Part 1 General

1.1 SUMMARY

.1 TAB is used throughout this Section to describe the process, methods and requirements of testing, adjusting and balancing for HVAC.

.2 TAB means to test, adjust and balance to perform in accordance with requirements of Contract Documents and to do other work as specified in this section.

1.2 QUALIFICATIONS OF TAB PERSONNEL

.1 Submit names of personnel to perform TAB to Departmental Representative within 90 days of award of contract.

.2 Provide documentation confirming qualifications, successful experience.

.3 TAB: performed in accordance with the requirements of standard under which TAB Firm's qualifications are approved:

.1 Associated Air Balance Council, (AABC) National Standards for Total System Balance, MN-1-2002, 6th Edition.

.2 National Environmental Balancing Bureau (NEBB) TABES, Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems-2005, Seventh Edition.

.3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), HVAC TAB HVAC Systems - Testing, Adjusting and Balancing-2002.

.4 Recommendations and suggested practices contained in the TAB Standard: mandatory.

.5 Use TAB Standard provisions, including checklists, and report forms to satisfy Contract requirements.

.6 Use TAB Standard for TAB, including qualifications for TAB Firm and Specialist and calibration of TAB instruments.

.7 Where instrument manufacturer calibration recommendations are more stringent than those listed in TAB Standard, use manufacturer's recommendations.

.8 TAB Standard quality assurance provisions such as performance guarantees form part of this contract.

.1 For systems or system components not covered in TAB Standard, use TAB procedures developed by TAB Specialist.

.2 Where new procedures, and requirements, are applicable to Contract requirements have been published or adopted by body responsible for TAB Standard used (AABC, NEBB, or TABB), requirements and recommendations contained in these procedures and requirements are mandatory.

1.3 PURPOSE OF TAB

.1 Test to verify proper and safe operation, determine actual point of performance, evaluate qualitative and quantitative performance of equipment, systems and controls at design, average and low loads using actual or simulated loads

.2 Adjust and regulate equipment and systems to meet specified performance requirements and to achieve specified interaction with other related systems under normal and emergency loads and operating conditions.

.3 Balance systems and equipment to regulate flow rates to match load requirements over full operating ranges.

1.4 EXCEPTIONS

.1 TAB of systems and equipment regulated by codes, standards to satisfaction of authority having jurisdiction.

1.5 CO-ORDINATION

.1 Schedule time required for TAB (including repairs, re-testing) into project construction and completion schedule to ensure completion before acceptance of project.

.2 Do TAB of each system independently and subsequently, where interlocked with other systems, in unison with those systems.

1.6 PRE-TAB REVIEW

.1 Review contract documents before project construction is started and confirm in writing to Departmental Representative adequacy of provisions for TAB and other aspects of design and installation pertinent to success of TAB.

.2 Review specified standards and report to Departmental Representative in writing proposed procedures which vary from standard.

.3 During construction, co-ordinate location and installation of TAB devices, equipment, accessories, measurement ports and fittings.

1.7 START-UP

.1 Follow start-up procedures as recommended by equipment manufacturer unless specified otherwise.

.2 Follow special start-up procedures specified elsewhere in Division 23.

1.8 OPERATION OF SYSTEMS DURING TAB

.1 Operate systems for length of time required for TAB and as required by Departmental Representative for verification of TAB reports.

1.9 START OF TAB

.1 Notify Departmental Representative 7 days prior to start of TAB.

.2 Start TAB when building is essentially completed, including:

.1 Installation of all construction affecting TAB.

.2 Provisions for TAB installed and operational.

.3 Start-up, verification for proper, normal and safe operation of mechanical and associated electrical and control systems affecting TAB including but not limited to:

.1 Proper thermal overload protection in place for electrical equipment.

.2 Air systems:

.1 Filters in place, clean.

.2 Duct systems clean.

.3 Ducts, air shafts, ceiling plenums are airtight to within specified tolerances.

.4 Correct fan rotation.

.5 Fire, smoke, volume control dampers installed and open.

.6 Coil fins combed, clean.

.7 Access doors, installed, closed.

.8 Outlets installed, volume control dampers open.

.3 Liquid systems:

.1 Flushed, filled, vented.

.2 Correct pump rotation.

.3 No short circuit in the system.

.4 Strainers in place, baskets clean.

.5 Isolating and balancing valves installed, open.

.6 Calibrated balancing valves installed, at factory settings.

.7 Chemical treatment systems complete, operational.

.8 Prepare hydraulic diagram of the system, identifying all devices or equipment that will be used for testing and balancing the flow. Identify all locations where measurements will be taken and ensure that connections are available. Use this diagram as a reference in the balancing report.

1.10 APPLICATION TOLERANCES

.1 Do TAB to following tolerances of design values:

.1 Ventilation Systems:

.1 At terminal units: plus or minus 10%.

.2 At main branches: plus or minus 5%.

.2 Hydronic systems: plus or minus 10%.

1.11 ACCURACY TOLERANCES

.1 Measured values accurate to within plus or minus 2% of actual values.

1.12 INSTRUMENTS

.1 Prior to TAB, submit to Departmental Representative list of instruments used together with serial numbers.

.2 Calibrate in accordance with requirements of most stringent of referenced standard for either applicable system or HVAC system.

.3 Calibrate within 3 months of TAB. Provide certificate of calibration to Departmental Representative.

1.13 PROCEDURES - VENTILATION

.1 Systems requiring TAB:

.1 New Rooftop Units RTU-1 and RTU-2.

.2 New Rooftop Units RTU-3 for Main Building Addition (called RTU-3 in these documents for clarity).

.3 All VAV Boxes, diffusers, and fan-coils in the Main Building.

.4 New Fan-coils AC-01 and AC-02 in Hydraulic Building.

.5 New Fluid Coolers on Hydraulic Building:

.1 Assist Div. 25 by starting all fan stages while Division 25 records amperages associated with fan power.

.6 Assist Division 25 for determination of all differential pressure set-points and flows required for programming.

.2 Verification of equipment and system:

.1 Start-up fans (supply, return, exhaust) and check:

.1 Voltage and amperage of motors to avoid overload.

.2 Fan rotation

.3 Adequate operation of differential pressure detector

.4 Position of motorized dampers

.5 Temperature control of chilled water, hot water or glycol with controls contractor.

.6 Obvious air leaks.

.2 Develop a ventilation system diagram which identifies all device that will be used for testing, adjusting and/or balancing flow. Also identify all locations where measurements will be taken to ensure that sufficient connections are provided on ductwork. Use this identification as a reference in the balancing report. Ensure there is no short circuiting in the ductwork system.

.3 Air flow at main branches:

.1 Using a Pitot tube, measure flow in the main branches

.2 If required, adjust fan speed the design air flow.

.3 Check motor power as well as fan rpm to ensure that operation is within critical limits.

.4 Adjust balancing dampers at main branches until the design airflow is reached.

.4 Minimum outside air:

.1 Adjust static pressure in the mixing plenum at zero or slightly negative, following the requirements and site conditions, when the return damper is open to its maximum position. Balancing damper installed in the mixing plenum is used to set the static pressure inside the plenum.

.2 Adjust dampers to set the outside air to a maximum of 105% of design requirements.

.5 Terminal equipment adjustments:

.1 Adjust air flow from terminal units up to fans.

.2 Use balancing dampers at main branches for major adjustments and dampers at terminal equipment for precision adjustments.

.3 These adjustments may require multiple iterations.

.6 When airflow is adjusted at system, main branches and at outlets, perform the following readings:

.1 Motor amperage

.2 Differential pressure at fans (discharge minus inlet)

.3 Differential pressure at all secondary component in the system

.4 Differential pressure at all primary component of the system (air intake, exhaust air, filters, coils, mixing dampers, etc.)

.7 Adjustment procedure:

.1 Check maximum air flows that must be obtained from supply and return fans. Diversity implies that the airflow at fans will be lower than the sum of all airflows at grilles and diffusers.

.2 Get fan curves and surge data.

.3 Get characteristics of VFD or any other airflow control device where applicable.

.4 Get minimum and maximum operating pressure of terminal units.

.5 Establish theoretical operating curve of the system.

.6 Adjust terminal units in accordance with maximum air flow.

.7 Adjust fans at the required speed plus 5%.

.8 Spot check terminal units that are the most representative. If the variation of static pressure is significant or if air flow at terminal units is inferior when fan speed is at the maximum, check all terminal units

.9 Read airflow at main branches with Pitot tube.

.10 If static pressure or flow is too low, accelerate fan.

.1 If flow is satisfactory but static pressure too high, decelerate fan.

.2 If static pressure is high or satisfactory but airflow too low, check fan installation for system effect. If there is no system effect, re-adjust all terminal units to required airflow.

.11 Repeat the procedures from 1.13.6.7 to 1.13.6.10 for the return air and exhaust air fans once the system is adjusted to the minimum outside air.

.12 Adjust air to the diffusers and check design air flow when terminal unit is open to its maximum position. Check minimum adjustment.

.13 Set terminal elements at their minimum position and adjust air flow control mechanisms at fans to get minimum flow and pressure.

.14 Coordinate with division 25 – CONTROLS for the adjustment of flow switches, static pressure detectors, air flow regulators, etc.

.15 Verify that the return fan speed is adjusted in synchronization with supply fan to ensure that the right outside airflow is supplied at that static pressure is maintained in the mixing plenum on all operating conditions.

.16 Operate system at 100% outside air to verify power and static pressure of that supply and return fans.

1.14 PROCEDURES – HYDRAULIC SYSTEMS

.1 Systems requiring TAB:

.1 Temporary Chiller.

.2 Permanent Chiller:

.1 Free-cooling Mode

.2 Mechanical Cooling Mode

.3 Assist Division 25 for determination of all differential pressure set-points and flows required for programming.

.2 Generalities:

.1 Produce hydraulic schematics of the system showing all device or equipment that will be needed to measure and/or adjust the flow. Also identify all measuring points to ensure that sufficient connections are provided in appropriate piping locations. Refer to this identification as a reference for the balancing report. Ensure that piping does not have any short-circuit.

.2 Establish diversity factor by comparing pumping capacity to the sum of the flows to the end devices.

.3 Using the controls diagrams, determine the required position of controls devices in order to obtain flow conditions representative of the diversity factor calculated. Coordinate with Division 25.

.4 Check that system is clean and purged from all air.

.1 Use all manual valves and leave in normal position.

.2 Ensure that all control valves are in desired position prior to any measurement is taken.

.3 Ensure that expansion tanks are adequately charged.

.5 When design flow conditions are obtained, measure pressure at the suction and discharge of pumps.

.6 Measure shut-off pressure of pumps (no flow).

.7 Measure voltage between phases and amperage for each phase at pumps motors.

.8 Check correspondence between measured data and pump curves.

.9 Flow shall be maintained as constant for the entire TAB procedure, by adjusting manually valves at the inlet or discharge of pumps, as applicable.

.10 Proceed with TAB starting with branches with less resistance (usually, but not necessarily, the shortest), and finishing with branches with the highest restriction.

.3 Primary / Secondary loops

.1 For primary / secondary pumping systems, reasonably adjust the primary loop prior to adjust the secondary. While adjusting the primary system, secondary pumps must be in operation and ensure that there is flow.

.4 Flow measurements:

.1 Where circuit balancing valves are shown, refer to technical data on the valves and provide measurements in accordance with manufacturer’s instructions.

.2 Any equipment such as coils, some valves, control valves, chiller, etc., with a relation between the equipment pressure drop specified by the manufacturer can

be used to measure the flow. If fluid density is constant, flow through the equipment can be determined by measuring the differential pressure P_2 between the inlet and outlet and by applying Bernouilli's equation:

.1 Where P_1 is the pressure drop at flow Q_1 as provided by the manufacturer, actual flow (Q_2) can be calculated by measuring the actual pressure drop P_2:

$$\frac{Q_1^2}{Q_2^2} = \frac{\Delta P_1}{\Delta P_2}$$

.2 Control valves are excellent devices for measuring flow. Cv or Kv is from the technical data of the valves, the pressure drop through the known valve can be determined and therefore determine the flow:

$h = 2.3 (Q_1/Cv)^2$, where Q_1 is in usgpm and h is in feet.

Or $h = (36 Q_1/Kv)^2$, where Q_1 is in L/s and h is in kPa.

.3 Ensure that control valve is fully open prior to any measurement. Adjust the valve at the required "h" value.

.3 The pump of a system can be used as a flow indicator when pump curve provided is a "calibration pump curve".

.1 Measure pressure differential between pump suction and discharge. Flow can be established using the pump curve. If pump curve is a "calibration pump curve", resulting flow can be considered as exact.

.2 Ensure that the measured pressure at the suction of the pumps is over the NPSH ("Net Positive Suction Head") as required by the manufacturer.

.3 Measure the voltage and amperage of pump motors at operating flow. Indication point of operation on the pump curve and compare with power calculations to check concordance.

.4 Compare flow at the pump with flow in the system.

1.15 SUBMITTALS

.1 Submit, prior to commencement of TAB:

.2 Proposed methodology and procedures for performing TAB if different from referenced standard.

1.16 PRELIMINARY TAB REPORT

.1 Submit for checking and approval of Departmental Representative, prior to submission of formal TAB report, sample of rough TAB sheets. Include:

.1 Details of instruments used.

.2 Details of TAB procedures employed.

.3 Calculations procedures.

.4 Summaries.

1.17 VENTILATION TAB REPORT

.1 Format in accordance with referenced standard.

.2 TAB report to show results in SI units and to include:

.1 Project record drawings.

.2 System schematics.

.3 Submit 3 copies of TAB Report to Departmental Representative for verification and approval, in English in D-ring binders, complete with index tabs.

.4 TAB report shall include, as a minimum, the following information:

.1 Dated reports: On the report's cover page as well as on all pages of the report, dates when measurements were taken must be clearly indicated.

.5 Design Data:

.1 Air flows:

.1 Supply

.2 Return

.3 Exhaust

.2 Fans static pressure

.3 Motor horsepower (HP)

.4 Brake horsepower (BHP)

.5 Fan speed (rpm)

.6 Minimum outside air percentage.

.6 Characteristics of the installed equipment:

.1 Manufacturer, model, serial number.

.2 Dimensions.

.3 Arrangement.

.4 Construction class

.5 Motor nameplate:

.1 Horsepower

.2 Voltage

.3 Number of phases

.4 Frequency

.5 FLA

.6 Rpm

.7 Tests at main elements:

.1 Fan speed

.2 Power reading at motor connections (voltage and amperage at all phases)

.3 Differential pressure through each system component (coils, filters, etc.)

.4 Pressure at suction and discharge of fans

.5 Measures air flow

.6 Fan curve indicating the operating point, based on readings.

.7 Pressure as measures at pressure sensors provided and installed by division 25.

.8 Test at terminal devices:

.1 Identification of the terminal element by ID number and location

.2 Type of terminal device:

.1 Manufacturer

.2 Model
.3 Dimension
.4 K factor

.3 Design air flow and air speed.

.4 Air flow and air speed results.

.5 Adjustment (where applicable) of airflow pattern at diffuser.

