SECTION 15990

TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Testing, Adjustment, and Balancing of Air Systems.

B. Measurement of Final Operating Condition of HVAC Systems.

1.02 RELATED SECTIONS

A. Section 01400 - Quality Control: Testing laboratory services: Employment of testing agency and payment for services.

1.03 REFERENCES

A. AABC - National Standards for Total System Balance.

B. ADC - Test Code for Grilles, Registers, and Diffusers.

C. ASHRAE 111 - Practices for Measurement, Testing, Adjusting, and Balancing of Building Heating, Ventilation, Air-conditioning, and Refrigeration Systems.

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

E. SMACNA - HVAC Systems Testing, Adjusting, and Balancing.

1.04 SUBMITTALS

A. Submit under provisions of Section 01300.

B. Submit name of Testing, Adjusting, and Balancing (TAB) Agency for approval within 14 days after award of Contract.

C. Design Review Reports:
1. Submit prior to commencement of construction under provisions of Section 01400.
2. Review the Contract Documents, and indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.

D. Preliminary Report Submittals:
1. Prior to commencing work of this Section, and no more than 30 days after approval of TAB Agency submittals, submit report forms or outlines indicating adjusting, balancing, and equipment data required, with columns of design data filled in. By means of plan views, equipment profiles, and similar graphical descriptions, indicate where measurements will be taken.
2. Submit the procedures to be used.

E. Field Reports: Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect/Engineer and for inclusion in operating and maintenance manuals.

F. Provide reports in letter size, 3-ring binder manuals, complete with index page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.

G. Include detailed procedures, agenda, sample report forms and copy of AABC National Project Performance Guaranty prior to commencing system balance.

H. Test Reports: Indicate data on AABC National Standards for Total System Balance forms, or forms prepared following ASHRAE 111, or NEBB forms.

1.05 QUALITY ASSURANCE

A. Perform total system balance in accordance with AABC National Standards for Field Measurement and Instrumentation, Total System Balance; or ASHRAE 111;or NEBB Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.

1.06 QUALIFICATIONS

A. Agency: Company specializing in the testing, adjusting, and balancing of systems specified in this Section with minimum three years experience and certified by AABC or NEBB, or equivalent experience which would qualify for membership in these testing organizations. Agency shall be one of those listed under paragraph 3.01 AGENCIES in this Section.

B. Perform Work under supervision of AABC Certified Test and Balance Engineer NEBB Certified Testing, Balancing and Adjusting Supervisor or registered Professional Engineer experienced in performance of this Work and licensed at the place where the Project is located.

C. The approved Agency shall be in no way affiliated with the installing Subcontractor.

1.07 SEQUENCING

A. Sequence work under the provisions of Section 01010.

B. Sequence work to commence after completion of systems or portions of work, and schedule completion of work before Substantial Completion of Project.

1.08 SCHEDULING

A. Schedule and provide assistance in final adjustment and test of life safety, smoke evacuation, smoke control system with Fire Authority.

B. Complete all balancing and commissioning of duct furnace DF-1 prior to the installations of the plenum ceiling. Balancing and commissioning shall not be considered complete until balancing and commissioning reports have been returned approved with no comments.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 AGENCIES

A. Central Air Balance.

B. Tekon.

C. TAB-TECH International.

D. Maine Air Balance.

E. No Substitutions.

3.02 EXAMINATION

A. Verify that systems are complete and operating correctly in accordance with sequence of operations before commencing work. Ensure the following conditions:
   1. Systems are started and operating in a safe and normal condition.
   2. Temperature control systems are installed complete and operable.
   3. Proper thermal overload protection is in place for electrical equipment.
   4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
   5. Duct systems are clean of debris.
   6. Fans are rotating correctly.
   7. Fire and volume dampers are in place and open.
   8. Air coil fins are cleaned and combed.
   9. Access doors are closed and duct end caps are in place.
   10. Air outlets are installed and connected.
   11. Duct system leakage is minimized.

B. Submit field reports. Report to the responsible Subcontractors, defects and deficiencies noted during performance of services which prevent system balance. Submit list of locations where the Contractor needs to provide additional balancing devices.

C. Beginning of work means acceptance of existing conditions.

3.03 PREPARATION

A. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Architect/Engineer to facilitate spot checks during testing.

3.04 INSTALLATION TOLERANCES

A. Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 5 percent of design for return and exhaust systems.

B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.

3.05 ADJUSTING

A. Ensure recorded data represents actual measured or observed conditions.

B. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.

C. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.

D. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

E. For belt driven equipment, provide sheave and belt modifications and/or replacements as required to ensure design flow rates as specified.

3.06 AIR SYSTEM PROCEDURE

A. Adjust air handling and distribution systems to provide design supply, return, and exhaust air quantities.

B. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.

C. Measure air quantities at air inlets and outlets.

D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.

E. Use volume control devices to regulate air quantities only to extent that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.

F. Vary total system air quantities by adjustment of fan speeds. Vary branch air quantities by damper regulation.

G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.

H. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.

I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions. Adjust at minimum position and maximum position, and use manual dampers and actuator limit stops to minimize differences.

J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.

K. Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate, full heating.

L. Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately 0.05 inches positive static pressure.

M. Check multi-zone units for motorized damper leakage. Adjust air quantities with mixing dampers set first for cooling, then heating, then modulating.

N. For variable air volume system powered units set volume controller to air flow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable air volume temperature control.

O. Where available fan capacity is less than total flow requirements of individual system parts (due to system diversity), full flow in one part may be simulated by temporary restriction of flow to other parts.

3.07 VERIFICATION OF DUCT LEAKAGE TESTING

A. The TAB Agent shall witness the duct leakage tests performed under Specification section 15890. At a minimum, the first duct leakage test shall be witnessed and approved by the TAB Agent and the Engineer. At a minimum, subsequent duct leakage tests shall be witnessed and approved by the TAB Agent. The TAB Agent shall confirm proper testing procedures and shall give written approval to leakage tests. If deficiencies are discovered, the TAB Agent shall document these deficiencies to the Contractor and the Engineer. Once deficiencies are corrected, the TAB Agent shall witness follow-up leakage tests.

3.08 PROJECT CLOSEOUT

A. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Architect.

B. Retests: If random tests elicit a measured flow deviation of ten percent or more from, that recorded in the certified report listings, at ten percent or more of the rechecked selections, the report shall be automatically rejected. In the event the report is rejected, systems shall be readjusted and tested, new data recorded, new certified reports submitted, and new inspection tests made.

3.09 SCHEDULES

A. Equipment Requiring Testing, Adjusting, and Balancing:
Duct Furnace
Packaged Roof Top Heating/Cooling Units
Air Coils
Exhaust Fans
Air Terminal Units
Air Inlets and Outlets
Variable Air Volume Boxes

B. Report Forms:
1. Title Page:
   a. Name of Testing, Adjusting, and Balancing Agency
   b. Address of Testing, Adjusting, and Balancing Agency
   c. Telephone number of Testing, Adjusting, and Balancing Agency
   d. Project name
   e. Project location
   f. Project Architect
   g. Project Engineer
   h. Project Contractor
   i. Project altitude
   j. Report date
2. Summary Comments:
   a. Design versus final performance
   b. Notable characteristics of system
   c. Description of systems operation sequence
   d. Summary of outdoor and exhaust flows to indicate amount of building pressurization
   e. Nomenclature used throughout report
   f. Test conditions
3. Instrument List:
   a. Instrument
   b. Manufacturer
   c. Model number
   d. Serial number
   e. Range
   f. Calibration date
4. Electric Motors:
   a. Manufacturer
   b. Model/Frame
   c. HP/BHP
   d. Phase, voltage, amperage; nameplate, actual, no load
   e. RPM
   f. Service factor
   g. Starter size, rating, heater elements
   h. Sheave Make/Size/Bore

