SECTION 15990 - TESTING, ADJUSTING, AND BALANCING

City of San Diego, CWP Guidelines

PART 1 -- GENERAL

1.1 WORK OF THIS SECTION

A. The WORK of this Section includes furnishing the following WORK by a Specialist company:

1. Testing, adjusting, and balancing of air systems.
2. Testing, adjusting, and balancing of hydronic systems.
3. Measurement of final operating condition of HVAC systems.
4. Sound measurement of operating equipment.
5. Vibration measurement of operating equipment.

1.2 RELATED SECTIONS

A. The WORK of the following Sections applies to the WORK of this Section. Other Sections of the Specifications, not referenced below, shall also apply to the extent required for proper performance of this WORK.

1. Section 11175 Pumps, General
2. Section 15000 Piping Components
3. Section 15050 Vibration Isolation
4. Section 15410 Plumbing Piping
5. Section 15550 Water Tube Boilers and Accessories
6. Section 15750 Packaged Air Conditioning Equipment
7. Section 15855 Air Handling and Moving Equipment
8. Section 15880 Air Distribution, Devices and Accessories
9. Section 15950 HVAC Controls and Sequence of Operations

1.3 CODES

A. The WORK of this Section shall comply with the current editions of the following codes as adopted by the City of San Diego Municipal Code:

1. Uniform Mechanical Code

1.4 SPECIFICATIONS AND STANDARDS

A. Except as otherwise indicated, the current editions of the following apply to the WORK of this Section:

1. AABC National Standards for Field Measurement and Instrumentation, Total System Balance

2. ASHRAE — 1984 Systems Handbook: Chapter 37, Testing, Adjusting and Balancing

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

1.5 SHOP DRAWINGS AND SAMPLES

A. The following shall be submitted in compliance with Section 01300:

1. Name of Specialist company and documentation of qualifications within [30] [ ] days after [award of Contract] [date established in Notice to Proceed] [ ].

2. Prior to commencing work, draft reports indicating adjusting, balancing, and equipment data required.

3. Draft copies of final report for review prior to final acceptance of project.

4. Detailed procedures, agenda, sample report forms[,] [and copy of AABC National Project Performance Guaranty] [ ] prior to commencing WORK.

1.6 OWNER'S MANUAL

A. The following shall be included in the OWNER'S MANUAL in compliance with Section 01300:

1. Final reports, letter size, complete with index page and indexing tabs, with cover identification at front end including set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.

1.7 REPORT FORMS

A. Reports shall be prepared on [AABC National Standards for Total System Balance][NEBB] forms.

B. Reports shall be submitted to the CONSTRUCTION MANAGER prior to requesting final payment.

C. Forms shall include the following information:

1. Title Page:
   Company name
   Company address
   Company telephone number
   Project name
   Project location
   Specialist's Project Engineer

Project Construction Manager
Project Contractor
Project altitude

2. Instrument List:
   Instrument
   Manufacturer
   Model
   Serial number
   Range
   Calibration date

3. Air Moving Equipment:
   Location
   Manufacturer
   Model
   Supply air flow, specified and actual
   Return air flow, specified and actual
   Outside air flow, specified and actual
   Total static pressure (total external), specified and actual
   Inlet pressure
   Discharge pressure
   Fan RPM

4. Exhaust Fan Data:
   Location
   Manufacturer
   Model
   Air flow, specified and actual
   Total static pressure (total external), specified and actual
   Inlet pressure
   Discharge pressure
   Fan RPM

5. Return Air/Outside Air Data:
   Identification/location
   Design air flow
   Actual air flow
   Design return air flow
   Actual return air flow
   Design outside air flow
   Actual outside air flow
   Return air temperature
   Outside air temperature
   Required mixed air temperature
   Actual mixed air temperature
   Design outside/return air ratio
   Actual outside/return air ratio

6. Electric Motors:
    - Manufacturer
    - HP/BHP
    - Phase, voltage, amperage; nameplate, actual, no load
    - RPM
    - Service factor
    - Starter size, rating, heater elements

7. V-Belt Drive:
    - Identification/location
    - Required driven RPM
    - Driven sheave, diameter and RPM
    - Belt, size and quantity
    - Motor sheave, diameter and RPM
    - Center to center distance, maximum, minimum, and actual

8. Duct Traverse:
    - System zone/branch
    - Duct size
    - Area
    - Design velocity
    - Design air flow
    - Test velocity
    - Test air flow
    - Duct static pressure
    - Air temperature
    - Air correction factor

