Functional Test (Cover Sheet)

Project _____

FT-_____ TERMINAL UNITS (VAV Dual Duct with Series Fan, no coil)
DATA COMMON FOR ALL UNITS

1. Participants (fill out once, to cover all TU's)

Party	Participation	Party	Participation

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

2. Test Prerequisites (fill out once, to cover all TU's)

a. The following have been started up and startup reports and prefunctional checklists submitted and approved:
__ All terminal units, except _____
__ All air handlers serving terminal units, except _____

b. __ All control system functions for this 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. _____ _____
Controls Contractor Signature or Verbal Date

c. __ Airside TAB calibration of BAS readings of TU flows complete (system total flow need not be complete).

d. __ All A/E punchlist items for this equipment corrected.

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

f. __ Test requirements and sequences of operation attached.

g. __ Schedules and setpoints attached.

h. __ Have all energy savings control strategies, setpoints and schedules been incorporated that this TU and control system are capable of? If not, list recommendations below.

i. __ The controller & actuator runtime accumulator set to 0 after prefunctional checkout of the entire system.

j. __ Obtain and review the full program of 5% (randomly chosen) of all TU's of each type (parameters & setpoints, etc.). Examine variances. Clarify as needed, reconcile and document differences with controls contractor. If too many corrections exist with this sample, controls contractor shall recheck all programming.

k. __ Verify that the unit and controls contain all specified fan backward rotation prevention devices and any specified backdraft dampers.

3. Sampling and Additional Testing.

The terminal unit testing requirements in the specifications call for a random sample of _____% of all TU's of each type to be tested. Total number to be tested of this type = _____. The specifications also require that if _____% of the sampled TU's fail in the testing (any No Pass items), then another _____% of the total population must be tested. This applies to the subsections of the test, i.e., if sub-sections fail, only subsections of additional TU's need to be tested. Record results in the table below.

Sub-Section	% Failed of 1st Sample	% Failed of 2nd Sample
I. Sensor calibration		
II. Actuator calibration		
III. Static inspections		

Sub-Section	% Failed of 1st Sample	% Failed of 2nd Sample
IV. Programming		
V. Functional tests		

Functional Test Record

Project _____

FT-_____ TERMINAL UNIT _____ (VAV Dual Duct with Series Fan, no coil)

Common values for all terminal units are recorded on the Cover Sheet. The following pages of procedures are to be filled out for each TU tested.

Seasonal Testing and General Conditions of Test

Air handler or rooftop unit and boiler (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.

Testing Procedures and Record

___ Computer printout or list made and attached of the current TU setpoints and control parameters and schedules, lockouts, etc. of other systems that may be changed to accomodate testing.

I. Sensor Calibration Checks. Check the sensors listed below for calibration and adequate location. "In calibration" means making a reading with a calibrated test instrument within 6 inches of the site sensor. Verify that the sensor reading (via the permanent thermostat, gage or building automation system (BAS)) compared to the test instrument-measured value is within the tolerances specified in the prefunctional checklist requirements (_____). If not, install offset in BAS, calibrate or replace sensor. Use the same test instruments as used for the original calibration, if possible.

Sensor & Location	Location OK[1]	**1st** Gage or BAS Value	Instrument Measured Value	**Final** Gage or BAS Value	Pass Y/N?
Space temp.					

[1] Sensor location is appropriate and away from causes of erratic operation.

II. Device Calibration Checks.

1. Heating Damper Minimum Positive Closure Verification. For terminal units with a 0 (zero) cfm minimum heating cfm setpoint: With hot and cold decks operating, lower the space temperature setpoint 20F. Visually verify that the heating damper is shut tight and feel that no warm air is passing through damper. If damper is not accessible, close the return air isolation damper, measure the temperature at the cold duct inlet to the box and compare to the temperature at the discharge. If discharge temperature is more than 0.5F greater than the cooling inlet, leakage may be occurring and the unit fails this test. **PASS? (Y/N) _____**

Proced. No. & Spec. Seq. ID[1]	**Req ID No.[2]**	**Test Procedure[3]** (including special conditions)	**Expected and Actual Response[4]** [Write ACTUAL response or finding in brackets or circle]	**Pass Y/N & Note #**
III. STATIC INSPECTIONS				
1.		Verify sufficient clearance around equipment for servicing.		
2.		Verify installation of specified sound wrapping and joint sealant.		
3.		Unit secured per spec.		
4.		Model and tag checked against plans & equipment list. TU & valve tags affixed.		
5.		Verify that inlet conditions are OK: Smooth, round, straight duct for at least 3 duct diameters when possible and 2 diameters minimum for velocity pressure sensor and 3 to 5 diameters for single point electronic sensors, else airflow straighteners.		

