

PART 1 GENERAL**1.01 DESCRIPTION**

- A. Work Included: After completion of the work of installation, owner is responsible for procuring an air balancing and testing agency to test and regulate all components of the new heating, air conditioning and ventilating systems to verify air volumes and heating-cooling flow rates indicated on the Drawings. Provide TAB report to T.I. mechanical engineer for review. This specification section is provided for reference only.
- B. Related Work: The requirements of Section 23 0500, Common HVAC Materials and Methods, also apply to this section.
- C. Balancing Organization:
 - 1. Balancing of the Heating and Air Conditioning Systems: Performed by a firm providing this service established in the State of Oregon.
 - 2. Provide all necessary personnel, equipment, and services.
 - 3. Balancing Organization: Subject to compliance with these specifications, the following organizations may submit qualifications for approval Precision Test & Balance, Inc., Northwest Engineering Services, Air Balancing Specialties, Neudorfer Engineers, Air Introduction & Regulation, Accurate Balancing Agency or approved.

1.02 QUALITY ASSURANCE

- A. Balancing of the Heating and Air Conditioning Systems: Agency shall be a current member of NEBB or AABC specializing in the adjusting and balancing of systems specified with a minimum of 10 years documented experience.
- B. Testing, adjusting, and balancing shall be performed under direct field supervision of a Certified NEBB Supervisor or a Certified AABC Supervisor.

1.03 SUBMITTALS

- A. Balancing Data: Include the following minimum information in the Operation and Maintenance Data, as specified in Section 23 0500.
- B. Submit name of adjusting and balancing agency for approval within 30 days after award of Contract.
- C. Field Reports: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
 - 1. Submit under provisions of Section 230500.
 - 2. Prior to commencing work, submit report forms or outlines indicating adjusting, balancing, and equipment data required.
 - 3. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect and for inclusion in operating and maintenance manuals.
 - 4. 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.
 - 5. Include detailed procedures, agenda, sample report forms, and copy of AABC National Project Performance Guaranty or other certifying agency prior to commencing system balance.

6. Test Reports: Indicate data on AABC MN-1 forms, forms prepared following ASHRAE 111, NEBB forms, or forms containing information indicated in Schedules.
 7. Include the following on the title page of each report:
 - 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 and Owner.
 - g. Project Engineer.
 - h. Project Contractor.
 - i. Project altitude.
 - j. Report date.
- D. Project Record Documents: Record actual locations of flow measuring stations and balancing valves and rough setting.
- E. Provide a list of equipment, air supply, return and exhaust, heating water, and chilled water systems not in compliance with tolerances subsequently specified.

1.04 SEQUENCING

- A. Prebalancing meeting shall be conducted 30 days prior to start of balancing.
- B. Begin testing, adjusting, and balancing of systems after Construction Check/Start-up Plans are certified by the Commissioning Authority.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Test Instruments: Furnished by Contractor.
- B. Plugs: Provide plastic plugs in test holes drilled in ductwork. Provide UV resistant plugs for equipment located outdoors.

PART 3 EXECUTION

3.01 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 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.
 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.

3.02 INSTALLATION TOLERANCES

- A. Air Handling Systems: Adjust to within plus 10 percent or minus 5 percent of design for supply systems and +/- 10 percent of design for return and exhaust systems.
- B. Air Outlets and Inlets: Adjust total to within plus 10 percent or minus 5 percent of design to space. Adjust outlets and inlets in space to within +/- 10 percent of design.
- C. Hydronic Systems: Adjust to within +/- 10 percent of design.

3.03 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.

3.4 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 noise distribution system to obtain uniform space temperatures free from objectionable drafts and noise.
- E. Use volume control devices to regulate air quantities only to the 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. 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 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 0.02” (12.5 Pa) 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 are properly made and confirm proper operating for automatic variable air volume temperature control. Adjust drives to maximum airflow for highest static condition (maximum amps of motor). Allow VFD to regulate airflow per specification.
- N. Space pressure Control, Return Fan Speed Endpoints AHU-1 to 3 & 5. For variable air volume system with terminal unit zoning, attain return fan speed control endpoints based on the following values for the given operating mode. Coordinate with the HVAC control contractor for system setup and provide values when determined.

Return Fan Speed Endpoint Values				
Mode	Supply Fan Speed Hi/Lo Reset Limits	Desired Space Pressure (InH2O)	Economizer Position	Return Fan Speed
Full Heating (All terminal units are operating at heating flow setpoints)	TBD – Noted during the full heating condition	Ideal - 0.02 Acceptable Test Range: 0.01 – 0.03	Min-Min (25% of the minimum ventilation requirement)	Minimum Return Fan Speed-TBD
Full Cooling (All terminal units are operating at cooling flow setpoints)	TBD – Noted during the full cooling condition	Ideal - 0.02 Acceptable Test Range: 0.01 – 0.03	Min-Max (100% of the minimum ventilation requirement)	Maximum Return Fan Speed-TBD

- O. CO2 controller set points – minimum CO2 setpoint (ppm), maximum CO2 setpoint (ppm)(setting for min OSA at full occupancy).
- P. Outside air intake damper settings at minimum CO2 and maximum CO2 setpoint.

3.5 WATER SYSTEM PROCEDURE

- A. Adjust water systems to provide required or design quantities. This includes domestic HVAC systems.

- B. 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 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.
- G. Where automatic flow control valves are installed (Dynamic devices, not circuit setters) record listed flow rate of device based on field verification. Testing is not required.
- H. Balancing contractor shall be trained on balancing procedures by certified representative of differential pressure control valves.

3.6 SCHEDULES

- A. Equipment Requiring Testing, Adjusting, and Balancing:
 - 1. Plumbing pumps
 - 2. HVAC pumps
 - 3. Forced air furnaces
 - 4. Air cooled water chillers
 - 5. Packaged rooftop heating/cooling units
 - 6. Air coils
 - 7. Air handling units
 - 8. Fans
 - 9. Air filters
 - 10. Air terminal units
 - 11. Air inlets and outlets
- B. Report:
 - 1. 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
 - 2. Instrument List:
 - a. Instrument
 - b. Manufacturer
 - c. Model number
 - d. Serial number
 - e. Range
 - f. Calibration date
- C. Electric Motors:

1. Manufacturer
 2. Model/frame
 3. HP/BHP
 4. Phase, voltage, amperage; nameplate, actual, no load
 5. RPM
 6. Service factor
 7. Starter size, rating, heater elements
 8. Sheave make/size/model
- D. V-Belt Drives:
1. Identification/location
 2. Required driven RPM
 3. Driven sheave, diameter, and RPM
 4. Belt, size, and quantity
 5. Motor sheave diameter and RPM
 6. Center to center distance, maximum, minimum, and tested
- E. Pumps:
1. Identification/number
 2. Manufacturer
 3. Size/model
 4. Impeller
 5. Service
 6. Design flow rate, pressure drop, BHP
 7. Actual flow rate, pressure drop, BHP
 8. Discharge pressure
 9. Suction pressure
 10. Total operating head pressure
 11. Shut off, discharge, and suction pressure
 12. Shut off, total head pressure
- F. Refrigerant Cooling Coils:
1. Identification/number
 2. Location
 3. Service
 4. Manufacturer
 5. Air flow, design and actual
 6. Entering air DB temperature, design and tested
 7. Entering air WB temperature, design and tested
 8. Leaving air DB temperature, design and tested
 9. Leaving air WB temperature, design and tested
 10. Air pressure drop, design and tested
 11. Saturated suction temperature, design and tested
- G. Heating & Chilled Water Coils:
1. Identification/number
 2. Location
 3. Service
 4. Manufacturer
 5. Air flow, design and tested
 6. Water flow, design and tested

7. Water pressure drop, design and tested
8. Entering water temperature, design and tested
9. Leaving water temperature, design and tested
10. Entering air temperature, design and tested
11. Leaving air temperature, design and tested
12. Air pressure drop, design and tested

H. Air Moving Equipment:

1. Location
2. Manufacturer
3. Model number
4. Serial number
5. Arrangement/Class/Discharge
6. Air flow, specified and tested
7. Return air flow, specified and tested
8. Outside air flow, specified and tested
9. Total static pressure (total external), specified and tested
10. Inlet pressure
11. Discharge pressure
12. Sheave make/size/bore
13. Number of Belts/Make/Size
14. Fan RPM

I. Return Air/Outside Air:

1. Identification/location
2. Supply air flow, design and tested
3. Return air flow, design and tested
4. Outside air flow, design and tested
5. Return air temperature
6. Outside air temperature
7. Mixed air temperature, design and tested

J. Exhaust Fans:

1. Location
2. Manufacturer
3. Model number
4. Serial number
5. Air flow, specified and tested
6. Total static pressure (total external), specified and tested
7. Inlet pressure
8. Discharge pressure
9. Sheave Make/Size/Bore
10. Number of Belts/Make/Size
11. Fan RPM

K. Duct Traverses:

1. System zone/branch
2. Duct size
3. Area
4. Design velocity
5. Design air flow
6. Test velocity

7. Test air flow
8. Duct static pressure
9. Air temperature
10. Air correction factor

L. Terminal Unit Data:

1. Manufacturer
2. Type, constant, variable, single, dual duct
3. Identification/number
4. Location
5. Model number
6. Size
7. Minimum static pressure
8. Minimum air flow, design and tested
9. Maximum air flow, design and tested
10. Inlet static pressure, design and tested

M. Air Distribution Tests:

1. Air terminal number
2. Room number/location
3. Terminal type
4. Terminal size
5. Area factor
6. Design velocity
7. Design air flow
8. Test (final) velocity
9. Test (final) air flow
10. Percent of design air flow

3.7 DETAILED REQUIREMENTS

A. Adjusting and Balancing:

1. Adjust and balance all portions of the mechanical systems to produce indicated results within limits of minus 5 or plus 10 percent or as subsequently directed by the Architect.
2. Balancing data may be spot checked with instruments similar to that used by the balancing firm.
3. If, in the judgment of the Architect, the discrepancies warrant additional adjustment, readjust and rebalance the systems at no additional project cost.

B. Duct Pressure Test: To be conducted and/or witnessed by balancer.

END OF SECTION