



Request for Information 710

ARE 1150 Eastlake Core & Shell
1150 Eastlake Ave E,
Seattle, WA 98109

DPR Construction, A General Partnership
Project #: D7-A18012-00
Tel: Fax:

Date Created: 10/18/2023 Date Required: 10/25/2023 Date Answered: 10/30/2023 Days Open: 8

To Company	To Contact	Author Company	Authored By
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Co-Author	Agency Review Required	Co-Author RFI Number
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Subject	Discipline	Source	Reason
Revised Sequence of Operations			

Question
Please see attached update to sequence of operations and confirm this is acceptable. Updates are in Red and clouded.

Suggestion	Location / Building
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Potential Cost Impact	Potential Amount	Potential Schedule Impact	Working Days
Potentially		Potentially	

Answer
CONFIRMED
- GENSLER - MY - 2023-10-30

Answered By: 1150 Eastlake CA Ad

REQUEST FOR INFORMATION

Project Name: 1150 EastlakeProject Number: 2689PSF RFI No.: 051

To: Sri Sundaram
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Phone: (206) 300-5325Phone: (206) 437-6288Email: Srisu@dpr.comEmail: dkennedy@psfmech.com**SUBJECT:** Revised Sequence of Operations

Drawing Ref.: _____

Location: _____

Potential Schedule Impact: ☐ Yes ☒ NoDate: 09/15/2023Potential Cost Impact: ☐ Yes ☒ No

Response Required By: _____

DESCRIPTION

Please see attached update to sequence of operations and confirm this is acceptable.

Updates are in Red and clouded.

REQUEST

BUILDING AUTOMATION AND CONTROL SYSTEMS (BACS)

SEQUENCE OF OPERATIONS

1. PREFACE

THIS SEQUENCE OF OPERATION IS WRITTEN FOR CONTROLLING THE HEATING VENTILATING AND AIR CONDITIONING (HVAC) SYSTEMS WITHIN THE BUILDING AT 1150 EASTLAKE

A. DEFINITIONS

1. BUILDING AUTOMATION AND CONTROL SYSTEM (BACS): CONTROL SYSTEM INCLUDES HARDWARE COMPONENTS, SOFTWARE COMPONENTS, PNEUMATIC TUBING, WIRE, CABLE, RACEWAY, ENCLOSURES AND OTHER PRODUCT REQUIRED TO AUTOMATE AND MONITOR THE OPERATION OF THE HEATING, VENTILATING AND AIR-CONDITIONING (HVAC) SYSTEMS AND OTHER PROCESSES IN THE BUILDING.
2. OPERATOR: THE OPERATOR MAY BE THE BUILDING OWNER AND/OR HIS/HER AGENTS/EMPLOYEES, THE MECHANICAL ENGINEER/CONSULTANT INCLUDING ITS DESIGN PROFESSIONALS.
3. FRONT END: FRONT END IS GENERALLY USED TO DESCRIBE THE ON-SITE SERVER AND REMOTE OPERATOR WORKSTATIONS THAT ALLOW THE OPERATOR TO VIEW AND COMMAND THE CONTROL SYSTEM THROUGH A GRAPHICAL INTERFACE.
4. ADJUSTABLE: THROUGHOUT THIS SEQUENCE OF OPERATION, "ADJUSTABLE" DESIGNATES THAT THERE ARE DATA ENTRY BOXES AND CHECK BOXES ON FRONT END DISPLAYS OF THE CONTROL SYSTEM THAT ALLOW THE OPERATOR THE MEANS TO INTERACTIVELY CHANGE SETPOINTS AND MAKE SELECTIONS THAT INFLUENCE THE OPERATION OF THE CONTROL SYSTEM.
5. FIELD-ADJUSTABLE: THROUGHOUT THIS SEQUENCE OF OPERATION, "FIELD-ADJUSTABLE" DESIGNATES THAT THERE ARE FIELD CONTROL DEVICES, INCLUDING KEYPADS AT THE VFD'S, KEYPADS TO THE FACTORY CONTROLLERS, LINE-VOLTAGE THERMOSTATS, AND OTHER MANUAL SWITCHES, THAT ALLOW THE OPERATOR THE MEANS TO INTERACTIVELY CHANGE SETPOINTS AND MAKE SELECTIONS THAT INFLUENCE THE OPERATION OF THE EQUIPMENT CONTROLS.

B. SYSTEMS CONTROLLED

1. THE CONTROL SYSTEM SHALL EXECUTE CONTROL FUNCTIONS OVER THE FOLLOWING SYSTEMS:
2. PREFACE
3. SUPPLY AIR-HANDLING UNITS (SAHU, TAGGED: 1150-LXX-SAHU-01)
4. EXHAUST AIR-HANDLING UNITS (EAHU, TAGGED: 11150-LXX-EAHU-01)
5. GARAGE EXHAUST FANS (GEF, TAGGED: 1150-LXX-GEF-XX)
6. GARAGE SUPPLY FAN (GSF, TAGGED: 1150-P4-GEF-01)
7. AIR-COOLED HEAT RECOVERY CHILLER (HRCH, TAGGED: 1150-L12-HRCH-XX)
8. HEATING WATER SYSTEM
9. CHILLED WATER SYSTEM
10. FOUR-PIPE CHILLED/HOT WATER FAN COIL UNITS (FCU, TAGGED:

1150-LXX-FCU-XX)

11. SUPPLY VARIABLE AIR VOLUME UNIT WITH HYDRONIC REHEAT (SV, TAGGED: 1150-LXX-SV-XX)
12. EXHAUST VARIABLE AIR VOLUME UNIT (EV, TAGGED: 1150-LXX-EV-XX)
13. TRANSFER FANS (TF, TAGGED: 1150-LXX-TF-XX)
14. ROOF MECHANICAL ROOM EXHAUST FAN (1150-L12-EF-02)
15. ROOF ELECTRICAL ROOM TRANSFER FAN (1150-L12-TF-02)
16. PENTHOUSE RESTROOM EXHAUST FAN (1150-L12-EF-01)
17. P1 LOCKER/RESTROOM EXHAUST FAN (1150-P1-EF-01)
18. TRANSFER FAN (1150-P4-TF-01, 1150-P3-TF-P3-02)
19. ROOF AMENITY DEDICATED OUTSIDE AIR SUPPLY UNIT (1150-L12-DOAS-01)
20. AUTOCLAVE AND GLASS-WASH (1150-L1-SV-04, 1150-L1-SV-05,1150-L1-EV-02)
21. AIR COMPRESSOR ROOM TRANSFER FAN (1150-P3-TF-03)
22. NEUTRALIZER ROOM EXHAUST FAN (1150-P1-EF-0

C. OTHER POINTS MONITORED

1. FIRE ALARM STATUS.
2. GLYCOL PUMP LIQUID LEVEL.
3. ELEVATOR CONTROL ROOM TEMPERATURES.
4. FIRE COMMAND CENTER TEMPERATURE.
5. SECURITY OFFICE TEMPERATURE.
6. TEMPERATURE OF ZONES SERVED BY HVAC SYSTEMS WITH STAND-ALONE THERMOSTAT CONTROLS.

2. A SUPPLY AIR-HANDLING UNIT (SAHU, TAGGED: 1150-LXX-SAHU-01)

SUPPLY AIR, USING 100% OUTSIDE AIR, IS DISTRIBUTED TO THE BUILDING WITH VARIABLE-SPEED DRIVEN, TWIN SUPPLY FANS. THE SUPPLY AIR IS CONDITIONED USING CHILLED WATER-COOLING COILS, AND HOT WATER HEATING COILS. THERE IS NOT AN ADDITIONAL HEAT RECOVERY COIL PROVIDED WITH THE SAHU. INSTEAD, THE SAHU HEATING COILS ARE CONNECTED TO A HEATING WATER DISTRIBUTION SYSTEM WHICH IS CONNECTED TO AND RECOVERS HEAT FROM THE HEAT RECOVERY CHILLERS. THE HEAT RECOVERY CHILLERS SOURCE THEIR HEAT RECOVERY FROM THE BUILDING COOLING LOADS (WHICH ARE TRANSFERRED TO THE CHILLED WATER), EXHAUST AIR-HANDLING UNIT HEAT RECOVERY COILS (WHICH TRANSFERS HEAT FROM THE EXHAUST AIR TO THE CHILLED WATER), AND COMPRESSOR HEAT FROM THE CHILLER RERIGERATION SYSTEMS.

A. SAHU OFF CONDITIONS.

1. SAHU OPERATES 24 HOURS PER DAY, 365 DAYS PER YEAR. UNIT WILL ONLY SHUT DOWN,
 - a. DURING SCHEDULED MAINTENANCE.
 - b. WHILE ITS ASSOCIATED EAHU IS SHUT DOWN OR BOTH SUPPLY OR BOTH EXHAUST FANS HAVE FAILED OR EITHER OSADs FAIL.
 - c. WHEN SAFETY LIMITS ARE EXCEEDED.
 - 1) HIGH DUCT STATIC PRESSURE CUT-OUT SWITCH (DOWNSTREAM OF THE SUPPLY FANS).
 - 2) LOW DUCT STATIC PRESSURE CUT-OUT SWITCH (UPSTREAM OF THE SUPPLY FANS).

- 3) FIRE ALARM PANEL SIGNAL.
 - a) GENERATE AN ALARM AND INITIATE THE SHUTDOWN MODE UPON RECEIVING A SIGNAL FROM THE FIRE ALARM PANEL.
- 4) LOW LIMIT TRIP AT 32°F.

2. WHEN SAHU IS SHUT DOWN,
 - a. BOTH SUPPLY FAN VFDS ARE DISABLED AND THE SUPPLY FANS ARE STOPPED.
 - b. OUTSIDE AIR INTAKE DAMPERS ARE CLOSED.
 - c. SUPPLY FAN (GRAVITY) BACKDRAFT DAMPERS ARE CLOSED.
 - d. CHILLED WATER COIL CONTROL VALVE IS CLOSED.
 - e. HOT WATER COIL CONTROL VALVE IS CLOSED.

B. SAHU START-UP SEQUENCE

1. SAHU IS COMMANDED TO RUN IN THE OPERATING MODE FOLLOWING A DELAY (ADJUSTABLE PER AHU) TO PREVENT ALL BUILDING AHUS FROM STARTING AT THE SAME TIME. SAHU & EAHU PAIRS TO START AT THE SAME TIME.
 - a. ASSOCIATED EAHU IS COMMANDED TO RUN IN THE OPERATING MODE.
2. OUTSIDE AIR INTAKE DAMPERS ARE COMMANDED OPEN AND THEIR OPEN STATUS IS PROVEN.
3. SUPPLY FAN VFDS ARE ENABLED AT A MINIMUM SPEED AND RUN STATUS IS PROVEN.
4. SUPPLY FANS OPERATE AT THE SAME SPEED AND MODULATE TO MAINTAIN THE DUCT STATIC PRESSURE SETPOINT.
5. CHILLED WATER COIL CONTROL VALVE MODULATES TO MAINTAIN THE DISCHARGE AIR TEMPERATURE COOLING SETPOINT.
6. HOT WATER COIL CONTROL VALVE MODULATES AS REQUIRED TO TEMPER THE OUTSIDE AIR UP THE DISCHARGE AIR TEMPERATURE COOLING SETPOINT.

C. SAHU SHUT-DOWN SEQUENCE

1. SAHU IS COMMANDED TO STOP
 - a. ASSOCIATED EAHU IS COMMANDED OFF
2. CHILLED WATER COIL CONTROL VALVE CLOSES (EVEN IN THE CASE OF A POWER OUTAGE)
3. HOT WATER COIL CONTROL VALVE CLOSES (EVEN IN THE CASE OF A POWER OUTAGE)
4. SUPPLY FAN VFDS ARE RUN STATUS OFF
5. OUTSIDE AIR INTAKE DAMPERS ARE COMMANDED CLOSED AND THEIR STATUS IS PROVEN CLOSED.

D. OPERATING MODE

1. DISCHARGE AIR TEMPERATURE RESET
 - a. A CONDITION FOR DECREMENTING THE DISCHARGE AIR TEMPERATURE COOLING SETPOINT SHALL HAVE PRIORITY OVER A CONDITION FOR INCREMENTING THE DISCHARGE AIR TEMPERATURE SETPOINT.
 - b. THE MAXIMUM DISCHARGE AIR TEMPERATURE COOLING SETPOINT SHALL BE 65 DEG. F. (ADJUSTABLE).
 - c. THE MINIMUM DISCHARGE AIR TEMPERATURE COOLING SETPOINT SHALL BE 55 DEG. F. (ADJUSTABLE).
 - d. THE SAHU WILL START WITH A DISCHARGE AIR TEMPERATURE COOLING SETPOINT RESET TO 55 DEG. F. (ADJUSTABLE).
 - e. THE DISCHARGE AIR TEMPERATURE COOLING SETPOINT WILL

RESET AS FOLLOWS:

- 1) THE COOLING SIGNAL FROM ALL SELECTED SUPPLY TERMINAL UNITS (SV) WILL BE READ BY THE GLOBAL CONTROLLER.
 - a) FOR EACH SV ZONE, THE OPERATOR SHALL BE GIVEN THE ABILITY TO DE-SELECT CERTAIN ZONES FROM CAUSING THE DISCHARGE AIR TEMPERATURE COOLING SETPOINT TO RESET.
- 2) DISCHARGE AIR TEMPERATURE COOLING SETPOINT DECREMENT.
 - a) A DECREMENT CONDITION WILL BE QUALIFIED EVERY 10 MINUTES (ADJUSTABLE).
 - b) IF THE COOLING SIGNAL OF 1 (ADJUSTABLE) OR MORE SUPPLY TERMINAL UNITS RISES ABOVE 90% (ADJUSTABLE), THEN DECREMENT THE DISCHARGE AIR TEMPERATURE COOLING SETPOINT BY AN AMOUNT OF 1 DEG. F. (ADJUSTABLE).
- 3) DISCHARGE AIR TEMPERATURE COOLING SETPOINT INCREMENT.
 - a) AN INCREMENT CONDITION WILL BE QUALIFIED EVERY 10 MINUTES (ADJUSTABLE).
 - b) IF THE COOLING SIGNAL OF ALL (ADJUSTABLE) OR FEWER SUPPLY TERMINAL UNITS FALLS BELOW 70% (ADJUSTABLE), THEN INCREMENT THE DISCHARGE AIR TEMPERATURE COOLING SETPOINT BY AN AMOUNT OF 1 DEG. F. (ADJUSTABLE).

2. DISCHARGE AIR TEMPERATURE CONTROL

- a. THE MEASURED DISCHARGE AIR TEMPERATURE IS CONTINUOUSLY COMPARED TO THE DISCHARGE AIR TEMPERATURE COOLING SETPOINT.
- b. THE SAHU CONTROLLER GENERATES A DISCHARGE AIR COOLING SIGNAL BETWEEN 0% AND 100% AS A FUNCTION OF HOW FAR THE MEASURED DISCHARGE AIR TEMPERATURE IS ABOVE THE DISCHARGE AIR TEMPERATURE COOLING SETPOINT.
 - 1) AS THE DISCHARGE AIR COOLING SIGNAL VARIES BETWEEN 0% AND 100%, THE CHILLED WATER CONTROL VALVE MODULATES BETWEEN 0% OPEN AND 100% OPEN AS REQUIRED TO MAINTAIN THE DISCHARGE AIR TEMPERATURE RESET SETPOINT.
 - a) ONCE THE DISCHARGE AIR COOLING SIGNAL HAS EXPIRED AND THE OUTSIDE AIR TEMPERATURE IS LESS THAN 52 DEG. F. (ADJUSTABLE), SAHU COOLING COIL CONTROL VALVE SHALL BE LOCKED OUT AS LONG AS THE OUTSIDE AIR TEMPERATURE REMAINS LESS THAN 52 DEG. F. AS MEASURED BY THE INCOMING OUTSIDE AIR TEMPERATURE SENSOR.
 - b) USE THE BUILDING OUTSIDE AIR TEMP SENSOR AS THE REDUNDANT OUTSIDE AIR TEMPERATURE SENSOR IF THE MAIN DUCT MOUNTED TEMP SENSOR AT THE INLET OF EACH SAHU FAILS. IF THE MAIN SENSOR FAILS, AN ALARM SHALL BE GENERATED AT THE FRONT END AND THE STAND-BY SENSOR SHALL BE USED FOR CONTROL.

- c. THE SAHU CONTROLLER GENERATES A DISCHARGE AIR HEATING SIGNAL BETWEEN 0% AND 100% AS A FUNCTION OF HOW FAR THE MEASURED DISCHARGE AIR TEMPERATURE IS BELOW THE DISCHARGE AIR TEMPERATURE HEATING SETPOINT.
 - 1) THE SAHU CONTROLLER WILL TEMPER THE OUTSIDE AIR UP TO THE DISCHARGE AIR TEMPERATURE HEATING SETPOINT.
 - 2) THE DISCHARGE AIR TEMPERATURE HEATING SETPOINT EQUALS THE DISCHARGE AIR TEMPERATURE COOLING SETPOINT MINUS 1 DEG. F. (ADJUSTABLE).
 - 3) AS THE DISCHARGE AIR HEATING SIGNAL VARIES BETWEEN 0% AND 100%, THE HOT WATER CONTROL VALVE MODULATES BETWEEN 0% OPEN AND 100% OPEN AS REQUIRED TO MAINTAIN THE DISCHARGE AIR HEATING SETPOINT.

3. POSITIVE DUCT STATIC PRESSURE RESET

- a. A CONDITION FOR INCREMENTING THE POSITIVE DUCT STATIC PRESSURE SETPOINT SHALL HAVE PRIORITY OVER A CONDITION FOR DECREMENTING THE POSITIVE DUCT STATIC PRESSURE SETPOINT.
- b. THE MAXIMUM POSITIVE DUCT STATIC PRESSURE SETPOINT SHALL BE (+) 2.5 IWC (ADJUSTABLE) AS DETERMINED AND SET BY THE TEST AND BALANCE TECHNICIAN.
- c. THE MINIMUM POSITIVE DUCT STATIC PRESSURE SETPOINT SHALL BE (+) 0.75 IWC (ADJUSTABLE) AS DETERMINED AND SET BY THE TEST AND BALANCE TECHNICIAN.
- d. THE SAHU WILL START WITH A POSITIVE DUCT STATIC PRESSURE SETPOINT RESET TO (+) 1.8 IWC (ADJUSTABLE).
- e. THE POSITIVE DUCT STATIC PRESSURE SETPOINT WILL RESET AS FOLLOWS:
 - 1) THE DAMPER POSITIONS OF ALL SELECTED SUPPLY TERMINAL UNITS (SV) WILL BE READ BY THE GLOBAL CONTROLLER.
 - a) FOR EACH SV ZONE, THE OPERATOR SHALL BE GIVEN THE ABILITY TO DE-SELECT CERTAIN ZONES FROM CAUSING THE POSITIVE DUCT STATIC PRESSURE SETPOINT TO RESET.
 - 2) POSITIVE DUCT STATIC PRESSURE SETPOINT INCREMENT.
 - a) AN INCREMENT CONDITION WILL BE QUALIFIED EVERY 3 MINUTES (ADJUSTABLE).
 - b) IF THE DAMPER POSITION OF 1 (ADJUSTABLE) OR MORE SELECTED SV TERMINAL UNITS INCREASES ABOVE 80% (ADJUSTABLE), THEN INCREMENT THE POSITIVE DUCT STATIC PRESSURE SETPOINT BY AN AMOUNT OF (+) 0.2 IWC (ADJUSTABLE).
 - 3) POSITIVE DUCT STATIC PRESSURE SETPOINT DECREMENT.
 - a) A DECREMENT CONDITION WILL BE QUALIFIED EVERY 10 MINUTES (ADJUSTABLE).
 - b) IF THE MEASURED DAMPER POSITIONS OF ALL (ADJUSTABLE) OR FEWER SV TERMINAL UNITS DECREASES BELOW 70% (ADJUSTABLE), THEN DECREMENT THE POSITIVE DUCT STATIC PRESSURE SETPOINT BY AN AMOUNT OF (+) 0.1 IWC (ADJUSTABLE).

4. POSITIVE DUCT STATIC PRESSURE CONTROL

A PRESSURE TRANSDUCER MEASURING THE DUCT PRESSURE (HIGH) RELATIVE TO THE SPACE OR OUTSIDE AIR (LOW), WILL BE INSTALLED IN A STRAIGHT SECTION OF DUCT, 2/3 DOWN THE LONGEST LENGTH OF DOWNSTREAM SUPPLY DUCTWORK.

- a. THE MEASURED POSITIVE DUCT STATIC PRESSURE IS CONTINUOUSLY COMPARED TO THE POSITIVE DUCT STATIC PRESSURE SETPOINT.
- b. THE SAHU CONTROLLER GENERATES A POSITIVE DUCT STATIC PRESSURE SIGNAL BETWEEN 0% AND 100% DEPENDING ON HOW FAR THE MEASURED POSITIVE DUCT STATIC PRESSURE IS BELOW THE POSITIVE DUCT STATIC PRESSURE SETPOINT.
 - 1) AS THE POSITIVE DUCT STATIC PRESSURE SIGNAL VARIES BETWEEN 0% AND 100%, BOTH SUPPLY FANS MODULATE AT THE SAME SPEED WITHIN THE RANGE OF THE MINIMUM AND MAXIMUM VFD (HZ) SPEED SETPOINTS.
 - a) THE VFD MINIMUM AND MAXIMUM VFD SPEED SETPOINTS SHALL BE DETERMINED AND SET BY THE TEST AND BALANCE TECHNICIAN.
 - b) ALL VFD SPEEDS SHALL BE REPRESENTED IN HERTZ (HZ) ON THE FRONT END GRAPHICAL USER INTERFACE THROUGHOUT THE ENTIRE OPERATING SPEED RANGE WHICH THE VFD IS CONFIGURED.
 - c) THE HZ DISPLAYED AT THE FRONT END SHALL MATCH THE HZ DISPLACED ON THE VFD KEYPAD INTERFACE.
 - 2) IF THE POSITIVE DUCT STATIC PRESSURE SENSOR FAILS, AN ALARM WILL BE SENT TO THE FRONT END AND THE SUPPLY FAN SPEED COMMAND SHALL REMAIN AS IT WERE AT THE TIME OF THE POSITIVE DUCT STATIC PRESSURE SENSOR FAILURE.
 - 3) IF ANY ONE OF THE SUPPLY FANS FAIL TO OPERATE, AN ALARM WILL BE GENERATED AND SENT TO THE FRONT END. THE SAHU WILL CONTINUE TO OPERATE WITH THE REMAINING FAN. **TO ATTEMPT TO REACH DUCT STATIC PRESSURE SETPOINT, ANY ADDITIONAL SEQUENCES AS REQUIRED TO PROPERLY SERVE TI SPACES SHALL BE DETERMINED BY TI.** EACH FAN IS EQUIPPED WITH A GRAVITY-OPERATED BACKDRAFT DAMPER WHICH AUTOMATICALLY CLOSES AND ISOLATES THE NON-OPERATING FAN AND PREVENTS AIR SUPPLIED BY THE OPERATING FAN FROM RECIRCULATING BACK THROUGH THE NON- OPERATING FAN. FAN FAILURE SHALL BE QUALIFIED BY ANY ONE OF THE FOLLOWING CONDITIONS:
 - a) VFD FAULT **CAUSING FAILURE**
 - b) MEASURED MOTOR **LOADS** ARE NOT WITHIN NORMAL PARAMETERS SET BY THE **VFD MANUFACTURER**
 - c) **FAN IS OFF: IN HAND OR OTHER INTERNAL SAHU SAFETY CAUSING FAILURE.**

E. AIRFLOW MONITORING

1. SAHU IS PROVIDED WITH FACTORY INSTALLED HAAKON FREEFLOW AIRFLOW MONITORS. SAHUs ARE 100% OUTSIDE AIR.

F. SAFETIES

1. SAHU SHALL SHUT DOWN IMMEDIATELY UPON FAN RUN FAILURE OF ITS ASSOCIATED EAHU. SAHU OR EAHU FAN FAILURE IS DEFINED AS TWO VFD'S IN THE SAME UNIT NOT OPERATING WHEN COMMANDED IN THIS SCENARIO.
2. A HIGH DUCT STATIC PRESSURE CUT-OUT SWITCH SHALL CAUSE THE UNIT TO SHUT DOWN IF THE UNIT DISCHARGE PRESSURE EXCEEDS (+) 3.8 IWC (FIELD-ADJUSTABLE).
3. A LOW DUCT STATIC PRESSURE CUT-OUT SWITCH SHALL CAUSE THE UNIT TO SHUT DOWN IF THE PRESSURE UPSTREAM OF THE SUPPLY FANS FALLS BELOW (-) 3 IWC (FIELD-ADJUSTABLE).
4. UNIT SHALL SHUT DOWN THROUGH HARDWIRE IN A FIRE ALARM EVENT VIA FIRE ALARM SYSTEM AUXILIARY RELAY.
5. CONDENSATE DETECTION ALARM: GENERATE CONDENSATE DETECTION ALARM IF HIGH LEVEL IS DETECTED WITHIN THE COIL DRAIN PAN, AND SHUTDOWN THE UNIT.

G. ALARMS:

1. DISCHARGE AIR TEMP FAILURE: TEMPERATURE IS READING A VALUE OUT OF THE EXPECTED RANGE.
2. SMOKE DETECTOR ALARM: A DUCT SMOKE DETECTOR INPUT IS RECEIVED. THIS IS ALSO A HARDWIRED INTERLOCK THAT WILL ENSURE THE FAN IS SHUT DOWN.
3. FREEZE STAT ALARM: A FREEZE STAT INPUT IS RECEIVED. THIS IS A HARDWIRED INTERLOCK THAT WILL ENSURE THE FAN IS SHUT DOWN AND THE HOT WATER VALVE'S POWER IS CUT CAUSING IT TO SPRING OPEN ALLOWING 100% FLOW THRU THE COIL WHEN TEMPERATURE IS BELOW 32°F. HW & CHW SYSTEMS ARE FILLED WITH A 20% PROPYLENE GLYCOL SOLUTION.
4. HIGH STATIC PRESSURE ALARM: A PRESSURE VALUE IS MEASURED THAT IS GREATER THAN (+)3.8 IWC (ADJUSTABLE) ON THE DISCHARGE SIDE OF THE FAN.
5. LOW STATIC PRESSURE ALARM: AN ALARM THAT TRIGGERS WHEN A PRESSURE VALUE THAT IS LESS THAN (-)3 IWC (ADJUSTABLE) IS MEASURED.
6. SUPPLY FAN IN HAND ALARM: ALARM IS TRIGGERED WHEN FAN STATUS IS CONFIRMED, BUT THE FAN IS NOT COMMANDED ON.
7. SUPPLY FAN FAIL ALARM: ALARM IS TRIGGERED WHEN FAN IS COMMANDED ON, BUT FAN STATUS DOES NOT ENABLE. ADDITIONAL ALARMS PER 4.b.3) ABOVE.
8. VFD FAULT ALARM: THE VFD WILL FAULT IF THE MOTOR AMPS ARE NOT WITHIN NORMAL (ADJUSTABLE) PARAMETERS SET BY THE TAB.
9. OUTSIDE AIR TEMPERATURE SENSOR FAILS ALARM: ALARM IF THE PRIMARY OUTSIDE AIR TEMPERATURE SENSOR FAILS. IF FAILS, THE GLOBAL OUTSIDE AIR TEMPERATURE VALUE SHALL BE USED INSTEAD.
10. POSITIVE DUCT STATIC PRESSURE SENSOR FAILURE: IF THE PDSP SENSOR FAILS
11. AIRFLOW MONITOR ABNORMAL AIRFLOW ALARM: GENERATE AN AIRFLOW DEVIATION ALARM WHEN PAIRED SUPPLY FAN AIRFLOWS DEVIATE BY MORE THAN 15% FROM ONE ANOTHER.
12. ROOM LEAK DETECTION ALARM: GENERATE ROOM LEAK DETECTION ALARM IF WATER IS DETECTED WITHIN THE ROOM.

H. MANUAL SCREEN COMMANDS

THE OPERATOR SHALL BE GIVEN THE ABILITY TO MANUALLY COMMAND,

1. UNIT SHUTDOWN.
2. DISCHARGE AIR TEMPETURE SETPOINT.
3. POSITIVE DUCT STATIC PRESSURE SETPOINT.
4. SUPPLY FAN SPEED (HZ).
5. CHILLED WATER COIL CONTROL VALVE POSITION.
6. HOT WATER COIL CONTROL VALVE POSITION.

3. EXHAUST AIR-HANDLING UNIT (EAHU, TAGGED: 1150-LXX-EAHU-01)

EXHAUST AIR IS REMOVED FROM THE BUILDING WITH VARIABLE-SPEED DRIVEN, TWIN EXHAUST FANS. THE EAHU IS EQUIPPED WITH AN EXHAUST AIR HEAT RECOVERY COIL WHICH TRANSFERS HEAT FROM THE EXHAUST AIR TO THE CHILLED WATER DISTRIBUTION SYSTEM. THE EXHAUST AIR HEAT RECOVERY COIL THEN REMOVES HEAT FROM THE BUILDING AIR AND TRANSFERS THE HEAT TO THE CHILLED WATER DISTRIBUTION SYSTEM ANALOGOUS TO THE WAY THE SAHU COOLING COILS TRANSFER HEAT FROM THE BUILDING TO THE CHILLED WATER DISTRIBUTION SYSTEM.

A. EAHU OFF CONDITIONS.

1. EAHU OPERATES 24 HOURS PER DAY, 365 DAYS PER YEAR. UNIT WILL ONLY SHUT DOWN,
 - a. DURING SCHEDULED MAINTENANCE.
 - b. WHILE ITS ASSOCIATED SAHU IS SHUT DOWN.
 - c. WHEN SAFETY LIMITS ARE EXCEEDED.
 - 1) HIGH DUCT STATIC PRESSURE CUT-OUT SWITCH (DOWNSTREAM OF THE EXHAUST FANS).
 - 2) LOW DUCT STATIC PRESSURE CUT-OUT SWITCH (UPSTREAM OF THE EXHAUST FANS).
 - 3) FIRE ALARM PANEL SIGNAL.
 - a) GENERATE AN ALARM AND INITIATE THE SHUTDOWN MODE UPON RECEIVING A SIGNAL FROM THE FIRE ALARM PANEL.
2. WHEN EAHU IS SHUT DOWN,
 - a. BOTH EXHAUST FAN VFDS ARE DISABLED AND THE EXHAUST FANS ARE STOPPED.
 - b. EXHAUST AIR DISCHARGE DAMPERS ARE CLOSED.
 - c. HEAT RECOVERY COIL CONTROL VALVE IS CLOSED.

B. EAHU START-UP SEQUENCE

1. EAHU IS COMMANDED TO RUN IN THE OPERATING MODE FOLLOWING A DELAY (ADJUSTABLE PER AHU) TO PREVENT ALL BUILDING AHUS FROM STARTING AT THE SAME TIME. SAHU & EAHU PAIRS TO START AT THE SAME TIME.
 - a. ASSOCIATED SAHU IS COMMANDED TO RUN IN THE OPERATING MODE.
2. EXHAUST AIR DISCHARGE DAMPERS ARE COMMANDED OPEN AND THEIR OPEN STATUS IS PROVEN.
3. EXHAUST FAN VFDS ARE ENABLED AT A MINIMUM SPEED AND RUN STATUS IS PROVEN.
4. EXHAUST FANS OPERATE AT THE SAME SPEED AND MODULATE TO MAINTAIN THE DUCT STATIC PRESSURE SETPOINT.
5. HEAT RECOVERY COIL CONTROL VALVE MODULATES TO TRANSFER A CONTROLLED AMOUNT OF HEAT TO THE HEAT RECOVERY CHILLERS VIA THE CHILLED WATER DISTRIBUTION SYSTEM.

C. EAHU SHUT-DOWN SEQUENCE

1. EAHU IS COMMANDED TO STOP
 - a. ASSOCIATED SAHU IS COMMANDED TO STOP
2. HEAT RECOVERY COIL CONTROL VALVE CLOSSES (EVEN IN THE CASE OF A POWER OUTAGE)
3. EXHAUST FAN VFDS RUN STATUS IS OFF.
4. EXHAUST AIR DISCHARGE DAMPERS ARE COMMANDED CLOSED AND THEIR STATUS IS PROVEN.

D. OPERATING MODE

1. EXHAUST AIR HEAT RECOVERY COIL CAPACITY CONTROL
 - a. THE HEAT RECOVERY COIL CONTROL VALVES AT EACH EAHU WILL BE MODULATED IN ORDER TO MAXIMIZE THE HEAT RECOVERY AT THE CHILLER AND HOW MANY MODULES IN THE HEAT RECOVERY CHILLER ARE OPERATING IN HEAT RECOVERY MODE (WATER TO WATER).
 - 1) AS THE BUILDING HEATING SIGNAL INCREASES AND THE BUILDING COOLING SIGNAL DECREASES, THE AMOUNT OF HEAT RECOVERED FROM THE CHILLED WATER LOOP AND TRANSFERRED TO THE HEATING WATER LOOP WILL DECREASE AND THE MODULES OPERATING IN HEAT RECOVERY MODE (WATER TO WATER) WILL NO LONGER BE ABLE TO MAINTAIN THE HEATING WATER TEMPERATURE SETPOINT. WHEN THIS OCCURS THE EAHU HEAT RECOVERY COIL CONTROL VALVES WILL MODULATE OPEN TO MAINTAIN THE REQUIRED CAPACITY FOR THE HEAT RECOVERY CHILLERS TO OPERATE IN HEAT RECOVERY MODE.
 - 2) THE BAC SHALL CALCULATE THE BTU OF THE BUILDING EVERY 5 MINUTES. VALUES CALCUALTED ARE AS FOLLOWS:
 - a) BTU OF CHILLED WATER LOADS.
 - b) BTU OF HEAT RECOVERY LOADS.
 - c) BTU OF HEATING WATER LOADS.
 - d) BTU OF 1150-L12-HRCH-01 HEATING WATER CAPACITY.
 - e) BTU OF 1150-L12-HRCH-01 CHILLED WATER CAPACITY.
 - f) BTU OF 1150-L12-HRCH-02 HEATING WATER CAPACITY.
 - g) BTU OF 1150-L12-HRCH-02 CHILLED WATER CAPACITY.
 - 3) THE BAC SHALL ALSO TAKE THE LEVEL 12 BTU METER READINGS FOR HEATING WATER AND CHILLED WATER, AND ADD THEM TO THE LOADS CALCULATED AT THE FLOW METERS TO OBTAIN ESTIMATED BUILDING LOAD TOTALS.
 - 4) IF THE COMBINED BUILDING HEAT RECOVERY LOAD AND BUILDING CHILLED WATER LOAD IS LESS THAN THE HEATING WATER LOAD, THEN ALL HEAT RECOVERY COILS SHALL BE RESET PER 6a) BELOW TO 100% (ADJUSTABLE) OPEN.
 - 5) IF THE BUILDING CHILLED WATER LOAD IS GREATER THAN THE HEATING WATER LOAD, THEN ALL HEAT RECOVERY COILS SHALL BE RESET CLOSED PER 6b) BELOW.
 - 6) ALL HEAT RECOVERY COILS SHALL BE INCREMENTALLY SET BETWEEN 0 AND 100% OPEN (ADJUSTABLE), IN 10% INCREMENTS (ADJUSTABLE), TO RESPOND TO THE HEAT RECOVERY LOAD EVERY 15 MINUTES AS FOLLOWS:
 - a) IF THE COMBINED BUILDING HEAT RECOVERY LOAD

AND BUILDING CHILLED WATER LOAD IS LESS THAN THE HEATING WATER LOAD, THEN OPEN THE HEAT RECOVERY COILS BY 10%.

- b) IF THE COMBINED BUILDING HEAT RECOVERY LOAD AND BUILDING CHILLED WATER LOAD IS GREATER THAN THE HEATING WATER LOAD, THEN CLOSE THE HEAT RECOVERY COILS BY 10%..

2. NEGATIVE DUCT STATIC PRESSURE RESET

- a. A CONDITION FOR INCREMENTING THE NEGATIVE DUCT STATIC PRESSURE SETPOINT SHALL HAVE PRIORITY OVER A CONDITION FOR DECREMENTING THE NEGATIVE DUCT STATIC PRESSURE SETPOINT.
- b. THE MAXIMUM NEGATIVE DUCT STATIC PRESSURE SETPOINT SHALL BE (-) 2.5 IWC (ADJUSTABLE) AS DETERMINED AND SET BY THE TEST AND BALANCE TECHNICIAN.
- c. THE MINIMUM NEGATIVE DUCT STATIC PRESSURE SETPOINT SHALL BE (-) 0.75 IWC (ADJUSTABLE) AS DETERMINED AND SET BY THE TEST AND BALANCE TECHNICIAN.
- d. THE EAHU WILL START WITH A NEGATIVE DUCT STATIC PRESSURE SETPOINT SET TO (-) 1.8 IWC (ADJUSTABLE).
- e. THE NEGATIVE DUCT STATIC PRESSURE SETPOINT WILL RESET AS FOLLOWS:
- 1) THE DAMPER POSITIONS OF ALL SELECTED SUPPLY TERMINAL UNITS (EV) WILL BE READ BY THE GLOBAL CONTROLLER.
- a) FOR EACH EV ZONE, THE OPERATOR SHALL BE GIVEN THE ABILITY TO DE-SELECT CERTAIN ZONES FROM CAUSING THE NEGATIVE DUCT STATIC PRESSURE SETPOINT TO RESET.
- 2) NEGATIVE DUCT STATIC PRESSURE SETPOINT INCREMENT.
- a) AN INCREMENT CONDITION WILL BE QUALIFIED EVERY 3 MINUTES (ADJUSTABLE).
- b) IF THE DAMPER POSITION OF 1 (ADJUSTABLE) OR MORE SELECTED EV TERMINAL UNITS INCREASES ABOVE 80% (ADJUSTABLE), THEN INCREMENT THE NEGATIVE DUCT STATIC PRESSURE SETPOINT BY AN AMOUNT OF (-) 0.2 IWC (ADJUSTABLE).
- 3) NEGATIVE DUCT STATIC PRESSURE SETPOINT DECREMENT.
- a) A DECREMENT CONDITION WILL BE QUALIFIED EVERY 10 MINUTES (ADJUSTABLE).
- b) IF THE MEASURED DAMPER POSITIONS OF ALL (ADJUSTABLE) OR FEWER EV TERMINAL UNITS DECREASES BELOW 70% (ADJUSTABLE), THEN DECREMENT THE NEGATIVE DUCT STATIC PRESSURE SETPOINT BY AN AMOUNT OF (-) 0.1 IWC (ADJUSTABLE).

3. NEGATIVE DUCT STATIC PRESSURE CONTROL

- A PRESSURE TRANSDUCER MEASURING THE DUCT PRESSURE (LOW) RELATIVE TO THE SPACE OR OUTSIDE AIR (HIGH), WILL BE INSTALLED IN A STRAIGHT SECTION OF DUCT, 2/3 DOWN THE LONGEST LENGTH OF DOWNSTREAM SUPPLY DUCTWORK.
- a. THE MEASURED NEGATIVE DUCT STATIC PRESSURE IS CONTINUOUSLY COMPARED TO THE NEGATIVE DUCT STATIC

PRESSURE SETPOINT.

- b. THE EAHU CONTROLLER GENERATES A NEGATIVE DUCT STATIC PRESSURE SIGNAL BETWEEN 0% AND 100% DEPENDING ON HOW FAR THE MEASURED NEGATIVE DUCT STATIC PRESSURE IS BELOW THE NEGATIVE DUCT STATIC PRESSURE SETPOINT.

- 1) AS THE NEGATIVE DUCT STATIC PRESSURE SIGNAL VARIES BETWEEN 0% AND 100%, BOTH EXHAUST FANS MODULATE AT THE SAME SPEED WITHIN THE RANGE OF THE MINIMUM AND MAXIMUM VFD (HZ) SPEED SETPOINTS.
- a) THE VFD MINIMUM AND MAXIMUM VFD SPEED SETPOINTS SHALL BE DETERMINED AND SET BY THE TEST AND BALANCE TECHNICIAN.
- b) ALL VFD SPEEDS SHALL BE REPRESENTED IN HERTZ (HZ) ON THE FRONT END GRAPHICAL USER INTERFACE THROUGHOUT THE ENTIRE OPERATING SPEED RANGE WHICH THE VFD IS CONFIGURED.
- c) THE HZ DISPLAYED AT THE FRONT END SHALL MATCH THE HZ DISPLACED ON THE VFD KEYPAD INTERFACE.
- 2) IF THE NEGATIVE DUCT STATIC PRESSURE SENSOR FAILS, AN ALARM WILL BE SENT TO THE FRONT END AND THE EXHAUST FAN SPEED COMMAND SHALL REMAIN AS IT WERE AT THE TIME OF THE NEGATIVE DUCT STATIC PRESSURE SENSOR FAILURE.
- 3) IF ANY ONE OF THE EXHAUST FANS FAIL TO OPERATE, AN ALARM WILL BE GENERATED AND SENT TO THE FRONT END. THE EAHU WILL CONTINUE TO OPERATE WITH THE REMAINING FAN TO ATTEMPT TO REACH DUCT STATIC PRESSURE SETPOINT. ANY ADDITIONAL SEQUENCES AS REQUIRED TO PROPERLY SERVE TI SPACES SHALL BE DETERMINED BY TI PROJECT. EACH FAN IS EQUIPPED WITH A GRAVITY-OPERATED BACKDRAFT DAMPER WHICH AUTOMATICALLY CLOSES AND ISOLATES THE NON-OPERATING FAN AND PREVENTS AIR SUPPLIED BY THE OPERATING FAN FROM RECIRCULATING BACK THROUGH THE NON-OPERATING FAN. FAN FAILURE SHALL BE QUALIFIED BY ANY ONE OF THE FOLLOWING CONDITIONS:
- a) VFD FAULT CAUSING FAILURE.
- b) MEASURED MOTOR RUNNING AMPS ARE NOT WITHIN NORMAL (ADJUSTABLE) PARAMETERS SET BY THE TEST AND BALANCE TECHNICIAN.
- c) FAN IS OFF: IN HAND OR OTHER INTERNAL EAHU SAFETY CAUSING FAILURE.

E. SAFETIES

1. EAHU SHALL SHUT DOWN IMMEDIATELY UPON FAN RUN FAILURE OF ITS ASSOCIATED SAHU. SAHU OR EAHU FAN FAILURE IS DEFINED AS TWO VFD'S IN THE SAME UNIT NOT OPERATING WHEN COMMANDED IN THIS SCENARIO.
2. A HIGH DUCT STATIC PRESSURE CUT-OUT SWITCH SHALL CAUSE THE UNIT TO SHUT DOWN IF THE PRESSURE ON THE DISCHARGE SIDE OF THE FANS EXCEEDS (+) 3.0 IWC (FIELD-ADJUSTABLE).
3. A LOW DUCT STATIC PRESSURE CUT-OUT SWITCH SHALL CAUSE THE UNIT TO SHUT DOWN IF THE PRESSURE UPSTREAM OF THE EXHAUST FANS FALLS BELOW (-) 3.8 IWC (FIELD-ADJUSTABLE).

4. UNIT SHALL SHUT DOWN THROUGH HARDWIRE IN A FIRE ALARM EVENT VIA FIRE ALARM SYSTEM AUXILIARY RELAY.

5. CONDENSATE DETECTION ALARM: GENERATE CONDENSATE DETECTION ALARM IF HIGH LEVEL IS DETECTED WITHIN THE COIL DRAIN PAN, AND SHUT DOWN THE UNIT.

F. ALARMS:

1. HIGH STATIC PRESSURE ALARM: A PRESSURE VALUE IS MEASURED THAT IS GREATER THAN (+)3 IWC (ADJUSTABLE) ON THE DISCHARGE SIDE OF THE FAN.
2. LOW STATIC PRESSURE ALARM: AN ALARM THAT TRIGGERS WHEN A PRESSURE VALUE THAT IS LESS THAN (-)3.8 IWC (ADJUSTABLE) IS MEASURED.
3. EXHAUST FAN IN HAND ALARM: ALARM IS TRIGGERED WHEN FAN STATUS IS CONFIRMED, BUT THE FAN IS NOT COMMANDED ON.
4. EXHAUST FAN FAIL ALARM: ALARM IS TRIGGERED WHEN FAN IS COMMANDED ON, BUT FAN STATUS DOES NOT ENABLE. ADDITIONAL ALARMS PER 3.b.3) ABOVE.
5. VFD FAULT ALARM: THE VFD WILL FAULT IF THE MOTOR AMPS ARE NOT WITHIN NORMAL (ADJUSTABLE) PARAMETERS SET BY THE TAB.
6. POSITIVE DUCT STATIC PRESSURE SENSOR FAILURE: IF THE PDSP SENSOR FAILS
7. AIRFLOW MONITOR ABNORMAL AIRFLOW ALARM: GENERATE AN AIRFLOW DEVIATION ALARM WHEN PAIRED EXHAUST FAN AIRFLOWS DEVIATE BY MORE THAN 15% FROM ONE ANOTHER.
8. ROOM LEAK DETECTION ALARM: GENERATE ROOM LEAK DETECTION ALARM IF WATER IS DETECTED WITHIN THE ROOM.

G. MANUAL SCREEN COMMANDS

- THE OPERATOR SHALL BE GIVEN THE ABILITY TO MANUALLY COMMAND,
1. UNIT SHUTDOWN.
2. NEGATIVE DUCT STATIC PRESSURE SETPOINT.
3. EXHAUST FAN SPEED (HZ).
4. HEAT RECOVERY COIL CONTROL VALVE POSITION.

4. PARKING GARAGE VENTILATION EXHAUST FANS (1150-P1-GEF-01, 1150-P2-GEF-01, 1150-P3-GEF-01, 1150-P4-GEF-01)

THERE ARE FOUR LEVELS OF BELOW GRADE PARKING STRUCTURE. IN ORDER TO CONTROL AND CONTAIN THE LEVEL OF CARBON MONOXIDE (CO) AND NITROGEN DIOXIDE (NO2), VENTILATION IS PROVIDED BY FOUR EXHAUST FANS. ONE OF THE FOUR EXHAUST FANS IS INSTALLED ON EACH PARKING LEVEL. EACH FAN IS EQUIPPED WITH A VFD FOR SPEED MODULATION. FIVE SETS OF CO AND NO2 GAS SENSORS ARE INSTALLED AT DIFFERENT SENSING LOCATIONS ON EACH LEVEL. CO GAS IS AN UNSAFE BI-PRODUCT OF GASOLINE EXHAUST AND NO2 IS AN UNSAFE BI-PRODUCT OF DIESEL EXHAUST. FANS ARE CONTROLLED THROUGH A BACNET COMMUNICATION NETWORK INTERFACE.