Proced. No. & Spec. Seq. ID[1]	Req ID No.[2]	Test Procedure[3] (including special conditions)	Expected and Actual Response[4] [Write ACTUAL response or finding in brackets or circle]	Pass Y/N & Note #
6.		Visually verify that the return air isolation or balancing damper is open.		
7.		Auto TU Diagnostics. In the control system diagnostics, check the controller and actuator accumulated run times, the moving avg. flow error and moving avg. space temp. deviation from setpoint.	The ratio of actuator to controller runtime should be ideally < 3% & < 5% is acceptable. [_____%]. Moving avg. flow error should be < 10% of max. cooling cfm [_____%]. The moving avg. space temp. deviation should be < 3F [_____F].	
IV. CONTROL PROGRAMMING. In the procedures of this section, compare specified written sequences and parameters with that found programmed in the TU or BAS. Variances that, in the CA's opinion, reduce performance, must be corrected. Variances that make no difference or enhance performance pass. Document all variances.				
8.		Control drawing sequences of operation	Per spec and detail adequate.	
9.		Verify that the TU address matches the TU location and ID on the plan drawings and control drawings.	Address matches.	
10.		Verify that the TU max and min setpoints in the BAS match the latest plan drawings and balance report (TAB).	Cooling: Drawing max =_____ min =_____ BAS max = [_____] min = [_____] TAB max = _____ min = _____ Heating: Drawing max =_____ min =_____ BAS max = [_____] min = [_____] TAB max = _____ min = _____	
11.		Temperature adjustment range by tenants (indicate if a setting was spec'd)	Spec'd or reasonable value _____ Found [_____]	
12.		Cooling-- occupied zone temp. setpoint (indicate if a setting was spec'd)	Spec'd or reasonable value _____ Found [_____]	
13.		Unoccupied zone temperature setpoint (indicate if a setting was spec'd)	Spec'd or reasonable value _____ Found [_____]	
14.		Occupied zone temp. bias (deadband) (indicate if a setting was spec'd)	Spec'd or reasonable value _____ Found [_____]	
15.		Unnuccupied zone temp. bias (deadband) (indicate if a setting was spec'd)	Spec'd or reasonable value _____ Found [_____]	
16.		Cooling space setpoint proportional band (indicate if a setting was spec'd)	Spec'd or reasonable value _____ Found [_____]	
17.		Heating space setpoint proportional band (indicate if a setting was spec'd)	Spec'd or reasonable value _____ Found [_____]	
18.		Cooling cfm proportional band (indicate if a setting was spec'd)	Spec'd or reasonable value _____ Found [_____]	
19.		Heating cfm proportional band (indicate if a setting was spec'd)	Spec'd or reasonable value _____ Found [_____]	
20.		Auto-zero function schedule set and enabled.	Set and enabled.	

Notes:

Proced. No. & Spec. Seq. ID[1]	Req ID No.[2]	Test Procedure[3] (including special conditions)	Expected and Actual Response[4] [Write ACTUAL response or finding in brackets or circle]	Pass Y/N & Note #
21.		Duct area at flow station (sf)	Clg: Prints _____ Found [_____] Htg: Prints _____ Found [_____]	
22.		Verify that BAS TU K factor is within 20% of K on the submitted control drawings, unless explained by TAB.	Cooling: Drawing K = _____ BAS K = [_____] TAB K = _____ Heating: Drawing K = _____ BAS K = [_____] TAB K = _____	
23.		Damper stroke time (Spec'd value comes from controller spec, unless oval duct, which should then be timed)	Spec'd _____ Found [_____]	
24.				
V. FUNCTIONAL TESTING.				
25.		Occupied CFM Test & Fans, Cooling. For TU's controlled from DDC flow stations: a. During occupied mode with only a few lights ON in the zone and with the duct SP setpoint being met, lower space setpoint 20F and observe in BAS that cooling flow goes to maximum and heating flow goes to minimum. b. Turn OFF all lights in the zone. For TU's controlled by damper position only, observe that the damper goes to min. and max. as expected.	a. Fan is ON. Specified max. cooling cfm = _____ Achieved cfm or position= [_____] Within deadband (if DDC)? _____ Specified min. heating cfm = _____ Achieved cfm or position = [_____] Within deadband? (if DDC) _____ b. Fan turns OFF. [_____] Flows remain under previous control control. [_____]	
26.		Occupied CFM Test & Fans, Heating. For TU's controlled from DDC flow stations: a. During occupied mode with only a few lights ON in the zone and with the duct SP setpoint being met, raise space setpoint 20F and observe in BAS that heating flow goes to maximum and cooling flow goes to minimum.	a. Fan is ON. Specified max. htg cfm = _____ Achieved cfm or position= [_____] Within deadband (if DDC)? _____ Specified min. clg cfm = _____ Achieved cfm or position = [_____] Within deadband? (if DDC) _____	
27.		--continuing: b. Turn OFF all lights in zone. For TU's controlled by damper position only, observe that the damper goes to min. and max. as expected. Return setpoints to normal.	b. Fan turns OFF. [_____] Flows remain under previous control control. [_____]	
28.		*(Verify for only 1/2 of the tested TU's)* Warmup cycle--heating. Adjust schedule or time so TU will be in warmup mode. Adjust the space setpoint to be 5F above space.	TU damper goes to heating min. [_____] Fan is ON. [_____]	

Notes:

Proced. No. & Spec. Seq. ID[1]	**Req ID No.[2]**	**Test Procedure[3]** (including special conditions)	**Expected and Actual Response[4]** [Write ACTUAL response or finding in brackets or circle]	**Pass Y/N & Note #**
29.		*(Verify for only 1/2 of the tested TU's)* Warmup cycle--cooling. Adjust schedule or time so TU will be in warmup mode. Adjust the space setpoint to be 5F below space.	TU damper goes to cooling max. [_____] Fan is ON. [_____]	
30.		Interlocks. This unit is interlocked with radiant panel or fin tube heating (Y/N) _____. If Yes, the fin tube or radiant panel functional tests will verify the interlocks with the TU.	TU operates normally during cycling ON and OFF of radiant panels and fin tubes.	
31.		Unoccupied & Night High Limit Operation. a. Fans. Schedule the space so it is in unoccupied mode. Turn all lights OFF in the zone. Observe that the fan is OFF. b. Turn a few lights ON in zone. Change the NHL setpoint (_____) so it engages the NHL. _____	a. Fan is OFF. [____] b. Fan is OFF. [____]	
32.		--cont. Unoccupied & Night High Limit. c. Change the zone unoccupied setpoint to be 20F below the space temp. Observe in BAS that cooling flow goes to maximum and heating flow goes to minimum. d. Change the zone unoccupied setpoint to be = to the space temp. Observe in the BAS that the cooling and heating flows go to min. For TU's controlled by damper position only, observe that the dampers go to their expected positions.	c. Specified max. unoccupied cooling cfm = _____ Achieved cfm or position= [_____] Within deadband (if DDC)? _____ Specified min. heating cfm = _____ Achieved cfm or position = [_____] Within deadband? (if DDC) _____ Fan is OFF. [_____] d. Cooling and heating flows or postions go to minimum. [_____] Fan is OFF. [____] e. TU remains in normal mode until NHL setpoint minus offset is reached by the determining zones, when AHU and TU will shut down.	

