Functional Test

Project:_____

FT-_____ COOLING AIR HANDLING UNIT AHU_____

And Associated Equipment Including:

___Return Fans, RF_____

___Outside Air Handling Unit, AHU_____

Related Tests: _____

1. Participants

Party	Participation

Party filling out this form & witnessing _____ Date of test _____

2. Prerequisite Checklist

a. The following have been started up and startup reports and prefunctional 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

b. __ 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.

_____ _____
Controls Contractor Signature or Verbal Date

c. __ Piping system flushing complete and required reports approved.
d. __ Water treatment system complete and operational.
e. __ Vibration control report approved (if required).
f. __ Test and balance (TAB) completed and approved for the hydronic systems and terminal units connected.
g. __ All A/E punchlist items for this equipment corrected.
h. __ These functional test procedures reviewed and approved by installing contractor.
i. __ Safeties and operating ranges reviewed.
j. __ Test requirements and sequences of operation attached.

Notes:

k. __ Schedules and setpoints attached.
l. __ False loading equipment, system and procedures ready (boilers, preheat or reheat coils, control loops, override on OSA dampers, etc.)
m. __ Have all energy savings control strategies, setpoints and schedules been incorporated that this equipment and control system are capable of? If not, list recommendations below.
n. **__ Control Program Review.** Review the software control program(s) for this equipment. Parameters, setpoints and logic sequences appear to follow the specified written sequences.

o. __ Record of All Values for Current Setpoints (SP), Control Parameters, Limits, Delays, Lockouts, Schedules, Etc. Changed to Accommodate Testing:

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

Parameter	Pre-Test Values	Returned to Pre-Test Values √
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. Meas'd Value	**Final** Gage or BAS Value	Pass Y/N?
DAT					
RAT					
OSAT					

Sensor & Location	Location OK[1]	**1st** Gage or BAS Value	Instr. Meas'd Value	**Final** Gage or BAS Value	Pass Y/N?
Disch. SP					

[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 prefunctional checklisting and startup.

Notes:

"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				
	2. Full open				
	3. Increase pressure (open)				
	4. Closed				
	5. Remove power or air (closed)				
Relief damper position **	1. Closed				
	2. Full open				
Mixed air damper position **	1. Closed				
	2. Full open				
Main OSA damper position**	1. Closed				
	2. Full open				
Min. OSA damper position**	1. Closed				
	2. Full open				
Inlet guide vane position***	1. Closed				
	2. Full open				
Variable fequency drive speed (VFD)***	1. Min.: _____%				
	2. Max.: _____%				

* 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.

5. Verification of Misc. Prefunctional Checks.

Misc. site checks of the prefunctional checklist and startup reports completed successfully. Pass? Y / N _____

Notes:

General Conditions of Test

_____

_____

Notes:

6. Functional Testing Record

Seq. ID From Specs[1]	Mode ID[2]	Test Procedure[3] (including special conditions)	Expected Response[4]	Pass Y/N	Note
1	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		
1	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.		
2	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		

Notes:

Seq. ID From Specs[1]	Mode ID[2]	Test Procedure[3] (including special conditions)	Expected Response[4]	Pass Y/N	Note
3	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.		
3	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.		
4	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		
4	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		
4	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.		

Notes:

Seq. ID From Specs[1]	Mode ID[2]	Test Procedure[3] (including special conditions)	Expected Response[4]	Pass Y/N	Note
5	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.		
6	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.		
7	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.		
7	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		
11	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.		
13	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.		

Notes:

Seq. ID From Specs[1]	Mode ID[2]	Test Procedure[3] (including special conditions)	Expected Response[4]	Pass Y/N	Note
14	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,		
15	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.		
B1	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.		
B1	MIN OSA UNIT FAN OFF	Simulate a OSA temperature below 35 Deg. F.	Verify that heating coil control valve opens		
B2	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.		
B3	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.		
	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		

Notes:

Seq. ID From Specs[1]	Mode ID[2]	Test Procedure[3] (including special conditions)	Expected Response[4]	Pass Y/N	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.		
	AHU FILTER DROP	Reset the Filter Differential Pressure to exceed the settting recommended by the filter manufacturer.	Verify that the BAS reports an alarm.		
-	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.		
--	SUPPLY FAN ISOLATION DAMPER	Utilizing BAS, Command AHU-1, SF-1 into the off position	Verify that AHU-1, SF-1 Isolation Dampers Close.		
	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.		

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.

-- END OF TEST --

Notes: