AIR HANDLING UNIT – VARIABLE-VOLUME – RELIEF AIR FAN

1. INTRODUCTION

This sample functional performance test (FPT) procedure is for a hypothetical variable-air-volume air handling unit system with relief air fan.

The following system diagram is intended to communicate information about this hypothetical system and is not required to be included as part of any FPT.

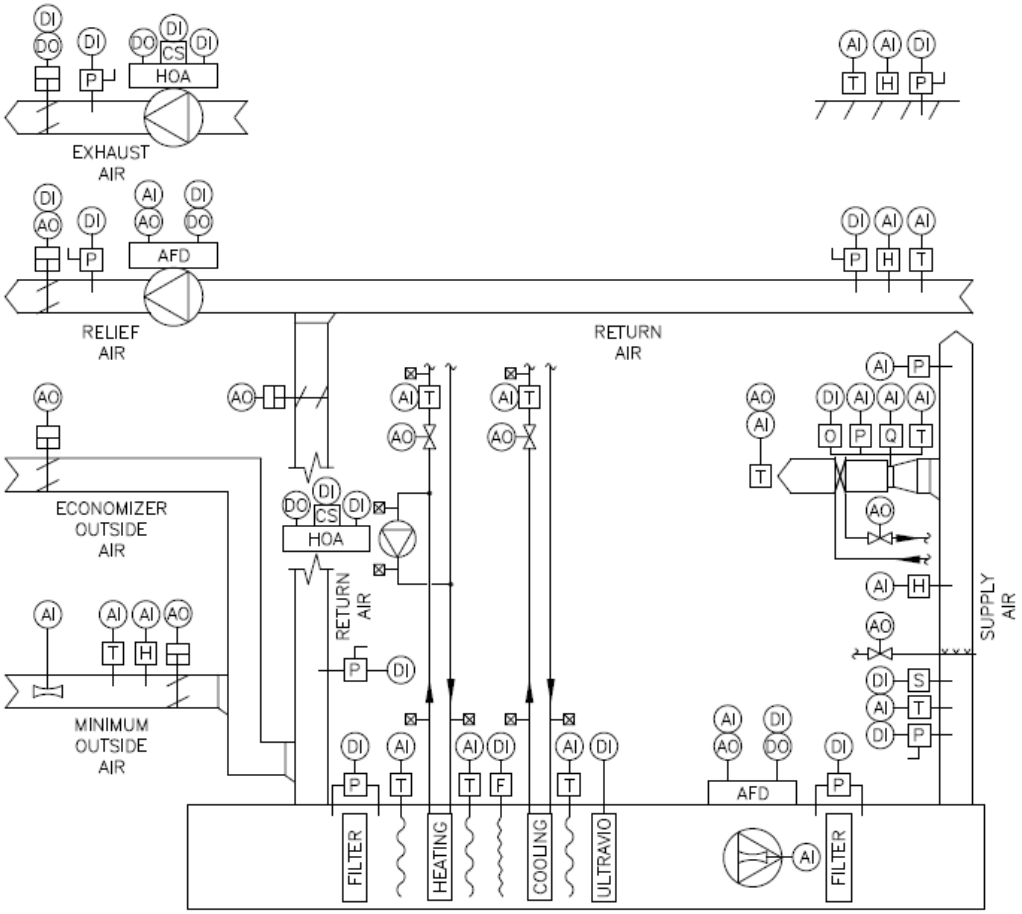

DIAGRAM SYMBOLOGY

BCS INPUTS/OUTPUTS	SENSORS
AI ANALOG INPUT	AVERAGING TYPE; INSERTION TYPE; P HIGH/LOW PRESS LIMIT; Q AIRFLOW
AO ANALOG OUTPUT	C CARBON DIOXIDE; F LOW TEMP LIMIT; M CARBON MONOXIDE; S SMOKE DETECTOR
DI DISCRETE INPUT	CS CURRENT; P PRESSURE /POSITION; O OPERATION MODE; T TEMPERATURE
DO DISCRETE OUTPUT	H HUMIDITY; SECTIONAL TYPE

DEVICES

AIR TERMINAL UNIT	HUMIDIFIER	TERMINAL HEATING COIL
AFD ADJUSTABLE FREQUENCY DRIVE	FAN/PUMP	MOTORIZED DAMPER
AIRFLOW METER AIR VALVE	HOA HAND–OFF–AUTO SWITCH	S SMOKE DAMPER

2. NOTABLE SYSTEM FEATURES

The purpose of this section is to identify notable system features to facilitate an understanding of system operation.

Notable system features include:

a. Supply air fan is selected to meet block load equivalent to 85-percent of peak requirements.

b. Relief air fan is selected to meet block load equivalent to 85-percent of peak requirements.

c. Cooling coil is selected to meet block load equivalent to 85-percent of peak requirements.

d. Pre-heat coil is selected to meet 100-percent of peak requirements.

e. Supply air fan control algorithm includes supply air fan pressure reset based on air valve position of terminal equipment to minimize fan energy usage.

f. Relief air fan control algorithm includes speed modulation of relief air fan in conjunction with modulation of relief air control damper to maintain facility pressure relative to the outside.

g. Relief air fan control algorithm includes relief air fan enable, relief air fan disable, and relief air control damper minimum position to address conditions that prevent facility pressurization relative to the outside and to prevent no flow condition.

h. Minimum outside air and economizer control algorithms include time delays allowing other control loops to stabilize to help prevent low limit temperature (freezestat) alarm conditions.

i. Minimum outside air control algorithm includes modulating minimum outside air control damper to fine tune outside airflow after repositioning return air control damper to minimize fan energy usage by minimizing suction static pressure noting minimum outside control air damper is significantly smaller than return air control damper.

j. Economizer control algorithm is based on dry-bulb temperature sensors due their reliability over relative humidity and wet-bulb temperature sensors. This operation mode is activated upon detection of outside air dry-bulb temperature being equal to or less than actual return air dry-bulb temperature minus five degrees allowing a reasonable number of annual operating hours when outside air relative humidity results in an outside air enthalpy being less than return air enthalpy.

k. Economizer control algorithm includes first modulating minimum outside air control damper, followed by modulating return air control damper, followed by modulating economizer outside air control damper to maintain minimum outside air setpoint airflow followed by mixed air setpoint temperature to minimize fan energy usage by minimizing suction static pressure noting minimum outside control air damper is significantly smaller than economizer and return air control dampers.

l. Pre-occupied operation mode includes enabling terminal equipment featuring a fan prior to commanding supply air fan to its active status. Near completion of operation mode, supply air fan is commanded to its inactive status and associated external energy recovery equipment featuring a fan is enabled to prevent excessive current inrush for this associated equipment.

m. Pre-heat coil brine temperature and cooling coil brine temperature alarm conditions include visual indication of coils whose water-side temperature change is significantly less than design thus negatively impacting central plant efficiency.

n. Low limit temperature (freezestat) alarm condition includes disabling associated external energy recovery equipment featuring a fan upon activation of algorithm to prevent low temperature air being introduced into this equipment.

o. Fire alarm condition includes disabling associated external energy recovery equipment featuring a fan upon activation of algorithm to prevent oxygen from being introduced into this equipment and to meet requirements of life safety codes.

3. CONCLUSIONS AND RECOMMENDATIONS

The purpose of this section is to identify conclusions and recommendations based on control system feature observations, point-to-point observations, actuator observations, and system operation observations.

It is concluded that this system [does / does not perform] in accordance with contract requirements.

It is recommended that this system [be / not be] accepted by the government.

The following system control enhancements are recommended:

4. TEST CONDITIONS

The purpose of this section is to identify conditions occurring at time of testing.

Test date: _____

Test begin time: _____

Test end time: _____

Test begin outside air temp: _____

Test end outside air temp: _____

5. EQUIPMENT IDENTIFICATION

The purpose of this section is to identify equipment included in this system.

Air handling unit: _____
Relief air fan: _____
Exhaust air fan: _____
Pre-heat coil circ. pump: _____

6. ATTENDEES

The purpose of this section is to identify persons present during system functional performance testing.

ATTENDEES			
REPRESENTING	**NAME**	**COMPANY**	**TELEPHONE NUMBER**
Mechanical Commissioning Specialist:			
Owner's Representative:			
Mechanical Contractor:			
Controls Contractor:			
Test & Balance Contractor:			

7. CONTROL SYSTEM FEATURE OBSERVATIONS

The purpose of this section is to identify control system features including control point description, imbedded / visible type, adjustable / monitoring type, actual value, setpoint value / alarm range.

Abbreviations used in the matrix below include:

a. Unit:

Unit of measure for control point.

b. Imbedded / Visible:

I - Imbedded such that control point is not observable by Operator.

V - Visible such that control point is observable by Operator.

c. Type:

A1 - Both setpoint and minimum / maximum alarm or alarm range are adjustable by Operator.

A2 - Only minimum / maximum alarm or alarm range is adjustable by Operator.

A3 - Only setpoint is adjustable by Operator.

M - Control point is visible, but not adjustable by Operator.

d. Value / Status:

As-found imbedded or visible value or status of control point observed prior to control point(s) manipulation.

A - Status of control point is in alarm.

N - Status of control point is normal operation.

e. Setpt / Alarm Range:

Alarm Min - Alarm activated when actual value is equal to or less than alarm activation setpoint.

Setpt - Setpoint.

Alarm Max - Alarm activated when actual value is equal to or greater than alarm activation setpoint.

CONTROL SYSTEM FEATURES								
POINT DESCRIPTION	**UNIT**	**VISIBLE / IMBEDDED**	**TYPE**	**VALUE / STATUS**	**SETPT / ALARM**			**NOTES**
					ALARM MIN	**SETPT**	**ALARM MAX**	
Minimum outside air ductwork:								
Airflow								
Dry-bulb temp					-	-	-	
Relative humidity					-	-	-	
Damper position	% Open				-	-	-	
Economizer outside air ductwork:								
Damper position	% Open				-	-	-	
Return air ductwork:								
Dry-bulb temp						-		
Relative humidity					-			
High limit static pressure						-		
High limit static pressure					-			
Damper position	% Open				-	-	-	
Mixed air section:								
Filter differential pressure					-			
Dry-bulb temp					-		-	
Pre-heat coil:								
Dry-bulb temp								
Low limit temp					-	-	-	
Valve position	% Open				-	-	-	
Leaving water / brine temp					-			
Cooling coil:								
Dry-bulb temp					-			
Valve position	% Open				-	-	-	
Leaving water / brine temp							-	

CONTROL SYSTEM FEATURES								
POINT DESCRIPTION	UNIT	VISIBLE / IMBEDDED	TYPE	VALUE / STATUS	SETPT / ALARM			NOTES
					ALARM MIN	SETPT	ALARM MAX	
Ultraviolet light					-	-	-	
Supply air fan:								
Status					-	-	-	
Speed					-	-	-	
Airflow					-	-	-	
Discharge air section:								
Filter differential pressure					-			
Discharge air ductwork:								
High limit static pressure					-			
Dry-bulb temp					-			
Smoke damper position confirmation					-			
Relative humidity					-		-	
Static pressure					-			
Relief air ductwork:								
High limit static pressure					-			
Damper position	% Open				-	-	-	
Damper position confirmation					-			
Relief air fan:								
Status					-	-	-	
Speed					-	-	-	
Exhaust air ductwork:								
High limit static pressure					-			
Damper position	% Open				-	-	-	
Damper position confirmation					-			
Exhaust air fan:								
Status					-	-	-	
Pre-heat coil circulating pump:								
Status						-		

CONTROL SYSTEM FEATURES								
POINT DESCRIPTION	UNIT	VISIBLE / IMBEDDED	TYPE	VALUE / STATUS	SETPT / ALARM			NOTES
					ALARM MIN	SETPT	ALARM MAX	
Facility:								
Outside dry-bulb temp					-	-	-	
Outside relative humidity					-	-	-	
Facility pressure								

8. POINT-TO-POINT OBSERVATIONS

The purpose of this section is to identify system meters and sensors have been calibrated.

Abbreviations used in the matrix below include:

a. Display:

As-found imbedded or visible value of control point documented at Operator workstation at same time measurement or observation occurred and prior to control point(s) manipulation.

Value / status is recorded for both locations when control point is displayed locally at equipment Operator workstation.

b. Measured / Observed:

As-found imbedded or visible value of control point measured or observed at same time documentation of value at Operator workstation occurred and prior to control point(s) manipulation.

POINT-TO-POINT			
POINT DESCRIPTION	DISPLAY (LOCAL / CONTROL SYSTEM)	MEASURED / OBSERVED	NOTES
Minimum outside air ductwork:			
Airflow	/		
Dry-bulb temp			
Relative humidity			
Return air ductwork:			
Dry-bulb temp			
Relative humidity			
Mixed air section:			
Filter differential pressure			
Dry-bulb temp			
Pre-heat coil:			
Dry-bulb temp			
Low limit temp	/		
Leaving water / brine temp			

POINT-TO-POINT			
POINT DESCRIPTION	**DISPLAY (LOCAL / CONTROL SYSTEM)**	**MEASURED / OBSERVED**	**NOTES**
Cooling coil:			
Dry-bulb temp			
Leaving water / brine temp			
Supply air fan:			
Airflow	/		
Discharge air ductwork:			
High limit static pressure			
Dry-bulb temp			
Relative humidity			
Static pressure			
Relief air ductwork:			
High limit static pressure			
Facility:			
Outside dry-bulb temp			
Outside relative humidity			
Facility pressure			

9. ACTUATOR AND MOTOR OBSERVATIONS

The purpose of this section is to identify actuator responses to commands from the control system.

Abbreviations used in the matrix below include:

a. Type:

A - Actuator / controlled device is controlled by an analog control signal.

D - Actuator / controlled device is controlled by a discrete (binary) control signal.

b. Maximum Command:

Control system command resulting in actuator moving controlled device to its full open position with maximum / full flow across device.

c. Minimum Command:

Control system command resulting in actuator moving controlled device to its full closed position with minimum / no flow across device.

d. Signal:

Output from control system measured in units of 0 to 100 percent, 0 to 10 volts, etc.

e. Position:

Position of controlled device (not actuator) physically observed that corresponds to control system signal observed in units of 0-percent open (minimum / no flow across device) and 100-percent open (maximum / full flow across device).

ACTUATORS AND MOTORS						
ACTUATOR DESCRIPTION	TYPE	MAXIMUM COMMAND		MINIMUM COMMAND		NOTES
		SIGNAL	POSITION / SPEED	SIGNAL	POSITION / SPEED	
Minimum outside air control damper						
Economizer outside air control damper						
Return air control damper						
Pre-heat coil control valve						
Cooling coil Control valve						
Supply air fan speed						
Relief air control damper						
Relief air fan speed						
Exhaust air control damper						

10. VARIABLE FREQUENCY DRIVE OBSERVATIONS

The purpose of this section is to identify characteristics of variable frequency drives (VFD's).

Procedure for obtaining characteristics included:

a. Procedure for documenting maximum motor speed allowed by VFD included:
   - Record served motor's nameplate full load current
   - Confirm / manually set VFD's maximum allowed speed of 60 Hz
   - Manually set VFD hand-off-auto switch to "hand" position
   - Manually set VFD to maximum allowed speed of 60 Hz
   - Record served motor's running load current at motor conductors

b. Procedure for documenting minimum safe motor speed allowed by VFD included:
   - Manually set VFD speed to 24 Hz
   - Repeatedly decreased VFD speed by 3 Hz and recorded served motor's running load amperes until running load amperes increases
   - Set VFD's minimum allowed speed equivalent to speed at which running load amperes increased plus 3 Hz
   - Manually set VFD speed to VFD's minimum allowed speed
   - Record served motor's running load amperes at motor conductors

VARIABLE FREQUENCY DRIVE INFORMATION														
PARAMETER DESCRIPTION	**SERVED EQUIPMENT**													
Data for maximum motor speed allowed by VFD:														
Motor nameplate full load current														
VFD maximum allowed speed (Hz)														
Running load current with VFD at 60 Hz														
Data for minimum safe motor speed allowed by VFD:														
Current at 24 Hz														
Current at 21 Hz														
Current at 18 Hz														
Current at 15 Hz														
Current at 12 Hz														
Current at 9 Hz														
Current at 6 Hz														
Minimum allowed speed (Hz)														
Current at minimum allowed speed (Amps)														

11. SYSTEM OPERATION OBSERVATIONS

The purpose of this section is to document results from system-based testing of responses for each control algorithm, operation mode, and alarm condition resulting from manipulated control point(s).

Testing is sequentially grouped based on similar functions to maximize testing efficiency and is categorized as follows:

a. As-found conditions.
b. Control algorithms.
c. Operation modes.
d. Alarm conditions.

Control algorithms initiated by operation modes are tested prior to testing operation modes.
Operation modes initiated by alarm conditions are tested prior to testing alarm conditions.

Because point-to-point and actuator observations were physically made, system responses are observed from Operator workstation unless indicated otherwise.

Some equipment / component responses may be combined in a single test.

The following control algorithm testing is provided in the matrix below:

a. Supply air fan.
b. Relief air fan.
c. Pre-heat coil / cooling coil.
d. Minimum outside air.
e. Economizer.
f. Exhaust air fan.
g. Pre-heat coil circulating pump.
h. Humidifier.

The following operation mode testing is provided in the matrix below:

a. Unoccupied.
b. Timed override.
c. Pre-occupied.
d. Occupied.

The following alarm condition testing is provided in the matrix below:

a. Pre-filter high static pressure.
b. Pre-heat coil brine temperature.
c. Pre-heat coil air temperature.
d. Pre-heat coil circulating pump failure.
e. Cooling coil brine temperature.
f. Cooling coil air temperature.
g. Final filter high static pressure.
h. Return air relative humidity.
i. Relief air fan general fault.
j. Relief air fan failure.
k. Exhaust air fan failure.
l. High relief air ductwork static pressure.
m. High exhaust air ductwork static pressure.
n. Facility relative pressure.
o. Supply air fan general fault.
p. Supply air fan failure.
q. High supply air ductwork static pressure.
r. High return air ductwork number one static pressure.
s. High return air ductwork number two static pressure.
t. Low limit temperature (freezestat).
u. Fire.
v. Emergency air distribution shutoff.
w. Pre-heat coil circulating pump opposite status.
x. Supply air fan opposite status.
y. Relief air fan opposite status.
z. Exhaust air fan opposite status.

Abbreviations used in the matrix below include:

a. Test Method:
   Manipulated parameter(s) necessary to produce expected system response.
b. Expected Response:
   Anticipated system reaction to manipulated parameter(s).
c. Comments:
   Commissioning specialist’s issues related to observations.
d. Pass / Fail:
   P - Expected response is observed without issues of concern.
   F - Expected response is not observed resulting in noted issues of concern.
e. Miscellaneous:
   CS - Control signal.

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
As-Found Conditions				
01	To observe as-found conditions: • Confirm / initiate air handling unit's active status • Record observations in expected response /comments columns prior to manipulating parameters	Supply air fan speed	CS of _____	
02		Relief air fan speed	CS of _____	
03		Minimum outside air control damper position	CS of _____	
04		Return air control damper position	CS of _____	
05		Economizer outside air control damper position	CS of _____	
06		Relief air control damper position	CS of _____	
07		Pre-heat coil control valve position	CS of _____	
08		Cooling coil control valve position	CS of _____	
09		Exhaust air control damper position	CS of _____	
10		Exhaust air fan status	CS of _____	
11		Pre-heat coil circulating pump status	CS of _____	
12		Minimum outside air setpoint maintained	CS of _____	
13		Facility setpoint pressure relative to the outside maintained	CS of _____	

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
Supply Air Fan Control Algorithm Design Control Sequence: Upon detection of this algorithm having been activated, the control system shall: • Set minimum supply air ductwork setpoint static pressure equivalent to 0.75 INWG • Set maximum supply air ductwork setpoint static pressure equivalent to 2.50 INWG • Poll each air terminal unit's air valve position every five-minutes • Monitor supply air ductwork static pressure sensor • Command supply air fan to its minimum allowed motor speed • Command supply air fan towards its maximum allowed motor speed upon detection of actual supply air ductwork static pressure being equal to or less than maximum setpoint and any air valve having been commanded to greater than its 95-percent open position • Command supply air fan towards its minimum allowed motor speed upon detection of actual supply air ductwork static pressure being equal to or greater than minimum setpoint and no air valve having been commanded to greater than its 80-percent open position • Command supply air fan to its inactive status upon detection of this control algorithm having been deactivated				
14	To prepare for system response: • Override scheduled unoccupied time to be slightly after actual time • Wait for overridden unoccupied time to occur • Override scheduled occupied time to be slightly after actual time • Observe system status	Minimum supply air ductwork setpoint static pressure set	CS of _____	
15		Maximum supply air ductwork setpoint static pressure set	CS of _____	
16		Supply air ductwork static pressure sensor monitored	CS of _____	
17		Supply air fan commanded to its minimum allowed motor speed	CS of _____	
18	To observe system response to air valve based deficient static pressure: • Override one air valve to its 97-percent open position	Supply air fan commanded towards its maximum allowed motor speed	CS of _____	
19		Supply air ductwork static pressure maximum setpoint obtained	CS of _____	
20	To observe system response to air valve based excessive static	Supply air fan commanded towards its minimum allowed motor speed	CS of _____	

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
21	pressure: • Override all air valves to their 50-percent open position	Supply air ductwork static pressure minimum setpoint obtained	CS of _____	
22	To observe system response to static pressure based deficient static pressure: • Command all air valves to their 50-percent open position • Override minimum supply air ductwork setpoint static pressure setpoint to slightly greater than actual pressure	Supply air fan commanded towards its maximum allowed motor speed	CS of _____	
23	To observe system response to static pressure based excessive static pressure: • Command all air valves to their 100-percent open position • Override maximum supply air ductwork setpoint static pressure setpoint to slightly less than actual pressure	Supply air fan commanded towards its minimum allowed motor speed	CS of _____	
24	Release all overrides	System returns to pre-test conditions		

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
Relief Air Fan Control Algorithm Design Control Sequence: Upon detection of this algorithm having been activated, the control system shall: • Continuously set activation / deactivation setpoint relative pressure equivalent to 0.01 INWG • Continuously set facility relative pressure control setpoint equivalent to 0.02 INWG • Monitor facility relative pressure sensor located across facility envelope • Command relief air control damper to its 10-percent open position upon detection of facility actual relative pressure being equal to or greater than activation setpoint for a five-minute period • Command relief air control damper towards its 100-percent open position upon detection of facility actual relative pressure being equal to or greater than facility relative pressure control setpoint • Maintain relief air control damper in its 100-percent open position, confirm relief air control damper in its 100-percent open position, enable relief air fan, and command relief air fan to its minimum allowed motor speed upon detection of relief air control damper having been commanded to its 100-percent open position and facility actual relative pressure being equal to or greater than facility relative pressure control setpoint • Maintain relief air control damper in its 100-percent open position and command relief air fan towards its maximum allowed motor speed upon detection of relief air control damper having been commanded to its 100-percent open position and facility actual relative pressure being equal to or greater than facility relative pressure control setpoint • Maintain relief air control damper in its 100-percent open position and command relief air fan towards its minimum allowed motor speed upon detection of facility actual relative pressure being less than facility relative pressure control setpoint • Maintain relief air fan at its minimum allowed motor speed and command relief air control damper towards its 10-percent open position upon detection of facility actual relative pressure being less than facility relative pressure control setpoint • Disable relief air fan and command relief air control damper to its 0-percent open position upon detection of facility actual relative pressure being less than deactivation setpoint for a 15-minute period • Disable relief air fan and command relief air control damper to its 0-percent open position upon detection of this control algorithm having been deactivated			
25	To prepare for system response:	Activation / deactivation setpoint set	CS of _____	

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
26	• Observe system status	Facility pressure control setpoint set	CS of _____	
27		Facility relative pressure monitored	CS of _____	
28	To observe system response to activation: • Confirm / override facility actual relative pressure to greater than activation setpoint and less than control setpoint	Five-minute period passes without control system action		
29		Relief air control damper commanded to its 10-percent open position	CS of _____	
30		Relief air fan disabled status maintained	CS of _____	
31	To observe system response to excessive relative pressure: • Override outside airflow to maximum demand • Override facility setpoint relative pressure to slightly less than actual pressure	Relief air control damper commanded to its 100-percent open position	CS of _____	
32		Relief air control damper confirmed in its 100-percent open position	CS of _____	
33		Relief air fan commanded to its minimum allowed motor speed, then	CS of _____	
34		Relief air fan commanded to its maximum allowed motor speed	CS of _____	
35	To observe system response to deficient relative pressure: • Override outside airflow to minimum demand • Override facility setpoint relative pressure to slightly greater than actual pressure	Relief air control damper maintained in its 100-percent open position	CS of _____	
36		Relief air fan commanded to its minimum allowed motor speed, then	CS of _____	
37		Relief air fan maintained at its minimum allowed motor speed	CS of _____	
38		Relief air control damper commanded to its 10-percent open position	CS of _____	
39	To observe system response to continued deficient relative pressure: • Override facility actual relative pressure to less than deactivation setpoint	Relief air fan disabled	CS of _____	
40		Relief air control damper commanded to its 0-percent open position	CS of _____	

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
41	Release all overrides	System returns to pre-test conditions		

Pre-Heat Coil Control Algorithm

Design Control Sequence:

Upon detection of this algorithm having been activated, the control system shall:

- Set pre-heat coil discharge setpoint temperature equivalent to cooling coil discharge air setpoint temperature minus 2.0 °F
- Monitor temperature sensor located immediately downstream of this coil
- Command control valve towards its 100-percent open position upon detection of pre-heat coil discharge air temperature being less than setpoint
- Command control valve towards its 0-percent open position upon detection of pre-heat coil discharge air temperature being greater than setpoint

Cooling Coil Control Algorithm

Design Control Sequence:

Upon detection of this algorithm having been activated, the control system shall:

- Monitor temperature sensor located immediately downstream of this coil
- Command control valve towards its 100-percent open position upon detection of cooling coil discharge air temperature being greater than setpoint of 55.0 °F
- Command control valve towards its 0-percent open position upon detection of cooling coil discharge air temperature being less than setpoint of 55.0 °F

42	To prepare for system response: • Observe system status	Pre-heat coil discharge setpoint temperature	CS of _____	
43		Cooling coil discharge setpoint temperature	CS of _____	
44	To observe system response to deficient heating / excessive cooling capacities: • Override cooling coil discharge air setpoint temperature to a significantly greater value such that pre-heat setpoint temperature is slightly greater than actual temperature	Pre-heat coil discharge setpoint temperature set	CS of _____	
45		Cooling coil discharge setpoint temperature set	CS of _____	
46		Pre-heat coil control valve commanded towards its 100-percent open position	CS of _____	
47		Cooling coil control valve commanded towards its 0-percent open position	CS of _____	

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
48	To observe system response to excessive heating / deficient cooling capacities: • Override cooling coil discharge air setpoint temperature to a significantly lesser value such that pre-heat setpoint temperature is slightly less than actual temperature	Pre-heat coil discharge setpoint temperature set	CS of _____	
49		Cooling coil discharge setpoint temperature set	CS of _____	
50		Pre-heat coil control valve commanded towards its 0-percent open position	CS of _____	
51		Cooling coil control valve commanded towards its 100-percent open position	CS of _____	
52	Release all overrides	System returns to pre-test conditions		

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
Minimum Outside Air Control Algorithm Design Control Sequence: Upon detection of this algorithm having been activated, the control system shall: • Set outside air setpoint airflow equivalent to 1,000 cfm • Take no action for a five-minute period • Maintain economizer outside air control damper in its 0-percent open position • Command minimum outside air control damper towards its 100-percent open position until outside air actual airflow is equal to setpoint • Momentarily maintain minimum outside air control damper in its current position and command return air control damper towards its 0-percent open position until outside air actual airflow is equal to 110 percent of setpoint upon detection of outside air actual airflow being less than setpoint and minimum outside air control damper having been commanded to its 100-percent open position • Temporarily maintain return air control damper in its current position and command minimum outside air control damper up to an additional 20-percent towards its 10-percent open position upon detection of outside air actual airflow being greater than setpoint and return air control damper having been repositioned • Temporarily maintain return air control damper in its current position and command minimum outside air control damper towards its 100-percent open position upon detection of outside air actual airflow being less than setpoint and return air control damper having been repositioned • Momentarily maintain minimum outside air control damper in its current position and command return air control damper towards its 100-percent open position until outside air actual airflow is equal to 90 percent of setpoint upon detection of outside air actual airflow being greater than setpoint and minimum outside air control damper having been commanded an additional 20-percent towards its 10-percent open position			
53	To prepare for system response: • Override scheduled unoccupied time to be slightly after actual time • Wait for overridden unoccupied time to occur • Override economizer operation mode to inactive	Outside air setpoint airflow set	CS of _____	
54		Return air control damper commanded to its 100-percent open position	CS of _____	
55		Minimum outside air control damper commanded to its 0-percent open position	CS of _____	
56		Economizer outside air control damper maintained in its 0-percent open position	CS of _____	

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
57	To observe system stabilization: • Override scheduled occupied time to be slightly after actual time • Override supply fan to minimum demand	Five-minute period passes without control system action		
58		Minimum outside air control damper commanded towards its 100-percent open position	CS of _____	
59		Return air control damper maintained in its 0-percent open position	CS of _____	
60		Minimum outside air setpoint airflow obtained	CS of _____	
61	To observe system response to deficient outside air airflow: • Override supply fan to minimum demand • Override outside air setpoint airflow to slightly greater than actual airflow	Minimum outside air control damper maintained in its 100-percent open position	CS of _____	
62		Return air control damper commanded towards its 0-percent open position	CS of _____	
63		Minimum outside air actual airflow of 110-percent of setpoint obtained	CS of _____	
64	To observe system response to excessive outside air airflow: • Override supply fan to maximum demand • Override outside air setpoint airflow to significantly less than actual airflow	Return air control damper maintained in its current position	CS of _____	
65		Minimum outside air control damper commanded an additional 20-percent towards its 10-percent open position, then	CS of _____	
66		Minimum outside air control damper maintained in its current position	CS of _____	
67		Return air control damper commanded towards its 100-percent open position	CS of _____	
68		Minimum outside air actual airflow of 90-percent of setpoint obtained	CS of _____	
69	Release all overrides	System returns to pre-test conditions		

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
Economizer Control Algorithm Design Control Sequence: Upon detection of this algorithm having been activated, the control system shall: • Continuously set economizer activation setpoint temperature equivalent to actual return air dry-bulb temperature minus five degrees • Set economizer setpoint temperature equivalent to cooling coil discharge air setpoint temperature • Set minimum outside air setpoint airflow equivalent to 1,000 cfm • Take no action for a five-minute period • Initiate economizer response, deactivate minimum outside air control algorithm, maintain economizer outside air control damper in its 0-percent open position, and command return air control damper to its 100-percent open position upon detection of outside air dry-bulb temperature being equal to or less than economizer activation setpoint temperature • Maintain economizer outside air control damper in its 0-percent open position, maintain return air control damper in its 100-percent open position, and command minimum outside air control damper towards its 100-percent open position upon detection of minimum outside air actual airflow being less than setpoint or actual mixed air temperature being greater than economizer setpoint temperature • Maintain economizer outside air control damper in its 0-percent open position, maintain minimum outside air control damper in its 100-percent open position, and command return air control damper towards its 0-percent open position until minimum outside air actual airflow is equal to setpoint upon detection of minimum outside air control damper having been commanded to its 100-percent open position and minimum outside air actual airflow being less than setpoint • Maintain minimum outside air control damper in its 100-percent open position and command return air control damper towards its 100-percent open position upon detection of minimum outside air control damper having been commanded to its 100-percent open position, actual mixed air temperature being equal to or greater than economizer setpoint temperature, and minimum outside air actual airflow being greater than setpoint • Maintain return air control damper in its 100-percent open position and command minimum outside air control damper towards its 0-percent open position upon detection of return air control damper having been commanded to its 100-percent open position, minimum outside air actual airflow being greater than setpoint, and actual mixed air temperature being equal to or less than economizer setpoint temperature minus 1.0 °F			

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
Design Control Sequence (Concluded): • Maintain minimum outside air control damper in its 100-percent open position and command economizer outside air control damper towards its 100-percent open position upon detection of minimum outside air control damper having been commanded to its 100-percent open position and actual mixed air temperature being greater than economizer setpoint temperature • Maintain economizer outside air control damper in its 100–percent open position and command return air control damper towards its 0-percent open position upon detection of economizer outside air control damper having been commanded to its 100–percent open position and actual mixed air temperature being greater than economizer setpoint temperature • Maintain minimum outside air control damper in its 100-percent open position, maintain economizer outside air control damper in its current position, and command return air control damper towards its 100-percent open position upon detection of actual mixed air temperature being equal to or less than economizer setpoint temperature minus 1.0 °F • Maintain minimum outside air control damper in its 100-percent open position, maintain return air control damper in its 100-percent open position, and command economizer outside air control damper towards its 0-percent open position upon detection of return air control damper having been commanded to its 100-percent open position and actual mixed air temperature being equal to or less than economizer setpoint temperature minus 1.0 °F • Maintain return air control damper in its 100-percent open position, and maintain economizer outside air control damper in its 0-percent open position, and command minimum outside air control towards its 0-percent open position upon detection of return air control damper having been commanded to its 100-percent open position, minimum outside air actual flow being greater than setpoint, and actual mixed air temperature being equal to or less than economizer setpoint temperature minus 1.0 °F • Cancel economizer response and activate minimum outside air control algorithm upon detection of outside air dry-bulb temperature being greater than economizer activation setpoint temperature			
70	To prepare for system response: • Override economizer activation setpoint temperature equivalent to actual return air dry-bulb temperature plus 50.0 °F	Economizer activation setpoint temperature set	CS of _____	
71		Economizer setpoint temperature set	CS of _____	
72		Minimum outside air setpoint airflow set	CS of _____	
73		Five-minute period passes without control system action		

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
74		Economizer response initiated		
75		Minimum outside air control algorithm deactivated	CS of _____	
76		Economizer outside air control damper maintained in its 0-percent open position	CS of _____	
77		Return air control damper commanded to its 100-percent open position	CS of _____	
78	To observe system response to deficient minimum outside air airflow: • Override economizer setpoint temperature to significantly less than actual temperature • Override supply air airflow to minimum demand • Override minimum outside air setpoint airflow to significantly greater than actual airflow	Supply air fan commanded to minimum allowed motor speed	CS of _____	
79		Economizer outside air control damper maintained in its 0-percent open position	CS of _____	
80		Return air control damper maintained in its 100-percent open position	CS of _____	
81		Minimum outside air control damper commanded to its 100-percent open position, then	CS of _____	
82		Return air control damper commanded to its 0-percent open position	CS of _____	
83	To observe system response to excessive minimum outside air airflow: • Override economizer setpoint temperature to significantly greater than actual temperature • Override supply air airflow to maximum demand • Override minimum outside air setpoint airflow to significantly less than actual airflow	Supply air fan commanded to maximum allowed motor speed	CS of _____	
84		Economizer outside air control damper maintained in its 0-percent open position	CS of _____	
85		Minimum outside air control damper maintained in its 100-percent open position	CS of _____	
86		Return air control damper commanded to its 100-percent open position, then	CS of _____	
87		Minimum outside air control damper commanded towards its 0-percent open position	CS of _____	

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
88	To prepare for additional system response: • Release economizer setpoint temperature override • Release supply air airflow override • Release minimum outside air setpoint airflow	Economizer setpoint temperature returned to pre-test conditions	CS of _____	
89		Supply air airflow returned to pre-test conditions	CS of _____	
90		Minimum outside air setpoint airflow returned to pre-test conditions	CS of _____	
91	To observe system response to deficient cooling: • Override mixed air setpoint temperature to significantly less than actual temperature	Economizer outside air control damper maintained in its 0-percent open position	CS of _____	
92		Return air control damper maintained in its 100-percent open position	CS of _____	
93		Minimum outside air control damper commanded to its 100-percent open position, then	CS of _____	
94		Economizer outside air control damper commanded to its 100-percent open position, then	CS of _____	
95		Return air control damper commanded to its 0-percent open position	CS of _____	
96	To observe system response to excessive cooling: • Override mixed air setpoint temperature to significantly greater than actual temperature • Override minimum outside air setpoint airflow to significantly less than actual airflow	Minimum outside air control damper maintained in its 100-percent open position	CS of _____	
97		Economizer outside air control damper maintained in its current position	CS of _____	
98		Return air control damper commanded to its 100-percent open position, then	CS of _____	
99		Economizer outside air control damper commanded to its 0-percent open position, then	CS of _____	
100		Minimum outside air control damper commanded towards its 0-percent open position	CS of _____	

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
101	To observe system response to economizer cancellation:	Economizer response cancelled	CS of _____	
102	• Override economizer activation setpoint temperature to significantly less than outside air actual dry-bulb temperature	Minimum outside air control algorithm activated	CS of _____	
103	Release all overrides	System returns to pre-test conditions		
Exhaust Air Fan Control Algorithm Design Control Sequence: Upon detection of this algorithm having been activated, the control system shall: • Command exhaust air damper to its 100-percent open position • Command exhaust air fan to operate at constant speed • Confirm exhaust air damper in its 100-percent open position Upon detection of this algorithm having been deactivated, the control system shall: • Command exhaust air fan to its inactive status • Command exhaust air damper to its 0-percent open position				
104	To observe system response to activated Control Algorithm	Exhaust air fan control algorithm initiated		
105	• Confirm / initiate activation of this control algorithm	Exhaust air damper commanded to its 100-percent open position	CS of _____	
106		Exhaust air damper confirmed in its 100-percent open position	CS of _____	
107		Exhaust air fan commanded to operate at constant speed	CS of _____	
108	To observe system response to deactivated Control Algorithm	Exhaust air fan commanded to inactive status		
109	• Deactivate this control algorithm	Exhaust air damper commanded to its 0-percent open position	CS of _____	

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
Pre-Heat Coil Circulating Pump Control Algorithm Design Control Sequence: Upon detection of this algorithm having been activated, the control system shall: • Command pre-heat coil circulating pump to operate at constant speed upon detection of outside air temperature being equal to or less than activation setpoint of 38.0 °F • Command pre-heat coil circulating pump to its inactive status upon detection of outside air temperature being greater than deactivation setpoint of 38.0 °F				
110	To observe system response to activation: • Override activation setpoint temperature to significantly less than actual outside air temperature	Pre-heat coil circulating pump control algorithm initiated		
111		Pre-heat coil circulating pump commanded to active status	CS of _____	
112	To observe system response to deactivation: • Override activation setpoint temperature to significantly greater than actual outside air temperature	Pre-heat coil circulating pump commanded to inactive status	CS of _____	
113	Release all overrides	System returns to pre-test conditions		

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
Humidifier Control Algorithm Design Control Sequence: Upon detection of this algorithm having been activated, the control system shall: • Monitor return air relative humidity sensor located in return air ductwork • Monitor supply air relative humidity sensor located downstream of humidifier distribution manifold • Enable humidifier upon detection of return air relative humidity being equal to or less than enable setpoint of 25-percent • Command humidifier control valve towards its 100-percent open position upon detection of supply air actual relative humidity being equal to or less than control setpoint of 80-percent • Command humidifier control valve towards its 0-percent open position upon detection of supply air actual relative humidity being greater than control setpoint of 80-percent • Disable humidifier upon detection of supply air relative humidity being equal to or greater than high-limit setpoint of 90-percent • Disable humidifier upon detection of return air relative humidity being greater than disable setpoint of 30-percent				
114	To observe system response to being enabled: • Override humidifier enable setpoint to significantly less than return air actual relative humidity	Humidifier enabled	CS of _____	
115	To observe system response to deficient capacity: • Override control setpoint relative humidity to slightly greater than actual relative humidity	Humidifier coil control valve commanded towards its 100-percent open position	CS of _____	
116	To observe system response to excessive capacity: • Override control setpoint relative humidity to slightly less than actual relative humidity	Humidifier coil control valve commanded towards its 0-percent open position	CS of _____	

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
117	To observe system response to capacity in excess of high-limit: • Override humidifier high-limit setpoint to significantly less than supply air actual relative humidity	Humidifier disabled	CS of _____	
118	To prepare to observe system response to being disabled: • Release humidifier high-limit setpoint override	Humidifier enabled	CS of _____	
119	To observe system response to being disabled: • Release humidifier enable setpoint override • Override humidifier disable setpoint to significantly greater than return air actual relative humidity	Humidifier disabled	CS of _____	
120	Release all overrides	System returns to pre-test conditions		

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
Unoccupied Operation Mode Design Control Sequence: Upon detection of unoccupied time having occurred, the control system shall: • Deactivate supply air fan control algorithm • Deactivate relief air fan control algorithm • Command minimum outside air control damper to its 0-percent open position • Command return air control damper to its 100-percent open position • Command economizer outside air control damper to its 0-percent open position • Command relief air control damper to its 0-percent open position • Deactivate pre-heat coil control algorithm • Deactivate cooling coil control algorithm • Deactivate minimum outside air control algorithm • Deactivate economizer control algorithm • Deactivate exhaust air fan control algorithm • Deactivate pre-heat coil circulating pump control algorithm • Deactivate humidifier control algorithm Upon detection of five zones' actual temperatures being either greater than or less than respective unoccupied setpoint temperature, the control system shall: • Activate supply air fan control algorithm • Maintain relief air fan control algorithm inactive status • Maintain minimum outside air control damper in its 0-percent open position • Maintain return air control damper in its 100-percent open position • Maintain economizer outside air control damper in its 0-percent open position • Maintain relief air control damper in its 0-percent open position • Activate pre-heat coil control algorithm • Activate cooling coil control algorithm • Maintain minimum outside air control algorithm inactive status • Maintain economizer control algorithm inactive status • Maintain exhaust air fan control algorithm inactive status • Activate pre-heat coil circulating pump control algorithm • Maintain humidifier control algorithm inactive status			
121	To observe system response to no heating / cooling demand: • Override scheduled unoccupied time to be slightly after actual time	Supply air fan control algorithm deactivated	CS of _____	
122		Relief air fan control algorithm deactivated	CS of _____	
123		Minimum outside air control damper commanded to its 0-percent open position	CS of _____	

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
124		Return air control damper commanded to its 100-percent open position	CS of _____	
125		Economizer outside air control damper commanded its 0-percent open position	CS of _____	
126		Relief air control damper commanded its 0-percent open position	CS of _____	
127		Pre-heat coil control algorithm deactivated	CS of _____	
128		Cooling coil control algorithm deactivated	CS of _____	
129		Minimum outside air control algorithm deactivated	CS of _____	
130		Economizer control algorithm deactivated	CS of _____	
131		Exhaust air fan control algorithm deactivated	CS of _____	
132		Pre-heat coil circulating pump control algorithm deactivated	CS of _____	
133		Humidifier control algorithm deactivated	CS of _____	
134	To observe system response: • Override appropriate number of zones' unoccupied heating setpoint temperature to significantly greater than zone actual temperatures • Override appropriate number of zones' unoccupied cooling setpoint temperature to significantly less than zone actual temperatures	Supply air fan control algorithm activated	CS of _____	
135		Relief air fan control algorithm maintained inactive	CS of _____	
136		Minimum outside air control damper maintained in its 0-percent open position	CS of _____	
137		Return air control damper maintained in its 100-percent open position	CS of _____	
138		Economizer outside air control damper maintained in its 0-percent open position	CS of _____	

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
139		Relief air control damper maintained in its 0-percent open position	CS of _____	
140		Pre-heat coil control algorithm activated	CS of _____	
141		Cooling coil control algorithm activated	CS of _____	
142		Minimum outside air control algorithm maintained inactive	CS of _____	
143		Economizer control algorithm maintained inactive	CS of _____	
144		Exhaust air fan control algorithm maintained inactive	CS of _____	
145		Pre-heat coil circulating pump control algorithm activated	CS of _____	
146		Humidifier control algorithm maintained inactive	CS of _____	
147	Release selected overrides	Selected components return to pre-test conditions		

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
Timed Override Operation Mode Design Control Sequence: Upon detection of any single timed override switch having been activated, the control system shall: • Maintain return air control damper in its 100-percent open position • Maintain minimum outside air control damper in its 0-percent open position • Maintain economizer outside air control damper in its 0-percent open position • Maintain relief air control damper in its 0-percent open position • Activate supply air fan control algorithm • Maintain relief air fan control algorithm inactive status • Activate pre-heat coil control algorithm • Activate cooling coil control algorithm • Maintain minimum outside air control algorithm inactive status • Maintain economizer control algorithm inactive status • Maintain exhaust air fan control algorithm inactive status • Activate pre-heat coil circulating pump control algorithm • Maintain humidifier control algorithm inactive status				
148	To observe system response: • Activate one timed override switch to active	Timed override operation mode initiated		
149		Return air control damper maintained in its 100-percent open position	CS of _____	
150		Minimum outside air control damper maintained in its 0-percent open position	CS of _____	
151		Economizer outside air control damper maintained in its 0-percent open position	CS of _____	
152		Relief air control damper maintained in its 0-percent open position	CS of _____	
153		Supply air fan control algorithm activated	CS of _____	
154		Relief air fan control algorithm maintained inactive	CS of _____	
155		Pre-heat coil control algorithm activated	CS of _____	
156		Cooling coil control algorithm activated	CS of _____	

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
157		Minimum outside air control algorithm maintained inactive	CS of _____	
158		Economizer control algorithm maintained inactive	CS of _____	
159		Exhaust air fan control algorithm maintained inactive	CS of _____	
160		Pre-heat coil circulating pump control algorithm activated	CS of _____	
161		Humidifier control algorithm maintained inactive	CS of _____	
162	Release selected overrides	Selected components return to pre-test conditions		

Pre-Occupied Operation Mode

Design Control Sequence:

Upon detection of learned system start-up time in advance of occupied time having occurred, the control system shall:

- Enable associated terminal equipment featuring a fan
- Take no action for a two-minute period
- Maintain minimum outside air control damper in its 0-percent open position
- Maintain return outside air control damper in its 100-percent open position
- Maintain economizer outside air control damper in its 0-percent open position
- Maintain relief air control damper in its 0-percent open position
- Activate supply air fan control algorithm
- Maintain relief air fan control algorithm inactive status
- Activate pre-heat coil control algorithm
- Activate cooling coil control algorithm
- Maintain minimum outside air control algorithm inactive status
- Maintain economizer control algorithm inactive status
- Maintain exhaust air fan control algorithm inactive status
- Activate pre-heat coil circulating pump control algorithm
- Maintain humidifier control algorithm inactive status
- Deactivate supply air fan control algorithm upon detection of five-minutes prior to occupied time having occurred
- Command minimum outside air control damper to its 10-percent open position
- Enable associated external energy recovery equipment featuring a fan

163	To observe system response:	Pre-occupied operation mode initiated		

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
164	• Override learned system start-up time to slightly after actual time • Wait for overridden system start-up time to occur	Associated terminal equipment featuring a fan enabled	CS of _____	
165		Two-minute period passes without control system action		
166		Minimum outside air control damper maintained in its 0-percent open position	CS of _____	
167		Return air control damper maintained in its 100-percent open position	CS of _____	
168		Economizer outside air control damper maintained in its 0-percent open position	CS of _____	
169		Relief air control damper maintained in its 0-percent open position	CS of _____	
170		Supply air fan control algorithm activated	CS of _____	
171		Relief air fan control algorithm maintained inactive	CS of _____	
172		Pre-heat coil control algorithm activated	CS of _____	
173		Cooling coil control algorithm activated	CS of _____	
174		Minimum outside air control algorithm maintained inactive	CS of _____	
175		Economizer control algorithm maintained inactive	CS of _____	
176		Exhaust air fan control algorithm maintained inactive	CS of _____	
177		Pre-heat coil circulating pump control algorithm activated	CS of _____	
178		Humidifier control algorithm maintained inactive	CS of _____	

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
179		Deactivate supply air fan control algorithm	CS of _____	
180		Minimum outside air control damper commanded its 10-percent open position	CS of _____	
181		Associated external energy recovery equipment featuring a fan enabled	CS of _____	
Occupied Operation Mode Design Control Sequence: Upon detection of completion of pre-occupied operation mode, the control system shall: • Activate supply air fan control algorithm • Activate relief air fan control algorithm • Maintain pre-heat coil control algorithm active status • Maintain cooling coil control algorithm active status • Activate minimum outside air control algorithm • Activate economizer control algorithm • Activate exhaust air fan control algorithm • Maintain pre-heat coil circulating pump control algorithm active status • Activate humidifier control algorithm				
182	To observe system response: Take no action beyond documenting control algorithm statuses	Supply air fan control algorithm activated	CS of _____	
183		Relief air fan control algorithm activated	CS of _____	
184		Pre-heat coil control algorithm maintained active	CS of _____	
185		Cooling coil control algorithm maintained active	CS of _____	
186		Minimum outside air control algorithm activated	CS of _____	
187		Economizer control algorithm activated	CS of _____	
188		Exhaust air fan control algorithm activated	CS of _____	
189		Pre-heat coil circulating pump control algorithm maintained active	CS of _____	

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
190		Humidifier control algorithm activated	CS of _____	
191	Release all overrides	System returns to pre-test conditions		
Pre-Filter High Static Pressure Alarm Condition Design Control Sequence: Upon detection of receiving enable command and pre-filter actual static pressure being equal to or greater than alarm setpoint of 1.0 INWG, the control system shall: • Initiate visual alarm at Operator workstation • Maintain system active status				
192	To observe system response: • Force air pressure on high pressure side of differential pressure switch sampling tube	Visual alarm initiated at Operator workstation		
193		System active status maintained	CS of _____	
194	Release air pressure and return sampling tube to its original position	System returns to pre-test conditions		
Pre-Heat Coil Brine Temperature Alarm Condition Design Control Sequence: Upon detection of receiving enable command, the control system shall: • Set pre-heat coil high limit alarm setpoint temperature equivalent to plant actual supply temperature minus 10.0 °F • Monitor temperature sensor located in this coil’s return piping • Initiate visual alarm at Operator workstation upon detection of control valve having been commanded towards its 100-percent open position and temperature in this coil’s return piping being equal to or greater than high limit alarm setpoint temperature for a five-minute period • Maintain system active status				
195	To observe system response to excessive heating: • Override high limit alarm setpoint temperature to significantly less than actual temperature	Five-minute period passes without control system action		
196		Visual alarm initiated at Operator workstation		
197		System active status maintained	CS of _____	
198	Release all overrides	System returns to pre-test conditions		

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
Pre-Heat Coil Air Temperature Alarm Condition Design Control Sequence: Upon detection of receiving enable command, the control system shall: • Set pre-heat coil low limit alarm setpoint temperature equivalent to pre-heat coil setpoint temperature minus 8.0 °F • Set pre-heat coil high limit alarm setpoint temperature equivalent to pre-heat coil setpoint temperature plus 15.0 °F • Monitor temperature sensor located immediately downstream of this coil		• Initiate visual alarm at Operator workstation upon detection of temperature immediately downstream of this coil being equal to or less than low limit alarm setpoint temperature for a five-minute period • Maintain system active status • Initiate visual alarm at Operator workstation upon detection of temperature immediately downstream of this coil being equal to or greater than high limit alarm setpoint temperature for a five-minute period • Maintain system active status		
199	To observe system response to deficient heating: • Override low limit alarm setpoint temperature to significantly greater than actual temperature	Five-minute period passes without control system action		
200		Visual alarm initiated at Operator workstation		
201		System active status maintained	CS of _____	
202	To observe system response to excessive heating: • Override high limit alarm setpoint temperature to significantly less than actual temperature	Five-minute period passes without control system action		
203		Visual alarm initiated at Operator workstation		
204		System active status maintained	CS of _____	
205	Release all overrides	System returns to pre-test conditions		

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
Pre-Heat Coil Circulating Pump Failure Alarm Condition Design Control Sequence: Upon detection of control algorithm being activated, pre-heat coil circulating pump active status being initiated, and pre-heat coil circulating pump status being inactive, the control system shall: • Initiate visual alarm at Operator workstation • Command pre-heat coil circulating pump to inactive status • Maintain system active status				
206	To observe system response: • Manually set pump disconnect switch to “off” position • Override pump activation setpoint temperature to significantly less than actual outside air temperature	Visual alarm initiated at Operator workstation		
207		Pre-heat coil circulating pump commanded to inactive status	CS of _____	
208		System active status maintained	CS of _____	
209	Release all overrides	System returns to pre-test conditions		
Cooling Coil Brine Temperature Alarm Condition Design Control Sequence: Upon detection of receiving enable command, the control system shall: • Set cooling coil low limit alarm setpoint temperature equivalent to plant actual supply temperature plus 8.0 °F • Monitor temperature sensor located in this coil’s return piping • Initiate visual alarm at Operator workstation upon detection of control valve having been commanded towards its 100-percent open position and temperature in this coil’s return piping being equal to or less than high limit alarm setpoint temperature for a five-minute period • Maintain system active status				
210	To observe system response to excessive heating: • Override low limit alarm setpoint temperature to significantly greater than actual temperature	Five-minute period passes without control system action		
211		Visual alarm initiated at Operator workstation		
212		System active status maintained	CS of _____	
213	Release all overrides	System returns to pre-test conditions		

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
Cooling Coil Air Temperature Alarm Condition Design Control Sequence: Upon detection of receiving enable command, the control system shall: • Set cooling coil high limit alarm setpoint temperature equivalent to cooling coil setpoint temperature plus 10.0 °F • Monitor temperature sensor located immediately downstream of this coil • Initiate visual alarm at Operator workstation upon detection of temperature immediately downstream of this coil being equal to or greater than high limit alarm setpoint temperature for a five-minute period • Maintain system active status				
214	To observe system response to excessive heating: • Override high limit alarm setpoint temperature to significantly less than actual temperature	Five-minute period passes without control system action		
215		Visual alarm initiated at Operator workstation		
216		System active status maintained	CS of _____	
217	Release all overrides	System returns to pre-test conditions		
Final Filter High Static Pressure Alarm Condition Design Control Sequence: Upon detection of receiving enable command and final filter actual static pressure being equal to or greater than alarm setpoint of 1.5 INWG, the control system shall: • Initiate visual alarm at Operator workstation • Maintain system active status				
218	To observe system response: • Force air pressure on high pressure side of differential pressure switch sampling tube	Visual alarm initiated at Operator workstation		
219		System active status maintained	CS of _____	
220	Release air pressure and return sampling tube to its original position	System returns to pre-test conditions		

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
Return Air Relative Humidity Alarm Condition Design Control Sequence: Upon detection of receiving enable command, the control system shall: • Set return air high limit alarm setpoint relative humidity equivalent to return air setpoint relative humidity plus 15-percent • Monitor relative humidity sensor located in return air ductwork • Initiate visual alarm at Operator workstation upon detection of relative humidity in return air ductwork being equal to or greater than high limit alarm setpoint temperature for a five-minute period • Maintain system active status				
221	To observe system response to excessive heating: • Override high limit alarm setpoint temperature to significantly less than actual temperature	Five-minute period passes without control system action		
222		Visual alarm initiated at Operator workstation		
223		System active status maintained	CS of _____	
224	Release all overrides	System returns to pre-test conditions		
Relief Air Fan General Fault Alarm Condition Design Control Sequence: Upon detection of receiving enable command and relief air fan general fault alarm, the control system shall: • Initiate visual alarm at Operator workstation • Maintain system active status				
225	To observe system response: • Initiate general fault at adjustable frequency drive	Visual alarm initiated at Operator workstation		
226		System active status maintained	CS of _____	
227	Release all overrides	System returns to pre-test conditions		
Relief Air Fan Failure Alarm Condition Design Control Sequence: Upon detection of receiving enable command and relief air failure alarm status, the control system shall: • Initiate audible and visual alarms at Operator workstation • Disable relief air fan • Maintain system active status				
228	To observe system response:	Audible and visual alarms initiated at Operator workstation		

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
229	• Manually turn relief air fan's disconnect switch to off position	Relief air fan disabled	CS of _____	
230		System active status maintained	CS of _____	
231	Release all overrides	System returns to pre-test conditions		
Exhaust Air Fan Failure Alarm Condition Design Control Sequence: Upon detection of control algorithm being activated, exhaust air fan active status being initiated, and exhaust air fan status being inactive, the control system shall: • Initiate visual alarm at Operator workstation • Command exhaust air fan to inactive status • Maintain system active status				
232	To observe system response: • Manually set fan disconnect switch to "off" position	Visual alarm initiated at Operator workstation		
233		Exhaust air fan commanded to inactive status	CS of _____	
234		System active status maintained		
High Relief Air Ductwork Static Pressure Alarm Condition Design Control Sequence: Upon detection of receiving enable command and return air ductwork actual static pressure being equal to or greater than alarm setpoint of absolute 2.0 INWG, the control system shall: • Initiate audible and visual alarms at Operator workstation • Disable relief air fan • Maintain system active status				
235	To observe system response: • Override alarm setpoint static pressure to slightly less than actual pressure	Audible and visual alarms initiated at Operator workstation		
236		Relief air fan disabled	CS of _____	
237		System active status maintained	CS of _____	
238	Release all overrides	System returns to pre-test conditions		

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
High Exhaust Air Ductwork Static Pressure Alarm Condition Design Control Sequence: Upon detection of receiving enable command and exhaust air ductwork actual static pressure being equal to or greater than alarm setpoint of absolute 2.0 INWG, the control system shall: • Initiate visual alarm at Operator workstation • Command exhaust air fan to its inactive status • Maintain system active status				
239	To observe system response: • Override alarm setpoint static pressure to slightly less than actual pressure	Visual alarm initiated at Operator workstation		
240		Exhaust air fan commanded to its inactive status	CS of _____	
241		System active status maintained	CS of _____	
242	Release all overrides	System returns to pre-test conditions		
Facility Relative Pressure Alarm Condition Design Control Sequence: Upon detection of receiving enable command, the control system shall: • Initiate visual alarm at Operator workstation upon detection of facility actual pressure relative to the outside being greater than high alarm setpoint of 0.05 INWG for a five-minute period • Initiate visual alarm at Operator workstation upon detection of facility actual pressure relative to the outside being less than low alarm setpoint of 0.01 INWG for a five-minute period • Maintain system active status • Maintain system active status				
243	To observe system response: • Override high alarm setpoint to slightly less than actual facility actual pressure	Five-minute period passes without control system action		
244		Visual alarm initiated at Operator workstation		
245		System active status maintained	CS of _____	
246	To observe system response: • Override low alarm setpoint to slightly greater than actual facility actual	Five-minute period passes without control system action		
247		Visual alarm initiated at Operator workstation		

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
248	pressure	System active status maintained	CS of _____	
249	Release all overrides	System returns to pre-test conditions		
Supply Air Fan General Fault Alarm Condition Design Control Sequence: Upon detection of receiving enable command and supply air fan general fault alarm, the control system shall: • Initiate visual alarm at Operator workstation • Maintain system active status				
250	To observe system response: • Initiate general fault at adjustable frequency drive	Visual alarm initiated at Operator workstation		
251		System active status maintained	CS of _____	
252	Release all overrides	System returns to pre-test conditions		
Supply Air Fan Failure Alarm Condition Design Control Sequence: Upon detection of receiving enable command and supply air failure alarm status, the control system shall: • Initiate audible and visual alarms at Operator workstation • Disable system				
253	To observe system response: • Initiate failure condition at adjustable frequency drive	Audible and visual alarms initiated at Operator workstation		
254		System disabled	CS of _____	
255	Release all overrides	System returns to pre-test conditions		
High Supply Air Ductwork Static Pressure Alarm Condition Design Control Sequence: Upon detection of receiving enable command and supply air ductwork actual static pressure being equal to or greater than alarm setpoint of absolute 4.0 INWG, the control system shall: • Initiate audible and visual alarms at Operator workstation • Disable system				
256	To observe system response:	Audible and visual alarms initiated at Operator workstation		

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
257	• Override alarm setpoint static pressure to slightly less than actual pressure	System disabled	CS of _____	
258	Release all overrides	System returns to pre-test conditions		
High Return Air Ductwork Number One Static Pressure Alarm Condition Design Control Sequence: Upon detection of receiving enable command and return air ductwork actual static pressure being equal to or greater than alarm setpoint of absolute 2.0 INWG, the control system shall: • Initiate audible and visual alarms at Operator workstation • Disable system				
259	To observe system response: • Override alarm setpoint static pressure to slightly less than actual pressure	Audible and visual alarms initiated at Operator workstation		
260		System disabled	CS of _____	
261	Release all overrides	System returns to pre-test conditions		
High Return Air Ductwork Number Two Static Pressure Alarm Condition Design Control Sequence: Upon detection of receiving enable command and return air ductwork actual static pressure being equal to or greater than alarm setpoint of absolute 2.0 INWG, the control system shall: • Initiate audible and visual alarms at Operator workstation • System disabled				
262	To observe system response: • Override alarm setpoint static pressure to slightly less than actual pressure	Audible and visual alarms initiated at Operator workstation		
263		System disabled	CS of _____	
264	Release all overrides	System returns to pre-test conditions		

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
Low Limit Temperature (Freezestat) Alarm Condition Design Control Sequence: Upon detection of receiving enable command and temperature downstream of pre-heat coil being equal to or less than alarm setpoint of 36.0 °F, the control system shall: • Initiate audible and visual alarms at Operator workstation • Disable air handling unit • Disable relief air fan • Command exhaust air fan to inactive status • Command pre-heat coil control valve to its 100-percent open position • Command cooling coil control valve to its 100-percent open position • Activate pre-heat coil circulating pump control algorithm • Disable associated external energy recovery equipment featuring a fan • Disable associated terminal equipment featuring a fan				
265	To observe system response: • Manually place sensing element of low limit temperature sensor in ice water	Audible and visual alarms initiated at Operator workstation		
266		Air handling unit disabled	CS of _____	
267		Relief air fan disabled	CS of _____	
268		Exhaust air fan commended to its inactive status	CS of _____	
269		Pre-heat coil control valve commanded to its 100-percent open position	CS of _____	
270		Cooling coil control valve commanded to its 100-percent open position	CS of _____	
271		Pre-heat coil circulating pump control algorithm activated	CS of _____	
272		Associated external energy recovery equipment featuring a fan disabled	CS of _____	
273		Associated terminal equipment featuring a fan disabled	CS of _____	
274	Remove sensing element of low limit temperature sensor from ice water and return to its original location	System returns to pre-test conditions		

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
Fire Alarm Condition Design Control Sequence: Upon detection of receiving enable command and supply air ductwork smoke detector sensing products of combustion, the fire alarm and control systems shall: • Initiate audible and visual alarms at Operator workstation • Disable air handling unit • Disable relief air fan • Command exhaust air fan to inactive status • Disable associated external energy recovery equipment featuring a fan • Disable associated terminal equipment featuring a fan				
275	To observe system response: • Manually force artificial smoke through ductwork smoke detector sampling tube	Audible and visual alarms initiated at Operator workstation		
276		Air handling unit disabled	CS of _____	
277		Relief air fan disabled	CS of _____	
278		Exhaust air fan commanded to inactive status	CS of _____	
279		Associated external energy recovery equipment featuring a fan disabled	CS of _____	
280		Associated terminal equipment featuring a fan disabled	CS of _____	
281	Clear smoke from ductwork smoke detector sampling tube	System returns to pre-test conditions		
Emergency Air Distribution Shutoff Alarm Condition Design Control Sequence: Upon detection of activation of emergency air distribution shutoff switch, the control system shall: • Initiate audible and visual alarms at Operator workstation • Disable air handling unit • Disable relief air fan • Command exhaust air fan to inactive status • Disable associated terminal equipment featuring a fan				
282	To observe system response: • Activate emergency air distribution shutoff switch	Audible and visual alarms initiated at Operator workstation		
283		Air handling unit disabled	CS of _____	

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
284		Relief air fan disabled	CS of _____	
285		Exhaust air fan commanded to inactive status	CS of _____	
286		Associated terminal equipment featuring a fan disabled	CS of _____	
287	Deactivate emergency air distribution shutoff switch	System returns to pre-test conditions		
Pre-Heat Coil Circulating Pump Opposite Status Alarm Condition Design Control Sequence: Upon detection of receiving activation command and status being opposite command, the control system shall: • Initiate visual alarm at Operator workstation • Maintain system active status				
288	To observe system response to equipment off status:	Visual alarm initiated at Operator workstation		
289	• Enable / confirm system active status and manually set pump disconnect switch to “off” position	System active status maintained	CS of _____	
290	Release all overrides	System returns to pre-test conditions		
Supply Air Fan Opposite Status Alarm Condition Design Control Sequence: Upon detection of receiving enable command and status being opposite command, the control system shall: • Initiate audible and visual alarms at Operator workstation • Maintain system active status				
291	To observe system response to equipment off status:	Audible and visual alarms initiated at Operator workstation		
292	• Enable / confirm system active status and manually set hand-off-auto switch at adjustable frequency drive to “off” position	Equipment and system status maintained	CS of _____	
293	To observe system response to equipment on status:	Audible and visual alarms initiated at Operator workstation		

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
294	• Disable system and manually set hand-off-auto switch at adjustable frequency drive to “on” position	Equipment and system status maintained	CS of _____	
295	Release all overrides	System returns to pre-test conditions		
Relief Air Fan Opposite Status Alarm Condition Design Control Sequence: Upon detection of receiving enable command and status being opposite command, the control system shall: • Initiate visual alarm at Operator workstation • Maintain system active status				
296	To observe system response to equipment off status:	Visual alarm initiated at Operator workstation		
297	• Enable / confirm system active status and manually set hand-off-auto switch at adjustable frequency drive to “off” position	Equipment and system status maintained	CS of _____	
298	To observe system response to equipment on status:	Visual alarm initiated at Operator workstation		
299	• Disable system and manually set hand-off-auto switch at adjustable frequency drive to “on” position	Equipment and system status maintained	CS of _____	
300	Release all overrides	System returns to pre-test conditions		
Exhaust Air Fan Opposite Status Alarm Condition Design Control Sequence: Upon detection of receiving activation command and status being opposite command, the control system shall: • Initiate visual alarm at Operator workstation • Maintain system active status				
301	To observe system response to equipment off status:	Visual alarm initiated at Operator workstation		

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
302	• Enable / confirm system active status and manually set fan disconnect switch to “off” position	System active status maintained	CS of _____	
303	Release all overrides	System returns to pre-test conditions		

-- End of Test --