Functional Test Plan

Project _____

FT-_____ TEST AND BALANCE (TAB) CHECKOUT

1. Participants (fill out once, to cover all TAB work)

Party	Participation	Party	Participation
_____	_____	_____	_____
_____	_____	_____	_____

Party filling out this form and witnessing testing _____
Dates of tests _____

2. TAB Scope

The scope of the TAB for this project includes:
__ supply and return air handling systems, including __cooling coil capacity verification, __heating coil capacity verification, __heat exchanger efficiency verification, __OSA quantity verification
__ exhaust fan flows for all exhaust fans except _____
__ chilled water system TAB, including __ chilled water, condenser water and cooling tower flows.
__ heating water TAB
__ laboratory or specialty room balancing
__ fume hood balancing
__ sound level testing in the following areas: _____
__ other: _____

3. Test Prerequisites (fill out once, to cover all TAB recheck work)

a. The following have been started up and startup reports and prefunctional checklists submitted and approved and the TAB work completed for this equipment and draft TAB report submitted:
   __ All air handlers, except _____
   __ All terminal units, except _____
   __ All exhaust fans
   __ Hot water system
   __ Chilled water system
   __ Other _____

b. __ All control system functions for the above applicable systems and all interlocking systems are programmed and operable per contract documents, including final setpoints and schedules and with debugging, loop tuning and sensor and device calibrations completed. Exceptions: _____
   _____
   _____ _____
   Controls Contractor Signature or Verbal Date

c. __ All A/E punchlist items for this equipment corrected that may affect TAB, except _____
   _____

d. __ All deficient items identified during TAB have been addressed and verified to have been corrected, except:
   _____

e. __ These functional test procedures reviewed and approved by TAB contractor.

f. __ Verify that final settings of all valves, splitters, dampers and other adjustment devices have been permanently marked by the TAB Contractor. List devices checked: _____
   _____

4. Verification Requirements

From interpreting the TAB testing requirements in the specifications, the verification of the following systems will be required:

Spec Writer: "R" at the beginning of a requirement means generally Recommended. "O" means Optional, and not always necessary. Edit as appropriate. Note: Test procedures (on subsequent pages) have not been written for all the requirements below.

1. (O) The total supply air flow of ____% of the air handlers, which equals _____ units to test.
2. (O) The total return air flow of ____% of the air handlers, which equals _____ units to test.
3. (O) The fan static discharge pressure during full cooling of ____% of the air handlers, which equals _____ units to test.
4. (R) The OSA flow at air handler flows of: ___near minimum, ___intermediate, ___near maximum, for ____% of the air handlers, which equals _____ units to test.
5. (R) The total measured flow for the TU, at near minimum and maximum flows, matches the value shown on the BAS readout. of _____% of each TU type, which equals _____ units to test total.
6. (R) ___ The measured flow of the diffusers and the total maximum and minimum flows of the TU match that of the TAB report for the TU's verified.
7. (O) The discharge velocity of ____% of the diffusers of ____% of the TUs tested.
8. (O) The coil capacity of ____% of the cooling coils and ____% of the heating coils, which equals _____ units to test.
9. (O) The efficiency of ____% of the heat exchangers, which equals _____ units to test.
10. (O) The chilled water flow through ____% of the chillers, which equals _____ units to test.
11. (O) Chilled water pump discharge pressure during full cooling on ____% of the pumps, which equals _____ units to test.
12. (O) Condenser water pump discharge pressure during full cooling on ____% of the pumps, which equals _____ units to test.
13. (O) The condenser water flow through ____% of the chillers, which equals _____ units to test.
14. (O) The condenser water flow through ____% of the cooling towers, which equals _____ units to test.
15. (O) The heating water flow through ____% of the boilers, which equals _____ units to test.
16. (R) The flow requirements for ____% of the fume hoods under the following conditions: _____ _____
17. (R) The following laboratory flows and pressure differentials: _____ _____
18. (O) Sound levels in the following areas: _____ _____
19. (R) ___Verification that the air system is being controlled to the lowest possible static pressure while still meeting design loads, less diversity. This shall include a review of TAB methods, control setpoints established by TAB and a physical verification of at least one leg from fan to diffuser having all balancing dampers wide open and that during full cooling of all TUs taking off downstream of the static pressure sensor, the TU on the critical leg has its damper 90% or more open.
20. (R) ___Verification that the water system is being controlled to the lowest possible pressure while still meeting design loads, less diversity. This shall include a review of TAB methods, control setpoints established by TAB and a physical verification of at least one leg from the pump to the coil having all balancing valves wide open.
21. ___Other:_____

Notes:

5. Acceptance Criteria

According to the specifications, section _____:

A failure[1] of more than 10% of the selected items of a given system[2] shall result in the failure of acceptance of the final TAB report for that system and the TAB contractor shall be responsible to rebalance the system, provide a new system TAB report and repeat random verifications of the new TAB report.

[1]Failure of an item is defined as follows:
For air flow of supply and return: a deviation of more than 10% of instrument reading
For minimum outside air flow: 20% of instrument reading (30% for reading at intermediate supply flow for inlet vane or VFD OSA compensation system using linear proportional control)
For temperatures: a deviation of more than 1°F
For air and water pressures: a deviation of more than 10% of full scale of test instrument reading
For sound pressures: a deviation of more than 3 decibels. (Variations in background noise must be considered)

[2]Examples of a "system" are: the air distribution system served by one air handler or the hydronic chilled water supply system served by a chiller or the condenser water system. Systems can be defined smaller if inaccuracies in TAB work within the smaller defined system will have little or no impact on connected systems.

Notes:

TAB Functional Test Record

FT-_____ TAB CHECKOUT

Seasonal Testing and General Conditions of Test

Air handler or rooftop unit and boilers (if applicable) should be running in normal and occupied mode, unless noted. The tests may be performed in any season, if any temperature lockouts can be overridden.

___ TAB is using the same equipment for verification as for the original work. If not, explain.

Spec Writer: The following are sample test procedures for a few of the Verifications Requirements listed above. Testing procedures and recording format should be developed for all required verifications.

1. TU and Diffuser Flow Procedures (for each terminal box)

Party filling out this form and witnessing testing _____ Date of tests _____

Objectives:

1) Verify that the total measured flow for the TU, at *near or at* minimum and maximum flows, matches the value shown on the BAS readout, that is verify calibration of the EMS readout.
2) Verify that the measured flow of the diffusers and the *total* maximum and minimum flows of the TU match that of the TAB report.

Procedures:

Measure the flow of each diffuser at minimum flow (by raising the space temperature setpoint 10F). Repeat for maximum flow (by lowering the space temperture setpoint 10F below the current space temperature). On a copy of the original TAB report along side the original report values, record the flow at each diffuser and the percent difference from the report. Sum for the total box flow and record with the percent difference from the report (clearly identify which values are the recheck values). At both the minimum and maximum flows, record the flow shown in the BAS and record the percent difference from the current actual measured flow. Attach the documentation to this form. Record summary data in the table below.

2. Summary Record. Record the results in the table below. Pass means within 10% of TAB report reading.

TU ID	**AHU ID**	**All Diffusers Pass?** (List Failed Diffusers and Percent Variance From TAB Report)	**TU Actual Max. & Min's Match TAB Report?** (Give Percent Variance From TAB Report)	**TU Actual Max. & Min's Match BAS Readout?**	Setpoints Returned to Original?

2. Minimum Outside Air Volume Procedures

Party filling out this form and witnessing testing _____ Date of tests _____

This test applies for designs where there is a requirement for a constant volume of OSA into the building with VAV, but no requirement for constant OSA volume at the zone level inside the building.

1. Adjust air handler flow to minimum, intermediate, and maximum, by lowering, adjusting and raising the duct static pressure setpoint, after locking out economizer by raising its changeover setpoint or other method.
2. Measure the OSA flow at the intake using the same method as during original balance. Describe measurement method: _____
   _____
3. Record the results in the table below.
   Pass means within 20% of TAB report reading for maximum and minimum supply fan flows. Within 30% is acceptable for intermediate reading, if using a OSA compensating routine with a linearly proportional strategy between max. and min. supply fan flows. If compensating routine, list parameters for each AHU in notes below.

