

TESTING, ADJUSTING AND BALANCING FOR HVAC (BALANCING)

1. GENERAL

1.1 Scope

- .1 Balance, adjust, and test air and water systems and equipment and submit reports in identical units to those shown on Contract Documents.
- .2 Contractor shall prepare the facility for balancing.

1.2 Quality Assurance

- .1 Work specified in this Section shall be performed by an Independent Agency specialising in this type of Work, and paid by the Contractor.
- .2 Test equipment and material where required by specification or authority having jurisdiction to demonstrate its proper and safe operation.
- .3 Test procedures in accordance with the current applicable portions of ASME, ASHRAE, and other recognised test codes as far as field conditions permit.
- .4 Perform tests on-site to the satisfaction of the Contract Administrator.
- .5 Piping or equipment shall not be concealed or covered until inspected and approved by the Contract Administrator. Provide ample written notice (two working days) to the Contract Administrator before tests.
- .6 Coordinate with Contract Administrator at start of project, those tests that will require witnessing by the Contract Administrator.
- .7 Use factory trained representatives and submit manufacturer's check sheets for starting the following specialty equipment.
 - .1 Air handling units
 - .2 Pumps
 - .3 Boilers
 - .4 Control components
 - .5 Chemical cleaning and treatment
- .8 Prior to starting, testing, balancing, adjusting and cleaning processes, verify with Contract Administrator any tests required to be witnessed. Provide sufficient notice to Contract Administrator prior to commencement of procedures.
- .9 Contract Administrator shall be allowed to witness any testing, adjusting, starting, balancing and cleaning procedures.
- .10 Assume all costs associated with starting and testing, including the supply of testing or cleaning medium.

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- .11 Prior to starting equipment or systems, secure and review Manufacturer's installation, operation and starting instructions. Read in conjunction with procedures defined herein.
- .12 Use Manufacturer's or Supplier's starting personnel where required to ensure integrity of Manufacturer's warranty.
- .13 Compare installations to published Manufacturer's data and record discrepancies. Items proving detrimental to equipment performance shall be corrected prior to equipment starting.
- .14 Some processes involved in starting procedures defined in this Section may be duplications of authorities' verification. To facilitate expedient completion of project, arrange for authorities to assist or witness these procedures. (Gas inspectors, boiler and pressure vessels inspections etc.)
- .15 All starting, testing procedures shall be in accordance with applicable portions of the latest, current ASME, ASHRAE, AABC, CSA, NFPA, SMACNA, ASTM and ASPE codes and standards.
- .16 Personnel involved in starting, testing, balancing and adjusting procedures shall be experienced in the design and operation of mechanical equipment and systems being checked and shall be able to interpret results of the reading and tests.
- .17 Assume all liabilities associated with starting, testing and balancing procedures.

1.3 Submittals

- .1 Obtain certificates of approval, acceptance, and comply with current rules and regulations from authorities having jurisdiction and include in Operating and Maintenance Manuals.
- .2 Perform tests as specified and upon completion of mechanical installation. Provide certification of tests with detailed data as required. Itemise each test as to time performed and personnel responsible. Include in Operating and Maintenance Manuals.

1.4 Liability

- .1 Take charge of plant during tests, assume responsibility for damages in event of injury to personnel, building or equipment and bear costs for liability, repairs, and restoration in this connection.

1.5 Balancing Agenda

- .1 General: Submit balancing agenda to the Contract Administrator for review at least fifteen (15) days prior to the start of balancing Work. Start balancing Work after agenda has been approved. Include descriptive data, procedure data, and sample forms in agenda.
- .2 Descriptive Data: General description of each system including associated equipment and different operation cycles, listing of flow and terminal measurements to be performed and selection points for proposed sound measurements.
- .3 Procedure Data: Procedures for converting test measurements to establish compliance with requirements, specify type of instrument to be used, method of instrument application (by sketch) and correction factors.

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- .4 Sample Forms: Form showing application of procedures to typical systems.

1.6 Balance Report

- .1 Submit two (2) copies of draft balancing reports to Contract Administrator for review.
- .2 Provide copies of final reports in Operating and Maintenance Manuals.
- .3 Include types, serial number and dates of calibration of instruments in the reports.

1.7 System Data

- .1 The following information shall be provided:

- .1 Outdoor Make-up Air Unit (MUA-1)

Design Data:

Total air flow rate;
Fan total static pressure;
System static pressure;
Motor kW (hp), r/min, amps, volts, phase;
Outside air flow rate L/s (cfm);
Fan r/min;
Fan kW (hp);
Inlet and outlet, dry and wet bulb temperatures.

Manufacturer and model;

Size;
Arrangement discharge and class;
Motor type, kW (hp), r/min, voltage, phase, cycles, and load amperage;
Location and local identification data.

Recorded Data:

Air flow rate;
Fan total static pressure;
System static pressure;
Fan r/min;
Motor operating amperage;
Inlet and outlet, dry and wet bulb temperatures.

- .2 Air Inlet and Outlets: New diffuser in main floor mechanical room and diffusers off basement heat pump, HP-B-1
Outlet identification location and designation;
Manufacturers catalogue identification and type;
Application factors;
Design and recorded velocities;
Design and recorded air flow rates;
Deflector vane or diffuser cone settings.

- .3 Pumps: P-5, P-6 & P-14

Design Data:

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Fluid flow rate;
Total head;
kW (hp), r/min, amps, volts, phase.

Installation Data:

Manufacturer and model;
Size;
Type drive;
Motor type, kW (hp), r/min, voltage, phase, and full load amperage.

Recorded Data:

Discharge and suction pressures (full flow and no flow);
Operating head;
Operating water flow rate (from pump curves if metering not provided);
Motor operating amps (full flow and no flow);
r/min.

.4 Circuit Setters

Design Data:

Fluid flow rate;
Total head;

Installation Data:

Manufacturer and model;
Size;

Recorded Data:

Fluid flow rate;
Total head;

.5 Heating Equipment: B-1 & B-2

Design Data:

Heat transfer rate (heating and cooling);
Fluid flow rate;
Entering and leaving fluid temperatures;
Fluid pressure drop.

Installation Data:

Manufacturer, model, type;
Entering and leaving fluid temperatures;
Capacity;
Pressure drops;
Flow rates.

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Recorded Data:

Element type and identification (location and designation);
Entering and leaving fluid temp (for varying outdoor temperatures);
Fluid pressure drop;
Fluid flow rate;
Pressure relief valve setting.

2. PRODUCTS

2.1 Instruments

- .1 Provide calibration histories for each instrument. Recalibration or use of other instruments may be requested when accuracy of readings is questionable.

3. EXECUTION

3.1 General Procedure

- .1 Conduct performance tests to demonstrate equipment and systems meet specified requirements after mechanical installations are completed and pressure tested. Conduct tests as soon as conditions permit. Make changes, repairs, and adjustments required prior to operating tests.
- .2 Where required by the Authority having jurisdiction, gas fired appliances rated in excess of 117 kW (400 MBH) shall be subjected to an operational test established by the Authority and shall pass this test before being approved for operation.
- .3 Meet with Division 26 manufacturers, suppliers, and other specialists as required to ensure all phases of Work are properly coordinated prior to the commencement of each particular testing procedure. Establish all necessary manpower requirements.
- .4 Operate and test motors and speed switches for correct wiring and sequences and direction of rotation. Check and record overload heaters in motor starters.
- .5 Confirm voltages and operating amperages at full load.
- .6 Failure to follow instruction pertaining to correct starting procedures may result in re-evaluation of equipment by an Independent Testing Agency selected by the City at Contractor's expense. Should results reveal equipment has not been properly started, equipment may be rejected, removed from site, and replaced. Replacement equipment shall also be subject to full starting procedures, using same procedures specified on the originally installed equipment.
- .7 Permanently mark, by stick-on labels, settings on valves, splitters, dampers, and other adjustment devices.
- .8 Subsequent to correctional work, take measurements to verify balance has not been disrupted or that any such disruption has been rectified.
- .9 Balancing shall be performed to the following accuracies:

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| | | | |
|----|----------|-------------------|------------|
| .1 | Air | terminal outlets | $\pm 10\%$ |
| .2 | Air | central equipment | $\pm 5\%$ |
| .3 | Hydronic | terminal outlets | $\pm 10\%$ |
| .4 | Hydronic | pumps and central | $\pm 5\%$ |

3.2 Air System Procedure

- .1 Perform balancing, adjusting and testing with building doors and windows in their normal operation position.
- .2 The following procedure shall be adopted for central systems:
 - .1 Balance central apparatus to $\pm 10\%$ air flow.
 - .2 Balance branches, mains to $\pm 10\%$ air flow.
 - .3 Recheck central apparatus.
 - .4 Rebalance central apparatus to $\pm 5\%$.
- .3 Take static pressure readings and air supply temperature readings at ten (10) points on each air system.
- .4 Make air quantity measurements in ducts by "Pitot Tube" traverse of entire cross sectional area. If readings are inconsistent across duct, relocate to two duct diameters or widths and re-do traverse.
- .5 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 only by duct internal devices such as dampers and splitters.
- .6 Vary total system air quantities by adjustment of fan speeds. Vary branch air quantities by damper regulation.
- .7 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).
- .8 The final balanced condition of each area shall include testing and adjusting of pressure conditions. Test and record building pressurisation levels in variable volume systems throughout full range of fan delivery rates, under both heating and cooling conditions. Full multi-storey building test pressure conditions at ground, intermediate and upper levels. Front doors, exits, elevator shafts, should be checked for air flow so that exterior conditions do not cause excessive or abnormal pressure conditions. Document abnormal building leakage conditions noted.
- .9 Complete balancing to achieve positive building pressure unless otherwise instructed. A positive pressure relative to outside of 10 Pa (0.04 in wg) minimum and 20 Pa (0.08 in wg) maximum shall be achieved, measured with negligible outside wind velocity.

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3.3 Pressure Tests

- .1 Provide equipment, materials and labour for tests and pay expenses. Use test instruments from approved laboratory or manufacturer and furnish certificate showing degree of accuracy. Install permanent gauges and thermometers used for tests just prior to tests to avoid possible changes in calibration.
- .2 Carry out tests for eight-hour period and maintain pressure with no appreciable pressure drop. Where leakage occurs, repair and re-test and pay necessary costs for re-witnessing.
- .3 Drainage Systems: Test by filling with water to produce water pressure to 30 kPa (5 psi) minimum and 62 kPa (10 psi) maximum.
- .4 Water Piping: Test to 1-1/2 times maximum working pressure or 1033 kPa (150 psi), whichever is greater, water pressure measured at system low point.
- .5 Natural Gas: Test as required by current edition of CAN/CGA 149.1, and authority having jurisdiction.
- .6 Condensate Piping: Test to 690 kPa (100 psi) hydrostatic pressure.
- .7 Check systems during application of test pressure including visual check for leakage of water test medium, soap bubble test for air.
- .8 During heating and cooling piping system tests, check linear expansion at elbows, U bends, expansion joints and offsets for proper clearance.
- .9 When using water as test medium for system not using water, evacuate and dehydrate the piping and certify the lines are dry. Use agency specialising in this type of Work.
- .10 Should tests indicate defective Work or variance with specified requirements, make changes immediately to correct the defects. Correct leaks by re-making joints in screwed fittings, cutting out and re-welding welded joints, re-making joints in copper lines. Do not caulk.

3.4 Balancing of Hydronic Systems

- .1 Open all (except pressure bypass must be closed) valves to fully open position including balancing valves, isolation valves, and control valves.
- .2 Execute air balance prior to initiating hydronic balance.
- .3 Adjust flows through each boiler or to ensure equal flow.
- .4 Check and record flows and temperatures at inlet and outlet side of coils.
- .5 Position and mark all automatic valves, hand valves and balancing valves for design flow through all equipment, connectors and all items in system requiring circulation of hot water or glycol.
- .6 Upon completion of flow readings and coil adjustments, mark setting and record data.
- .7 Coordinate VFD frequency to operating condition on pumps.

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- .8 Ensure all bypass valves are tightly closed.
- .9 After making all terminal unit adjustments, re-check settings at pumps. Re-adjust as required.
- .10 Calibrate all pressure and temperature gauges.
- .11 For each pump, plot maximum and minimum flows on curve. Vary balancing valve and VFD to maximize pump efficiency. Record final operating VFD frequency.
- .12 Verify and record pressure drops and flows through all balancing valves.
- .13 Verify pressure drops and flows through pressure control bypass valves at full operating range.

3.5 Balancing Report

- .1 Submit draft copies of reports prior to final acceptance of project.
- .2 Include types, serial number and dates of calibration of instruments.
- .3 Record test data on CAD Drawings made from the latest available revised set of mechanical Drawings and submit copies upon completion of the balancing contract for inclusion in equipment and maintenance manuals. CAD drawings available from the Contract Administrator upon request.
- .4 Install at each piece of mechanical equipment a "Data Register" showing significant operating temperatures, pressures, amperes, voltage, brake horsepower. "Data Register" to be enclosed in a plastic holder securely attached to the equipment or to a wall in the adjacent area.
- .5 Submit with report, fan and pump curves with operating conditions plotted.
- .6 Report will be indexed as follows:

Air

Summary
Procedure
Instrumentation
Drawings
Equipment Summary
Fan Sheets
Fan Curves
Fan Profile Data
Static Data
Traverse Data and Schedule
Terminal Unit Summary
Outlet Data Summary and Schematics (per system)

Water

Summary
Procedure

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Instrumentation
Drawings
Pump Data
Pump Curves
Flow Stations
Coils
Equipment Data
Element Data Summary and Schematics (per system)
Diagnostic

3.6 Bring the work to an operating state and ready for balancing, including:

- .1 Clean equipment.
- .2 Replace filters with specified filters prior to balancing.
- .3 Verify lubrication of equipment.
- .4 Install permanent instrumentation.
- .5 Clean piping systems and strainers, clean systems, drain and fill with clean heat exchange fluid.
- .6 Complete the "start-up" of equipment.
- .7 Adjust stuffing boxes and packing glands on pumps and valves.
- .8 Check rotation and alignment of rotating equipment and tension of belted drives.
- .9 Set control points of automatic apparatus, check-out sequence of operation.
- .10 Make available control diagrams and sequence of operation.
- .11 Clean Work, remove temporary tags, stickers, and coverings.
- .12 Make available one (1) copy of Maintenance Manuals especially for use in balancing.

3.7 Balancing Valves and Dampers

- .1 Provide and install balancing valves, dampers, and other materials requested by the Balancing Agency and/or necessary to properly adjust or correct the systems to design flows, without additional cost to the City.

END OF SECTION