CFM.

j) Adjust all zones to proper design CFM (± 10%), supply and return.

k) Test and adjust each diffuser, grille and register to within ±10% of design requirements.

l) Each grille, diffuser and register shall be identified as to location, area and system.

m) Test and record all room temperatures upon completion of system balances DB and WB. Test shall be made near room thermostat where installed at four feet above floor.

3) Variable Air Column Systems shall be balanced according to the specific type of VAV system supplied and method of controlling air flow. The following requirements shall be met:

a) Verify that inlet ducts have sufficient straight runs (4-6 diameters) before VAV boxes and the VAV box manufacturer's control system complements the building control system.

b) Determine the minimum and maximum operating pressures for the boxes used and verify that the operating conditions fall within the design operating range.

c) Check static pressures and volume flows and adjust to proper values as necessary. Test and report air flow under minimum settings.

d) Set outlets to design flow with VAV box on maximum setting.

4) Size, type, manufacturer and location of diffusers, grilles, registers, and all tested equipment shall be identified and listed. Manufacturer's ratings on all equipment shall be used to make required calculations.

5) Readings and tests of diffusers, grilles, and registers shall include test resultant velocity, required CFM and test resultant CFM after adjustments.

6) In cooperation with the control manufacturer's representative, the test and balance agency shall set adjustments of automatically operated dampers to operate as specified, indicated, and/or noted.

7) Testing and balance agency shall check all controls for proper calibrations and list all controls requiring adjustment by control installers.

8) Diffusers, grilles and registers shall be adjusted by the test and balance agency to minimize drafts in all areas.

9) The test and balance agency shall verify duct work leakage tests. Data from duct work leakage tests shall be tabulated and included with the test and balance report.

10) Tested sections of duct work shall be marked by this (mechanical) Contractor and verified by the test and balance agency. All tests and repairs shall be made before duct sections are concealed or insulated.

11) The test and balance agency shall visually inspect low pressure duct systems and verify such are constructed and sealed in accordance with SMACNA construction standards.

12) The test and balance agency shall systematically survey and inspect the HVAC insulation. As part of its initial report, the test and balance agency shall note non-compliance with Drawings and Specifications and/or good installation practices.

B. Water Balance:

1) This (mechanical) Contractor shall prepare the water systems for balancing, and verify in writing to the Project Architect/Engineer and Owner, in the following manner:

a) Open all valves to full open position. Close all by-pass valves. Set modulating valve to full coil flow.

b) All strainers shall be cleaned with the start-up strainer removed after a minimum of three (3) days operation. The start-up strainer shall be hung adjacent to the new strainer after removal.

c) Water in the system is to be treated and cleaned. If water appears dirty, test and balance work shall stop and this Contractor shall reclean system as specified in the Project Specifications. When water has been properly treated and cleaned, this Contractor and water treatment firm shall certify such in writing to the Project Architect/Engineer and the Owner.

d) Verify pump rotations are correct.

e) Inspect expansion tanks to determine such are not air bound and the system is completely full of water.

f) Verify all air vents at high points of water system and determine all are installed and operating freely. Make sure all air is removed from the system.

g) Set all temperature controls so all coils are calling for full cooling (and in season, full heating,) and determine that this closes all automatic by-pass valves at coils.

h) Verify operation of automatic by-pass valves.

i) Insure that operating temperatures of chillers and heat exchangers are at design requirements.

j) Complete air balance work must have been accomplished and all work adjusted and corrected before actual water balance is complete.

2) The test and balance agency shall perform the following:

a) Set chilled and hot water pumps to proper gallons per minute delivery and record operating voltage, current and rpm.

b) Adjust flow of water through chillers and boilers.

c) Check and record "leaving water" temperatures and "return water" temperatures through chillers and boilers. Reset to correct to design temperatures, if necessary.

d) Check and record water temperatures at inlet side of coils. Note rise or drop of temperatures from chillers or boilers.

e) Balance each water coil.

f) Upon completion of flow readings and adjustments at coils, mark all settings and record data.

g) After adjustments to coils are made, recheck settings at the pumps, chillers and boilers and re-adjust if required. Verify actual pump operating curve and impeller size.

h) Determine pressure drop through coil at flow rate set on-call for full cooling. Set pressure drop across by-pass valve to match coil full flow pressure drop. (This prevents unbalanced flow conditions when coils are on full by-pass). Follow the same procedure on chiller to adjust chiller by-pass valve.

i) Record settings and readings on all gauges as found when testing began, and as left when testing is complete.

j) Record and check the following items at each cooling/heating element:

(1) "Inlet water" temperature.

(2) "Leaving water" temperatures.

(3) Pressure drop of each coil and across by-pass valve, where appropriate.

k) Record pump suction and discharge pressures and total developed head. Compare with design head.

l) If a primary-secondary pumping system is employed, the test and balance agency shall ensure that a proper balance is obtained between primary and secondary loops and that sufficient flow is maintained in the secondary loop at all times.

m) Verify that all boiler safety and operating controls are properly set and adjustable. Testing of boiler safety devices is not required.

3) The test and balance agency shall systematically survey and inspect the pipe insulation. As part of its initial report the test and balance agency shall note non-compliance with Drawings and Specifications and/or good installation practices.

C. Unit Cooling/Heating Units (Direct expansion or split system)

1) Air Distribution (as applicable)

a) Measure fan speeds, motor voltages, operating currents, CFM and static pressure at fan outlet.

b) Adjust dampers, air supply and return and exhaust outlets to ± 10 percent of design quantities. Supply grilles shall be adjusted to provide proper throw and uniform pattern.

c) Measure air flow at duct connected return or exhaust grilles.

d) Record the specified horsepower and all electrical characteristics of all motors and whether self or permanently lubricated.

e) Record the actual installed motors as to horsepower and electrical characteristics and whether self or permanently lubricated. Make special effort to call to Project Architect/Engineer's attention if discrepancies are discovered.

2) Verify function and calibration of temperature controls to ± 2.0 degree F of set points.

3) Perform the following Cooling Cycle Temperature Measurements:

a) "Entering air" temperature (D.B. and W.B.)

b) "Leaving air" temperature (D.B. and W.B.)

c) Outside air temperature (D.B. and W.B.)

d) Room temperature (D.B. and W.B.) measured near thermostats, four feet above floor.

e) Air CFM at unit discharge.

4) Perform the following heating cycle measurements:

a) "Entering" and "Leaving" air temperatures (D.B.)

b) Outside air temperature (D.B. and W.B.)

c) Room temperature measured near thermostats four feet above floor.

d) Air CFM at unit discharge.

D. Temperature Control Systems

1) The temperature controls installer shall cooperate fully with the test and balance agency to ensure maximum effective systems operation. The controls installer for this (mechanical) Contractor shall initially set, adjust, relocate (if necessary), and calibrate all controls.

2) A copy of all worksheets utilized to create the control sequencing of the HVAC system will be provided to the Owner, via the Project Mechanical Engineer, by the Control Contractor.

3) A computer printout of the system operation through a continuous 48 hour period will be furnished, prior to the test and balance beginning, by the Contractor. This printout shall indicate as a minimum space temperatures, humidity readings, valve positions, damper positions, chilled water temperatures, and any other readings required for the Mechanical Engineer to validate proper control sequencing.

4) The test and balance agency shall perform the following:

a) Check for proper location of humidistats, sensors and thermostats as well as verify proper design settings.

b) Verify proper operation of switches, damper motors, motorized valves, solenoids and interlocks.

c) Verify that proper sequence of operation occurs in all control modes and is in accordance with shop drawings and control diagrams (or point list).

d) Verify proper calibration of all controls and list those controls requiring adjustment or recalibration.

E. Exhaust Fans/Hoods

1) Measure exhaust fan static pressures, total CFM, makeup air and fan RPM.

2) Measure motor operating voltage and amperage.

3) Measure hood average face velocities and adjust as necessary. Where possible, balance flow using a pitot transverse within hood where ducts are connected.

4) Record the specified horsepower and electrical characteristics, against the actual supplied horsepower and electrical characteristics of all motors.

5) Record if specified to be self or permanently lubricated. Record the actual installed motors whether motors supplied are self or permanently lubricated.

F. Sound Testing:

1) Using approved instruments, the test and balance agency shall conduct sound level measurements in selected areas of the building as specified below. Sound level measurements shall be in decibels using a Type 1 or Type 2 sound level meter that complies with American National Standards Institute (ANSI)S1.4. and octave band filters that comply with ANSI S1.11. The decibel reference pressure shall be 20 uPA (microPascals). Measurements shall be by octave bands beginning at 63 Hz through 8,000 Hz, in selected rooms. Measurements shall include: ambient sound levels (HVAC systems off) and normal conditions (HVAC systems operating). Both sets of curves (system off and system on) should be plotted on the same graph. The graph sheet should have preprinted Noise Criterion (NC) curves as published in ASHRAE. The NC rating is determined by the maximum NC curve point touched by and individual octave band level as plotted. NC values between the five point spread of the NC curves shall be interpolated. If NC levels are above those listed, adjustments shall be made by this (mechanical) Contractor to bring the sound level within the range set forth below. If this cannot be done with the equipment as installed, recommendations shall be made by the test and balance agency to correct the sound level to within the specified range. Additions of sound traps, insulation, or dampers shall be made by this (mechanical) Contractor under the direction of the test and balance agency at no additional cost to the Owner. Sound level readings (in decibels) shall be taken at random locations, in occupied areas. The sound levels shall be measured approximately 5-feet above the floor, on a line approximately 45 degrees to the center of the diffuser, etc. The NC levels shall not exceed 35 for general office type space, 30 for classrooms and 25 for sensitive areas such assembly areas, auditoriums, rehearsal spaces, and conference room type space, nor 30 for sensitive areas such as libraries or auditoriums.

2) Octave band sound measurements shall be taken in the following locations.

a) A typical classroom remote from mechanical equipment rooms.

b) A typical classroom adjacent to mechanical equipment room.

c) Typical offices.

d) Special assembly rooms such as auditoriums, music rooms, libraries.

3) When a typical space (a, b, or c above) has been tested and passed, all such spaces served by the same air handler shall be considered as complying. Conversely, if a typical space fails, all such spaces shall be considered as failed and require testing.

4) Unless test results indicate failure to comply with the intention of these Specifications, sound testing shall be done only once, preferably during an HVAC cooling season.

5) Final sound testing shall only be done after all other test and balance work is completed and after areas are furnished (furniture, carpet, etc. installed).

6) Copies of all sound measurements plotted against NC curves shall be submitted as part of the T&B report.

G. Cooling Tower

1) The test and balance agency shall test the cooling tower(s) in accordance with procedures outlined in AABC National Standards for Total System Balance, 1982 or NEBB Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems, 1983 and in conformance with ASHRAE Handbook, 1984 Chapter 37.

a) This (mechanical) Contractor shall certify to the Project Architect/Engineer and Owner that water level in the basins is correct, by-pass valves are properly set, cooling water system is properly cleaned and flushed, fans and pumps are operating properly, cooling tower fill is clean, and makeup and blow down are functioning properly.

b) In systems with water cooled heat pumps, the test and balance agency shall balance condenser water flow to heat pump loops.

c) The test and balance agency shall verify that condenser water flow is maintained within design limits for each heat pump loop.

H. Equipment

 The test and balance agency shall submit, as part of its report, complete identification and operating data on the following:

a) Air handling units

b) Fan coil, unit ventilators and heat pumps

c) Exhaust fans.

d) Pumps

e) Air devices (grilles, registers, diffusers)

f) Chiller(s)

g) Cooling tower

h) Boiler(s)

i) Terminal devices

j) Water flow devices

2. GUARANTEE PERIOD, TROUBLE SHOOTING AND CERTIFICATION

A. After the initial test and balance the test and balance agency shall perform follow up visits at these intervals:

1) Third month of operation, unless called sooner.

2) Once, sometime during the fourth through tenth month, for opposite season balance.

B. The test and balance agency shall perform the following during each visit:

1) Spot check and adjust outlets as required.

2) Report abnormal conditions and complaints. Recommend necessary corrective action.

3) Submit written report of each visit to the Project Architect/Engineer in two (2) copies and three (3) to the Owner with two (2) copies to this Contractor.

C. Guarantee Period Inspection

 After eleven (11) months but less than twelve (12) months of occupancy, the test and balance agency shall perform a complete analysis putting controls through their normal operating cycle. A written report citing conditions found and recommendations shall be submitted with three (3) copies to Owner, two (2) to the Project Architect/Engineer and two (2) copies to the Contractor within fifteen (15) days of completion but in no event less than ten (10) days prior to the end of the twelve (12) month warranty period. The test and balance agency shall pay particular attention to problem areas and deficiencies that need correction prior to the end of the warranty period. The report shall be in the form approved and recommended by the Test & Balance Contractors Certifying Agency.

D. Certification

 The test and balance reports to the Project Architect/Engineer and to the Owner shall be signed, "sealed" and certified by a Professional Engineer registered in the State of Florida whose specialty discipline is HVAC, together with a signed statement that this Professional Engineer's specialty is HVAC.

**END OF SECTION**