AHU	Design Min. OSA (cfm)	Min. Supply Fan Flow		Intermediate Supply Fan Flow		Maximum Supply Fan Flow		Return Parameters to Original?
		OSA (cfm) TAB Report	OSA (cfm) ReCheck	OSA (cfm) TAB Report	OSA (cfm) ReCheck	OSA (cfm) TAB Report	OSA (cfm) ReCheck	

Notes:

Notes:

3. Minimum Duct Static Pressure Setpoint Verification Procedures AHU- _____

Party filling out this form and witnessing testing _____ Date of tests _____

This test applies to systems where the fan volume is controlled by a static pressure sensor with a fixed setpoint (not being reset).

Objectives: Verify that the air system is being controlled to the lowest possible static pressure while still meeting design loads, less diversity.

1. Review TAB *methods* for determining static pressure setpoint. OK? Y/N _____
2. Review control setpoints established by TAB. OK? Y/N _____
3. Physically verify that at least one leg (the critical leg or TU) from fan to diffuser has all balancing dampers wide open. Critical TU: _____
   All balancing dampers full open? _____

4. Verify by one of the following methods that the TU on the critical leg has its damper 90% or more open when all TUs (less some TUs for diversity, if applicable) taking off upstream of the static pressure sensor are in full cooling (TU's downstream may be or may not be in full cooling). With the units in full cooling and the critical TU meeting design flow:

Do 4a or 4b:

4a. Lower static pressure setpoint:

1) Lower static pressure setpoint 0.2". The critical TU should be starved (not getting to within its max. cfm setpoint deadband). Does critical TU starve? _____. If so, original setpoint is OK. If not, permanently lower static pressure setpoint and repeat until lowest satisfying setpoint is found.

4b. Physically examine ducts:

1) Put all TUs, with branch takeoffs downstream of the static pressure sensor, in full cooling.
2) Examine the critical TU damper. Is it at least 90% open? _____. If so, original setpoint is OK. If not, permanently lower the static pressure setpoint and repeat until lowest satisfying setpoint is found.

5. ___Record any permanently changed parameter values and submit changes to Owner.

Notes:

4. Minimum Hydronic Differential Pressure Setpoint Verification Procedures

Party filling out this form and witnessing testing _____ Date of tests _____

This test applies to systems where the water volume is controlled by a differential pressure sensor with a fixed setpoint (not being reset).

Hydronic system type: ___Chilled water, ___Heating water

Objective: Verify that the water system is being controlled to the lowest possible differential pressure while still meeting design loads, less diversity.

1. Review TAB methods for determining differential pressure setpoint. OK? Y/N _____
2. Review control setpoints established by TAB. OK? Y/N _____
3. Physically verify that at least one leg (the critical leg or coil) from pump to coil has all balancing valves wide open. Critical coil: _____
   All balancing valves wide open? _____

4. Verify that the coil on the critical leg has its valve 90% or more open during full load of all coils taking off upstream of the pressure sensor (less any diversity) by one of the following methods. With the coils in full cooling and the critical coil meeting design flow:

Do 4a or 4b:

a. Lower pressure setpoint:
   1) Lower pressure setpoint 10%. The critical coil should be starved (not getting to within its max. gpm setpoint deadband). Does coil starve? _____ If so, original setpoint is OK. If not, permanently lower pressure setpoint and repeat until lowest satisfying setpoint is found.

b. Physically examine the valves:
   1) Put all coils, with branch takeoffs downstream of the static pressure sensor, in full load or demand (less any diversity).
   2) Examine the critical coil. Is it at least 90% open? _____. If so, original setpoint is OK. If not, permanently lower the pressure setpoint and repeat until lowest satisfying setpoint is found.

5. ___Record any permanently changed parameter values and submit changes to Owner.

A SUMMARY OF DEFICIENCIES IDENTIFIED DURING TESTING IS ATTACHED

-- END OF TEST --

Notes: