Functional Test FT-

- If this form is not used for documenting, one of similar rigor shall be used.
- Contractor(s) assigned responsibility for sections of the Procedure shall be responsible to see that items by their subcontractors are completed validated accurate and recorded.
- When completing these Forms electronically - enter all Text in the shaded boxes.

PROJECT:		UNIT NO:	
LOCATION:		SERVICE:	
MANUFACTURER:		MODEL:	
Serial Number:		CFM =	
Service Area		Cap MBH	

Associated Equipment Including:

☐ **Return Fans, RF** ☐ **Outside Air Handling Unit,** Drop down List

1. Participants

Name of Firm ***(use drop down list for Firm type)***	Participation *(multiple names are allowed per line)*
drop-down list	
drop-down list	
drop-down list	
drop-down list	
drop-down list	
drop-down list	
drop-down list	

Party filling out this form & witnessing _ Date of test (M/D/Y)

2. Prerequisite Checklist

REQUIRED DOCUMENTATION Have the Following Contractor Submittals been provided to the CxA?	CxA to Answer this Section
Pre-Functional checklists and startup reports completed successfully?	
Manufacturer's cut sheets provided with P-F Checklist ?	
Performance data (fan curves, coil data, etc.)	
Installation and startup manual and plan	
O&M manuals	
Flushing and cleaning plan	
Manufacturer Start-Up Sheets filled in & Submitted	
Sequences and control strategies	
Leak test reports	
Water treatment report	
Welder Certification	
Warranty Certificate	

Pass? Y / N pick

The following have been started up and Startup Reports and Pre-Functional Checklists submitted and approved ready for functional testing:

☐__ Chilled Water System
☐__ Connected Terminal Units
☐__ Cooling towers
☐__ Condenser water pumps
☐__ Chilled water piping and valves
☐__ Variable speed drives for pumps

☐__ All control system functions for this and all interlocking systems are programmed and operable per contract documents, including final setpoints and schedules with debugging, loop tuning and sensor calibrations completed.

(M/D/Y)

Controls Contractor Signature or Verbal Date

Notes:

☐__ Vibration control report approved (as required per Project).

☐__ Testing (for calibration and functionality) and balance (TAB) completed and approved for the Air and Water systems with terminal units connected.

☐__ Safeties and operating ranges reviewed.

☐__ All A/E Issues / Punchlist items for this equipment corrected.

☐__ Test requirements and sequences of operation attached if different than that listed.

☐__ Schedules and setpoints attached.

☐__ False loading equipment, system and procedures ready (boilers, preheat or reheat coils, control loops, over-ride on OSA dampers, etc.)

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

☐__ **Control Program Review**. Review the software control program(s) for this equipment. Parameters, setpoints and logic sequences appear to follow the specified written sequences.

☐__ Record of All Values for Current Setpoints (SetPt), Control Parameters, Limits, Delays, Lockouts, Schedules, Etc. changed to accommodate Testing:

Parameter	Pre-Test Values	Returned to Pre-Test Values √
Discharge air static pressure (SetPt)		
Discharge air temp.		
Static P. reset schedule		

Parameter	Pre-Test Values	Returned to Pre-Test Values √
Discharge air reset schedule		
Bldg. static P.		
Dirty filter D.P.		
OSA CFM		

3. Sensor Calibration Checks. Check the sensors listed below for calibration and adequate location. This is a sampling check of calibrations done during prefunctional checklisting.

"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	Instr. Measured Value	**Final** Gage or BAS Value	Pass Y/N?
DAT	pick				pick
RAT	pick				pick
OSAT	pick				pick
Disch. SP	pick				pick

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

4. Device Calibration Checks. The actuators or devices listed below checked for calibration. This is a spot check on a sample of the calibrations done during pre-functional check-listing and startup.

"In calibration" means observing a readout in the BAS and going to the actuator or controlled device and verifying that the BAS reading is correct. For items out of calibration or adjustment, fix now if easy, via an offset in the BAS, or a mechanical fix.

Device or Actuator & Location	**Procedure / State**	**1st** BAS Value	Site Observation	**Final** BAS Reading	Pass Y/N
Cooling coil valve (CCV) position or command and stroke*	1. Intermediate positions				pick
	2. Full open				pick
	3. Increase pressure (open)				pick
	4. Closed				pick
	5. Remove power or air (closed)				pick
Relief damper position **	1. Closed				pick
	2. Full open				pick
Mixed air damper position **	1. Closed				pick
	2. Full open				pick

Device or Actuator & Location	**Procedure / State**	**1st** BAS Value	Site Observation	**Final** BAS Reading	Pass Y/N
Main OSA damper position**	1. Closed				pick
	2. Full open				pick
Min. OSA damper position**	1. Closed				pick
	2. Full open				pick
Inlet guide vane position***	1. Closed				pick
	2. Full open				pick
VFD speed (VFD)***	1. Min.: _ _%				pick
	2. Max.: _ __%				pick

* Set pumps to normal mode. *Procedure 1.* Command valve to a few intermediate positions. Verify that readings in BAS reasonably correspond to the actual positions. For cooling coil valves (NC): *Procedure 2.* Lower space setpoint to 20F below space temperature. Verify BAS reading says CCV is 100% open. Visually verify valve is 100% open. *Procedure 3.* For pneumatic actuators, by override in the EMS, increase pressure to valve by 3 psi (do not exceed actuator rating). Verify valve stem & actuator position does not change. Restore to normal. *Procedure 4.* Set space setpoint to 20F above space temperature. Verify BAS reading says CCV is closed. Visually verify valve is closed. *Procedure 5.* Remove control air or electricity from the valve and verify that the valve stem and actuator position do not change.

**1. Command damper closed and verify that damper is shut and BAS reads shut. 2. Do the same, commanding damper fully open.

***Vanes or VFD: *Procedure 1.* Lower the controlling static pressure setpoint (duct or discharge) to be 1/4 of its current value. Verify that the vanes are shut, or fan speed is at minimum for VFD *and* packaged controller reads the same. Return the static pressure setpoint to normal. *Procedure 2.* Lower the space temperature setpoint to be 20F below space temp. and cause TU dampers to go to full cooling. Raise the static pressure setpoint as necessary to cause the setpoint to not be met. Verify that the inlet vanes are fully open or the fan speed is at its max. and verify that the packaged controller reads the same. Return all to normal.

6. General Sequence Functional Testing Record (Replace with Actual Project Specific Sequence when available)

Seq. ID From Specs[1]	Mode ID[2]	Test Procedure[3] (including special conditions)	Expected Response[4]	Pass Y/N
	FAN OFF	Standby Check. With Units Commanded off by BAS.	Verify by visual inspection that: Return Air Dampers in AHU 3&4 are Open Outside Air Dampers in AHU-3&4 are Closed Isolation Dampers on AHU-9&10 are Closed. Relief Dampers in RF-3 and RF-4 are Closed Cooling Coil Valves on Cooling Coils of AHU--3&4 are Closed	pick
	Note			
	UNIT STARTUP	With Units Commanded on by BAS	Supply Fan Isolation Dampers Open in AHU-3&4(Both Supply Fans in each Unit) Supply Fan start through VSDs Supply Fan Isolation Dampers in AHU 9&10 Open AHU-9&10 Fans Start RF-3&4 Isolation Dampers Open RF-3&4 Fans start through VSDs Exhaust Fans EF-5,6,7,8,9&12 start.	pick
	Note			
	RF VOLUME CONTROL	1. Verify RF Volume, utilizing air flow meters in Return Fans RF3&4, Supply Fans in AHU-3&4 and Garage Exhaust Fan EF-1, and TAB established CFMs for Exhaust Fans EF--5,6,7,8,9,12, TAB established Fixed Differential, make the following calculation: Return Air Flow=1/2{Supply Air Flow(AHU-3Flow+AHU-4 Flow) - EF5 Flow-EF6 Flow-EF7 Flow-EF8 Flow-EF9 Flow-EF-12 Flow--SF1 Flow-Fixed Differential} 2. Trend Log RF3&4, AHU 3&4, and SF-1 air flow rates at 5 min. intervals. Command off EF-5,6,7,8,9 and 12 sequentially at 5 min. Intervals.	Verify that RF air flow meter readings correspond to calculation. Verify that RF air flow meter readings continue to correspond to calculation	pick
	Note			
	TEMPERATURE CONTROL--ECONOMIZER	1. Utilizing BAS, Record OSA Temp. and OSA Dewpoint. 2. Calculate Enthalpy of OSA. 3. Utilizing Enthalpy calculations, reset DAT setpoint such that Enthalpy of OSA is less than Enthalpy of Supply Air at revised conditions.	Outdoor Air Dampers and Return Air Dampers should modulate in sequence to maintain DAT setpoint. Cooling Coil Valves should be closed.	pick
	Note			

Seq. ID From Specs[1]	Mode ID[2]	Test Procedure[3] (including special conditions)	Expected Response[4]	Pass Y/N
	TEMPERATURE CONTROL--ECONOMIZER	1. Utilizing Enthalpy calculations above, reset DAT setpoint such that the Enthalpy of Supply Air is less than that of OSA. 2. Return to normal operation. Utilizing BAS trend logging capabilities, record OSA temperature, Return Air Temperature, OSA Dewpoint, DAT setpoint and DAT at 15 min intervals for an 8 hr. period	OSA Dampers should close, Return Air Dampers should open, Chilled Water Coil Valves should modulate to maintain discharge Temp. Unit should attempt to utilize economizer cycle when possible for cooling.	pick
	Note			
	DUCT STATIC PRESSURE CONTROL	Disable Duct Static Pressure Reset utilizing BAS Software. Adjust space temperature setpoint on significant quantity of zones to be well below observed reading.	Verify that VSD's modulate as required to maintain SP setpoint without hunting or overshooting setpoint	pick
	Note			
	HIGH STATIC PRESSURE ALARM AND SHUTDOWN	With units running at low flow condition, utilizing a squeeze bulb, simulate an increase in discharge air static pressure.	Verify that BAS indicates an alarm condition at 3.6" WG and shuts fans down at 4"WG	pick
	Note			
	STATIC PRESSURE RESET	1. For PerimeterTerminal Units on floors 9-16, Reset space temperature setpoints to be below space temperatures. Utiliziing BAS trend logging capablilities, Record at 5 min. intervals, Discharge Air SP Spt, Perimeter TU Units in saturation. 2. Reset space temperature setpoints to be above space temperatures. Utilizing the same Trending as above, Record the same data points.	Verify that DA SP Spts increase by 0.10" WG at 5 min intervals until only one Perimeter TU remains in saturation. Verify that setpoints are met and maintained without excessive hunting. Verify that DA SP Spt decreases by 0.10"WG at 5 min intervals until one Perimeter TU reaches saturation.	pick
	Note			
	DISCHARGE TEMPERATURE RESET	1. For Perimeter Terminal Units Floors 9-16, Reset space sensor setpoints to be above space temperatures. Utilizing BAS Trend Logging, at 6 min intervals, record DAT setpoint, DAT, and perimeter TU cooling Flow rates. 2. For Perimeter Terminal Units Floors 9-16, Reset space sensor setpoints to be below space temperatures. Utilizing BAS Trend Logging, at 6 min intervals, record DAT setpoint, DAT, and perimeter TU cooling Flow rates.	Verify that Discharge Air Temperature Setpoint is reset upwards at 2 deg increments every 6 min to maintain design cooling CFM at 5 perimeter TUs to maintain design cooling CFM Verify that Discharge Air Temperature Setpoint is reset downwards at 2 deg increments every 6 min to reach design cooling CFM at only 5 perimeter Tus. Both should happen without excessive hunting.	pick

Seq. ID From Specs[1]	Mode ID[2]	Test Procedure[3] (including special conditions)	Expected Response[4]	Pass Y/N
	Note			
	SMOKE CONDITIONS	Interfacing with EC, simulate a fire mode with the Fire Alarm System	Verify that AHU System returns to FAN OFF Status., with OSA and Relief Dampers in a Closed Position.	pick
	Note			
	WARMUP CONTROL	Place Units BAS Control Mode into Warmup. Overwrite RAT Sensor Reading to be 65 Deg. F.	Verify that dampers assume a 100% Return Air Mode.	pick
	Note			
	WARMUP CONTROL	Place Units BAS Control Mode in Warmup. Overwrite RAT Sensor Reading to be 72 Deg. F.	Verify that unit returns to Normal Operation Mode	pick
	Note			
	FREEZE CONDITION	Overwrite Low Limit Detection Thermostat reading to be 38 Deg. F.	Verify that system alarms, fans stop, OSA Dampers close, Relief Dampers Close, and RA dampers open.	pick
	Note			
	RETURN FAN STATIC PRESSURE	With AHU Units 3&4 Units running at low air flow condition, Overwrite RF 3 or 4 return air fan inlet SP to a reading below -1.5" W.G.	Verify that system alarms and that all Fans are shut down.	pick
	Note			
	NIGHT PURGE	With Units in Night Low Limit Mode, Select a space temperature sensor at random and overwrite this value to be 82 Deg. F. Overwrite OSA temperature value to 63 Deg. F. Overwrite Relief Air Temp. Sensor to a value of 82 Deg. F., after 15 minutes, Overwrite Relief Air Temp Sensor to a Value of 75 Deg. F.	Verify that Unit Starts, Return Air Dampers Close, Heating Control Valves remain Closed, OSA Dampers open, flushing space with OSA, When Return Air Temperature reaches a value of 75 Deg. F., Purge Cycle should terminate,	pick
	Note			
	MANUAL SMOKE PRESSURIZ. SYSTEM	With Fire Alarm System in alarm, utilizing control panel in Fireman Control Center, select a floor and place floor into purge mode	Verify that Single Fan operates, Isolation dampers open only on selected Fans, Return Fans are off, Outside Air Handling Units are off, OSA dampers open, and return air dampers close.	pick
	Note			
	MIN OSA UNIT FAN OFF	Command AHU-1&2 System off	Verify that AHU 9&10 isolation dampers are closed, and if OSA temperature is above 35 Deg. F, heating coil control valve is closed.	pick
	Note			
	MIN OSA UNIT FAN OFF	Simulate a OSA temperature below 35 Deg. F.	Verify that heating coil control valve opens	pick
	Note			
	MIN OSA UNIT TEMPERATURE CONTROL	Utilizing BAS software, reset discharge air setpoint to 80 Deg. F.	Verify that Face and Bypass Dampers and Heating Coil Control Valves modulate in sequence to maintain 80 Deg. F. Setpoint.	pick

Seq. ID From Specs[1]	Mode ID[2]	Test Procedure[3] (including special conditions)	Expected Response[4]	Pass Y/N
	Note			
	MIN OSA UNIT FREEZE CONDITION	Simulate a condition at low limit detection thermostat of below 40 Deg. F.	Verify that BAS system goes into alarm, AHU 7&8 Fans Shut Down, AHU-7&8 Isolation Dampers Close, and Heating Valve Opens.	pick
	Note			
	ON-FLOOR RETURN FAN OPERATION	Place AHU-3&4 in normal operating mode	Verify that RAF 9-1,9-2,10-1,10-2,11-1,11-2,12-1,12-2,13-1,13-2,14-1,14-2,15-1,15-2 Start and Run	pick
	Note			
	BUILDING STATIC PRESSURE	Trend log the supply fan speed, the relief fan speed, relief damper position and the building static pressure for 24 hrs at 5 min. intervals. During the trend, force, if necessary, the economizer damper to be full open and at minimum. Document these times.	Observe in the trends that the building static pressure is maintained within +/- 0.05" of setpoint without excessive hunting. Carefully examine during the extreme economizer damper positions. Observe that any relief dampers modulate as expected relative to relief fan operation and static pressure.	pick
	Note			
	AHU FILTER DROP	Reset the Filter Differential Pressure to exceed the settting recommended by the filter manufacturer.	Verify that the BAS reports an alarm.	pick
	Note			
	CHILLED WATER VALVE CLOSING EFFICIENCY	1. Utilizing BAS, place AHU Units in WARMUP Mode. 2. Manually close isolation Valve in Chilled Water Supply to AHU Coil. 3. Place thermometer in Chilled Water Return Piping adjacent to AHU. Record temp. at 1 min. intervals for 15 min. 4. Manually open isolation Valve in Chilled Water Supply to AHU Coil. 5. Repeat Step 3. 6. Graph Results on Temperature-Time Basis.	Chilled Water Return Temp. should approach RAT. If significant divergence is noted, review specified performance requirements of Chilled Water Control Valves.	pick
	Note			
	SUPPLY FAN ISOLATION DAMPER	Utilizing BAS, Command AHU-1, SF-1 into the off position	Verify that AHU-1, SF-1 Isolation Dampers Close.	pick
	Note			
	REVIEW	Reveiw schedules, current setpoints and sequences with Specification Section 15950-3.3A and Control Drawings prepared by CC	Submit approved differences to be incorporated into as-builts.	pick
	Note			

Record Foot Notes

[1]Sequences of operation specified in Contract Documents (attached).

[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.
[5]Record any permanently changed parameter values and submit to Owner.

7. Functional Test Data

- ***Append Project Specific Equipment Schedule:***

READINGS TAKEN BY:		DATE	

Attach Schedule for Design Criteria (Otherwise update this table).

AHU DATA	DESIGN		FINAL
Manufacturer			
Model Number			
Serial Number			
Total Cooling CFM			
Total Heating CFM			
Outdoor Air CFM			
Return Air CFM			
Arrangement			
No. of Pre-Filters			
Filter Sizes (in.)			
Filter Types			
No. of Bag Filters			
Bag Filter Sizes (in.)			
Bag Filter Type			

TEST DATA	DESIGN			As Found			FINAL		
Max Supply CFM									
Discharge S.P. (in.)									
Suction S.P. (in.)									
Total Δ S.P. (in.)									
	BEFORE	BEFORE	Δ	BEFORE	AFTER	Δ	BEFORE	AFTER	Δ
Filter Δ S.P.									
Return Fan Δ S.P.									
Preheat Coil Δ S.P.									
Energy Wheel Δ SP.									
Plate HX Δ S.P.									
Cooling Coil Δ S.P.									
Supply Fan Δ S.P.									
Reheat Coil Δ S.P.									

Temperature and BTUH Data Continued next page

COIL DATA	Pre Ht Coil		CHW Coil		Re Ht Coil	
Make						
Model Number						
Serial Number						
Type / Size						
TEST DATA	**DESIGN**	**ACTUAL**	**DESIGN**	**ACTUAL**	**DESIGN**	**ACTUAL**
Flow, CFM						
Ent./ Lvg. DB, ºF						
DB Temp. ΔT						
Ent. WB, ºF						
Lvg. WB, ºF						
WB Temp. ΔT						
Ent. Air Pres						
Lvg. Air Pres						
Air Pressure ΔP						
BTU/Hr Total						
Flow, GPM						
EWT, ºF						
LWT, ºF						
Water ΔT						
BTU/Hr Total						
Variance % Air / Water						

REMARKS:

The attached filled-out AHU Functional Test Procedure has been reviewed.

[Each Group shall receive an Evaluation of “Approved”, “Approved as Noted”, “Resubmit” [Resubmit = Retain this form and resubmit it with new data for new signatures].

Group 1	Group 2	Group 3	Group 4
Group 5	Group 6	Group 7	
Test as shown, is		CxA	Date
Engineer	Date	PM	Date
Return to the CxA			

-- END OF TEST --