.9 Additional information:

.1 Fans:

.1 Dimensions and number of belts
.2 Dimensions of pulleys
.3 Position of adjustable pulleys
.4 Full load motor rotation
.5 Overload protection adjustments
.6 Filter type, initial pressure drop at full flow, pressure drop for filter replacement
.7 Air speed readings at coils
.8 Airflow control device type

.2 Air distribution system:

.1 Pressure reading at main branches
.2 Pressure reading in ceilings
.3 Pressure difference between the building and exterior when the building is in operation at minimum outside air and at maximum outside air
.4 List of Pitot tests and results
.5 List of all airflow readings at each grille and diffuser, indicating also design airflow requirement
.6 Equipment Data:

.1 Identification.
.2 Manufacturer, model, serial number.

.1 Size.
.2 Type.
.3 Maximum operating pressure.
.4 Seals Type.
.5 Motor nameplate : HP, voltage, phases and frequency, FLA, rpm.

.3 Measurement results:

.1 At terminal equipment:

.1 Identification
.2 Manufacturer, model, size.
.3 Pressure in
.4 Pressure out
.5 Flow

.2 Other locations :

.1 Branches and risers: pressure readings. Identify location on diagram.

1.18 HYDRAULIC TAB REPORT

.1 Format in accordance with referenced standard.

.2 TAB report to show results in SI units and to include:

.1 Hydraulic diagram.

.3 Submit 3 copies of TAB Report to Departmental Representative for verification and approval, in English in D-ring binders, complete with index tabs.

.4 TAB report shall include, as a minimum, the following information:

.1 Dated reports: On the report's cover page as well as on all pages of the report, dates when measurements were taken must be clearly indicated.

.5 Pumps:

.1 Design information:

.1 Identification

.2 Flow

.3 Hydrostatic head

.4 Brake horse power

.5 Nominal motor HP

.2 Equipment Data:

.1 Identification (refer to specifications and drawings).

.2 Manufacturer, model, serial number.

.3 Size.

.4 Type.

.5 Maximum operating pressure.

.6 Seals Type.

.7 Motor nameplate : HP, voltage, phases and frequency, FLA, rpm.

.3 Measurement results:

.1 Pumps:

.1 Identification.

.2 RPM.

.3 Fluid type.

.4 Fluid temperature.

.5 Volts, amperage (each phase).

.6 Pressure before and after strainer.

.7 Shut-off pressure.

.8 Suction and discharge pressure at design flow.

.9 Pump curve.

.10 Measured pressure where controls sensors are installed.

.2 At terminal equipment:
- .1 Identification
- .2 Manufacturer, model, size.
- .3 Pressure in
- .4 Pressure out
- .5 Flow

.3 Other locations :
- .1 Branches and risers: pressure readings. Identify location on diagram.
- .2 At risers: pressure reading. Identify risers on schematics.
- .3 At primary / secondary bridges: pressure or flow. Identify primary / secondary bridges on schematics.

1.19 VERIFICATION

.1 Reported results subject to verification by Departmental Representative.

.2 Provide personnel and instrumentation to verify up to 30% of reported results.

.3 Number and location of verified results as directed by Departmental Representative.

.4 Pay costs to repeat TAB as required to satisfaction of Departmental Representative.

1.20 SETTINGS

.1 After TAB is completed to satisfaction of Departmental Representative, replace drive guards, close access doors, lock devices in set positions, ensure sensors are at required settings.

.2 Permanently mark settings to allow restoration at any time during life of facility. Do not eradicate or cover markings.

1.21 COMPLETION OF TAB

.1 TAB considered complete when final TAB Report received and approved by Departmental Representative.

1.22 OTHER TAB REQUIREMENTS

.1 General requirements applicable to work specified this paragraph:
- .1 Qualifications of TAB personnel: as for air systems specified this section.
- .2 Quality assurance: as for air systems specified this section.

1.23 POST-OCCUPANCY TAB

.1 Participate in systems checks twice during Warranty Period - #1 approximately 3 months after acceptance and #2 within 1 month of termination of Warranty Period.

Part 2 Products

2.1 NOT USED

.1 Not used.

Part 3 Execution

3.1 NOT USED

.1 Not used.

END OF SECTION