A. FAN RUN-STOP

1. FANS ARE AVAILABLE TO OPERATE 24 HOURS PER DAY, 365 DAYS PER YEAR.
- a. A TIME SCHEDULE FOR OPERATING THE FANS SHALL BE SET BY THE BUILDING OPERATOR.
- 1) IF TIME SCHEDULE COMMANDS THE FANS TO AN OFF MODE, AND ANY ONE CO OR NO2 SENSOR READS ABOVE

- ITS SETPOINT, THE OFF MODE WILL BE OVERRIDDEN TO COMMAND ALL FANS ON ALL LEVELS TO AN OPERATING MODE. WHEN LEVELS DROP BELOW THEIR SETPOINTS, THE FANS WILL CONTINUE TO RUN FOR AN ADDITIONAL 15 MINS (ADJ).
- 2) FANS SHALL OPERATE NO LOWER THAN A MINIMUM SPEED TO ACHIEVE THE MINIMUM AIRFLOW SHOWN IN THE FAN SCHEDULE.
 - 3) FANS SHALL MODULATE ABOVE THE MINIMUM SPEED TO A MAXIMUM SPEED TO ACHIEVE THE MAXIMUM AIRFLOW SHOWN IN THE FAN SCHEDULE FOR NORMAL OPERATION.
 - 4) THE MINIMUM AND MAXIMUM FAN SPEEDS SHALL BE FIELD-ADJUSTED BY THE TEST AND BALANCE TECHNICIAN IN COORDINATION WITH THE CONTROL SYSTEM TECHNICIAN.
- b. FANS MAY BE STOPPED FOR MAINTENANCE SCHEDULED BY THE BUILDING OPERATOR.
2. FAN CONTROL SETPOINTS:
- THE FOLLOWING CONTROL SETPOINTS APPLY TO EACH LEVEL. FOR EACH PARKING LEVEL, THE SENSOR ON EACH LEVEL WITH THE HIGHEST READING SHALL BE USED TO CONTROL THE SPEED AND CAPACITY OF THE EXHAUST FAN ON EACH LEVEL. A STEP CONTROL ALGORITHM IS USED TO ADJUST THE SPEED OF THE MOTOR AND CAPACITY OF THE FAN. THE FAN MINIMUM AND MAXIMUM SPEEDS SHALL STEP THROUGH A SCALE WHICH IS PROPORTIONED WITH THE MINIMUM AND MAXIMUM CO (PPM) READINGS AND NO2 (PPM) READINGS.
- a. PARKING LEVELS AND ASSOCIATED GARAGE EXHAUST FANS.
 - 1) PARKING LEVEL 1 (P1) IS VENTILATED WITH GARAGE EXHAUST FAN 1150-P1-GEF-01.
 - 2) PARKING LEVEL 2 (P2) IS VENTILATED WITH GARAGE EXHAUST FAN 1150-P2-GEF-01.
 - 3) PARKING LEVEL 3 (P3) IS VENTILATED WITH GARAGE EXHAUST FAN 1150-P3-GEF-01.
 - 4) PARKING LEVEL 4 (P4) IS VENTILATED WITH GARAGE EXHAUST FAN 1150-P4-GEF-01.
 - b. CO CONTROL SETPOINTS (PPM)
 - 1) CO LEVEL IS LESS THAN OR EQUAL TO 9 PPM: FAN OPERATES AT MINIMUM SPEED.
 - 2) CO LEVEL IS GREATER THAN 9 PPM BUT LESS THAN OR EQUAL TO 50 PPM: FAN MODULATES BETWEEN THE MINIMUM SPEED SETPOINT AND MAXIMUM SPEED SETPOINT.
 - a) THE FAN SPEED IS INCREMENTED LINEARLY IN PROPORTION WITH THE CO SENSOR READING.
 - b) FAN SPEED SHALL BE DECREMENTED IN STEPS ON TIME INTERVALS OF 5 MINS (ADJ).
 - c. NO2 CONTROL SETPOINTS (PPM)
 - 1) NO2 LEVEL IS LESS THAN OR EQUAL TO 0.5 PPM: FAN OPERATES AT MINIMUM SPEED.
 - 2) NO2 LEVEL IS GREATER THAN 0.5 PPM BUT LESS THAN OR EQUAL TO 4 PPM: FAN MODULATES BETWEEN THE MINIMUM SPEED SETPOINT AND MAXIMUM SPEED SETPOINT.

- a) THE FAN SPEED IS INCREMENTED LINEARLY IN PROPORTION WITH THE NO2 SENSOR READING.
 - i. FAN SPEED SHALL BE DECREMENTED IN STEPS ON TIME INTERVALS OF 5 MINS (ADJ).
3. EMERGENCY GENERATOR OPERATION:
- a. GARAGE FANS TO BE HARDWIRE INTERLOCKED BY E.C. WITH EMERGENCY GENERATORS VIA THE VFD'S. WHEN THE EMERGENCY GENERATOR IS RUNNING DURING AN EMERGENCY EVENT OR DURING TESTING, THE FANS ARE TO BE INTERLOCKED TO RUN AT FULL SPEED ON EMERGENCY POWER. THIS IS TO HELP REDUCE THE POSSIBILITY OF THE GENERATOR RADIATOR COOLING EXHAUST AIR SHORT CYCLING BACK TO THE GENERATOR ROOM INTAKE AIR.
 - b. THE BACS SHALL USE THE GENERATOR RUN SIGNAL TO OPERATE THE GARAGE EXHAUST FANS AT FULL SPEED FOR 30 MINUTES AFTER THE GENERATORS ARE OFF TO REMOVE HEAT FROM THE GARAGE AREA UPSTREAM OF THE TRANSFORMER VAULT FAN.
- B. SAFETIES
1. ANY TIME ANY ONE FAN IS ENABLED, AND THE RUN STATUS IS NOT PROVEN WITHIN 30 SECONDS, AN ALARM WILL BE GENERATED AT THE FRONT END, AND THE OPERATOR SHALL BE NOTIFIED.
 2. ANY TIME THE CO LEVEL EXCEEDS 100 PPM CONTINUOUSLY FOR 15 MINUTES, AN ALARM WILL BE GENERATED AT THE FRONT END, AND THE OPERATOR SHALL BE NOTIFIED.
 3. ANY TIME THE NO2 LEVEL EXCEEDS 5 PPM CONTINUOUSLY FOR 15 MINUTES, AN ALARM WILL BE GENERATED AT THE FRONT END, AND THE OPERATOR SHALL BE NOTIFIED.
5. **PARKING GARAGE VENTILATION SUPPLY FAN (1150-P4-GSF-01)**
- 1150-P4-GSF-01 BRINGS EXHAUST MAKE-UP AIR TO PARKING LEVEL 4 (P4) ONLY. FAN IS EQUIPPED WITH A VFD FOR SPEED MODULATION AND CONTROLLED THROUGH A BACNET COMMUNICATION NETWORK INTERFACE.
- A. FAN RUN-STOP
1. FAN IS AVAILABLE TO OPERATE 24 HOURS PER DAY, 365 DAYS PER YEAR.
 - a. THE TIME SCHEDULE FOR THE GARAGE VENTILATION SUPPLY FAN SHALL BE THE SAME AS THE GARAGE EXHAUST FAN 1150-P4-GEF-01.
 - 1) FAN SHALL OPERATE NO LOWER THAN A MINIMUM SPEED TO ACHIEVE THE MINIMUM AIRFLOW SHOWN IN THE FAN SCHEDULE.
 - 2) FAN SHALL MODULATE ABOVE THE MINIMUM SPEED TO A MAXIMUM SPEED TO ACHIEVE THE MAXIMUM AIRFLOW SHOWN IN THE FAN SCHEDULE.
 - 3) THE MINIMUM AND MAXIMUM FAN SPEEDS SHALL BE FIELD-ADJUSTED BY THE TEST AND BALANCE TECHNICIAN IN COORDINATION WITH THE CONTROL SYSTEM TECHNICIAN.
 - b. FANS MAY BE STOPPED FOR MAINTENANCE SCHEDULED BY THE BUILDING OPERATOR.
 2. FAN CONTROL SETPOINTS:
- 1150-P4-GSF-01 IS INSTALLED ON PARKING LEVEL 4 (P4). 1150-P4-GSF-01 SHALL TRACK 1150-P4-GEF-01 AND MODULATE WITH THE SAME CO AND NO2 CONTROL SETPOINTS, STEP CONTROL

- ALGORITHMS AND SPEED ADJUSTMENT INTERVALS AS 1150-P4-GEF-01. SEE SEQUENCE OF OPERATION FOR 1150-P4-GEF-01.
3. EMERGENCY GENERATOR OPERATION:
- a. GARAGE FANS TO BE HARDWIRE INTERLOCKED BY E.C. WITH EMERGENCY GENERATORS VIA THE VFD'S. WHEN THE EMERGENCY GENERATOR IS RUNNING DURING AN EMERGENCY EVENT OR DURING TESTING, THE FANS ARE TO BE INTERLOCKED TO RUN AT FULL SPEED ON EMERGENCY POWER. THIS IS TO HELP REDUCE THE POSSIBILITY OF THE GENERATOR RADIATOR COOLING EXHAUST AIR SHORT CYCLING BACK TO THE GENERATOR ROOM INTAKE AIR.
- B. SAFETIES
1. ANY TIME THE FAN IS ENABLED, AND THE RUN STATUS IS NOT PROVEN WITHIN 30 SECONDS, AN ALARM WILL BE GENERATED AT THE FRONT END, AND THE OPERATOR SHALL BE NOTIFIED.
6. **HEAT RECOVERY CHILLERS (1150-L12-HRCH-01, 1150-L12-HRCH-02)**
- THERE ARE TWO HEAT RECOVERY CHILLERS (HRCH'S). EACH CHILLER IS COMPOSED OF A BANK OF 9 MODULES. EACH MODULE CONTAINS 2 CONSTANT-SPEED COMPRESSORS, 4 AIR-COOLED CONDENSER COILS/FANS, A REFRIGERANT-TO-CHILLED WATER EVAPORATOR COIL, AND A REFRIGERANT-TO-HOT WATER HEAT RECOVERY COIL. THE HRCH'S CAN PROVIDE SIMULTANEOUS HEATING AND COOLING.
- A. HEAT RECOVERY CHILLER MODULE OPERATING MODES:
- THE BACS COMMANDS EACH HRCH TO CONTROL IN AUTO MODE OR OFF. IN AUTO MODE EACH MODULE IS CAPABLE OF OPERATING IN 1 OF 3 MODES, PRODUCING HEATING WATER, CHILLED WATER OR BOTH. A MODULE MAY NOT BE OPERATED IN MORE THAN ONE MODE AT A TIME.
1. MODULE MODE 1: HEAT RECOVERY MODE WITH FULL CHILLED WATER AND FULL HOT WATER.
 - a. THE CHILLER EVAPORATOR ISOLATION VALVE IS OPEN.
 - b. THE HEAT RECOVERY COIL ISOLATION VALVE IS OPEN.
 - c. THE AIR-COOLED CONDENSER IS INACTIVE.
 - d. THE HEATING WATER LOOP RECLAIMS HEAT (VIA CHILLED WATER-TO-REFRIGERANT-TO-HOT WATER) FROM:
 - 1) BUILDING COOLING LOADS VIA ANY AHU COOLING COIL HEAT TRANSFERRED TO THE CHILLED WATER LOOP.
 - 2) EXHAUST AIR HEAT RECOVERY VIA ANY EAHU HEAT RECOVERY COIL HEAT TRANSFERRED TO THE CHILLED WATER LOOP.
 - 3) HEAT OF COMPRESSION.
 2. MODULE MODE 2: CHILLER-ONLY MODE WITH FULL CHILLED WATER AND NO HOT WATER.
 - a. THE CHILLER EVAPORATOR ISOLATION VALVE IS OPEN.
 - b. THE HEAT RECOVERY COIL ISOLATION VALVE IS CLOSED.
 - c. THE AIR-COOLED CONDENSER IS ACTIVE.
 - d. THE HEATING WATER LOOP HAS NO HEAT RECLAMATION.
 3. MODULE MODE 3: HEATING-ONLY MODE WITH FULL HOT WATER AND NO CHILLED WATER.
 - a. THE CHILLER EVAPORATOR ISOLATION VALVE IS CLOSED.
 - b. THE HEAT RECOVERY COIL ISOLATION VALVE IS OPEN.

- c. THE AIR-COOLED CONDENSER IS ACTIVE IN HEAT PUMP MODE.
- d. THE HEATING WATER LOOP RECLAIMS HEAT (VIA OUTSIDE AIR-TO-REFRIGERANT-TO-HOT WATER) FROM:
 - 1) OUTSIDE AIR HEAT, VIA THE AIR-COOLED CONDENSER, IS TRANSFERRED TO THE REFRIGERATION LOOP.
 - 2) HEAT OF COMPRESSION.
- 4. THE HRC AND THE ASSOCIATED PUMPS SHALL BE COMMANDED ON IN AUTO MODE AS FOLLOWS:
 - a. THE LEAD HRCH SHALL BE COMMANDED ON CONTINUOUSLY. CYCLE WHICH HRCH IS THE LEAD ONCE PER WEEK.
 - b. A FAILURE OF THE LEAD HRCH OR ITS ASSOCIATED PUMP SHALL MAKE THE LAG CHILLER THE LEAD CHILLER.
 - c. THE LAG HRCH SHALL BE COMMANDED ON IN AUTO IF ANY OF THE FOLLOWING ARE TRUE:
 - 1) THE TOTAL CALCULATED CHILLED WATER BUILDING LOAD IS ABOVE 5,400 MBH FOR 15 MIN (ADJUSTABLE).
 - 2) THE RETURN CHILLED WATER TEMPERATURE IS ABOVE 56 °F FOR 15 MIN (ADJUSTABLE).
 - 3) THE TOTAL CALCULATED HEATING WATER BUILDING LOAD IS ABOVE 4,600 MBH FOR 15 MIN (ADJUSTABLE).
 - 4) THE RETURN HEATING WATER TEMPERATURE IS LESS THAN 100 °F FOR 15 MIN (ADJUSTABLE).
 - d. THE LAG HRCH SHALL BE COMMANDED OFF IF ANY OF THE FOLLOWING ARE TRUE:
 - 1) THE TOTAL CALCULATED CHILLED WATER BUILDING LOAD IS LESS THAN 3,600 MBH FOR 15 MIN (ADJUSTABLE). AND THE LAG HRCH CALCULATED CAPACITY IS LESS THAN 2,400 MBH FOR BOTH HW AND CHW.
 - 2) THE RETURN CHILLED WATER TEMPERATURE IS BELOW 49 °F FOR 15 MIN (ADJUSTABLE), AND c.(1), c.(3) OR c.(4) ABOVE ARE NOT TRUE.
 - 3) THE RETURN HEATING WATER TEMPERATURE IS ABOVE 105°F FOR 15 MIN (ADJUSTABLE), AND c.(1), c.(2) OR c.(4) ABOVE ARE NOT TRUE.
 - 4) THE TOTAL CALCULATED HEATING WATER BUILDING LOAD IS LESS THAN 3,000 MBH, FOR 15 MINS (ADJUSTABLE) AND THE LAG HRCH CALCULATED CAPACITY IS LESS THAN 2,400 MBH FOR BOTH HW AND CHW.
- 5. BUILDING LOADS AND EQUIPMENT CAPACITY SHALL BE ESTIMATED AS FOLLOWS:
 - a. THE BAC SHALL CALCULATE THE BTU OF THE BUILDING EVERY 5 MINUTES. VALUES CALCULATED ARE AS FOLLOWS:
 - 1) BTU OF CHILLED WATER LOADS.
 - 2) BTU OF HEAT RECOVERY LOADS.
 - 3) BTU OF HEATING WATER LOADS.
 - 4) BTU OF 1150-L12-HRCH-01 HEATING WATER CAPACITY.
 - 5) BTU OF 1150-L12-HRCH-01 CHILLED WATER CAPACITY.
 - 6) BTU OF 1150-L12-HRCH-02 HEATING WATER CAPACITY.
 - 7) BTU OF 1150-L12-HRCH-02 CHILLED WATER CAPACITY.
 - b. THE BAC SHALL ALSO TAKE THE LEVEL 12 BTU METER READINGS FOR HEATING WATER AND CHILLED WATER AND ADD THEM TO THE LOADS CALCULATED AT THE FLOW METERS TO OBTAIN

- ESTIMATED BUILDING LOAD TOTALS.
- B. HEAT RECOVERY CHILLER PRIMARY PUMP CONTROL
EACH HEAT RECOVERY CHILLER BANK IS ASSIGNED TWO VARIABLE-SPEED PRIMARY PUMPS. ONE PUMP DISTRIBUTES CHILLED WATER TO ALL EVAPORATOR COILS IN EACH MODULE AND THE OTHER PUMP DISTRIBUTES HEATING WATER TO ALL HEAT RECOVERY COILS IN EACH MODULE. FOR EACH BANK OF MODULES, ALL EVAPORATOR COILS ARE PIPED IN A PARALLEL FLOW, REVERSE-RETURN CONFIGURATION WITH EACH OTHER, AND ALL HEAT RECOVERY COILS ARE ALSO PIPED IN A PARALLEL FLOW, REVERSE-RETURN FLOW CONFIGURATION WITH EACH OTHER. THE REVERSE-RETURN, PARALLEL FLOW PIPING CONFIGURATION, IN CONJUNCTION WITH THE COORDINATION OF EACH BANK'S ISOLATION VALVES AND BYPASS VALVE, IS DESIGNED TO MAINTAIN A RELATIVELY CONSTANT FLOW THROUGH THE HEAT RECOVERY CHILLER WHILE MINIMIZING DIFFERENTIAL PRESSURE FLUCTUATIONS ACROSS EACH BANK. EACH EVAPORATOR COIL AND EACH HEAT RECOVERY COIL IS EQUIPPED WITH A 2-WAY, 2-POSITION MOTORIZED ISOLATION VALVE.
 - 1. EACH ISOLATION VALVE'S HEAT RECOVERY COIL IS EQUIPPED WITH A 2-WAY, 2-POSITION MOTORIZED ISOLATION VALVE. EACH ISOLATION VALVE'S OPEN OR CLOSED POSITION DEPENDS ON THE OPERATING MODE OF THE MODULE.
 - 2. THE MULTISTACK FACTORY CONTROLLER COMMANDS EACH MODULES ISOLATION VALVES AND BYPASSES A MINIMUM PERCENTAGE AS REQUIRED TO MAINTAIN CONTINUOUS FLOW.
 - 3. THE PRIMARY PUMP SPEED IS CONTROLLED BY A SIGNAL DIRECTLY FROM THE DIFFERENTIAL PRESSURE SIGNAL ACROSS THE HRCH BANK. EACH PUMP VFD SETPOINT AND RANGE SHALL BE SETUP TO MAINTAIN A FIXED DIFFERENTIAL PRESSURE SETPOINT (INITIALLY 5 PSI) ACROSS THE ASSOCIATED FLOW CIRCUIT, BOTH THE VAPORATOR HEAT EXCHANGER AND THE HEAT RECOVERY HEAT EXCHANGER. THE DIFFERENTIAL PRESSURE IS MEASURED ACROSS EACH BANK OF MODULES AT A POINT WHERE THE PIPING ENTERS AND EXITS THE HEAT RECOVERY CHILLER.
 - a. THE FIXED DIFFERENTIAL PRESSURE SETPOINT SHALL BE ADJUSTABLE AND DETERMINED BY THE TEST AND BALANCE TECHNICIAN.
 - C. CHILLED WATER SUPPLY TEMPERATURE SETPOINT.
 - 1. ALL CHILLER MODULES SHALL OPERATE WITH THE SAME CHILLED WATER SUPPLY TEMPERATURE SETPOINT.
 - a. THE CHW SUPPLY TEMPERATURE SETPOINT IS 42°F (ADJUSTABLE)
 - b. THE DESIGN CHW RETURN TEMPERATURE SETPOINT IS 56°F.
 - 2. THE INTERNAL HRCH CHW SUPPLY TEMPERATURE SETPOINT SHALL BE GIVEN THE FOLLOWING RANGE (+/- 2°F).
 - a. THIS CHW SUPPLY TEMPERATURE SETPOINT DEADBAND IS TO HELP MITIGATE SHORT CYCLING OF THE CHILLER COMPRESSORS. DURING TESTING AND BALANCING THIS DEADBAND IS TO BE REDUCED AS LOW AS POSSIBLE WHILE PREVENTING SHORT CYCLING OF THE CHILLER COMPRESSORS.
 - D. HEATING WATER SUPPLY TEMPERATURE SETPOINT.
 - 1. ALL CHILLER MODULES SHALL OPERATE WITH THE SAME HEATING WATER SUPPLY TEMPERATURE SETPOINT.

- a. THE HW SUPPLY TEMPERATURE SETPOINT IS 120°F (ADJUSTABLE, LIMITED BETWEEN 115-120°F)
- b. THE DESIGN HW RETURN TEMPERATURE SETPOINT IS 100°F.
- c. THE DESIGN HW SUPPLY TEMPERATURE SETPOINT SHALL BE RESET PROPORTIONALLY BETWEEN 40°F AND 17°F AMBIENT IN 1°F INCREMENTS EVERY 15 MINUTES BETWEEN 120°F AND 95°F.
- 2. THE INTERNAL HRCH HW SUPPLY TEMPERATURE SETPOINT SHALL BE GIVEN THE FOLLOWING RANGE (+/- 2°F) (ADJUSTABLE).
 - a. THIS HW SUPPLY TEMPERATURE SETPOINT DEADBAND IS TO HELP MITIGATE SHORT CYCLING OF THE CHILLER COMPRESSORS. DURING TESTING AND BALANCING THIS DEADBAND IS TO BE REDUCED AS LOW AS POSSIBLE WHILE PREVENTING SHORT CYCLING OF THE CHILLER COMPRESSORS.
- E. ALARMS
 - 1. EMERGENCY STOP PUSHBUTTON ALARM: ALARM IF THE PUSHBUTTON SENSOR STATUS IS DETECTED. BOILERS AND ASSOCIATED PUMPS SHALL BE DISABLED.
 - 2. GLYCOL MAKEUP PUMP ALARM: IF THE GLYCOL HW OR CHW PUMP STATUS IS DETECTED, A MAKEUP WATER LEAK ALARM SHALL TRIGGER.
 - 3. FILL PRESSURE ALARM: IF THE FILL PRESSURE OF THE GLYCOL MAKEUP SYSTEM IS TOO HIGH OR LOW THEN ALARM.
 - 4. CWGP FAILURE OR IN HAND ALARM: ALARM IF THE EXPECTED STATUS FEEDBACK DOES NOT MATCH THE COMMAND FOR 30 SECONDS.
 - 5. HWGP FAILURE OR IN HAND ALARM: ALARM IF THE EXPECTED STATUS FEEDBACK DOES NOT MATCH THE COMMAND FOR 30 SECONDS.
 - 6. HEAT RECOVERY CHILLER FAILURE OR IN HAND ALARM:
 - a. ALARM IF THE HRCH ALARM CONTACT IS CLOSED.
 - b. ALARM IF THE HRCH IS RUNNING WITH NO COMMAND.
 - 7. HEAT RECOVERY CHILLER MODULE FAULT: ALARM IF THE HRCH BACNET POINTS INDICATE A FAULT.
 - 8. DIFFERENTIAL PRESSURE SENSOR FAILURE: IF THE SENSOR DOES NOT READ WITHIN AN EXPECTED VALUE WITH PROOF OF WATER FLOW
 - 9. HIGH LOOP SUPPLY TEMP: ALARM IF THE LOOP SUPPLY TEMPERATURE IS ABOVE THE ALARM SETPOINT.
 - 10. LOW HRCH HW SUPPLY TEMP: AFTER THE SYSTEM HAS BEEN RUNNING FOR 5 MINUTES SECONDS (ADJUSTABLE), GENERATE A LOW HEATING WATER TEMPERATURE ALARM, IF HRCH IS IN HEATING MODE OR HEAT RECOVERY MODE, AND THE PRIMARY HEAT RECOVERY HEATING WATER LOOP SUPPLY TEMP DIFFERENTIAL TEMPERATURE (LWT-EWT) IS LESS 4°. THIS IS NOT A CRITICAL FAULT REQUIRING SHUTDOWN.
 - 11. HIGH HRCH CHW SUPPLY TEMP: AFTER THE SYSTEM HAS BEEN RUNNING FOR 5 MINUTES SECONDS (ADJUSTABLE), GENERATE A HIGH CHILLED WATER TEMPERATURE ALARM, IF HRCH IS IN COOLING MODE OR HEAT RECOVERY MODE, AND THE PRIMARY CHILLED WATER LOOP SUPPLY TEMP DIFFERENTIAL TEMPERATURE (EWT-LWT) IS LESS 4°. THIS IS NOT A CRITICAL FAULT REQUIRING SHUTDOWN.

7. **HEATING WATER SYSTEM**

- THE HEATING WATER SYSTEM IS COMPRISED OF (2) HEAT RECOVERY CHILLERS AND (2) 4000 MBH CONDENSING BOILERS LOCATED ON THE ROOF AND ARE PIPED IN A PRIMARY-SECONDARY ARRANGEMENT
- A. THE HEAT RECOVERY CHILLER IS THE DEFAULT SOURCE OF HEATING AND IS ENABLED CONTINUOUSLY IN AUTO MODE.
 - B. THE CONDENSING BOILERS ONLY PROVIDE SUPPLEMENTAL HEATING WHEN THE OUTSIDE AIR TEMPERATURE IS LESS THAN 33°F AND COME EQUIPPED WITH INTEGRAL FACTORY INSTALLED BOILER CIRCULATION (PRIMARY) PUMPS.
 - C. HEATING WATER DISTRIBUTION SYSTEM
 - 1. A COMMON PIPE SEPARATES THE HEATING HOT WATER PRIMARY LOOP FROM THE HEATING HOT WATER SECONDARY DISTRIBUTION SYSTEM. THE HEATING HOT WATER PRODUCED IS DISTRIBUTED THROUGHOUT THE BUILDING BY TWO HEATING HOT WATER DISTRIBUTION PUMPS WHICH ARE PIPED IN A PARALLEL ARRANGEMENT. EACH DISTRIBUTION PUMP HAS THE SAME FLOW CAPACITY, AND THE ARRANGEMENT IS DESIGNED TO PROVIDE MAXIMUM FLOW CAPACITY TO THE BUILDING WHILE OPERATING ONLY ONE DISTRIBUTION PUMP AT A TIME IN A LEAD-STANDBY SEQUENCE. AT LEAST ONE PUMP SHALL OPERATE CONTINUOUSLY.
 - a. THE SECONDARY DISTRIBUTION PUMPS ARE CONTROLLED BY THE BACS. THE BACS MODULATES THE SPEED OF THE **SECONDARY** PUMP TO MAINTAIN A FIXED DIFFERENTIAL PRESSURE SETPOINT (INITIALLY 10 PSI) ACROSS THE HEATING WATER LOOP OR OPERATE AT MINIMUM SPEED.
 - 1) THE FIXED DIFFERENTIAL PRESSURE SETPOINT SHALL BE ADJUSTABLE AND DETERMINED BY THE TEST AND BALANCE TECHNICIAN WITH A FULL FLOW TEST, AND THE BYPASSES FULLY CLOSED.
 - 2) BYPASS VALVES ARE MODULATED PER BELOW:
 - A) IF THE SECONDARY DISTRIBUTION PUMPS ARE AT MINIMUM SPEED, THE BACS MODULATES THE BYPASSES TO MAINTAIN THE PRIMARY DIFFERENTIAL PRESSURE SETPOINT ACROSS THE HEATING WATER LOOP.
 - I. THE MINIMUM PUMP SPEED SETPOINT SHALL BE DETERMINED BY THE TEST AND BALANCE TECHNICIAN BY CLOSING ALL SYSTEM VALVES AND WITH THE BYPASS VALVE UNDER CONTROL OF THE DPT. THE MINIMUM PUMP SPEED SETPOINT SHALL BE THE SPEED AT WHICH THE PUMP MAINTAINS THE MINIMUM PUMP FLOW AS TESTED IN THIS CONDITION.
 - B) BUFFERING BYPASS SEQUENCE: IN ORDER TO PREVENT SHORT CYCLING OF THE HEAT RECOVERY CHILLER(S), WATER IS CIRCULATED THROUGH LARGE VOLUME PIPING BY MODIFYING THE BYPASS VALVE POSITION AS FOLLOWS:
 - I. IF THE COMMON PRIMARY LOOP SUPPLY HOT WATER TEMPERATURE CHANGES MORE THAN 5°F

- (ADJ) IN ANY 10 MIN (ADJUSTABLE) INTERVAL, THEN INCREASE THE MINIMUM BYPASS VALVE POSITION (SMALLER VALVE FIRST) BY 5% (ADJUSTABLE) MORE OPEN.
- II. IF THE DIFFERENCE BETWEEN THE COMMON PRIMARY SUPPLY HOT WATER TEMPERATURE AND THE SECONDARY RETURN WATER TEMPERATURE IS LESS THAN 7°F (ADJUSTABLE) CONTINUOUSLY FOR 10 MINS (ADJ), THEN REDUCE THE MINIMUM BYPASS VALVE POSITION (SMALLER VALVE FIRST) BY 5% (ADJUSTABLE) LESS OPEN.
- III. IF THE SMALLER VALVE IS 100% OPEN, STAGE OPEN THE LARGER BYPASS VALVE.
- IV. QUALIFY THESE CONDITIONS AND VARY POSITION ONCE EVERY 5 MINS (ADJUSTABLE).
- b. THE BACS ENABLES EACH PUMP WITH A HARDWIRED SIGNAL TO THE VFD. IF THE LEAD PUMP FAILS THE BACS WILL ENABLE THE LAG PUMP AS THE LEAD PUMP. IF THE DIFFERENTIAL PRESSURE 2 PSI BELOW OR ABOVE SETPOINT FOR MORE THAN 15 MINUTES THE BACS SHALL GENERATE AN PUMP UNABLE TO MAINTAIN SETPOINT ALARM BUT CONTINUE TO ENABLE THE LEAD PUMP.
- c. THE BACS SHALL DETERMINE THE PUMP WITH THE LEAST RUNTIME, FOR THIS PURPOSE PUMP RUNTIME SHALL BE EVALUATED ONCE A WEEK. THE BACS SHALL START THE LAG PUMP AND SHALL PROVE PUMP FLOW VIA STATUS FEEDBACK, THE LAG PUMP SHALL RAMP UP SLOWLY TO MATCH THE SPEED OF THE LEAD PUMP. THE LEAD PUMP SHALL CONTINUE TO MAINTAIN THE DIFFERENTIAL PRESSURE SETPOINT. ONCE THE LAG PUMP AND LEAD PUMP ARE AT THE SAME SPEED THE LAG PUMP SHALL BECOME THE LEAD PUMP AND THE LEAD PUMP SHALL SLOWLY RAMP DOWN TO 15 HZ AND THEN TURN OFF.
- 2. A GLYCOL MAKE-UP WATER PACKAGE IS ON THE HEATING WATER SYSTEM. IT HAS A STANDALONE CONTROLLER, HAND-OFF-AUTO SWITCH, REDUNDANT FAIL-SAFE PUMP CONTROLS, PRESSURE GAUGE, PRV, AND LOW-LEVEL ALARM. BACS MONITORING SHALL INCLUDE PUMP STATUS AND LOW-LEVEL ALARM.
- 3. ADDITIONALLY, THE BACS SHALL MEASURE THE FILL PRESSURE AND ALARM ON A LOW OR HIGH PRESSURE OF 10 PSI AND 20 PSI RESPECTIVELY (BOTH SETTINGS SHALL BE ADJUSTABLE).
- D. BOILER CONTROL
 - 1. BOILER HEATED HOT WATER AND LOCAL PRIMARY BOILER WATER CIRCULATION PUMP CONTROL WILL BE ACCOMPLISHED THROUGH AN INTEGRATED FACTORY BOILER CONTROLLER. THE BACS SYSTEM SHALL SUPPLY THE FOLLOWING INPUTS TO THE BOILER CONTROLLER:
 - a. HEATING WATER SYSTEM ENABLE
 - b. HEATING WATER SUPPLY TEMPERATURE SETPOINT.
 - 2. THE BOILER CONTROLLER SHALL OPERATE THE BOILERS AND BOILER CIRCULATION PUMPS IN A LEAD-LAG CONFIGURATION TO MAINTAIN THE HEATING WATER SUPPLY TEMPERATURE SETPOINT.

- THE BOILER CONTROLLER SHALL SEND A GENERAL ALARM TO THE BACS.
- 3. DURING STARTUP OF THE BOILER PLANT THE HW SUPPLY TEMPERATURE SETPOINT IN THE SECONDARY LOOP SHALL BE 115 °F. A RESET SEQUENCE IS INCLUDED ON THE BOILERS TO KEEP THE HEAT RECOVERY CHILLER OPERATING. REDUCE HEATING WATER SETPOINT TO 105°F IN 1 °F INCREMENTS EVERY 10 MINUTES, IF THE HEAT RECOVERY CHILLER IS NOT OPERATING ALL MODULES, THE SECONDARY SUPPLY WATER TEMPERATURE IS ABOVE 113 °F, AND THE SECONDARY RETURN WATER TEMPERATURE ENTERING THE BRIDGE IS ABOVE 103 °F.
 - a. IF THE SECONDARY SUPPLY WATER TEMPERATURE IS BELOW 113 °F FOR 5 MINUTES RESET SETPOINT TO INCREASE BOILER SUPPLY WATER TEMPERATURE SETPOINT UP TO 115 °F IN INCREMENTS OF 1 °F.
 - b. IF THE MIXED HRCH LEAVING WATER TEMPERATURE IS MORE THAN 1 °F BELOW THE HEATING SETPOINT FOR 5 MINUTES, THEN THE BACS SHALL RESET THE BOILER SUPPLY HEATING WATER TEMPERATURE SETPOINT UP 1 °F EVERY 10 MINUTES.
 - c. IF THE AMBIENT TEMPERATURE IS BELOW 30°F (NOT ADJUSTABLE), THE MAXIMUM TEMPERATURE SETPOINT IN THE SECONDARY LOOP FOR THE BOILERS IS INCREASED FROM 115°F TO 120°F.
 - 4. d. INTERNAL TO THE BOILERS IS A 10 °F HW SUPPLY TEMPERATURE SETPOINT DEADBAND TO HELP MITIGATE SHORT CYCLING OF THE BOILERS. DISABLE BOILERS IF THE OUTDOOR AIR TEMPERATURE IS ABOVE 33°F (ADJUSTABLE) AND THERE ARE NO HRCH FAILURES.
 - E. ALARMS:
 - 1. PUMP UNABLE TO MAINTAIN SETPOINT ALARM: ALARM IS GENERATED IF THE DIFFERENTIAL PRESSURE IS 2 PSI (ADJUSTABLE) BELOW OR ABOVE SETPONIT FOR MORE THAN 15 MINUTES. (ADJUSTABLE)
 - 2. LOW LEVEL WATER ALARM: ALARM WILL GENERATE IF GLYCOL MAKE-UP WATER UNIT TRIGGERS A LOW LEVEL ALARM.
 - 3. FILL PRESSURE ALARM: GENERATES ALARM IF THE FILL PRESSURE IS 10 PSI OR LOWER.
 - 4. HIGH FILL PRESSURE ALARM: GENERATES ALARM IF THE FILL PRESSURE IS 20 PSI OR HIGHER.
 - 5. BOILER FAILURE OR IN HAND ALARM:
 - a. ALARM IF THE BOILER ALARM CONTACT IS CLOSED.
 - b. ALARM IF THE BOILER IS RUNNING WITH NO COMMAND.
 - 6. HWDP FAILURE OR IN HAND ALARM: ALARM IF THE EXPECTED STATUS FEEDBACK DOES NOT MATCH THE COMMAND.
 - 7. EMERGENCY STOP ALARM: ALARM WHEN E-STOP BUTTON (PROVIDED BY E.C.) IS ACTIVATED. UPON ACTIVATION, THE BOILERS AND ASSOCIATED PUMPS WILL SHUTDOWN. SHUT DOWN IS TO COMPLY WITH THE REQUIREMENTS OF ASME CSD-1 CODE PART CE. ONE PUSHBUTTON SHUTDOWN SWITCH FOR BOILERS SHALL BE AT EACH ENTRANCE TO THE BOILER ROOM.
 - 8. LOW LOOP SUPPLY TEMP: AFTER THE SYSTEM HAS BEEN RUNNING FOR 5 MINUTES (ADJUSTABLE), GENERATE AN ALARM IF THE PRIMARY HEAT RECOVERY CHILLED WATER LOOP SUPPLY TEMP IS BELOW 110°F (ADJUSTABLE). THIS IS NOT A CRITICAL ALARM

REQUIRING SHUTDOWN.

8. CHILLED WATER SYSTEM

A. CHILLED WATER FLOW AND PRESSURE CONTROL

1. THE CHILLED WATER SYSTEM IS COMPRISED OF (2) HEAT RECOVERY CHILLERS LOCATED ON THE ROOF AND ARE PIPED IN A PRIMARY-SECONDARY ARRANGEMENT.
2. THE HEAT RECOVERY CHILLERS ARE THE PRIMARY SOURCE OF COOLING
3. A COMMON PIPE SEPARATES THE CHILLED WATER PRIMARY LOOP FROM THE CHILLED WATER SECONDARY DISTRIBUTION SYSTEM. THE CHILLED WATER PRODUCED IS DISTRIBUTED THROUGHOUT THE BUILDING BY TWO CHILLED WATER DISTRIBUTION PUMPS (CHWP-R-03 AND CHWP-R-04) WHICH ARE PIPED IN A PARALLEL ARRANGEMENT. EACH DISTRIBUTION PUMP HAS THE SAME FLOW CAPACITY, AND THE ARRANGEMENT IS DESIGNED TO PROVIDE MAXIMUM FLOW CAPACITY TO THE BUILDING WHILE OPERATING ONLY ONE DISTRIBUTION PUMP AT A TIME IN A LEAD-STANDBY SEQUENCE.

- a. THE SECONDARY DISTRIBUTION PUMPS ARE CONTROLLED BY THE BACS. THE BACS MODULATES THE SPEED OF THE **SECONDARY** PUMP TO MAINTAIN A FIXED DIFFERENTIAL PRESSURE SETPOINT (INITIALLY 10 PSI) ACROSS THE CHILLED WATER LOOP OR OPERATE AT MINNMUM SPEED.

- 1) THE FIXED DIFFERENTIAL PRESSURE SETPOINT SHALL BE ADJUSTABLE AND DETERMINED BY THE TEST AND BALANCE TECHNICIAN WITH A FULL FLOW TEST, AND THE BYPASSES FULLY CLOSED.
- 2) BYPASS VALVES ARE MODULATED PER BELOW:.

- A) IF THE SECONDARY DISTRIBUTION PUMPS ARE AT MINIMUM SPEED, THE BACS MODULATES THE BYPASSES TO MAINTAIN THE PRIMARY DIFFERENTIAL PRESSURE SETPOINT ACROSS THE CHILLED WATER LOOP AND THE HEAT RECOVERY LOOP BYPASS TO MAINTAIN THE DIFFERENTIAL PRESSURE SETPOINT (INITIALLY 10 PSI) ACROSS THE HEAT RECOVERY LOOP.
- I. THE MINIMUM PUMP SPEED SETPOINT SHALL BE DETERMINED BY THE TEST AND BALANCE TECHICIAN BY CLOSING ALL SYSTEM VALVES AND WITH THE BYPASS VALVE UNDER CONTROL OF THE DPT. THE MINIMUM PUMP SPEED SETPOINT SHALL BE THE SPEED AT WHICH THE PUMP MAINTAINS THE MINIMUM PUMP FLOW AS TESTED IN THIS CONDITION.

- B) BUFFERING BYPASS SEQUENCE: IN ORDER TO PREVENT SHORT CYCLING OF THE HEAT RECOVERY CHILLER(S), WATER IS CIRCULATED THROUGH LARGE VOLUME PIPING BY MODIFYING THE BYPASS VALVE POSITION AS FOLLOWS:

- I. IF THE COMMON PRIMARY LOOP SUPPLY CHILLED WATER TEMPERATURE CHANGES MORE THAN 5°F (ADJ) IN ANY 10 MIN (ADJ) INTERVAL, THEN

INCREASE THE MINIMUM BYPASS VALVE POSITION (SMALLER VALVE FIRST) BY 5% (ADJUSTABLE) MORE OPEN.

- II. IF THE DIFFERENCE BETWEEN THE COMMON PRIMARY SUPPLY CHILLED WATER TEMPERATURE AND THE SECONDARY RETURN WATER TEMPERATURE IS LESS THAN 7°F (ADJUSTABLE) CONTINUOUSLY FOR 10 MINS (ADJ), THEN REDUCE THE MINIMUM BYPASS VALVE POSITION (SMALLER VALVE FIRST) BY 5% (ADJUSTABLE) LESS OPEN.

- III. IF THE SMALLER VALVE IS 100% OPEN, STAGE OPEN THE LARGER HEAT RECOVERY VALVE.

- IV. QUALIFY THESE CONDITIONS AND VARY POSITION ONCE EVERY 5 MINS (ADJUSTABLE).

- C) IF THE SECONDARY DISTRIBUTION PUMPS ARE AT MINIMUM SPEED, THE BACS MODULATES THE BYPASSES TO MAINTAIN THE PRIMARY DIFFERENTIAL PRESSURE SETPOINT ACROSS THE CHILLED WATER LOOP AND THE HEAT RECOVERY LOOP BYPASS TO MAINTAIN THE DIFFERENTIAL PRESSURE SETPOINT (INIT 10 PSI) ACROSS THE HEAT RECOVERY LOOP.

- I. THE MINIMUM PUMP SPEED SETPOINT SHALL BE DETERMINED BY THE TEST AND BALANCE TECHICIAN BY CLOSING ALL SYSTEM VALVES AND WITH THE BYPASS VALVE UNDER CONTROL OF THE DPT. THE MINIMUM PUMP SPEED SETPOINT SHALL BE THE SPEED AT WHICH THE PUMP MAINTAINS THE MINIMUM PUMP FLOW AS TESTED IN THIS CONDITION.

- b. THE BACS ENABLES EACH PUMP WITH A HARDWIRED SIGNAL TO THE VFD. IF THE LEAD PUMP FAILS THE BACS WILL ENABLE THE LAG PUMP AS THE LEAD PUMP. IF THE DIFFERENTIAL PRESSURE 2 PSI BELOW OR ABOVE SETPOINT FOR MORE THAN 15 MINUTES THE BACS SHALL GENERATE AN PUMP UNABLE TO MAINTAIN SETPOINT ALARM, BUT CONTINUE TO ENABLE THE LEAD PUMP.

- c. THE BACS SHALL DETERMINE THE PUMP WITH THE LEAST RUNTIME, FOR THIS PURPOSE PUMP RUNTIME SHALL BE EVALUATED ONCE A WEEK. THE BACS SHALL START THE LAG PUMP AND SHALL PROVE PUMP FLOW VIA STATUS FEEDBACK, THE LAG PUMP SHALL RAMP UP SLOWLY TO MATCH THE SPEED OF THE LEAD PUMP. THE LEAD PUMP SHALL CONTINUE TO MAINTAIN THE DIFFERENTIAL PRESSURE SETPOINT. ONCE THE LAG PUMP AND LEAD PUMP ARE AT THE SAME SPEED THE LAG PUMP SHALL BECOME THE LEAD PUMP AND THE LEAD PUMP SHALL SLOWLY RAMP DOWN TO 15 HZ AND THEN TURN OFF.

4. A GLYCOL MAKE-UP WATER PACKAGE IS ON THE CHILLED WATER SYSTEM. IT HAS A STANDALONE CONTROLLER, HAND-OFF-AUTO SWITCH, REDUNDANT FAIL SAFE PUMP CONTROLS, PRESSURE GAUGE, PRV, AND LOW LEVEL ALARM. BACS MONITORING SHALL INCLUDE PUMP STATUS AND LOW LEVEL ALARM.

5. ADDITIONALLY THE BACS SHALL MEASURE THE FILL PRESSURE AND ALARM ON A LOW OR HIGH PRESSURE OF 10 PSI AND 20 PSI RESPECTIVELY (BOTH SETTINGS SHALL BE ADJUSTABLE).

B. ALARMS:

1. PUMP UNABLE TO MAINTAIN SETPOINT ALARM: ALARM IS GENERATED IF THE DIFFERENTIAL PRESSURE IS 2 PSI (ADJUSTABLE) BELOW OR ABOVE SETPOINT FOR MORE THAN 15 MINUTES. (ADJUSTABLE)
2. LOW LEVEL WATER ALARM: ALARM WILL GENERATE IF GLYCOL MAKE-UP WATER UNIT TRIGGERS AN ALARM.
3. LOW FILL PRESSURE ALARM: GENERATES ALARM IF THE FILL PRESSURE IS 10 PSI OR LOWER.
4. HIGH FILL PRESSURE ALARM: GENERATES ALARM IF THE FILL PRESSURE IS 20 PSI OR HIGHER.
5. CWDP FAILURE OR IN HAND ALARM: ALARM IF THE EXPECTED STATUS FEEDBACK DOES NOT MATCH THE COMMAND.
6. **HIGH LOOP SUPPLY TEMP: AFTER THE SYSTEM HAS BEEN RUNNING FOR 5 MINUTES (ADJUSTABLE), GENERATE AN ALARM IF THE PRIMARY HEAT RECOVERY CHILLED WATER LOOP SUPPLY TEMP IS ABOVE 49 °F (ADJUSTABLE). THIS IS NOT A CRITICAL ALARM REQUIRING SHUTDOWN.**

9. 4-PIPE FAN COIL UNITS (EACH FCU, TAGGED: 1150-LXX-FCU-XX)

EACH 4-PIPE FAN COIL UNIT CONTROLS THEIR RESPECTIVE ZONE TEMPERATURE. UNITS ARE EQUIPPED WITH HOT WATER HEATING COILS AND CHILLED WATER-COOLING COILS.

A. UNOCCUPIED MODE

1. TERMINAL UNIT FAN IS STOPPED.
2. ZONE TEMPERATURE HEATING SETPOINT IS SET TO 60°F (ADJUSTABLE).
3. ZONE TEMPERATURE COOLING SETPOINT IS SET TO 80°F (ADJUSTABLE).
4. UNOCCUPIED COOLING MODE
 - a. IF THE MEASURED ZONE TEMPERATURE RISES ABOVE THE UNOCCUPIED COOLING MODE ZONE TEMPERATURE COOLING SETPOINT,
 - 1) TERMINAL UNITS SHALL OPERATE ALONE TO MAINTAIN THE UNOCCUPIED ZONE TEMPERATURE COOLING SETPOINT.
 - b. ONCE THE ZONE TEMPERATURE FALLS BELOW THE UNOCCUPIED ZONE TEMPERATURE COOLING SETPOINT MINUS AN (INITIALLY 5 °F, ADJUSTABLE) DEADBAND, THE FAN COIL UNIT WILL CEASE OPERATION.
5. UNOCCUPIED HEATING MODE
 - a. IF THE MEASURED ZONE TEMPERATURE FALLS BELOW THE UNOCCUPIED HEATING MODE ZONE TEMPERATURE HEATING SETPOINT,
 - 1) TERMINAL UNITS SHALL OPERATE ALONE TO MAINTAIN THE UNOCCUPIED ZONE TEMPERATURE HEATING SETPOINT.
 - b. ONCE THE ZONE TEMPERATURE RISES ABOVE THE UNOCCUPIED ZONE TEMPERATURE HEATING SETPOINT MINUS AN (INITIALLY 5

- °F, ADJUSTABLE) DEADBAND, THE FAN COIL UNIT WILL CEASE OPERATION.
- B. OCCUPIED MODE
1. TERMINAL UNIT WILL ENTER THE OCCUPIED MODE ACCORDING TO AN (ADJUSTABLE) OCCUPANCY SCHEDULE.
 2. THE BACS STARTS THE FAN COIL UNIT AND OPERATES IT CONTINUOUSLY TO SUPPLY ONE OF THE TWO SCHEDULED AIRFLOW RATES TO THE ZONE IN ORDER TO MAINTAIN ZONE FLOW.
 - a. IF THE FAN COIL UNIT IS IN HEATING OR COOLING MODE OPERATE AT THE SCHEDULED DESIGN AIRFLOW RATE.
 - b. IF THE FAN COIL UNIT IS NOT IN HEATING OR COOLING MODE SLOWLY RAMP FAN SPEED TO OPERATE AT THE SCHEDULED MINIMUM AIRFLOW RATE.
 - c. MINIMUM AND MAXIMUM AIRFLOW RATES SHALL BE SET BY THE TEST AND BALANCE CONTRACTOR.
 3. OCCUPIED COOLING MODE
 - a. AS THE ZONE COOLING SIGNAL VARIES BETWEEN 0%-100%, THE CHILLED WATER CONTROL VALVE AND FAN SPEED ARE STAGED AND MODULATED TO CONTROL THE ZONE TEMPERATURE TO THE ZONE TEMPERATURE COOLING SETPOINT.
 - 1) THE COOLING SIGNAL IS GENERATED AS THE ZONE TEMPERATURE RISES ABOVE THE ZONE TEMPERATURE COOLING SETPOINT OF 75 °F (ADJUSTABLE).
 4. OCCUPIED HEATING MODE
 - a. AS THE ZONE HEATING SIGNAL VARIES BETWEEN 0%-100%, THE HEATING WATER CONTROL VALVE AND FAN SPEED ARE STAGED AND MODULATED TO CONTROL THE ZONE TEMPERATURE TO THE ZONE TEMPERATURE HEATING SETPOINT.
 - 1) THE HEATING SIGNAL IS GENERATED AS THE ZONE TEMPERATURE FALLS BELOW THE ZONE TEMPERATURE HEATING SETPOINT OF 70 °F (ADJUSTABLE).
- C. SHUTDOWNS AND SAFETIES
1. GENERATE FCU FAILURE ALARM IF FAN STATUS DOES NOT MATCH COMMAND.
 2. THE INTERNAL CONDENSATE FLOAT SWITCH IS FACTORY WIRED TO SHUTDOWN THE FAN UPON HIGH LEVEL.
- D. ALARMS:
1. SPACE TOO WARM/COLD ALARMS: ALARM IF THE ZONE IS NOT ABLE TO ACHIEVE ZONE TEMPERATURE WITHIN 3°F OF DEADBAND AFTER 2 HOURS OF OCCUPIED MODE.
 2. SPACE TEMP FAILURE: TEMPERATURE IS READING A VALUE OUT OF THE EXPECTED RANGE. IF A RETURN SENSOR EXISTS AND HAS A VALID READING, THIS SHALL BE USED AS THE INTERIM SPACE TEMPERATURE READING UNTIL THE SPACE SENSOR READING IS FIXED.
 3. DISCHARGE AIR TEMP FAILURE: TEMPERATURE IS READING A VALUE OUT OF THE EXPECTED RANGE.
 4. DRAIN PAN FLOAT SWITCH ALARM: GENERATE AN ALARM IF THE INTERLOCKED FLOAT SWITCH IS ENABLED. THIS WILL SHUT DOWN THE FAN.
 5. SUPPLY FAN FAILURE OR IN HAND ALARM: ALARM IF THE EXPECTED FAN STATUS DOES NOT MATCH THE FAN COMMAND.

- E. L1 & L12 FCU: SAME SEQUENCES AS ABOVE WITH THESE EXCEPTIONS,
1. SUPPLY AIR FROM 1150-L1-ERV-1 (L1) & 1150-L12-DOAS-01 (L12) TERMINATE WITHIN 12 INCHES OF THE FCU INTAKE AIR OPENING AND ARE SUPPLIED WITH EITHER A VAV FOR UNITS SERVING DCV SPACES OR CONSTANT VOLUME AIR VALVES FOR NON DCV UNITS.
 2. MODULATE THE VAV (AV) BETWEEN MINIMUM AND MAXIMUM AIRFLOW AS CO2 IS ABOVE 1,000 PPM FOR BASED DEMAND CONTROL VENTILATION (DCV). ALARM CO2 IF ABOVE 2,000 PPM.

10. SUPPLY TERMINAL UNITS WITH HYDRONIC REHEAT (EACH SV, TAGGED: 1150-LXX-SV-XX)

SINGLE DUCT SUPPLY TERMINAL UNITS CONTROL THEIR RESPECTIVE ZONE TEMPERATURES AND PROVIDE A CONSTANT VOLUME OF AIR TO MAINTAIN MINIMUM VENTILATION RATES. UNITS ARE EQUIPPED WITH HOT WATER HEATING COILS FOR REHEATING THE PRIMARY AIR WHEN THE ZONE REQUIRES HEAT. PRIMARY AIR DAMPER IS MODULATED WITH A FLOATING-POINT DAMPER MOTOR.

- A. UNOCCUPIED MODE
1. TERMINAL UNIT GOES UNOCCUPIED WHENEVER ITS ASSOCIATED SUPPLY AIR HANDLING UNIT (SAHU) GOES UNOCCUPIED.
 2. SUPPLY AIR DAMPER IS COMMANDED CLOSED.
- B. OCCUPIED MODE
1. TERMINAL UNIT WILL ENTER THE OCCUPIED MODE AS LONG AS ITS ASSOCIATED SUPPLY AIR HANDLING UNIT (SAHU) IS IN THE OCCUPIED MODE.
 2. SUPPLY TERMINAL UNIT WILL MODULATE ITS DAMPER TO MAINTAIN A CONSTANT AIR VOLUME.
 3. AS THE ZONE HEATING SIGNAL VARIES BETWEEN 0%-100%, THE HEATING WATER CONTROL VALVE IS MODULATED TO CONTROL THE ZONE TEMPERATURE TO THE ZONE TEMPERATURE HEATING SETPOINT.
 - a. ZONE TEMPERATURE HEATING SETPOINT IS SET TO 69°F (ADJUSTABLE).
 - b. ZONE TEMPERATURE COOLING SETPOINT IS SET TO 75°F (ADJUSTABLE).
- C. FLOATING POINT DAMPER MOTOR POSITION RECALIBRATION
1. ESTIMATED DAMPER POSITION WILL BE RECALIBRATED ONCE EACH WEEK AT MIDNIGHT.
 - a. CALIBRATION OF EACH TERMINAL UNIT WILL BE STAGGERED SO THAT NO MORE THAN A SINGLE TERMINAL UNIT IS RECALIBRATING AT ANY TIME.
 - b. DAMPERS WILL BE CALIBRATED AT 100% POSITION COMMAND.
- D. ALARMS:
1. SPACE TOO WARM/COLD ALARMS: ALARM IF THE ZONE IS NOT ABLE TO ACHIEVE ZONE TEMPERATURE WITHIN 3°F OF DEADBAND AFTER 2 HOURS OF OCCUPIED MODE.
 2. SPACE TEMP FAILURE: TEMPERATURE IS READING A VALUE OUT OF THE EXPECTED RANGE.
 3. DISCHARGE AIR TEMP FAILURE: TEMPERATURE IS READING A VALUE OUT OF THE EXPECTED RANGE.
 4. DAMPER FAILURE: AN ALARM IS RAISED WHEN THE DAMPER FAILS TO OPEN AFTER THE DAMPER MOTORS STROKE TIME IS EXCEEDED.

5. CONDENSATE DETECTION ALARM: GENERATE CONDENSATE DETECTION ALARM IF HIGH LEVEL IS DETECTED WITHIN THE COIL DRAIN PAN.

11. EXHAUST TERMINAL UNITS (EACH EV, TAGGED: 1150-LXX-EV-XX)

EXHAUST VARIABLE AIR VOLUME (EV) CONTROL TO A CONSTANT AIR VOLUME FOR THEIR RESPECTIVE AREAS SERVED. EXHAUST AIR DAMPER IS MODULATED WITH A FLOATING-POINT DAMPER MOTOR. TERMINAL UNIT WILL ENTER THE OCCUPIED MODE ACCORDING TO AN (ADJUSTABLE) OCCUPANCY SCHEDULE.

- A. UNOCCUPIED MODE
1. TERMINAL UNIT GOES UNOCCUPIED WHENEVER ITS ASSOCIATED EXHAUST AIR HANDLING UNIT (EAHU) GOES UNOCCUPIED.
 2. EXHAUST AIR DAMPER IS COMMANDED CLOSED.
- B. OCCUPIED MODE
1. TERMINAL UNIT WILL ENTER THE OCCUPIED MODE AS LONG AS ITS ASSOCIATED EXHAUST AIR HANDLING UNIT (EAHU) IS IN THE OCCUPIED MODE.
 2. EXHAUST TERMINAL UNIT WILL MODULATE ITS DAMPER TO MAINTAIN A CONSTANT AIR VOLUME.
- C. FLOATING POINT DAMPER MOTOR POSITION RECALIBRATION
1. ESTIMATED DAMPER POSITION WILL BE RECALIBRATED ONCE EACH WEEK AT MIDNIGHT.
 - a. CALIBRATION OF EACH TERMINAL UNIT WILL BE STAGGERED SO THAT NO MORE THAN A SINGLE TERMINAL UNIT IS RECALIBRATING AT ANY TIME.
 - b. DAMPERS WILL BE CALIBRATED AT 100% POSITION COMMAND.
- D. ALARMS:
1. DAMPER FAILURE: AN ALARM IS RAISED WHEN THE DAMPER FAILS TO OPEN AFTER THE DAMPER MOTORS STROKE TIME IS EXCEEDED.

12. TRANSFER FAN (EACH TF, TAGGED: 1150-LXX-TF-XX, 1150-P3-TF-01, 1150-P3-TF-02, 1150-P2-TF-01, 1150-P2-TF-02, 1150-P1-TF-01, 1150-P1-TF-02, 1150-P1-TF-03, 1150-P1-TF-04)

- A. FAN START-STOP
1. THE FAN CONTROLS THE SPACE TEMPERATURE TO 85°F BY A LINE VOLTAGE COOLING ONLY THERMOSTAT FURNISHED BY MC AND INSTALLED BY EC.
- B. SPACE TEMPERATURE MONITORING BY BACS
1. REFER TO FAN SCHEDULE AND/OR FLOOR PLANS FOR WHICH SPACES WILL REQUIRE SPACE TEMPERATURE MONITORING BY BACS.
 2. C.C. TO FURNISH, INSTALL AND WIRE A TEMPERATURE SENSOR WITHIN THE SPACE FOR TEMPERATURE MONITORING ONLY. TEMP SENSOR TO CONNECTED TO THE BAS SYSTEM AND AN ALARM SHALL BE GENERATED WHEN THE SPACE TEMPERATURE EXCEEDS 90°F (ADJUSTABLE).
- C. ALARMS:
1. TEMP MONITOR ALARM: IF THE AIR TEMPERATURE FROM ANY TEMP MONITOR READS ABOVE 90°F (ADJUSTABLE), AN ALARM

WILL GENERATE AFTER A SHORT DELAY

13. MECHANICAL ROOM EXHAUST FAN (1150-L12-EF-02)

- A. FAN START-STOP
 - 1. THE FAN CONTROLS THE SPACE TEMPERATURE TO 85°F BY A LINE VOLTAGE COOLING ONLY THERMOSTAT FURNISHED BY MC AND INSTALLED BY EC.
 - 2. THE ROOM EXHAUST/RELIEF MOTORIZED DAMPER (1150-L12-MD-03) AND ROOM INTAKE MOTORIZED DAMPER (1150-L12-MD-02) WILL BE INTERLOCKED TO POWER OPEN WHEN 1150-L12-EF-02 IS RUNNING. HARD-WIRED INTERLOCK CIRCUITS REQUIRED BETWEEN THE FAN AND MOTORIZED DAMPER SHALL BE PROVIDED BY THE ELECTRICAL CONTRACTOR.
 - 3. WHILE THE UNIT IS SHUT DOWN.
 - a. EXHAUST FAN IS STOPPED.
 - b. ROOM EXHAUST/RELIEF MOTORIZED DAMPER (1150-L12-MD-03) IS CLOSED.
 - c. ROOM INTAKE MOTORIZED DAMPERS (1150-L12-MD-02) IS CLOSED.
- B. SPACE TEMPERATURE MONITORING BY BACS
 - 1. C.C. TO FURNISH, INSTALL AND WIRE A TEMPERATURE SENSOR WITHIN THE SPACE FOR TEMPERATURE MONITORING ONLY. TEMP SENSOR TO CONNECTED TO THE BAS SYSTEM AND AN ALARM SHALL BE GENERATED WHEN THE SPACE TEMPERATURE EXCEEDS 90°F (ADJUSTABLE).
- C. ALARMS:
 - 1. TEMP MONITOR ALARM: IF THE AIR TEMPERATURE FROM ANY TEMP MONITOR READS ABOVE 90°F (ADJUSTABLE), AN ALARM WILL GENERATE AFTER A SHORT DELAY

14. ELECTRICAL ROOM TRANSFER FAN (1150-L12-TF-02)

- A. FAN START-STOP
 - 1. THE FAN CONTROLS THE SPACE TEMPERATURE TO 85°F BY A LINE VOLTAGE COOLING ONLY THERMOSTAT FURNISHED BY MC AND INSTALLED BY EC.
 - 2. THE ROOM EXHAUST/RELIEF FIRE SMOKE DAMPER (1150-L12-FSD-01) AND ROOM INTAKE FIRE SMOKE DAMPER (1150-L12-FSD-02) WILL BE INTERLOCKED TO POWER OPEN WHEN 1150-L12-TF-02 IS RUNNING. HARD-WIRED INTERLOCK CIRCUITS REQUIRED BETWEEN THE FAN AND FIRE SMOKE DAMPER SHALL BE PROVIDED BY THE ELECTRICAL CONTRACTOR.
 - 3. WHILE THE UNIT IS SHUT DOWN.
 - a. EXHAUST FAN IS STOPPED.
 - b. ROOM EXHAUST/RELIEF MOTORIZED DAMPER (1150-L12-FSD-01) IS CLOSED.
 - c. ROOM INTAKE MOTORIZED DAMPERS (1150-L12-FSD-02) IS CLOSED.
- B. SPACE TEMPERATURE MONITORING BY BACS
 - 1. C.C. TO FURNISH, INSTALL AND WIRE A TEMPERATURE SENSOR WITHIN THE SPACE FOR TEMPERATURE MONITORING ONLY. TEMP SENSOR TO CONNECTED TO THE BAS SYSTEM AND AN ALARM SHALL BE GENERATED WHEN THE SPACE TEMPERATURE EXCEEDS 90°F (ADJUSTABLE).

- C. ALARMS:
 - 1. TEMP MONITOR ALARM: IF THE AIR TEMPERATURE FROM ANY TEMP MONITOR READS ABOVE 90°F (ADJUSTABLE), AN ALARM WILL GENERATE AFTER A SHORT DELAY

15. PENTHOUSE RESTROOM EXHAUST FAN (1150-L12-EF-01)

- A. FAN START-STOP
 - 1. EXHAUST FAN SHALL CONTROL TO A CONSTANT AIR VOLUME ACCORDING TO AN (ADJUSTABLE) OCCUPANCY SCHEDULE.
 - 2. THE ASSOCIATED MOTORIZED DAMPER (1150-L12-MD-01) SHALL BE INTERLOCKED TO POWER OPEN WHEN 1150-L12-EF-01 IS RUNNING. HARD-WIRED INTERLOCK CIRCUITS REQUIRED BETWEEN THE FAN AND MOTORIZED DAMPER SHALL BE PROVIDED BY THE ELECTRICAL CONTRACTOR
- B. UNOCCUPIED MODE
 - 1. EXHAUST FAN WILL ENETER THE UNOCCUPIED MODE AND IS STOPPED.
 - 2. MOTORIZED DAMPER (1150-L12-MD-01) IS CLOSED VIA A HARD-WIRED INTERLOCK WITH THE EXHAUST FAN.
- C. OCCUPIED MODE
 - 1. EXHAUST FAN WILL ENETER THE OCCUPIED MODE AND RUNS TO MAINTAIN A CONSTANT AIR VOLUME.
 - 2. MOTORIZED DAMPER (1150-L12-MD-01) IS OPENED VIA A HARD-WIRED INTERLOCK WITH THE EXHAUST FAN.

16. P1 LOCKER ROOM EXHAUST FAN (1150-P1-EF-01)

- A. FAN START-STOP
 - 1. EXHAUST FAN SHALL CONTROL TO A CONSTANT AIR VOLUME ACCORDING TO AN (ADJUSTABLE) OCCUPANCY SCHEDULE.
 - 2. THE ASSOCIATED MOTORIZED DAMPER (1150-L2-MD-01) SHALL BE COMMANDED OPEN OR CLOSED BY THE BACS SYSTEM AND PROVEN VIA DAMPER POSITION END SWITCHES.
- B. UNOCCUPIED MODE
 - 1. EXHAUST FAN WILL ENTER THE UNOCCUPIED MODE AND IS STOPPED.
 - 2. MOTORIZED DAMPER (1150-L2-MD-01) IS COMMANDED CLOSED.
- C. OCCUPIED MODE
 - 1. MOTORIZED DAMPER (1150-L2-MD-01) IS COMMANDED OPEN AND PROVEN OPEN.
 - 2. EXHAUST FAN WILL ENTER THE OCCUPIED MODE AND RUNS TO MAINTAIN A CONSTANT AIR VOLUME.

17. TRANSFER FAN (1150-P4-TF-01)

- A. FAN SHALL RUN CONTINUOUSLY. FAN SWITCH FURNISHED AND INSTALLED BY E.C. AND SHALL BE LABELED WITH PHENOLIC LABEL TO NOTIFY OPERATOR TO RUN CONTINUOUSLY FOR VENTILATION. WIRING BY E.C.