Notes:

Proced. No. & Spec. Seq. ID[1]	Req ID No.[2]	Test Procedure[3] (including special conditions)	Expected and Actual Response[4] [Write ACTUAL response or finding in brackets or circle]	Pass Y/N & Note #
33.		Unoccupied & Night Low Limit Operation. a. a. Fans. Schedule the space so it is in unoccupied mode. Turn ON some lights in the space. Observe that the fan is OFF. Change the NLL setpoint (____) so it engages the NLL functions. _____ b. Change the zone unoccupied setpoint (if used, else use occupied) to be 20F above the space temp. Observe in BAS that heating flow goes to maximum and cooling flow goes to minimum. c. Change the zone unoccupied setpoint (if used, else use occupied setpoint) to be = to the space temp. Observe in the BAS that the cooling and heating flows go to min. For TU's controlled by damper position only, observe dampers go to expected positions.	a. Fan is OFF. [____] b. Specified max. unoccupied heating cfm = _____ Achieved cfm or position= [_____] Within deadband (if DDC)? _____ Specified min. cooling cfm = _____ Achieved cfm or position = [_____] Within deadband? (if DDC) _____ Fan is OFF. [____] c. Cooling and heating flows or positions go to minimum. [_____] Fan is OFF. [____] d. TU remains in normal mode until NLL setpoint + offset is reached by the determining zones, when AHU and TU will shut down.	
34.		Backflow into RA Check. In occupied mode, with fan ON and return air damper open, lower the space temp. setpoint 20F. Wait until the cooling flow goes to maximum and remains fairly constant. Measure flows on all diffusers with a flow hood. (This test may be omitted if the TAB conducted and documented this procedure in a satisfactory manner on all fan powered TU's.)	BAS cooling max. design = _____. Box design = _____. Fan spec'd cfm = _____. Sum of diffusers = [_____]. Actual cooling flow = [_____]. Actual heating flow = [_____]. Htg flow + clg flow = [_____]. This should be within 10% of box design [_____] and less than or equal to the sum of all diffuser flows, else some flow is backing into RA and test fails (fan is undersized).	
35.		Alarms. With fan ON, flip OFF fan switch.	An alarm is registered in the BAS.	

Notes:

Proced. No. & Spec. Seq. ID[1]	Req ID No.[2]	Test Procedure[3] (including special conditions)	Expected and Actual Response[4] [Write ACTUAL response or finding in brackets or circle]	Pass Y/N & Note #
36.		Trending: Damper Control and Fans. Over an 26 hour occupied and unoccupied periods, trend at 2 min. intervals, the hot and cold damper positons or cfm, the dampers or cfm commands, the space temp., OSAT, fan status, lighting status and the duct static pressure at the controlling sensor.	Compare to the space temperature to the setpoint. Observe that there is little or no overshoot of space temperature or hunting of the damper. Compare actuals to cfm and space temp. setpoints. Compare to the schedule. Observe that there is little or no overshoot of space temperature or hunting of the damper or valve, that cfm is within its deadband cfms change from max to min. as the space temp goes outside deadbands per spec. Fan is OFF during unoccupied hours OR when lights are OFF.	
37.		*(Trend for only 1/2 of the tested TU's)* Trending, Space Temp. Over a 3 day period, during near design conditions for heating and cooling, trend space temp. at 10 min. steps. Omit the space temp. trend if auto diagnostics has a moving avg. space temp. deviation log and it was completed.	Observe that the space temp. does not drift more than 1°F outside the deadband range around the setpoint.	
38.	**--**	**Return all changed control parameters and conditions to their pre-test values[5]**	**Check off in program printout when completed**	

MONITORING AND TREND LOGGING

Monitoring via BAS trend logs are required for test procedures 34 and 35. Attach representative graphs or columnar data and explanatory analysis to this test report. The data should have time down the left column and four to six columns of parameters to the right. Provide a key to all abbreviations and attach setpoints and schedules for all trended parameters.

**Abbreviations: BAS = building automation system, CA = commissioning agent, HCV = heating coil valve, TU = terminal unit, SA = supply air, plan drawing = building drawings and schedules from design engineer.

[1]Sequences of operation attached to this test.
[2]Mode or function ID being tested from testing requirements section of the project Specifications.
[3]Step-by-step procedures for manual testing, trend logging or data-logger monitoring.
[4]Include tolerances for a passing condition. Fill-in spaces or lines not in brackets denote sequence parameters still to be specified by the A/E, conrols contractor or vendor. Write "Via BAS" for verifications of device position from BAS readout or "Via obs" for actual observation or from test instrument reading.
[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: