New Mexico Public School Facilities Authority
1312 Basehart Rd. SE, Suite 200
Albuquerque, NM 87106-4368

Functional Test Procedure

AIR HANDLING UNIT AHU-00

PROJECT: Project Name

PROJECT NUMBER: Project Number

REPORT ID: FPT-XXXX

SYSTEM DESCRIPTION: Air Handling Unit AHU-00

DATE OF TEST: _____

Test Participant List:

Participant	Company / Agency
	PAC Authority
	General Contractor
	Mechanical Contractor
	Controls Contractor
	TAB Contractor
	RFM / Owners Rep.

Functional Performance Test Prerequisites:

Prerequisite	Yes	No	Comments
1. Chilled Water hydronic piping system has been cleaned, flushed and pressure tested as required. Test reports submitted to CxA for review.			
2. Heating water hydronic piping system has been cleaned, flushed and pressure tested as required. Test reports submitted to CxA for review.			
3. Test & Balance is complete. TAB report submitted to CxA for review.			
4. Electrical feed and disconnect are suitably sized for Air Handler Unit – per AHU Manufacturer's requirements (32 – 45 Amps).			
5. Construction Checklists are complete and have been submitted to CxA for review. AHU, VFD & BMS			
6. All sensors have been calibrated with certified instruments.			
7. Operations & Maintenance Manuals submitted to CxA for review.			
8. Pre-FPT trend logs submitted to CxA for review. Refer to test procedure #3 below for list of specific trend logs to be submitted.			
9. Control programming, interlocks, safeties, alarms, set points, schedules and loop tuning are complete. Control sequences have been tested and debugged.			
10. Central plant is operating and providing both Chilled and Heating Water. If the central boiler plant is not in operation, then the circulation pumps should be turned on			

to provide pressure.			
11. System is ready for Functional Performance Testing.			
12. SA and RA Caps are ready for installation upon completion of FPT, as required.			

Test Equipment Required:

Equipment	Responsible
Infrared Thermometer	Mechanical Contractor
Digital Thermometer	Mechanical Contractor
CO2 Sensor	Mechanical Contractor
Laptop Computer	Controls Contractor
Duct Airflow Instruments	TAB Contractor
Magnahelic / Manometer (0" to 5")	TAB Contractor

Setpoints, Limits, and Schedules:

OCCUPANCY SCHEDULE			
Monday-Friday	***Saturday***	***Sunday***	***Holiday***

CONTROL SYSTEM POINTS				
Yes/No	***Description***	***Units***	***Setpt or Value***	***Comments***
	Supply Air Temp	°F		
	Supply Air Temp Setpoint	°F		
	Return Air Temp	°F		
	Outside Air Temp	°F		
	Mixed Air Temp	°F		
	Return Air Humidity	%		
	Outside Air Humidity	%		
	Supply Airflow	CFM		
	Return Airflow	CFM		
	Outside Airflow	CFM		
	Supply Duct Static Pressure	in. wg		
	Supply Duct Static Pressure SP	in. wg		
	Supply Fan Status	ON/OFF		
	Supply Fan Speed	%		
	Supply Fan Speed	Hz		
	Return Fan Status	ON/OFF		
	Return Fan Speed	%		
	Return Fan Speed	Hz		
	Return Air CO2	PPM		
	Outside Air CO2	PPM		

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CONTROL SYSTEM POINTS				
Yes/No	***Description***	***Units***	***Setpt or Value***	***Comments***
	Outside Air Damper Position	%		
	Mixed Air Damper Position	%		
	Exhaust Air Damper Position	%		
	Chilled Water Valve Position	%		
	Heating Water Valve Position			
	Pre-Filter Differential Pressure	in. wg		
	Final Filter Differential Pressure	in. wg		
	Carbon Filter Differential Pressure	in. wg		
	High Supply Duct Static Press	in. wg		

Functional Test Procedures:

Pass Y/N	No	TEST PROCEDURE	EXPECTED RESULTS
GENERAL SYSTEM READINESS			
	1	Verify system has been operating at stable, normal conditions. All test pre-requisites have been satisfied.	
		Field Notes:	
	2	Verify adequate access is provided to all components that require periodic maintenance.	1. Record any problems that interfere with equipment access.
		Field Notes:	

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Pass Y/N	No	TEST PROCEDURE	EXPECTED RESULTS
	3	Review trends for each point listed below. Trend data is required for a minimum of 3 consecutive business days sampled at five minute intervals. 1. Supply Air Temp 2. Supply Air Temp Setpoint 3. Return Air Temp 4. Mixed Air Temp 5. Outside Air Temp 6. Return Air Humidity 7. Outside Air Humidity 8. SA Duct Static Pressure 9. SA Duct Static Pressure Setpoint 10. Supply Air Flow 11. Return Air Flow 12. Outside Airflow 13. Supply Fan Speed % 14. Return Fan Speed Hz 15. Chilled Water Valve Position 16. Heating Water Valve Position 17. Outside Air Damper Position 18. Mixed Air Damper Position 19. Exhaust Air Damper Position 20. Return Air CO2 21. Outside Air CO2 22. Filter Differential Pressure	1 Controlled variables are stable and void of excess hunting. 2 System appears to be ready for FPT 3 Note variables not under control in notes.
		Field Notes:	

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SENSOR & ACTUATOR VERIFICATION

4 Verify the values shown at the BAS Workstation for all sensors in expected results column are within the acceptable tolerance of the temperature shown on the calibrated test instrument.

Verify sensors are accessible for future maintenance.

Sensor	BAS Value	Measured Value
Supply Air Temp (°F)		
Return Air Temp (°F)		
Mixed Air Temp (°F)		
Outside Air Temp (°F)	Existing	Existing
Duct Static Press (in. wg) Setting – 1.50		
Supply Airflow (CFM)		
Return Airflow (CFM)		
Outside Airflow (CFM)		
Return Air Humidity (%)		
Outside Air Humidity (%)	Existing	Existing
Return CO2 (PPM)		
Outside Air CO2 (PPM)	Existing	Existing

Field Notes:

5 Verify the values shown at the BAS Workstation for all actuators/control valves in the expected results column are within the acceptable tolerance shown on the calibrated test instrument.

Verify actuators/control valves are accessible for future maintenance.

Valve/Actuator	BAS Value	Observed Position	Measured Value
Chilled Water Valve (%)	0/100	%	%
Heating Water Valve (%)	0/100	%	%
Outside Air Damper (%)	0/100	%	%
Return Air Damper (%)	0/100	%	%
Exhaust Air Damper (%)	0/100	%	%

Field Notes:

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TIME OF DAY SCHEDULING			
	6	Set the unit to be in the OFF mode.	1. The air handler is in the OFF mode. 2. The air handler is OFF. a. The outside air damper is CLOSED. b. The exhaust damper is CLOSED. c. The mixed air damper is OPEN. d. The supply fan is OFF. e. The return fan is OFF f. Chilled water control valve is CLOSED. g. Heating water control valve is CLOSED.
		Field Notes:	
SUPPLY AIR TEMPERATURE CONTROL			
	7	Enable occupied mode via the BMS. Supply air temperature control is operating in fixed setpoint mode. NOTE: Lock out economizer mode for this portion of the test.	1. The air handling unit is in the occupied mode. 2. The air handling unit is ON. a. The outside air damper modulates to the MINIMUM. b. The exhaust air damper modulates to maintain equal airflow – SUPPLY= RETURN. c. The mixed air damper remains OPEN. d. The supply fan modulates to maintain the supply duct static pressure setpoint. e. The chilled water control valve modulates open as needed to maintain the supply air temperature setpoint. OR f. The heating water control valve modulates open as needed to maintain the supply air temperature setpoint. g. The Supply Fan VFD modulates to maintain the Static Pressure setpoint. h. The Return fan modulates to track the supply fan with measured volume of Return = Supply.
		Field Notes:	

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	8	Allow system to achieve equilibrium.	1. Unit is operating normally. Supply Air Temp. Setpoint: ____°F Chilled water valve Position: _____% Heating water valve Position: _____% Supply Fan VFD _____Hz _____% Return Fan VFD _____Hz _____%
		Field Notes:	
	9	Lower the supply air temperature set point 10°F below the current supply air temperature. Programmed Setpoint: _____°F Allow system to achieve equilibrium.	1. Chilled water valve modulates open to achieve supply air temperature set point. New Supply Air Temp. Setpoint: ____°F Supply Air Temp.: _____°F Chilled Water Valve Position: _____% Heating Water Valve Position: _____% Supply Fan VFD _____Hz _____% Return Fan VFD _____Hz _____%
		Field Notes:	
	10	Check for Heating Water Valve Leakage. Allow fan to run for at least five minutes with heating water valve closed. Measure water temp drop across the coil to check for heating water leak-by.	1. Heating water valve is closed. Water ΔT: ____°F If water delta T is greater than 2°F, leakage may be occurring.
		Field Notes:	

	11	Raise the supply air temperature set point 15°F above the current supply air temperature. Allow system to achieve equilibrium.	1. Chilled and Heating water valves modulate to achieve supply air temperature set point. New Supply Air Temp. Setpoint: ____°F Supply Air Temp.: _____°F Chilled Water Valve Position: _____% Heating Water Valve Position: _____% Supply Fan VFD _____Hz _____% Return Fan VFD _____Hz _____%
		Field Notes:	
	12	Check for chilled water valve leakage. Allow fan to run for at least five minutes with chilled water valve closed. Measure water temp drop across the coil to check for chilled water leak-by.	1. Chilled water valve is closed. Water ΔT: ____°F If water delta T is greater than 2°F, leakage may be occurring.
		Field Notes:	
	13	Return supply air temperature setpoint to original value.	Chilled and heating water valves modulate to maintain setpoint. New Supply Air Temp. Setpoint: ____°F Supply Air Temp.: _____°F Chilled Water Valve Position: _____% Heating Water Valve Position: _____% Supply Fan VFD _____Hz _____% Return Fan VFD _____Hz _____%
		Field Notes:	

SUPPLY AIR TEMPERATURE RESET			
	14	Verify the supply air temperature setpoint is at 53°F, from previous step. Globally change zone temperature set points to 80°F, such that all the associated VAVs are in heating mode. Allow system to run for 20 minutes.	1. After an initial delay, the SA temp setpoint is reset 0.2°F higher every 2 minutes. 2. The chilled and heating water valves modulate to maintain the new SA temp setpoint. Initial SAT Setpoint.: _____°F Final SAT Setpoint: _____°F Low SAT Reset Temp: _____°F Hi SAT Reset Temp: _____°F Chilled Water Valve Position: _____% Heating Water Valve Position: _____%
		Field Notes:	
	15	Globally change zone temperature set points to 60°F, such that all the associated VAVs are in cooling mode. Allow system to run for 20 minutes.	1. The supply air temperature setpoint is reset 0.5°F lower every 1 minute. 2. The chilled water valves modulate to maintain the new SA temp setpoint. Initial SAT Setpoint.: _____°F Final SAT Setpoint: _____°F Chilled Water Valve Position: _____% Heating Water Valve Position: _____%
		Field Notes:	
	16	Return all parameters to their initial values.	1. Unit resumes supply air setpoint mode operation.
		Field Notes:	

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ECONOMIZER MODE			
	17	Place air handling unit into economizer mode by simulating a return air enthalpy reading above the OSA enthalpy reading. Allow system to achieve equilibrium.	1. The air handling unit is in economizer mode. a. The outside air damper modulates open to maintain the SA temp setpoint b. Chilled and heating water control valves modulate to closed. 2. Verify unit is meeting setpoints and is operating normally. Economizer Damper Position: _____% Return Air Enthalpy: _____°F Outside Air Enthalpy: _____°F Chilled Water Valve Position: _____% Heating Water Valve Position: _____%
		Field Notes:	
	18	Disable economizer mode by simulating a return air enthalpy reading below the OSA enthalpy reading. Allow system to achieve equilibrium.	1. The air handling unit is not in economizer mode. a. The outside air damper closes. b. Chilled and hot water valves modulate to maintain the supply air temperature setpoint. 2. Verify unit is meeting setpoints and is operating normally.
		Field Notes:	
	19	Return all setpoints and parameters to their original values.	1. The air handler returns to normal operation.
		Field Notes:	

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RETURN CO2 CONTROL			
	20	Lower the Return CO2 setpoint 200 PPM below current Return CO2 level.	1. The outside air dampers modulate open to maintain return CO2 below new setpoint.
		Field Notes:	
	21	Raise the Return CO2 setpoint 200 PPM above current Return CO2 level.	1. The outside air dampers close to minimum position.
		Field Notes:	
	22	Return all setpoints and parameters to their original values.	1. The air handler returns to normal operation.
		Field Notes:	
SUPPLY DUCT STATIC PRESSURE CONTROL			
	23	Allow system to achieve equilibrium.	1. Unit is meeting setpoints and is operating normally. 2. Supply fan is meeting the supply air static pressure setpoint. 3. Return fan modulates to track the supply fan speed with measured volume of Return = Supply. Static Pressure SP: ____ in. wg Static Pressure: ____ in. wg. Supply Fan Speed: _____% Return Fan Speed: _____% Supply Fan Volume: _____ CFM Return Fan Volume: _____ CFM
		Field Notes:	

	24	Partially block the Supply Air Discharge approximately half way to introduce a higher than the current supply air static pressure. Allow system to achieve equilibrium.	1. The supply fan modulates to meet the new supply air static pressure setpoint 2. Return fan modulates to track the supply fan speed with measured volume of Return = Supply. Static Pressure SP: ____ in. wg Static Pressure: ____ in. wg. Supply Fan Speed: _____% Return Fan Speed: _____% Supply Fan Volume: _____ CFM Return Fan Volume: _____ CFM
		Field Notes:	
	25	Remove the Supply Air Discharge blockage.	1. Unit resumes normal operation.
		Field Notes:	
RETURN DUCT AIRFLOW CONTROL			
	26	Allow system to achieve equilibrium.	1. Unit is meeting setpoints and is operating normally. 2. Supply fan is meeting the supply air static pressure setpoint. 3. Return fan modulates to track the supply fan speed with measured volume of Return = Supply. Static Pressure SP: ____ in. wg Static Pressure: ____ in. wg. Supply Fan Speed: _____% Return Fan Speed: _____% Supply Fan Volume: _____ CFM Return Fan Volume: _____ CFM
		Field Notes:	

	27	Partially block the Return Air Intake approximately half way to introduce a lower than the current return air flow. Allow system to achieve equilibrium.	1. The supply fan modulates to meet the new supply air static pressure setpoint 2. Return fan modulates to track the supply fan speed with measured volume of Return = Supply. Static Pressure SP: ____ in. wg Static Pressure: ____ in. wg. Supply Fan Speed: _____% Return Fan Speed: _____% Supply Fan Volume: _____ CFM Return Fan Volume: _____ CFM
		Field Notes:	
	28	Remove the Return Air Intake blockage.	1. Unit resumes normal operation.
		Field Notes:	
SUPPLY DUCT STATIC PRESSURE RESET – WILL BE COMPLETED WHEN SYSTEM IS BUILT OUT			
	29	Globally change damper positions such that all the associated VAVs are at 90% open. Allow system to run for 10 minutes.	1. Supply duct static pressure is increased 0.1 in. wg increments 2. Supply fan is meeting the new supply air static pressure setpoint. 3. Return fan modulates to track the supply fan speed with measured volume of Return = Supply. Initial Static Pressure SP: ____ in. wg Final Static Pressure SP: ____ in. wg High Reset Static Pressure: ____ in. wg Low Reset Static Pressure: ____ in. wg
		Field Notes:	

	30	Globally change damper positions such that all the associated VAVs are at 40% open. Allow system to run for 10 minutes.	1. Supply duct static pressure is decreased 0.1 in. wg increments 2. Supply fan is meeting the new supply air static pressure setpoint. 3. Return fan modulates to track the supply fan speed with measured volume of Return = Supply. Initial Static Pressure SP: ____ in. wg Final Static Pressure SP: ____ in. wg
		Field Notes:	
	31	Return all parameters to their initial values.	1. Unit resumes normal operation.
		Field Notes:	
VERIFICATION OF SAFETIES & ALARMS			
	32	<u>Supply Fan Fault:</u> Move the H-O-A switch into the HAND position – at VFD, set drive to Start and Run at 55 Hz or more. With supply fan running, remove electrical power at local disconnect or breaker. Confirm system shutdown and alarm notification at BAS workstation. Repeat test with H-O-A switch in the AUTO position by removing the forced setting	1. Supply fan fault alarm received at BAS workstation. 2. System shut down is enabled. 3. Supply and Return fans are de-energized. 4. Outside Air and Relief Dampers close. 5. Return Air Damper Opens. 6. Chilled Water Valve closes. 7. BAS workstation graphics show correct status and/or value of field devices.
		Field Notes: Alarm Notification at BAS: PASS / FAIL System Shut Down – Hand Mode: PASS / FAIL System Shut Down – Auto Mode: PASS / FAIL	
	33	Restore electrical power to supply fan. Acknowledge and clear alarm at BAS workstation. Confirm system re-starts. Allow system to achieve equilibrium.	1. BAS acknowledges alarm condition is cleared. 2. System re-start is enabled 3. Fans, valves and dampers resume normal operation. 4. BAS workstation graphics show correct status and/or value of field devices.

		Field Notes: Alarm Acknowledged and Cleared at BAS: PASS / FAIL Air Handling Unit Restarts and resumes normal operation: PASS / FAIL	
	34	<u>Return Fan Fault:</u> Move the H-O-A switch into the HAND position – at VFD, set drive to Start and Run at 55 Hz or more. With supply fan running, remove electrical power at local disconnect or breaker. Confirm system shutdown and alarm notification at BAS workstation. Repeat test with H-O-A switch in the AUTO position by removing the forced setting	1. Return fan fault alarm received at BAS workstation. 2. System shut down is enabled. 3. Return fan is de-energized. 4. Supply fan remains running. 5. Outside Air and Relief Dampers close. 6. Return Air Damper Opens. 7. Chilled Water Valve closes. 8. BAS workstation graphics show correct status and/or value of field devices.
		Field Notes: Alarm Notification at BAS: PASS / FAIL System Shut Down – Hand Mode: PASS / FAIL System Shut Down – Auto Mode: PASS / FAIL	
	35	Restore electrical power to return fan. Acknowledge and clear alarm at BAS workstation. Confirm system re-starts. Allow system to achieve equilibrium.	1. BAS acknowledges alarm condition is cleared. 2. System re-start is enabled 3. Fans, valves and dampers resume normal operation. 4. BAS workstation graphics show correct status and/or value of field devices.
		Field Notes: Alarm Acknowledged and Cleared at BAS: PASS / FAIL Air Handling Unit Restarts and resumes normal operation: PASS / FAIL	
	36	<u>High Supply Air Static Pressure Alarm:</u> Move the H-O-A switch into the HAND position– at VFD, set drive to Start and Run at 60 Hz. With supply fan running, manually trip High Pressure cut-out switch using hand help pump with gage. Confirm system shutdown and alarm notification at BAS workstation. Repeat test with H-O-A switch in the AUTO position.	1. High Pressure alarm received at BAS workstation. 2. System shut down is enabled. 3. Supply and Return fans are de-energized. 4. Outside Air and Relief Dampers close. 5. Return Air Damper Opens. 6. Chilled Water Valve closes. 7. Hot water valve closes. 8. BAS workstation graphics show correct status and/or value of field devices.

		Field Notes: Alarm Notification at BAS: PASS / FAIL System Shut Down – Hand Mode: PASS / FAIL System Shut Down – Auto Mode: PASS / FAIL	
	37	Reset High Pressure cut-out switch back to normal operation. Acknowledge and clear alarm at BAS workstation. Confirm system re-starts. Allow system to achieve equilibrium.	1. BAS acknowledges alarm condition is cleared. 2. System re-start is enabled 3. Fans, valves and dampers resume normal operation. 4. BAS workstation graphics show correct status and/or value of field devices.
		Field Notes: Alarm Acknowledged and Cleared at BAS: PASS / FAIL Air Handling Unit Restarts and resumes normal operation: PASS / FAIL	
	38	Dirty Pre-Filter Alarm: Simulate a dirty filter alarm at the pre-filter.	1. Dirty pre-filter alarm is generated at the BAS Workstation.
		Field Notes:	
	39	Dirty Final Filter Alarm: Simulate a dirty filter alarm at the final filter.	1. Dirty final filter alarm is generated at the BAS Workstation.
		Field Notes:	
	40	Dirty Carbon Filter Alarm: Simulate a dirty filter alarm at the final filter.	2. Dirty carbon filter alarm is generated at the BAS Workstation.
		Field Notes:	
	41	Return all parameters to their initial values.	1. Unit resumes normal operation.
		Field Notes:	

Note: Duct Detector and Sequence will be tested as part of the Fire Detection System by the LAHJ. Jacobs will receive and review their report.

END OF TEST

DATE:

Functional Test Procedure

AIR HANDLING UNIT AHU-00

SUMMARY OF RESULTS:

LESSONS LEARNED:

-
-
-

CORRECTIVE ISSUES:

-
-
-

Acceptance of Test:

☐ This test cannot be accepted at this time due to the Corrective Issues noted above.

☐ This test is accepted by the Performance Assurance Authority identified below. Any Corrective Issues noted above do not adversely impact the overall performance of the system.

Witnessed _____ Date _____

Performance Assurance Authority