SECTION 230593

TESTING, ADJUSTING, AND BALANCING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Testing, adjustment, and balancing of air systems.

B. Testing, adjustment, and balancing of hydronic and refrigerating systems.

C. Measurement of final operating condition of HVAC systems.

D. Sound measurement of equipment operating conditions.

E. Vibration measurement of equipment operating conditions.

1.2 RELATED SECTIONS

A. Division 01 - Starting of Systems.

B. Division 01 - Testing, Adjusting, and Balancing of Systems.

1.3 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.

1.4 SUBMITTALS

A. Submit under the provisions of Division 01.

B. Submit the name of the adjusting and balancing agency for approval within 30 days after award of Contract.

C. Field Reports: Submit under the provisions of Division 01.

D. Field Reports: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.

E. Prior to commencing work, submit report forms or outlines indicating adjusting, balancing, and equipment data required.

F. 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.

G. Provide reports in soft cover, 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.

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

I. Test Reports: Indicate data on AABC National Standards for Total System Balance forms.

1.5 QUALITY ASSURANCE

A. Perform total system balance in accordance with AABC National Standards for Field Measurement and Instrumentation, Total System Balance.

1.6 QUALIFICATIONS

A. Agency: Company specializing in the testing, adjusting, and balancing of systems specified in this Section with minimum three years documented experience certified by AABC or NEBB.

B. Perform Work under supervision of AABC Certified Test and Balance Engineer or NEBB Certified Testing, Balancing and Adjusting Supervisor.

1.7 PRE-BALANCING CONFERENCE

A. Convene one week prior to commencing work of this section.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that systems are complete and operable 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 completely 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.
12. Hydronic systems are flushed, filled, and vented.
13. Pumps are rotating correctly.
14. Proper strainer baskets are clean and in place.
15. Service and balance valves are open.

B. Submit field reports. Report defects and deficiencies noted during performance of services which prevent system balance.

C. Beginning of work means acceptance of existing conditions.

3.2 PREPARATION

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

B. Provide additional balancing devices as required.

3.3 INSTALLATION TOLERANCES

A. Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 10 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.

C. Hydronic Systems: Adjust to within plus or minus 10 percent of design.

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

F. Check and adjust systems approximately six months after final acceptance and submit report.

3.5 AIR SYSTEM PROCEDURE

A. Adjust air handling and distribution systems to provide required or 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 the volume control devices to regulate air quantities only to extend 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. Provide drive changes required. 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.

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 in 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 near the building entries.

M. 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.

3.6 WATER SYSTEM PROCEDURE

A. Adjust water systems to provide required or design quantities.

B. Use calibrated fittings and pressure gages to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.

C. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.

D. Effect system balance with automatic control valves fully open to heat transfer elements.

E. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.

F. Where available pump capacity is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.

3.7 FINAL OPERATING CONDITIONS

A. Confirm that each HVAC system is operating as intended by the construction documents and the manufacturer’s recommendations.

3.8 SCHEDULES

A. Equipment Requiring Testing, Adjusting, and Balancing

Electric Water Coolers
Plumbing Pumps

HVAC Pumps
Water Tube Boilers
Air Cooled Water Chillers
Air Cooled Refrigerant Condensers
Packaged Roof Top Heating/Cooling Units
Unit Air Conditioners
Computer Room Air Conditioning Units
Air Coils
Terminal Heat Transfer Units
Air Handling Units
Fans
Air Filters
Air Terminal Units
Air Inlets and Outlets

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. Pump Data:
   a) Identification/number
   b) Manufacturer
   c) Size/model
   d) Impeller
   e) Service
   f) Design flow rate, pressure drop, BHP
   g) Actual flow rate, pressure drop, BHP
   h) Discharge pressure
   i) Suction pressure
   j) Total operating head pressure
   k) Shut off, discharge and suction pressures
   l) Shut off, total head pressure
7. Combustion Test:
   a) Boiler manufacturer
   b) Model number
   c) Serial number
   d) Firing rate
   e) Overfire draft
   f) Gas meter timing dial size
   g) Gas meter time per revolution
   h) Gas pressure at meter outlet
   i) Gas flow rate
   j) Heat input
   k) Burner manifold gas pressure
   l) Percent carbon monoxide (CO)
   m) Percent carbon dioxide (CO2)
   n) Percent oxygen (O2)
   o) Percent excess air
   p) Flue gas temperature at outlet
   q) Ambient temperature
   r) Net stack temperature
   s) Percent stack loss
   t) Percent combustion efficiency
   u) Heat output
8. Air Cooled Condenser:
   a) Identification/number
   b) Location
   c) Manufacturer
   d) Model number
   e) Serial number
   f) Entering DB air temperature, design, and actual
   g) Leaving DB air temperature, design, and actual
   h) Number of compressors
9. Chillers:
   a) Identification/number
   b) Manufacturer
   c) Capacity
   d) Model number
   e) Serial number
   f) Evaporator entering water temperature, design, and actual
   g) Evaporator leaving water temperature, design, and actual
   h) Evaporator pressure drop, design, and actual
   i) Evaporator water flow rate, design, and actual

j) Condenser entering water temperature, design, and actual
k) Condenser pressure drop, design, and actual
l) Condenser water flow rate, design, and actual

10. Cooling Coil Data:
    a) Identification/number
    b) Location
    c) Service
    d) Manufacturer
    e) Air flow, design and actual
    f) Entering air DB temperature, design and actual
    g) Entering air WB temperature, design and actual
    h) Leaving air DB temperature, design and actual
    i) Leaving air WB temperature, design and actual
    j) Water flow, design and actual
    k) Water pressure drop, design and actual
    l) Entering water temperature, design and actual
    m) Leaving water temperature, design and actual
    n) Saturated suction temperature, design and actual
    o) Air pressure drop, design and actual
11. Heating Coil Data:
    a) Identification/number
    b) Location
    c) Service
    d) Manufacturer
    e) Air flow, design and actual
    f) Water flow, design and actual
    g) Water pressure drop, design and actual
    h) Entering water temperature, design and actual
    i) Leaving water temperature, design and actual
    j) Entering air temperature, design and actual
    k) Leaving air temperature, design and actual
    l) Air pressure drop, design and actual
12. 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
13. Return Air/Outside Air Data:
    a) Identification/location
    b) Design airflow
    c) Actual airflow
    d) Design return airflow
    e) Actual return airflow
    f) Design outside airflow
    g) Actual outside airflow
    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

14. 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
15. 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
16. Duct Leak Test:
    a) Description of ductwork under test
    b) Duct design operating pressure
    c) Duct design test static pressure
    d) Duct capacity, air flow
    e) Maximum allowable leakage duct capacity times leak factor
    f) Test apparatus
        1) Blower
        2) Orifice, tube size
        3) Orifice size
        4) Calibrated
    g) Test static pressure
    h) Test orifice differential pressure
    i) Leakage
17. 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

18. 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) Maximum design air flow
    j) Maximum actual air flow
    k) Inlet static pressure
19. 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
20. Sound Level Report:
    a) Location
    b) Octave bands - equipment off
    c) Octave bands - equipment on

END OF SECTION