DEDICATED OUTSIDE AIR SYSTEM – TO AIR HANDLING UNITS

1. INTRODUCTION

This sample functional performance test (FPT) procedure is for a hypothetical dedicated outside air system serving air handling units.

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.

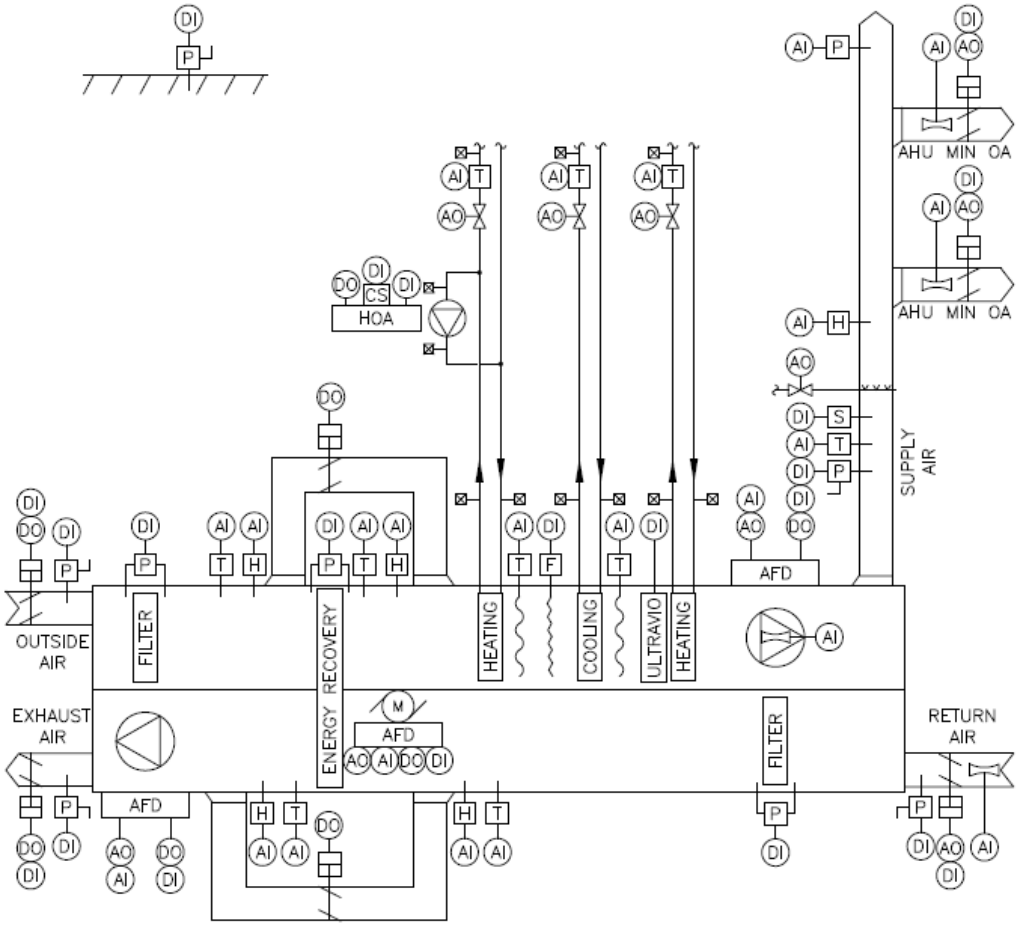

DIAGRAM SYMBOLOGY

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. This system is designed to provide outside air into the minimum outside air intakes of multiple variable-air-volume air handling units.

b. Supply air fan is selected to meet 100-percent of system requirements.

c. Exhaust air fan is selected to meet 100-percent of system requirements.

d. Pre-heat coil is selected to meet 100-percent of requirements without credit for energy recovery device.

e. Cooling coil is selected to meet 100-percent of requirements without credit for energy recovery device.

f. Reheat coil is selected to meet 100-percent of requirements.

g. Supply air fan control algorithm includes varying supply air fan speed to obtain / maintain setpoint static pressure as measured by static pressure sensor located in supply air ductwork. Setpoint static pressure set equivalent to that required to obtain supply air setpoint airflow. Initial system set-up included:
   - Commanding all associated air handling units to minimum supply air airflow
   - Commanding all associated air handling units to maximum outside air airflow
   - Progressively increasing supply air fan speed of energy recovery unit until one associated air handling unit's minimum outside air control damper was commanded to its approximate 95-percent open position and no minimum outside air control damper was commanded to greater than its 95-percent open position
   - Setting control system setpoint static pressure for supply air fan of energy recovery unit equivalent to value during this condition

h. Exhaust air fan control is accomplished by either of two Operator selectable modes of control:
   - Exhaust air fan (volumetric offset mode) [Default]
   - Exhaust air fan (facility pressure mode)

i. Exhaust air fan (volumetric offset mode) [Default] control algorithm includes speed modulation of exhaust air fan in conjunction with modulation of return air control damper to maintain return air / exhaust air airflow equivalent to outside air airflow minus a predetermined volumetric offset for facility pressurization relative to the outside.

j. Exhaust air fan (facility pressure mode) control algorithm includes speed modulation of exhaust air fan in conjunction with modulation of return air control damper to maintain facility pressure relative to the outside. The control algorithm includes exhaust air fan enable, exhaust air fan disable, and return air control damper minimum position to address conditions that prevent facility pressurization relative to the outside and to prevent no flow condition.

k. Energy recovery device control algorithm includes device activation / deactivation based on dry-bulb temperature comparisons of return air and outside air using dry-bulb temperature sensors. This approach avoids reliance on relative humidity sensors possessing poorer long-term reliability than dry-bulb temperature sensors. Effectiveness of energy recovery device is not considered for cooling or heating activation / deactivation of energy recovery device.

l. Cooling coil control algorithm includes a constant coil discharge air setpoint temperature equivalent to 55.0 °F which supports a 0.81 space sensible heat ratio for spaces at 78.0 °F dry-bulb / 58.0 °F dewpoint / 50.2-percent relative humidity. Space conditions conflict with UFC 3-410-01 – Oct 2015 page 8, section 3-4.3.1.

m. Reheat coil control algorithm includes a constant unit discharge air setpoint temperature to maintain ductwork relative humidity less than 90-percent to help prevent ductwork microbial growth and to help prevent ductwork smoke detector false alarms.

n. Pre-heat coil brine temperature, cooling coil brine temperature, and reheat 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.

o. Low limit temperature (freezestat) alarm condition includes disabling associated air handling units upon activation of algorithm to prevent low temperature air being introduced into this equipment.

p. Fire alarm condition includes disabling associated air handling units upon activation of algorithm to prevent oxygen from being introduced into this equipment and to meet requirements of life safety codes.

q. Occupied operation mode includes enabling this system. Other operation modes such as unoccupied, timed override, and pre-occupied include this system remaining disabled.

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.

Dedicated outside air unit: _____
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**	
Outside air ductwork:								
Damper position	% Open				-	-	-	
Damper position confirmation					-			
High limit static pressure					-			
Outside air section upstream of energy recovery:								
Filter differential pressure					-			
Dry-bulb temp					-	-	-	
Relative humidity					-	-	-	

CONTROL SYSTEM FEATURES								
POINT DESCRIPTION	UNIT	VISIBLE / IMBEDDED	TYPE	VALUE / STATUS	SETPT / ALARM			NOTES
					ALARM MIN	SETPT	ALARM MAX	
Outside air section energy recovery bypass:								
Damper position	% Open				-	-	-	
Energy recovery device:								
Differential pressure					-			
Status						-		
Speed					-	-	-	
Outside air section downstream of energy recovery:								
Dry-bulb temp					-	-	-	
Relative humidity					-	-	-	
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							-	
Ultraviolet light					-	-	-	
Reheat coil:								
Valve position	% Open				-	-	-	
Leaving water / brine temp						-		
Supply air fan:								
Status					-	-	-	
Speed					-	-	-	
Airflow					-	-	-	
Discharge air ductwork:								
High limit static pressure					-			
Dry-bulb temp					-			
Smoke damper position confirmation					-			
Relative humidity					-		-	
Static pressure					-			

CONTROL SYSTEM FEATURES								
POINT DESCRIPTION	UNIT	VISIBLE / IMBEDDED	TYPE	VALUE / STATUS	SETPT / ALARM			NOTES
					ALARM MIN	SETPT	ALARM MAX	
Return air ductwork:								
Airflow					-	-	-	
Damper position	% Open				-	-	-	
Damper position confirmation					-			
High limit static pressure					-			
Return air section upstream of energy recovery:								
Filter differential pressure					-			
Dry-bulb temp					-	-	-	
Relative humidity					-			
Return air section energy recovery bypass:								
Damper position	% Open				-	-	-	
Exhaust air section downstream of energy recovery:								
Dry-bulb temp					-	-	-	
Relative humidity					-	-	-	
Exhaust air fan:								
Status					-	-	-	
Speed					-	-	-	
Exhaust air ductwork:								
High limit static pressure					-			
Damper position	% Open				-	-	-	
Damper position confirmation					-			
Pre-heat coil circulating pump:								
Status						-		
Facility:								
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**
Outside air ductwork:			
High limit static pressure			
Outside air section upstream of energy recovery:			
Filter differential pressure			
Dry-bulb temp			
Relative humidity			
Energy recovery device:			
Differential pressure			
Outside air section downstream of energy recovery:			
Dry-bulb temp			
Relative humidity			
Pre-heat coil:			
Dry-bulb temp			
Low limit temp			
Leaving water / brine temp			
Cooling coil:			
Dry-bulb temp			
Leaving water / brine temp			
Reheat coil:			
Leaving water / brine temp			
Supply air fan:			
Airflow			
Discharge air ductwork:			
High limit static pressure			
Dry-bulb temp			
Relative humidity			
Static pressure			
Return air ductwork:			
Airflow	/		
High limit static pressure			

POINT-TO-POINT			
POINT DESCRIPTION	**DISPLAY (LOCAL / CONTROL SYSTEM)**	**MEASURED / OBSERVED**	**NOTES**
Return air section upstream of energy recovery:			
Filter differential pressure			
Dry-bulb temp			
Relative humidity			
Exhaust air section downstream of energy recovery:			
Dry-bulb temp			
Relative humidity			
Exhaust air ductwork:			
High limit static pressure			
Facility:			
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	
Outside air control damper						
Outside air bypass control damper						
Pre-heat coil control valve						
Cooling coil Control valve						
Reheat coil control valve						
Supply air fan speed						
Return air control damper						
Exhaust air bypass control damper						
Exhaust 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. Exhaust air fan (volumetric offset mode) [Default].
c. Exhaust air fan (facility pressure mode).
d. Energy recovery device.
e. Pre-heat coil / cooling coil / reheat coil.
f. Pre-heat coil circulating pump.
g. 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. Outside air filter high static pressure.
b. Energy recovery device high static pressure.
c. Energy recovery device effectiveness.
d. Energy recovery device general fault.
e. Energy recovery device failure.
f. Energy recovery device frost.
g. Pre-heat coil brine temperature.
h. Pre-heat coil air temperature.
i. Pre-heat coil circulating pump failure.
j. Cooling coil brine temperature.
k. Cooling coil air temperature.
l. Reheat coil brine temperature.
m. Discharge air temperature.
n. Return air relative humidity.
o. Return air filter high static pressure.
p. Outside air / return air volumetric offset.
q. Exhaust air fan general fault.
r. Exhaust air fan failure.
s. High return air ductwork static pressure.
t. High exhaust air ductwork static pressure.
u. Facility relative pressure.
v. Supply air fan general fault.
w. Supply air fan failure.
x. High outdoor air ductwork static pressure.
y. High supply air ductwork static pressure.
z. Low limit temperature (freezestat).
aa. Fire.
bb. Emergency air distribution shutoff.
cc. Energy recovery device opposite status.
dd. Pre-heat coil circulating pump opposite status.
ee. Supply air fan opposite status.
ff. 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 dedicated outside air handling unit's active status • Record observations in expected response / comments columns prior to manipulating parameters	Outside air control damper position	CS of _____	
02		Energy recovery device status	CS of _____	
03		Pre-heat coil control valve position	CS of _____	
04		Cooling coil control valve position	CS of _____	
05		Reheat coil control valve position	CS of _____	
06		Supply air fan speed	CS of _____	
07		Return air control damper position	CS of _____	
08		Exhaust air fan speed	CS of _____	
09		Exhaust air control damper position	CS of _____	
10		Pre-heat coil circulating pump status	CS of _____	
11		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 supply air fan setpoint static pressure equivalent to that determined during system set-up for supply air fan • Monitor supply air ductwork static pressure sensor • Enable and command supply air fan to its minimum allowed motor speed upon detection of this control algorithm having been activated • Command supply air fan towards its maximum allowed motor speed upon detection of actual static pressure being less than setpoint • Command supply air fan towards its minimum allowed motor speed upon detection of actual static pressure being greater than setpoint • Command supply air fan to its inactive status upon detection of this control algorithm having been deactivated				
12	To prepare for system response: • Initiate this control algorithm • Observe system status	Setpoint static pressure set	CS of _____	
13		Supply air fan commanded to its minimum allowed motor speed	CS of _____	
14	To observe system response to deficient static pressure: • Override all associated air handling units to minimum supply air airflow demand • Override all associated air handling units to maximum outside air airflow demand	Supply air fan commanded towards its maximum allowed motor speed	CS of _____	
15		Actual static pressure monitored	CS of _____	
16		Actual supply air airflow monitored	CS of _____	
17		Sum of air handling unit outside air airflows monitored	CS of _____	
18	To observe system response to excessive static pressure: • Override all associated air handling units to minimum outside air airflow demand	Supply air fan commanded towards its minimum allowed motor speed	CS of _____	
19		Actual static pressure monitored	CS of _____	
20		Actual supply air airflow monitored	CS of _____	
21		Sum of air handling unit outside air airflows monitored	CS of _____	

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

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
Exhaust Air Fan (Volumetric Offset Mode) [Default] Control Algorithm Design Control Sequence: Upon detection of this algorithm having been activated and Operator having selected “Volumetric Offset Mode”, the control system shall: • Continuously set activation / deactivation setpoint airflow equivalent to outside air actual airflow of 500 cfm • Continuously set volumetric offset control setpoint airflow equivalent to outside air actual airflow minus 450 cfm • Monitor outside air airflow measuring station • Monitor return air airflow measuring station • Maintain exhaust air control damper to its 100-percent open position and command return air control damper to its 10-percent open position upon detection of outside air actual airflow being equal to or greater than activation setpoint for a five-minute period • Command return air control damper towards its 100-percent open position upon detection of return air actual airflow being equal to or less than volumetric offset control setpoint • Maintain return air control damper in its 100-percent open position, enable exhaust air fan, and command exhaust air fan towards its maximum allowed motor speed upon detection of return air control damper having been commanded to its 100-percent open position and return air actual airflow being equal to or less than volumetric offset control setpoint • Maintain return air control damper in its 100-percent open position and command exhaust air fan towards its minimum allowed motor speed upon detection of return air actual airflow being greater than volumetric offset control setpoint • Maintain exhaust air fan at its minimum allowed motor speed and command return air control damper towards its 10-percent open position upon detection of return air actual airflow being greater than volumetric offset control setpoint • Disable exhaust air fan, command exhaust air control damper to its 0-percent open position, and command return air control damper to its 0-percent open position upon detection of outside air actual airflow being less than deactivation setpoint for a 15-minute period • Disable exhaust air fan, command exhaust air control damper to its 0-percent open position, and command return air control damper to its 0-percent open position upon detection of this control algorithm having been deactivated			
23	To prepare for system response:	Activation / deactivation setpoint set	CS of _____	

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
24	• Initiate this control algorithm • Observe system status	Volumetric offset control setpoint set	CS of _____	
25		Outside air airflow monitored	CS of _____	
26		Return air airflow monitored	CS of _____	
27	To observe system response to activation: • Initiate outside air airflow to greater than activation setpoint	Five-minute period passes without control system action		
28		Exhaust air control damper maintained in its 100-percent open position	CS of _____	
29		Return air control damper commanded to its 10-percent open position	CS of _____	
30		Exhaust air fan disabled status maintained	CS of _____	
31	To observe system response to deficient exhaust air airflow: • Override volumetric offset control setpoint to significantly greater than current setpoint	Return air control damper commanded to its 100-percent open position, then	CS of _____	
32		Exhaust air fan commanded to its maximum allowed motor speed	CS of _____	
33	To observe system response to excessive exhaust air airflow: • Override volumetric offset control setpoint to significantly less than current setpoint	Return air control damper maintained in its 100-percent open position	CS of _____	
34		Exhaust air fan commanded to its minimum allowed motor speed, then	CS of _____	
35		Exhaust air fan maintained at its minimum allowed motor speed	CS of _____	
36		Return air control damper commanded to its 10-percent open position	CS of _____	
37	To observe system response to deactivation: • Initiate outside air airflow to less than activation setpoint	Exhaust air fan disabled	CS of _____	
38		Exhaust air control damper commanded to its 0-percent open position	CS of _____	

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
39		Return air control damper commanded to its 0-percent open position	CS of _____	
40	Release all overrides	System returns to pre-test conditions		

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
Exhaust Air Fan (Facility Pressure Mode) Control Algorithm Design Control Sequence: Upon detection of this algorithm having been activated and Operator having selected “Facility Pressure Mode”, the control system shall: • Set activation / deactivation setpoint relative pressure equivalent to 0.01 INWG • Set facility relative pressure control setpoint equivalent to 0.02 INWG • Monitor facility relative pressure sensor located across facility envelope • Maintain exhaust air control damper to its 100-percent open position and command return 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 return 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 return air control damper in its 100-percent open position, enable exhaust air fan, and command exhaust air fan towards its maximum allowed motor speed upon detection of return 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 return air control damper in its 100-percent open position and command exhaust air fan towards its minimum allowed motor speed upon detection of facility actual relative pressure being less than facility relative pressure control setpoint • Maintain exhaust air fan at its minimum allowed motor speed and command return 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 exhaust air fan, command exhaust air control damper to its 0-percent open position, and command return 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 exhaust air fan, command exhaust air control damper to its 0-percent open position, and command return air control damper to its 0-percent open position upon detection of this control algorithm having been deactivated			
41	To prepare for system response: • Initiate this control algorithm • Observe system status	Activation / deactivation setpoint set	CS of _____	
42		Facility pressure control setpoint set	CS of _____	

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
43		Facility relative pressure monitored	CS of _____	
44	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		
45		Exhaust air control damper maintained in its 100-percent open position	CS of _____	
46		Return air control damper commanded to its 10-percent open position	CS of _____	
47		Exhaust air fan disabled status maintained	CS of _____	
48	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	Return air control damper commanded to its 100-percent open position, then	CS of _____	
49		Exhaust air fan commanded to its maximum allowed motor speed	CS of _____	
50	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	Return air control damper maintained in its 100-percent open position	CS of _____	
51		Exhaust air fan commanded to its minimum allowed motor speed, then	CS of _____	
52		Exhaust air fan maintained at its minimum allowed motor speed	CS of _____	
53		Return air control damper commanded to its 10-percent open position	CS of _____	
54	To observe system response to continued deficient relative pressure: • Override facility actual relative pressure to less than deactivation setpoint	Exhaust air fan disabled	CS of _____	
55		Exhaust air control damper commanded to its 0-percent open position	CS of _____	
56		Return air control damper commanded to its 0-percent open position	CS of _____	

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

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
Energy Recovery Device Control Algorithm Design Control Sequence: Upon detection of this algorithm having been activated and exhaust air fan being active, the control system shall: • Continuously set energy recovery device cooling mode activation / deactivation temperature equivalent to return air dry-bulb actual temperature • Set energy recovery device heating mode activation / deactivation temperature equivalent to pre-heat coil discharge air setpoint temperature minus 10.0 °F • Set energy recovery device control setpoint temperature equivalent to pre-heat coil setpoint temperature • Monitor outside temperature sensor located in outdoor air section immediately upstream of energy recovery device • Monitor return air dry-bulb temperature sensor located in return air section immediately upstream of energy recovery device • Monitor energy recovery device discharge temperature sensor located in supply air section immediately downstream of recovery device • Command outside air bypass damper to its 0-percent open position, command exhaust air bypass damper to its 0-percent open position, and enable energy recovery device upon detection of outside air dry-bulb temperature being equal to or greater than device cooling activation setpoint temperature for a five-minute period or being equal to or less than device heating activation setpoint temperature for a five-minute period	• Command energy recovery device towards its maximum allowed speed upon detection of device being enabled in cooling mode and device actual discharge air temperature being greater than control setpoint • Command energy recovery device towards its minimum allowed speed upon detection of device being enabled in cooling mode and device actual discharge air temperature being less than control setpoint • Command energy recovery device towards its maximum allowed speed upon detection of device being enabled in heating mode and device actual discharge air temperature being less than control setpoint • Command energy recovery device towards its minimum allowed speed upon detection of device being enabled in heating mode and device actual discharge air temperature being greater than control setpoint • Command outside air bypass damper to its 100-percent open position, command exhaust air bypass damper to its 100-percent open position, and disable energy recovery device upon detection of outside air dry-bulb temperature being less than device cooling deactivation setpoint temperature for a five-minute period and being greater than device heating deactivation setpoint temperature for a five-minute period • Command outside air bypass damper to its 0-percent open position, command exhaust air bypass damper to its 0-percent open position, and disable energy recovery device upon detection of this control algorithm having been deactivated		

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
58	To prepare for system response: • Observe system status	Energy recovery device cooling mode activation / deactivation temperature	CS of _____	
59		Energy recovery device heating mode activation / deactivation temperature	CS of _____	
60		Energy recovery device control setpoint temperature	CS of _____	
61		Outside air dry-bulb temperature monitored	CS of _____	
62		Return air dry-bulb temperature monitored	CS of _____	
63		Energy recovery device discharge air temperature monitored	CS of _____	
64		Energy recovery device status monitored	CS of _____	
65	To observe system response to deficient cooling: • Override energy recovery device cooling mode activation / deactivation setpoint temperature to significantly less than return air actual temperature • Override energy recovery device control setpoint temperature to significantly less than outdoor air actual temperature	Outside air bypass damper commanded to its 0-percent open position	CS of _____	
66		Exhaust air bypass damper commanded to its 0-percent open position	CS of _____	
67		Energy recovery device enabled	CS of _____	
68		Energy recovery device commanded towards its maximum allowed speed	CS of _____	
69	To observe system response to excessive cooling: • Override energy recovery device control setpoint temperature to significantly greater than outdoor air actual temperature	Outside air bypass damper maintained in its 0-percent open position	CS of _____	
70		Exhaust air bypass damper maintained in its 0-percent open position	CS of _____	
71		Energy recovery device commanded towards its minimum allowed speed	CS of _____	

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
72	To observe system response to deficient heating: • Override energy recovery device heating mode activation / deactivation setpoint temperature to significantly greater than return air actual temperature • Override energy recovery device control setpoint temperature to significantly greater than outdoor air actual temperature	Outside air bypass damper maintained in its 0-percent open position	CS of _____	
73		Exhaust air bypass damper maintained in its 0-percent open position	CS of _____	
74		Energy recovery device active status maintained	CS of _____	
75		Energy recovery device commanded towards its maximum allowed speed	CS of _____	
76	To observe system response to excessive heating: • Override energy recovery device control setpoint temperature to significantly less than outdoor air actual temperature	Outside air bypass damper maintained in its 0-percent open position	CS of _____	
77		Exhaust air bypass damper maintained in its 0-percent open position	CS of _____	
78		Energy recovery device active status maintained	CS of _____	
79		Energy recovery device commanded towards its minimum allowed speed	CS of _____	
80	To observe system response to no energy recovery demand: • Override energy recovery device cooling mode and heating mode activation / deactivation setpoint temperatures equivalent to return air actual temperature	Outside air bypass damper commanded to its 100-percent open position	CS of _____	
81		Exhaust air bypass damper commanded to its 100-percent open position	CS of _____	
82		Energy recovery device disabled	CS of _____	
83	To observe system response to inactive exhaust air fan: • Override exhaust air fan status to inactive	Outside air bypass damper commanded to its 100-percent open position	CS of _____	
84		Exhaust air bypass damper commanded to its 100-percent open position	CS of _____	

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
85		Energy recovery device disabled	CS of _____	
86	To observe system response to control algorithm being disabled: • Override exhaust air fan status to active and wait for energy recovery device to become active, then • Deactivate this control algorithm	Outside air bypass damper commanded to its 0-percent open position	CS of _____	
87		Exhaust air bypass damper commanded to its 0-percent open position	CS of _____	
88		Energy recovery device status maintained disabled	CS of _____	
89	Release all overrides	System returns to pre-test conditions		

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
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		
Reheat Coil Control Algorithm Design Control Sequence: Upon detection of this algorithm having been activated, the control system shall: • Set unit discharge setpoint temperature equivalent to cooling coil discharge air setpoint temperature plus 5.0 °F • Monitor temperature sensor located in supply air ductwork		• Command control valve towards its 100-percent open position upon detection of discharge air temperature being less than setpoint • Command control valve towards its 0-percent open position upon detection of discharge air temperature being greater than setpoint		
90	To prepare for system response: • Observe system status	Pre-heat coil discharge setpoint temperature	CS of _____	
91		Cooling coil discharge setpoint temperature	CS of _____	
92		Reheat coil discharge setpoint temperature	CS of _____	

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
93	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 _____	
94		Cooling coil discharge setpoint temperature set	CS of _____	
95		Reheat coil discharge setpoint temperature set	CS of _____	
96		Pre-heat coil control valve commanded towards its 100-percent open position	CS of _____	
97		Cooling coil control valve commanded towards its 0-percent open position	CS of _____	
98		Reheat coil control valve commanded towards its 100-percent open position	CS of _____	
99	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 _____	
100		Cooling coil discharge setpoint temperature set	CS of _____	
101		Reheat coil discharge setpoint temperature set	CS of _____	
102		Pre-heat coil control valve commanded towards its 0-percent open position	CS of _____	
103		Cooling coil control valve commanded towards its 100-percent open position	CS of _____	
104		Reheat coil control valve commanded towards its 0-percent open position	CS of _____	
105	Release all overrides	System returns to pre-test conditions		

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				
106	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		
107		Pre-heat coil circulating pump commanded to active status	CS of _____	
108	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 _____	
109	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 section immediately upstream of energy recovery device • 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				
110	To observe system response to being enabled: • Override humidifier enable setpoint to significantly less than return air actual relative humidity	Humidifier enabled	CS of _____	
111	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 _____	
112	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**
113	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 _____	
114	To prepare to observe system response to being disabled: • Release humidifier high-limit setpoint override	Humidifier enabled	CS of _____	
115	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 _____	
116	Release all overrides	System returns to pre-test conditions		
Unoccupied Operation Mode Design Control Sequence: Upon detection of unoccupied time having occurred, the control system shall: • Deactivate supply air fan control algorithm • Deactivate exhaust air fan control algorithm • Deactivate energy recovery device control algorithm • Command outside air control damper to its 0-percent open position • Command exhaust air control damper to its 0-percent open position • Deactivate pre-heat coil control algorithm • Deactivate cooling coil control algorithm • Deactivate reheat coil control algorithm • Deactivate pre-heat coil circulating pump control algorithm • Deactivate humidifier control algorithm				
117	To observe system response:	Supply air fan control algorithm deactivated	CS of _____	

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
118	• Override scheduled unoccupied time to be slightly after actual time	Exhaust air fan control algorithm deactivated	CS of _____	
119		Energy recovery device control algorithm deactivated	CS of _____	
120		Outside air control damper commanded to its 0-percent open position	CS of _____	
121		Exhaust air control damper commanded to its 0-percent open position	CS of _____	
122		Pre-heat coil control algorithm deactivated	CS of _____	
123		Cooling coil control algorithm deactivated	CS of _____	
124		Reheat coil control algorithm deactivated	CS of _____	
125		Pre-heat coil circulating pump control algorithm deactivated	CS of _____	
126		Humidifier control algorithm deactivated	CS of _____	
127	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 associated with any air handling unit having been activated, the control system shall: • Maintain supply air fan control algorithm inactive status • Maintain exhaust air fan control algorithm inactive status • Maintain energy recovery device control algorithm inactive status • Maintain outside air control damper in its 0-percent open position • Maintain exhaust air control damper in its 0-percent open position • Maintain pre-heat coil control algorithm inactive status • Maintain cooling coil control algorithm inactive status • Maintain reheat coil control algorithm inactive status • Maintain pre-heat coil circulating pump control algorithm • Maintain humidifier control algorithm inactive status				
128	To observe system response: • Activate one timed override switch to active	Supply air fan control algorithm maintained inactive	CS of _____	
129		Exhaust air fan control algorithm maintained inactive	CS of _____	
130		Energy recovery device control algorithm maintained inactive	CS of _____	
131		Outside air control damper maintained in its 0-percent open position	CS of _____	
132		Exhaust air control damper maintained in its 0-percent open position	CS of _____	
133		Pre-heat coil control algorithm maintained inactive	CS of _____	
134		Cooling coil control algorithm maintained inactive	CS of _____	
135		Reheat coil control algorithm maintained inactive	CS of _____	
136		Pre-heat coil circulating pump control algorithm maintained inactive	CS of _____	
137		Humidifier control algorithm maintained inactive	CS of _____	

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
138	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:

- Maintain supply air fan control algorithm inactive status
- Maintain exhaust air fan control algorithm inactive status
- Maintain energy recovery device control algorithm inactive status
- Maintain outside air control damper in its 0-percent open position
- Maintain exhaust air control damper in its 0-percent open position
- Maintain pre-heat coil control algorithm inactive status
- Maintain cooling coil control algorithm inactive status
- Maintain reheat coil control algorithm inactive status
- Maintain pre-heat coil circulating pump control algorithm
- Maintain humidifier control algorithm inactive status

139	To observe system response: • Override learned system start-up time to slightly after actual time • Wait for overridden system start-up time to occur	Supply air fan control algorithm maintained inactive	CS of _____	
140		Exhaust air fan control algorithm maintained inactive	CS of _____	
141		Energy recovery device control algorithm maintained inactive	CS of _____	
142		Outside air control damper maintained in its 0-percent open position	CS of _____	
143		Exhaust air control damper maintained in its 0-percent open position	CS of _____	
144		Pre-heat coil control algorithm maintained inactive	CS of _____	
145		Cooling coil control algorithm maintained inactive	CS of _____	
146		Reheat coil control algorithm maintained inactive	CS of _____	
147		Pre-heat coil circulating pump control algorithm maintained inactive	CS of _____	

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
148		Humidifier control algorithm maintained inactive	CS of _____	
Occupied Operation Mode Design Control Sequence: Upon detection of completion of pre-occupied operation mode, the control system shall: • Command outside air control damper to its 100-percent open position • Confirm outside air control damper in its 100-percent open position • Command exhaust air control damper to its 100-percent open position • Confirm exhaust air control damper in its 100-percent open position • Command return air control damper to its 10-percent open position • Confirm return air control damper in its 10-percent open position • Activate supply air fan control algorithm • Activate exhaust air fan control algorithm • Activate energy recovery device control algorithm • Activate pre-heat coil control algorithm • Activate cooling coil control algorithm • Activate reheat coil control algorithm • Activate pre-heat coil circulating pump control algorithm • Activate humidifier control algorithm				
149	To observe system response: • Override scheduled unoccupied time to be slightly after actual time	Outside air control damper commanded to its 100-percent open position	CS of _____	
150		Outside air control damper confirmed in its 100-percent open position	CS of _____	
151		Exhaust air control damper commanded to its 100-percent open position	CS of _____	
152		Exhaust air control damper confirmed in its 100-percent open position	CS of _____	
153		Return air control damper commanded to its 10-percent open position	CS of _____	
154		Return air control damper confirmed in its 10-percent open position	CS of _____	
155		Supply air fan control algorithm deactivated	CS of _____	

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
156		Exhaust air fan control algorithm activated	CS of _____	
157		Energy recovery device control algorithm activated	CS of _____	
158		Pre-heat coil control algorithm activated	CS of _____	
159		Cooling coil control algorithm activated	CS of _____	
160		Reheat coil control algorithm activated	CS of _____	
161		Pre-heat coil circulating pump control algorithm activated	CS of _____	
162		Humidifier control algorithm activated	CS of _____	
163	Release all overrides	System returns to pre-test conditions		
Outside Air Filter High Static Pressure Alarm Condition Design Control Sequence: Upon detection of receiving enable command and outside air 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				
164	To observe system response: • Force air pressure on high pressure side of differential pressure switch sampling tube	Visual alarm initiated at Operator workstation		
165		System active status maintained	CS of _____	
166	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**
Energy Recovery Device High Static Pressure Alarm Condition Design Control Sequence: Upon detection of receiving enable command, the control system shall: • Set energy recovery device high setpoint static pressure equivalent to 1.5 INWG • Set outside air high static alarm setpoint temperature equivalent to 35.0 °F • Monitor differential pressure sensor located across energy recovery device • Monitor outside temperature sensor located in outdoor air section immediately upstream of energy recovery device • Initiate audible alarm at Operator workstation upon detection of energy recovery device actual static pressure being equal to or greater than alarm setpoint for a five-minute period and actual outside air temperature being equal to or greater than high static alarm setpoint temperature for a five-minute period • Maintain system active status				
167	To observe system response: • Force air pressure on high pressure side of differential pressure switch sampling tube	Visual alarm initiated at Operator workstation		
168		System active status maintained	CS of _____	
169	Release air pressure and return sampling tube to its original position	System returns to pre-test conditions		
Energy Recovery Device Effectiveness Alarm Condition Design Control Sequence: Upon detection of receiving enable command, the control system shall: • Monitor return air upstream dry-bulb temperature sensor located immediately upstream of energy recovery device • Monitor outdoor air upstream dry-bulb temperature sensor located immediately upstream of energy recovery device • Monitor outdoor air downstream dry-bulb temperature sensor located immediately downstream of energy recovery device • Initiate visual alarm at Operator workstation upon detection of: – Energy recovery device commanded to maximum allowed motor speed – Outside air upstream actual temperature being equal to or greater than return air upstream actual temperature plus 10.0 °F – Outdoor air downstream temperature being equal to or greater than outdoor air upstream temperature minus 7.0 °F • Maintain system active status				
170	To prepare for system response: • Observe system status	Return air upstream dry-bulb temperature monitored	CS of _____	
171		Outdoor air upstream dry-bulb temperature monitored	CS of _____	

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
172		Outdoor air downstream dry-bulb temperature monitored	CS of _____	
173	To observe system response to deficient efficiency: • Confirm / override outside air / return air upstream temperature difference to significantly greater than 10.0 °F • Override outdoor air downstream temperature to slightly greater than outdoor air upstream temperature minus 7.0 °F	Visual alarm initiated at Operator workstation		
174		System active status maintained	CS of _____	
175	Release all overrides	System returns to pre-test conditions		
Energy Recovery Device General Fault Alarm Condition Design Control Sequence: Upon detection of receiving enable command and energy recovery device general fault alarm, the control system shall: • Initiate visual alarm at Operator workstation • Maintain system active status				
176	To observe system response: • Initiate general fault at adjustable frequency drive	Visual alarm initiated at Operator workstation		
177		System active status maintained	CS of _____	
178	Release all overrides	System returns to pre-test conditions		
Energy Recovery Device Failure Alarm Condition Design Control Sequence: Upon detection of receiving enable command and energy recovery device failure alarm status, the control system shall: • Initiate visual alarm at Operator workstation • Maintain system active status				
179	To observe system response: • Initiate failure condition at adjustable frequency drive	Visual alarm initiated at Operator workstation		
180		System active status maintained	CS of _____	

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

Energy Recovery Device Frost Alarm Condition

Design Control Sequence:

Upon detection of receiving enable command, the control system shall:

- Set energy recovery device frost alarm setpoint static pressure equivalent to 2.0 INWG
- Set outside air frost alarm setpoint temperature equivalent to 5.0 °F
- Monitor differential pressure sensor located across energy recovery device
- Monitor outside temperature sensor located in outdoor air section immediately upstream of energy recovery device
- Initiate visual alarm at Operator workstation and activate system alarm response upon detection of energy recovery device actual static pressure being equal to or greater than alarm setpoint for a five-minute period and actual outside air temperature being less than frost alarm setpoint temperature for a five-minute period
- Maintain system active status and command energy recovery device to its minimum allowed speed upon detection of system alarm response being activated
- Initiate audible alarm and maintain visual alarm at Operator workstation and maintain system alarm response upon detection of energy recovery device actual static pressure being equal to or greater than alarm setpoint for a 120-minute period and actual outside air temperature being less than frost alarm setpoint temperature for a 120-minute period
- Cancel audible and visual alarms at Operator workstation and deactivate system alarm response upon detection of energy recovery device actual static pressure being less than alarm setpoint for a five-minute period or actual outside air temperature being equal to or greater than frost alarm setpoint temperature for a 120-minute period

182	To prepare for system response: • Maintain audible alarm period • Override audible and visual alarms period to audible alarm period plus one-minute	Audible and visual alarms period setpoint set	CS of _____	
183	To observe system response: • Override energy recovery device frost alarm setpoint static pressure to significantly less than actual static	One-minute period passes without control system action		
184		Visual alarm initiated at Operator workstation		
185		System active status maintained	CS of _____	

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
186	pressure • Override outside air frost alarm setpoint temperature to significantly greater than actual outdoor air temperature	Energy recovery device commanded to its minimum allowed speed	CS of _____	
187		One-minute period passes without control system action		
188		Visual alarm maintained at Operator workstation		
189		Audible alarm initiated at Operator workstation		
190	To observe system response to increased outside air temperature: • Override audible and visual alarms cancellation period to two-minutes • Override outside air frost alarm setpoint temperature to significantly less than actual outdoor air temperature	Two-minute period passes without control system action		
191		Audible and visual alarms cancelled at Operator workstation		
192	Release all overrides	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				
193	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		
194		Visual alarm initiated at Operator workstation		
195		System active status maintained	CS of _____	

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
196	Release all overrides	System returns to pre-test conditions		
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				
197	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		
198		Visual alarm initiated at Operator workstation		
199		System active status maintained	CS of _____	
200	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		
201		Visual alarm initiated at Operator workstation		
202		System active status maintained	CS of _____	
203	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				
204	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		
205		Pre-heat coil circulating pump commanded to inactive status	CS of _____	
206		System active status maintained	CS of _____	
207	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				
208	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		
209		Visual alarm initiated at Operator workstation		
210		System active status maintained	CS of _____	
211	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 5.0 °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				
212	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		
213		Visual alarm initiated at Operator workstation		
214		System active status maintained	CS of _____	
215	Release all overrides	System returns to pre-test conditions		
Reheat Coil Brine Temperature Alarm Condition Design Control Sequence: Upon detection of receiving enable command, the control system shall: • Set reheat 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				
216	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		
217		Visual alarm initiated at Operator workstation		
218		System active status maintained	CS of _____	
219	Release all overrides	System returns to pre-test conditions		

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
Discharge Air Temperature Alarm Condition Design Control Sequence: Upon detection of receiving enable command, the control system shall: • Set discharge high limit alarm setpoint temperature equivalent to discharge air setpoint temperature plus 15.0 °F • Monitor temperature sensor located in supply air ductwork • 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				
220	To observe system response to deficient heating: • Override high limit alarm setpoint temperature to significantly less than actual temperature	Five-minute period passes without control system action		
221		Visual alarm initiated at Operator workstation		
222		System active status maintained	CS of _____	
223	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		
224		Visual alarm initiated at Operator workstation		
225		System active status maintained	CS of _____	
226	Release all overrides	System returns to pre-test conditions		
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				
227	To observe system response to excessive heating: • Override high limit alarm setpoint temperature to	Five-minute period passes without control system action		
228		Visual alarm initiated at Operator workstation		

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
229	significantly less than actual temperature	System active status maintained	CS of _____	
230	Release all overrides	System returns to pre-test conditions		
Return Air Filter High Static Pressure Alarm Condition Design Control Sequence: Upon detection of receiving enable command and return air 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				
231	To observe system response: • Force air pressure on high pressure side of differential pressure switch sampling tube	Visual alarm initiated at Operator workstation		
232		System active status maintained	CS of _____	
233	Release air pressure and return sampling tube to its original position	System returns to pre-test conditions		
Return Air / Outside Air Volumetric Offset Alarm Condition Design Control Sequence: Upon detection of receiving enable command and volumetric offset mode having been activated, the control system shall: • Initiate visual alarm at Operator workstation upon detection of difference between return air and outside air airflows being equal to or greater than volumetric control setpoint for a five-minute period • Maintain system active status				
234	To observe system response: • Override return air control damper to maintain current position and exhaust air fan to constant speed • Override volumetric control setpoint to greater than current offset	Five-minute period passes without control system action		
235		Visual alarm initiated at Operator workstation		
236		System active status maintained	CS of _____	

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
237	Release all overrides	System returns to pre-test conditions		
Exhaust Air Fan General Fault Alarm Condition Design Control Sequence: Upon detection of receiving enable command and exhaust air fan general fault alarm, the control system shall: • Initiate visual alarm at Operator workstation • Maintain system active status				
238	To observe system response: • Initiate general fault at adjustable frequency drive	Visual alarm initiated at Operator workstation		
239		System active status maintained	CS of _____	
240	Release all overrides	System returns to pre-test conditions		
Exhaust Air Fan Failure Alarm Condition Design Control Sequence: Upon detection of receiving enable command and exhaust air failure alarm status, the control system shall: • Initiate visual alarm at Operator workstation • Disable exhaust air fan • Maintain system active status				
241	To observe system response: • Initiate failure condition at adjustable frequency drive	Visual alarm initiated at Operator workstation		
242		Exhaust air fan disabled	CS of _____	
243		System active status maintained	CS of _____	
244	Release all overrides	System returns to pre-test conditions		
High Return 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 exhaust air fan • Maintain system active status				
245	To observe system response:	Audible and visual alarms initiated at Operator workstation		

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
246	• Override alarm setpoint static pressure to slightly less than actual pressure	Exhaust air fan disabled	CS of _____	
247		System active status maintained	CS of _____	
248	Release all overrides	System returns to pre-test conditions		
High Exhaust 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 exhaust air fan • Maintain system active status				
249	To observe system response: • Override alarm setpoint static pressure to slightly less than actual pressure	Audible and visual alarms initiated at Operator workstation		
250		Exhaust air fan disabled	CS of _____	
251		System active status maintained	CS of _____	
252	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				
253	To observe system response: • Override high alarm setpoint to slightly less than actual facility actual pressure	Five-minute period passes without control system action		
254		Visual alarm initiated at Operator workstation		
255		System active status maintained	CS of _____	

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
256	To observe system response: • Override low alarm setpoint to slightly greater than actual facility actual pressure	Five-minute period passes without control system action		
257		Visual alarm initiated at Operator workstation		
258		System active status maintained	CS of _____	
259	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				
260	To observe system response: • Initiate general fault at adjustable frequency drive	Visual alarm initiated at Operator workstation		
261		System active status maintained	CS of _____	
262	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				
263	To observe system response: • Initiate failure condition at adjustable frequency drive	Audible and visual alarms initiated at Operator workstation		
264		System disabled	CS of _____	
265	Release all overrides	System returns to pre-test conditions		

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
High Outside 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 system				
266	To observe system response: • Override alarm setpoint static pressure to slightly less than actual pressure	Audible and visual alarms initiated at Operator workstation		
267		System disabled	CS of _____	
268	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				
269	To observe system response: • Override alarm setpoint static pressure to slightly less than actual pressure	Audible and visual alarms initiated at Operator workstation		
270		System disabled	CS of _____	
271	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 dedicated outside air system • Command pre-heat coil control valve to its 100-percent open position • Command cooling coil control valve to its 100-percent open position • Command reheat coil control valve to its 100-percent open position • Activate pre-heat coil circulating pump control algorithm • Disable associated air handling units				
272	To observe system response: • Manually place sensing element of low limit temperature sensor in ice water	Audible and visual alarms initiated at Operator workstation		
273		Dedicated outside air system disabled	CS of _____	
274		Pre-heat coil control valve commanded to its 100-percent open position	CS of _____	
275		Cooling coil control valve commanded to its 100-percent open position	CS of _____	
276		Reheat coil control valve commanded to its 100-percent open position	CS of _____	
277		Pre-heat coil circulating pump control algorithm activated	CS of _____	
278		Associated air handling units disabled	CS of _____	
279	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 associated air handling units • Disable dedicated outside air system				
280	To observe system response: • Manually force artificial smoke through ductwork smoke detector sampling tube	Audible and visual alarms initiated at Operator workstation		
281		Dedicated outside air system disabled	CS of _____	
282		Associated air handling units disabled	CS of _____	
283	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 dedicated outside air system				
284	To observe system response: • Activate emergency air distribution shutoff switch	Audible and visual alarms initiated at Operator workstation		
285		Dedicated outside air system disabled	CS of _____	
286	Deactivate emergency air distribution shutoff switch	System returns to pre-test conditions		
Energy Recovery Device 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				
287	To observe system response to equipment off status:	Visual alarm initiated at Operator workstation		

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
288	• 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 _____	
289	To observe system response to equipment on status:	Visual alarm initiated at Operator workstation		
290	• Disable system and manually set hand-off-auto switch at adjustable frequency drive to “on” position	Equipment and system status maintained	CS of _____	
291	Release all overrides	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				
292	To observe system response to equipment off status:	Visual alarm initiated at Operator workstation		
293	• Enable / confirm system active status and manually set pump disconnect switch to “off” position	System active status maintained	CS of _____	
294	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				
295	To observe system response to equipment off status:	Audible and visual alarms initiated at Operator workstation		

SYSTEM OPERATION				
STEP	**TEST METHOD**	**EXPECTED RESPONSE**	**COMMENTS**	**PASS/ FAIL**
296	• 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 _____	
297	To observe system response to equipment on status:	Audible and visual alarms initiated at Operator workstation		
298	• Disable system and manually set hand-off-auto switch at adjustable frequency drive to “on” position	Equipment and system status maintained	CS of _____	
299	Release all overrides	System returns to pre-test conditions		
Exhaust 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				
300	To observe system response to equipment off status:	Visual alarm initiated at Operator workstation		
301	• 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 _____	
302	To observe system response to equipment on status:	Visual alarm initiated at Operator workstation		
303	• Disable system and manually set hand-off-auto switch at adjustable frequency drive to “on” position	Equipment and system status maintained	CS of _____	
304	Release all overrides	System returns to pre-test conditions		

-- End of Test --