

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 Balancing (of both air and water systems) and sound level readings shall be performed by the same agency.
- .3 Balancing procedures shall be in accordance with the latest, current requirements NEBB, SMACNA and ASHRAE Standards.

1.3 Site Visits

- .1 Minimum of 2 site visits shall be made during construction to correspond with the general monthly site meetings held by the Contractor. After each site visit, a written report shall be submitted to the Contractor and Contract Administrator. Site visits shall commence after the start of air and water distribution work and be spread over the construction period to the start of the balancing work.
- .2 A review of the installation shall be made at the specified site visit and any additional dampers or valves required for proper balance shall be reviewed with the Contract Administrator and the Contractor.
- .3 Begin balancing after balancing preparation and after systems have been completed and are in full working order. Place systems and equipment into full operation and continue operation during each working day of balancing.

1.4 Balancing Agenda

- .1 General: Submit balancing agenda to the Contract Administrator and Contractor for review at least thirty (30) 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.
- .4 Sample Forms: Form showing application of procedures to typical systems.

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1.5 Balance Report

- .1 Submit two (2) copies of balancing reports to Contract Administrator prior to final acceptance of project.
- .2 Provide four (4) copies of final reports to Contractor for inserting in Operating and Maintenance Manuals as described in Section 01 33 00 - Submittal Procedures.
- .3 Include types, serial number and dates of calibration of instruments in the reports.

1.6 System Data

- .1 The following information shall be provided:
 - .1 Air Handling Equipment
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.

Installation Data:

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 Duct Air Quantities: All mains supplying more than 10% of Volume, outside air and exhaust (maximum and minimum) major return air openings back to duct shafts.

Duct sizes;
Number of pressure readings;
Sum of velocity measurements;
Average velocity;
Duct recorded air flow rate;
Duct design air flow rate.

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- .3 Air Inlet and Outlets
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.
- .4 Pumps
- Design Data:
- 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.
- .5 Circuit Setters, Triple Duty Valves, Flow Control Valves
- Design Data:
- Fluid flow rate;
- Installation Data:
- Manufacturer and model;
Size.
- Recorded Data:
- Fluid flow rate;
Water pressure drops.

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.6 Indirect Water Heaters

Design Data:

Fluid flow rates (heated media, heating media);
Fluid type;
Inlet and outlet temperatures.

Installation Data:

Manufacturer, model, type;
Fluid flow rates (heated media and heating media);
Inlet and outlet temperatures;
Pressure relief valve setting.

Recorded Data:

Heating media entering flow rate;
Heated media leaving flow rate;
Entering and leaving temperatures (for varying outdoor temperatures) and pressures;

.7 Water Chiller

Design Data:

Cooling capacity;
Evaporator and condenser flow rates and pressure drops;
Motor kW (hp), voltage, phase, full load amps.

Installation Data:

Manufacturer and model;
Motor type, kW (hp), r/min, voltage, phase, and full load amperage;
Water flow rates;
Water pressure drops;
Entering and leaving water temperatures.

Recorded Data:

Water flow rates;
Water pressure drops;
Entering and leaving water temperatures.

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.8 Cooling Tower

Design Data:

Entering dry and wet bulb temperatures;
Water flow rate;
Water entering temperature;
Water leaving temperature;
Fan kW (hp)

Installation Data:

Manufacturer and model;
Motor type, kW (hp), r/min, voltage, phase, and full load amperage;
Water flow rates;
Entering dry and wet bulb temperature;
Fan r/min;
Entering water temperature;
Leaving water temperature.

Recorded Data:

Entering water temperature;
Leaving water temperature;
Entering air temperature wet and dry bulb;
Leaving air temperature wet and dry bulb;
Ambient temperature wet and dry bulb;
Fan r/min;
Fan motor r/min;
Fan sheave size;
Motor sheave size;
Belt size;
Water flow rates;
Fan motor amps, volts, phase, kW (hp).

.9 Sound Level Data

Diagram or description of relationship of sound source and measuring instrument;
"A" scale reading;
Reading at each octave band frequency.

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.

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3. EXECUTION

3.1 General Procedure

- .1 Permanently mark, by stick-on labels, settings on valves, splitters, dampers, and other adjustment devices.
- .2 Subsequent to correctional work, take measurements to verify balance has not been disrupted or that any such disruption has been rectified.
- .3 Balancing shall be performed to the following accuracies:
 - .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 Ensure dampers or volume control devices are in fully open position.
 - .2 Balance central apparatus to $\pm 10\%$ air flow.
 - .3 Balance branches, mains to $\pm 10\%$ air flow.
 - .4 Recheck central apparatus.
 - .5 Balance all terminal air outlets to $\pm 10\%$.
 - .6 Rebalance central apparatus to $\pm 5\%$.
 - .7 Recheck all air outlets.
 - .8 Perform acoustical measurements.
 - .9 Perform building pressurisation tests and measurements at minimum and maximum outdoor air damper positions of the main air unit(s).
- .3 When balancing air outlets:
 - .1 Rough balance furthest outlets and then balance sequentially back to source.
 - .2 Fine balance furthest outlet back to source.

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- .4 Take static pressure readings and air supply temperature readings on each air system.
- .5 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.
- .6 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.
- .7 Vary total system air quantities by adjustment of fan speeds. Vary branch air quantities by damper regulation.
- .8 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).
- .9 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.
- .10 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.

3.3 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 (if coils are provided).
- .3 Set pumps to deliver 10% excess flow if possible.
- .4 Adjust flows through each boiler or chiller to ensure equal flow.
- .5 Check and adjust flows and temperatures at inlet side of coils.
- .6 Position and mark all automatic valves, hand valves and balancing cocks for design flow through all coils, connectors and all items in system requiring circulation of chilled water, hot water or glycol.
- .7 Upon completion of flow readings and coil adjustments, mark setting and record data.
- .8 Co-ordinate shaving of impellor to operating condition on pumps larger than 1.5 kW (2 hp).
- .9 Ensure all bypass valves are tightly closed.

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- .10 After making all terminal unit adjustments, re-check settings at pumps. Re-adjust as required.
- .11 Calibrate all pressure and temperature gauges.
- .12 Install pressure gauges on each coil then read pressure drop through coil and set flow rate on call for full flow through coil. Set pressure drop across bypass valve to match coil full flow pressure drop.
- .13 For all parallel pumping systems, check all flows through boiler, chiller, heat exchanger, and pumps under the following situations:
 - .1 With two pumps operating.
 - .2 With one pump operating - repeat for each pump.
 - .3 With controls demanding no heating or cooling.
- .14 For each pump, plot maximum and minimum flows on curve.
- .15 Verify pressure drops and flows through pressure control bypass valves at full operating range.

3.4 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 latest available revised set of mechanical drawings and submit four (4) copies upon completion of the balancing contract for inclusion in equipment and maintenance manuals.
- .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. Submit grille and diffuser shop drawings and diffusion factors.
- .6 Report shall be indexed as follows:
 - Air
 - Summary
 - Procedure
 - Instrumentation
 - Drawings
 - Equipment Summary
 - Fan Sheets
 - Fan Curves
 - Fan Profile Data

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Static Data
Air Monitoring Station Data
Traverse Data and Schedule
Terminal Unit Summary
Outlet Data Summary and Schematics (per system)
Building Pressurisation Data Diagnostic
Water
Summary
Procedure
Instrumentation
Drawings
Pump Data
Pump Curves
Flow Stations
Coils
Equipment Data
Element Data Summary and Schematics (per system)
Diagnostic

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

- .1 Clean equipment and ductwork.
- .2 Install air terminal devices.
- .3 Provide temporary filters in air handling equipment and carry out a rough air balance to ensure all equipment performs required function.
- .4 Replace filters with specified filters prior to balancing.
- .5 Verify lubrication of equipment.
- .6 Install permanent instrumentation.
- .7 Clean piping systems and strainers, clean systems as per Section 15090, drain and fill with clean heat exchange fluid.
- .8 Complete the "start-up" of equipment.
- .9 Adjust stuffing boxes and packing glands on pumps and valves.
- .10 Check rotation and alignment of rotating equipment and tension of belted drives.
- .11 Verify ratings of overload heaters in motor starters.
- .12 Set control points of automatic apparatus, check-out sequence of operation.
- .13 Make available control diagrams and sequence of operation.
- .14 Clean work, remove temporary tags, stickers, and coverings.

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.15 Make available one (1) copy of Maintenance Manuals especially for use in balancing.

.16 Provide Balancing Agency a complete set of mechanical drawings and specifications.

3.6 Co-operate with the Balancing Agency as follows:

.1 Make corrections as required by Balancing Agency.

.2 Allow Balancing Agency free access to site during construction phase. Inform Balancing Agency of any major changes made to systems during construction and provide a complete set of record drawings for their use.

.3 Operate automatic control system and verify set points during balancing.

3.7 Co-operate with the Controls Contractor as follows:

.1 Co-ordinate any control changes needed by the Balancing Agency with the Controls Contractor.

.2 Make any controls corrections as required by Balancing Agency without additional cost.

3.8 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.

END OF SECTION