9. Air Distribution Test Sheet:
    - Air terminal number
    - Room number/location
    - Terminal type
    - Terminal size
    - Area factor
    - Design velocity
    - Design air flow
    - Test (final) velocity
    - Test (final) air flow
    - Percent of design air flow

10. Variable Air Volume Data:
    - Manufacturer
    - Identification/number
    - Location
    - Model
    - Size
    - Minimum static pressure

Minimum design air flow
Maximum design air flow
Maximum actual air flow
Inlet static pressure

11. Pump Data:
    Identification/number
    Manufacturer
    Size/model
    Impeller
    Service
    Design flow rate, pressure drop, BHP
    Actual flow rate, pressure drop, BHP
    Discharge pressure
    Suction pressure
    Total operating head pressure
    Shut off, discharge and suction pressures
    Shut off, total head pressure

12. Cooling Coil Data:
    Identification/number
    Location
    Service
    Manufacturer
    Air flow, design and actual
    Entering air DB temperature, design and actual
    Entering air WB temperature, design and actual
    Leaving air DB temperature, design and actual
    Leaving air WB temperature, design and actual
    Water flow, design and actual
    Water pressure drop, design and actual
    Entering water temperature, design and actual
    Leaving water temperature, design and actual
    Air pressure drop, design and actual

13. Heating Coil Data:
    Identification/number
    Location
    Service
    Manufacturer
    Air flow, design and actual
    Water flow, design and actual
    Water pressure drop, design and actual
    Entering water temperature, design and actual
    Leaving water temperature, design and actual
    Entering air temperature, design and actual
    Leaving air temperature, design and actual
    Air pressure drop, design and actual

14. Flow Measuring Station:
    - Identification/station
    - Location
    - Size
    - Manufacturer
    - Model
    - Design flow rate
    - Design pressure drop
    - Actual/final pressure drop
    - Actual/final flow rate
    - Station calibrated setting

15. Sound Level Report:
    - Location
    - Octave bands - equipment off
    - Octave bands - equipment on

16. Vibration Test:
    - Location of points:
        - Fan bearing, drive end
        - Fan bearing, opposite end
        - Motor bearing, center (if any)
        - Motor bearing, drive end
        - Motor bearing, opposite end
        - Casing (bottom or top)
        - Casing (side)
        - Duct after flexible connection (discharge)
        - Duct after flexible connection (suction)
    - Test readings:
        - Horizontal, velocity and displacement
        - Vertical, velocity and displacement
        - Axial, velocity and displacement
    - Normally acceptable readings, velocity and acceleration
    - Unusual conditions at time of test
    - Vibration source (if non-complying)

17. Duct Leak Test:
    - Description of ductwork under test
    - Duct design operating pressure
    - Duct test static pressure
    - Duct capacity, air flow
    - Maximum allowable leakage duct capacity times leak factor
    - Test apparatus
        - Blower
        - Orifice, tube size
        - Orifice size
        - Calibrated
    - Test static pressure

Test orifice differential pressure
Leakage

18. Combustion Test:
    Boiler manufacturer
    Model
    Firing rate
    Overfire draft
    Gas meter timing dial size
    Gas meter time per revolution
    Gas pressure at meter outlet
    Gas flow rate
    Heat input
    Burner manifold gas pressure
    Percent carbon monoxide (CO)
    Percent carbon dioxide (CO_2)
    Percent oxygen (O_2)
    Percent excess air
    Flue gas temperature at outlet
    Ambient temperature
    Temperature difference
    Percent stack loss
    Percent combustion efficiency
    Heat output

1.8 PROJECT RECORD DRAWINGS

A. The Specialist shall:

1. Accurately record actual locations of [flow measuring stations] [balancing valves and rough setting] on the Record Drawings.

1.9 QUALIFICATIONS

A. The Specialist shall be company specializing in the adjusting and balancing of systems indicated in this Section with minimum one successfully performing project completed within the recent past [certified by AABC]. WORK shall be performed under supervision of [AABC Certified Test and Balance Engineer.] [NEBB Certified Testing, Balancing and Adjusting Supervisor.] [Registered Professional Engineer.]

1.10 SEQUENCING AND SCHEDULING

A. The Specialist shall:

1. Sequence work to commence after installation of systems and schedule completion of WORK before Substantial Completion of Project.