5. V-Belt Drive:
    a. Identification/location
    b. Required driven RPM
    c. Driven sheave, diameter and RPM
    d. Belt, size and quantity
    e. Motor sheave diameter and RPM
    f. Center to center distance, maximum, minimum, and actual
6. Combustion Test:
    a. Gas-fired equipment
    b. Model number
    c. Serial number
    d. Fuel type
    e. Firing rate
    f. Fuel tank fill level
    g. Oil pump inlet pressure/vacuum
    h. Overfire draft
    i. Gas meter timing dial size
    j. Gas meter time per revolution
    k. Gas pressure at meter outlet
    l. Gas flow rate
    m. Heat input
    n. Burner manifold gas pressure
    o. Percent carbon monoxide (CO)
    p. Percent carbon dioxide (CO2)
    q. Percent oxygen (O2)
    r. Percent excess air
    s. Flue gas temperature at outlet
    t. Ambient temperature
    u. Net stack temperature
    v. Percent stack loss
    w. Percent combustion efficiency
    x. Heat output
7. Electric Duct Heater:
    a. Manufacturer
    b. Identification/number
    c. Location
    d. Model number
    e. Design kW
    f. Number of stages
    g. Phase, voltage, amperage
    h. Test voltage (each phase)
    i. Test amperage (each phase)
    j. Air flow, specified and actual
    k. Temperature rise, specified and actual
8. Air Moving Equipment
    a. Location
    b. Manufacturer
    c. Model number
    d. Serial number
    e. Arrangement/Class/Discharge
    f. Air flow, specified and actual
    g. Return air flow, specified and actual
    h. Outside air flow, specified and actual
    i. Total static pressure (total external), specified and actual
    j. Inlet pressure
    k. Discharge pressure
    l. Sheave Make/Size/Bore

m. Number of Belts/Make/Size
n. Fan RPM

9. Return Air/Outside Air Data:
   a. Identification/location
   b. Design air flow
   c. Actual air flow
   d. Design return air flow
   e. Actual return air flow
   f. Design outside air flow
   g. Actual outside air flow
   h. Return air temperature
   i. Outside air temperature
   j. Required mixed air temperature
   k. Actual mixed air temperature
   l. Design outside/return air ratio
   m. Actual outside/return air ratio
10. Exhaust Fan Data:
   a. Location
   b. Manufacturer
   c. Model number
   d. Serial number
   e. Air flow, specified and actual
   f. Total static pressure (total external), specified and actual
   g. Inlet pressure
   h. Discharge pressure
   i. Sheave Make/Size/Bore
   j. Number of Belts/Make/Size
   k. Fan RPM
11. Duct Traverse:
   a. System zone/branch
   b. Duct size
   c. Area
   d. Design velocity
   e. Design air flow
   f. Test velocity
   g. Test air flow
   h. Duct static pressure
   i. Air temperature
   j. Air correction factor
12. Air Monitoring Station Data:
   a. Identification/location
   b. System
   c. Size
   d. Area
   e. Design velocity
   f. Design air flow
   g. Test velocity
   h. Test air flow
13. Flow Measuring Station:
   a. Identification/number
   b. Location
   c. Size
   d. Manufacturer
   e. Model number
   f. Serial number
   g. Design Flow rate
   h. Design pressure drop

i. Actual/final pressure drop
j. Actual/final flow rate
k. Station calibrated setting

14. Terminal Unit Data:
    a. Manufacturer
    b. Type, constant, variable, single, dual duct
    c. Identification/number
    d. Location
    e. Model number
    f. Size
    g. Minimum static pressure
    h. Minimum design air flow
    i. Minimum actual air flow
    j. Maximum design air flow
    k. Maximum actual air flow
    l. Inlet static pressure
15. Air Distribution Test Sheet:
    a. Air terminal number
    b. Room number/location
    c. Terminal type
    d. Terminal size
    e. Area factor
    f. Design velocity
    g. Design air flow
    h. Test (final) velocity
    i. Test (final) air flow
    j. Percent of design air flow

END OF SECTION