2. Schedule and provide assistance in final adjustment and test of [life safety] [smoke

evacuation] [smoke control] [ ] system with Fire Authority.

1.11 TESTING, ADJUSTING AND BALANCING

A. A conference shall be convened [one] [ ] week prior to commencing WORK of this Section.

PART 2 -- PRODUCTS (Not Used)

PART 3 -- EXECUTION

3.1 EXAMINATION

A. The Specialist shall, before commencing WORK, verify that systems are complete and operable.

B. The Specialist shall ensure the following:

1. Equipment is operable and in 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; and where required, install temporary filters in addition to final filters.
5. Duct systems are clean of debris.
6. Fan rotation is correct.
7. Fire and volume dampers are in place and open.
8. Coil fins have been 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 has been minimized.
12. Hydronic systems have been flushed, filled, and vented.
13. Pump rotation is correct.
14. Proper strainer baskets are clean and in place.
15. Service and balance valves are open.

C. The Specialist shall:

1. Report any defects or deficiencies noted during performance of services to CONSTRUCTION MANAGER.

2. Promptly report abnormal conditions in mechanical systems or conditions which prevent system balance.

3. If, for design reasons, system cannot be properly balanced, report as soon as observed.

4. Acknowledge in writing that beginning of work means acceptance of existing conditions.

3.2 PREPARATION

A. The Specialist shall:

1. Provide instruments required for testing, adjusting, and balancing operations; and make instruments available to CONSTRUCTION MANAGER to facilitate spot checks during testing.

2. Provide additional balancing devices as required.

3.3 INSTALLATION TOLERANCES

A. The Specialist shall:

1. Adjust air handling systems to plus or minus 5 percent for supply systems and plus or minus 10 percent for return and exhaust systems from quantities indicated.

2. Adjust hydronic systems to plus or minus 10 percent of design conditions indicated.

3.4 ADJUSTING

A. The Specialist shall:

1. Ensure that recorded data represents actually measured, or observed, condition.

2. Permanently mark settings of valves, dampers, and other adjustment devices and set and lock memory stops.

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

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

5. At final inspection, recheck random selections of data recorded in report; and recheck points or areas as selected and witnessed by the [OWNER] [CONSTRUCTION MANAGER].

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

A. Total system balance shall be performed in accordance with [AABC National Standards for Field Measurement and Instrumentation, Total System Balance.] [ASHRAE - 1984 Systems Handbook.] [NEBB Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.]

3.5 AIR SYSTEM PROCEDURE

A. The Specialist shall:

1. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities.

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

3. Measure air quantities at air inlets and outlets.

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

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

6. Vary total system air quantities by adjustment of fan speeds; provide drive changes required; and vary branch air quantities by damper regulation.

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

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

9. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.

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

11. 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.]

12. Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately 0.05 inches (12.5 Pa) positive static pressure [near the building entries.] [in clean rooms.][ ].

13. Check multi-zone units for motorized damper leakage; and adjust air quantities with mixing dampers set first for cooling, then heating, then modulating.

14. For variable air volume 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. The Specialist shall:

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

2. Use calibrated [Venturi tubes, orifices, or other metered] fittings and pressure gauges to determine flow rates for system balance; where flow metering devices are not installed, base flow balance on temperature difference across heat transfer elements in the system.

3. Adjust systems to provide indicated pressure drops and flows through heat transfer elements prior to thermal testing; perform balancing by measurement of temperature differential in conjunction with air balancing.

4. Balance system with automatic control valves fully open to heat transfer elements.

5. Adjust water distribution systems by means of balancing cocks, valves, and fittings. [The Specialist shall not use service or shut-off valves for balancing unless indexed for balance point.]

6. 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 TESTING, ADJUSTING AND BALANCING SCHEDULE

A. The WORK of this Section includes testing, adjusting and balancing as indicated on the attached Schedule.

** END OF SECTION **

TESTING, ADJUSTING AND BALANCING SCHEDULE

Equipment	Air Balance	Hydronic Balance	Sound Measurement	Vibration Testing
Boiler Feedwater Pumps				
HVAC Pumps				
Packaged Steel Water Tube Boilers				

Air Cooled Chillers

Air Cooled Refrigerant Condensers

Packaged Roof Top Air Conditioning Units

Computer Room Air Conditioning Units

Air Handling Units

Fans

Air Terminal Units

Air Inlets and Outlets

Pneumatic Controls Compressor