18. DEDICATED OUTSIDE AIR UNIT (1150-L12-DOAS-01)

- THE DEDICATED OUTSIDE AIR UNIT (DOAS) PROVIDES TEMPERED VENTILATION AIR THE ROOF AMENITY SPACES. DOAS UNIT INCLUDES ENTHALPY WHEELS, OUTSIDE AIR SUPPLY FANS, EXHAUST FANS, LOW-TEMPERATURE CHILLED WATER COILS, HOT WATER COILS, OUTSIDE AIR INTAKE AND EXHAUST DAMPERS. THE DOAS UNIT SYSTEM OPERATING PARAMETERS ARE THE FOLLOWING:
- A. DOAS UNIT SHALL BE ON THE SAME OCCUPANCY SCHEDULE AS THE

PENTHOUSE RESTROOM EXHAUST FAN 1150-L12-EF-01 (ADJUSTABLE)

- B. UNOCCUPIED MODE
 - 1. SUPPLY AND EXHAUST FANS ARE STOPPED.
 - 2. CHILLED WATER AND HOT WATER MODULATING CONTROL VALVES ARE CLOSED.
 - 3. OUTSIDE AIR AND EXHAUST AIR MOTORIZED DAMPERS ARE CLOSED.
- C. OCCUPIED MODE
 - 1. DOAS UNIT WILL ENTER THE OCCUPIED MODE ACCORDING TO AN (ADJUSTABLE) OCCUPANCY SCHEDULE.
 - 2. DOAS UNIT SUPPLY AND EXHAUST FANS START AND RUN CONTINUOUSLY TO SUPPLY A CONSTANT VOLUME OF VENTILATION AIR TO THE SPACES.
 - 3. DISCHARGE AIR TEMPERATURE RESET
 - a. A CONDITION FOR DECREMENTING THE DISCHARGE AIR TEMPERATURE COOLING SETPOINT SHALL HAVE PRIORITY OVER A CONDITION FOR INCREMENTING THE DISCHARGE AIR TEMPERATURE SETPOINT.
 - b. THE MAXIMUM DISCHARGE AIR TEMPERATURE COOLING SETPOINT SHALL BE 70 DEG. F. (ADJUSTABLE).
 - c. THE MINIMUM DISCHARGE AIR TEMPERATURE COOLING SETPOINT SHALL BE 65 DEG. F. (ADJUSTABLE).
 - d. THE SAHU WILL START WITH A DISCHARGE AIR TEMPERATURE COOLING SETPOINT RESET TO 65 DEG. F. (ADJUSTABLE).
 - e. THE DISCHARGE AIR TEMPERATURE COOLING SETPOINT WILL RESET AS FOLLOWS:
 - 1) THE COOLING SIGNAL FROM ALL SELECTED FCU TERMINAL UNITS WILL BE READ BY THE GLOBAL CONTROLLER.
 - a) FOR EACH FCU ZONE, THE OPERATOR SHALL BE GIVEN THE ABILITY TO DE-SELECT CERTAIN ZONES FROM CAUSING THE DISCHARGE AIR TEMPERATURE COOLING SETPOINT TO RESET.
 - 2) DISCHARGE AIR TEMPERATURE COOLING SETPOINT DECREMENT.
 - a) A DECREMENT CONDITION WILL BE QUALIFIED EVERY 10 MINUTES (ADJUSTABLE).
 - b) IF THE COOLING SIGNAL OF 1 (ADJUSTABLE) OR MORE FCU TERMINAL UNITS RISES ABOVE 90% (ADJUSTABLE), THEN DECREMENT THE DISCHARGE AIR TEMPERATURE COOLING SETPOINT BY AN AMOUNT OF 1 DEG. F. (ADJUSTABLE).
 - 3) DISCHARGE AIR TEMPERATURE COOLING SETPOINT INCREMENT.
 - a) AN INCREMENT CONDITION WILL BE QUALIFIED EVERY 10 MINUTES (ADJUSTABLE).
 - b) IF THE COOLING SIGNAL OF ALL (ADJUSTABLE) OR FEWER FCU TERMINAL UNITS FALLS BELOW 70% (ADJUSTABLE), THEN INCREMENT THE DISCHARGE AIR TEMPERATURE COOLING SETPOINT BY AN AMOUNT OF 1 DEG. F. (ADJUSTABLE).
 - 4. DISCHARGE AIR TEMPERATURE CONTROL
 - a. THE MEASURED DISCHARGE AIR TEMPERATURE IS CONTINUOUSLY COMPARED TO THE DISCHARGE AIR

- TEMPERATURE COOLING SETPOINT.
- b. THE DOAS CONTROLLER GENERATES A DISCHARGE AIR COOLING SIGNAL BETWEEN 0% AND 100% AS A FUNCTION OF HOW FAR THE MEASURED DISCHARGE AIR TEMPERATURE IS ABOVE THE DISCHARGE AIR TEMPERATURE COOLING SETPOINT.
- 1) AS THE DISCHARGE AIR COOLING SIGNAL VARIES BETWEEN 0% AND 100%, THE CHILLED WATER CONTROL VALVE MODULATES BETWEEN 0% OPEN AND 100% OPEN AS REQUIRED TO MAINTAIN THE DISCHARGE AIR COOLING SETPOINT.
- a) ONCE THE DISCHARGE AIR COOLING SIGNAL HAS EXPIRED AND THE OUTSIDE AIR TEMPERATURE IS LESS THAN 62 DEG. F. (ADJUSTABLE), DOAS COOLING COIL CONTROL VALVE SHALL BE LOCKED OUT AS LONG AS THE OUTSIDE AIR TEMPERATURE REMAINS LESS THAN 62 DEG. F. AS MEASURED BY THE INCOMING OUTSIDE AIR TEMPERATURE SENSOR.
- c. THE DOAS CONTROLLER GENERATES A DISCHARGE AIR HEATING SIGNAL BETWEEN 0% AND 100% AS A FUNCTION OF HOW FAR THE MEASURED DISCHARGE AIR TEMPERATURE IS BELOW THE DISCHARGE AIR TEMPERATURE HEATING SETPOINT.
- 1) THE DOAS CONTROLLER WILL TEMPER THE OUTSIDE AIR UP TO THE DISCHARGE AIR TEMPERATURE HEATING SETPOINT.
- 2) THE DISCHARGE AIR TEMPERATURE HEATING SETPOINT EQUALS THE DISCHARGE AIR TEMPERATURE COOLING SETPOINT MINUS 1 DEG. F. (ADJUSTABLE).
- 3) AS THE DISCHARGE AIR HEATING SIGNAL VARIES BETWEEN 0% AND 100%, THE HOT WATER CONTROL VALVE MODULATES BETWEEN 0% OPEN AND 100% OPEN AS REQUIRED TO MAINTAIN THE DISCHARGE AIR HEATING SETPOINT.
5. POSITIVE DUCT STATIC PRESSURE RESET
- a. A CONDITION FOR INCREMENTING THE POSITIVE DUCT STATIC PRESSURE SETPOINT SHALL HAVE PRIORITY OVER A CONDITION FOR DECREMENTING THE POSITIVE DUCT STATIC PRESSURE SETPOINT.
- 1) FCU DAMPERS WILL OPERATE WITH AN OPEN POSITION IN THE RANGE BETWEEN 50% AND 75%
- b. THE MAXIMUM POSITIVE DUCT STATIC PRESSURE SETPOINT SHALL BE (+) 2.5 IWC (ADJUSTABLE) AS DETERMINED AND SET BY THE TEST AND BALANCE TECHNICIAN.
- c. THE MINIMUM POSITIVE DUCT STATIC PRESSURE SETPOINT SHALL BE (+) 0.75 IWC (ADJUSTABLE) AS DETERMINED AND SET BY THE TEST AND BALANCE TECHNICIAN.
- d. THE DOAS WILL START WITH A POSITIVE DUCT STATIC PRESSURE SETPOINT SET TO (+) 1.8 IWC (ADJUSTABLE).
- e. THE POSITIVE DUCT STATIC PRESSURE SETPOINT WILL RESET AS FOLLOWS:
- 1) THE DAMPER POSITIONS OF ALL SELECTED SUPPLY TERMINAL UNITS (SV) WILL BE READ BY THE GLOBAL CONTROLLER.
- a) FOR EACH SV ZONE, THE OPERATOR SHALL BE GIVEN THE ABILITY TO DE-SELECT CERTAIN ZONES FROM

- CAUSING THE POSITIVE DUCT STATIC PRESSURE SETPOINT TO RESET.
- 2) POSITIVE DUCT STATIC PRESSURE SETPOINT INCREMENT.
- a) AN INCREMENT CONDITION WILL BE QUALIFIED EVERY 3 MINUTES (ADJUSTABLE).
- b) IF THE DAMPER POSITION OF 1 (ADJUSTABLE) OR MORE SELECTED SV TERMINAL UNITS INCREASES ABOVE 80% (ADJUSTABLE), THEN INCREMENT THE POSITIVE DUCT STATIC PRESSURE SETPOINT BY AN AMOUNT OF (+) 0.2 IWC (ADJUSTABLE).
- 3) POSITIVE DUCT STATIC PRESSURE SETPOINT DECREMENT.
- a) A DECREMENT CONDITION WILL BE QUALIFIED EVERY 10 MINUTES (ADJUSTABLE).
- b) IF THE MEASURED DAMPER POSITIONS OF ALL (ADJUSTABLE) OR FEWER SV TERMINAL UNITS DECREASES BELOW 70% (ADJUSTABLE), THEN DECREMENT THE POSITIVE DUCT STATIC PRESSURE SETPOINT BY AN AMOUNT OF (+) 0.1 IWC (ADJUSTABLE).

D. ALARMS:

1. SPACE TOO WARM/COLD ALARMS: ALARM IF THE ZONE IS NOT ABLE TO ACHIEVE ZONE TEMPERATURE WITHIN 3°F OF DEADBAND AFTER 2 HOURS OF OCCUPIED MODE.
2. SPACE TEMP FAILURE: TEMPERATURE IS READING A VALUE OUT OF THE EXPECTED RANGE. IF A RETURN SENSOR EXISTS AND HAS A VALID READING, THIS SHALL BE USED AS THE INTERIM SPACE TEMPERATURE READING UNTIL THE SPACE SENSOR READING IS FIXED.
3. DISCHARGE AIR TEMP FAILURE: TEMPERATURE IS READING A VALUE OUT OF THE EXPECTED RANGE.
4. SMOKE DETECTOR ALARM: A DUCT SMOKE DETECTOR IS HARDWIRED INTERLOCKED AND WILL SHUT DOWN THE FAN UPON TRIGGERING.
5. FREEZE STAT ALARM: A FREEZE STAT IS HARDWIRED TO THE FAN AND WILL SHUTDOWN THE FAN UPON TRIGGERING.
6. SUPPLY FAN FAILURE OR IN HAND ALARM: ALARM IF THE EXPECTED FAN STATUS FEEDBACK DOES NOT MATCH THE FAN COMMAND.
7. RELIEF FAN FAILURE OR IN HAND ALARM: ALARM IF THE EXPECTED FAN STATUS FEEDBACK DOES NOT MATCH THE FAN COMMAND.
8. DISCHARGE AIR TEMP TOO COLD ALARM: ALARM IF THE SUPPLY AIR TEMPREATURE IS BELOW 35°F (ADJUSTABLE) FOR 300 SECONDS (ADJUSTABLE) AND SHUT DOWN THE UNIT.
9. DISCHARGE AIR PRESSURE SWITCH TO SHUTDOWN DOAS IF DUCT PRESSURE IS GREATER THAN 3.5”w.c.

19. AUTOCLAVE AND GLASS-WASH (1150-L1-SV-04, 1150-L1-SV-05, 1150-L1-EV-02)

A. UNOCCUPIED MODE

1. EXHAUST (EV) AND SUPPLY (SV) TERMINAL UNITS GO UNOCCUPIED WHENEVER ITS ASSOCIATED AIR HANDLING UNIT (1150-L2-SAHU-01 / 1150-L2-EAHU-01) GOES UNOCCUPIED.

B. OCCUPIED MODE

1. TERMINAL UNIT WILL ENTER THE OCCUPIED MODE AS LONG AS ITS

ASSOCIATED SUPPLY AIR HANDLING UNIT (SAHU) IS IN THE OCCUPIED MODE.

- a. THE SINGLE DUCT SUPPLY TERMINAL UNITS (1150-L1-SV-04 AND 1150-L1-SV-05) AND SINGLE DUCT EXHAUST TERMINAL UNIT (1150-L1-EV-02) OPERATE AT CONSTANT VOLUME AT DESIGN MAXIMUM CFM
- 1) AS THE ZONE HEATING SIGNAL VARIES BETWEEN 0%-100%, THE HEATING WATER CONTROL VALVE IS MODULATED TO CONTROL THE ZONE TEMPERATURE TO THE ZONE TEMPERATURE HEATING SETPOINT.
- a) ZONE TEMPERATURE HEATING SETPOINT IS SET TO 69°F (ADJUSTABLE).
- b) ZONE TEMPERATURE COOLING SETPOINT IS SET TO 75°F (ADJUSTABLE).

- b. THE BACS SHALL REPORT STATUS OF THE AUTOCLAVE AND GLASSWASH

C. ALARMS:

1. SPACE TOO WARM/COLD ALARMS: ALARM IF THE ZONE IS NOT ABLE TO ACHIEVE ZONE TEMPERATURE WITHIN 3°F OF DEADBAND AFTER 2 HOURS OF OCCUPIED MODE.
2. SPACE TEMP FAILURE: TEMPERATURE IS READING A VALUE OUT OF THE EXPECTED RANGE. IF A RETURN SENSOR EXISTS AND HAS A VALID READING, THIS SHALL BE USED AS THE INTERIM SPACE TEMPERATURE READING UNTIL THE SPACE SENSOR READING IS FIXED.
3. DISCHARGE AIR TEMP FAILURE: TEMPERATURE IS READING A VALUE OUT OF THE EXPECTED RANGE.

20. AIR COMPRESSOR ROOM TRANSFER FAN (1150-P3-TF-03)

A. FAN START-STOP

1. FAN TO BE ENABLE VIA THE TEMPERATURE SENSOR (PROVIDED BY C.C). THE FAN TO OPERATE AT MINIMUM SETTING UNTIL THE SPACE TEMPERATURE IS SATISFIED OR 10 MINUTES (ADJUSTABLE) HAS PASSED. SPACE TEMPERATURE TO BE SET AS 80°F (ADJUSTABLE). IF SPACE TEMPERATURE SET POINT IS NOT ACHIEVED, VFD (1150-P3-VFD-02) TO RAMP UP BY 20% (ADJUSTABLE). SEQUENCE TO REPEAT UNTIL TEMPERATURE SETPOINT IS ACHIEVED OR UNTIL FAN IS AT 100% CAPACITY.
2. THE ROOM EXHAUST/RELIEF MOTORIZED DAMPER (1150-P3-MD-01) AND ROOM INTAKE MOTORIZED DAMPER (1150-P3-MD-02) WILL BE INTERLOCKED TO POWER OPEN WHEN 1150-P3-TF-03 IS RUNNING. HARD-WIRED INTERLOCK CIRCUITS REQUIRED BETWEEN THE FAN AND MOTORIZED DAMPER SHALL BE PROVIDED BY THE ELECTRICAL CONTRACTOR.
3. WHILE THE UNIT IS SHUT DOWN.
 - a. EXHAUST FAN IS STOPPED.
 - b. ROOM EXHAUST/RELIEF MOTORIZED DAMPER (1150-P3-MD-01) IS CLOSED.
 - c. ROOM INTAKE MOTORIZED DAMPERS (1150-P3-MD-02) IS CLOSED.

B. SPACE TEMPERATURE MONITORING BY BACS

1. C.C. TO FURNISH, INSTALL AND WIRE A TEMPERATURE SENSOR WITHIN THE SPACE FOR TEMPERATURE MONITORING ONLY. TEMP

SENSOR TO CONNECTED TO THE BAS SYSTEM AND AN ALARM SHALL BE GENERATED WHEN THE SPACE TEMPERATURE EXCEEDS 90°F (ADJUSTABLE).

C. ALARMS:

1. TEMP MONITOR ALARM: IF THE AIR TEMPERATURE FROM ANY TEMP MONITOR READS ABOVE 90°F (ADJUSTABLE), AN ALARM WILL GENERATE AFTER A SHORT DELAY

21. NEUTRALIZER ROOM EXHAUST FAN (1150-P1-EF-02)

FAN SHALL RUN CONTINUOUSLY. FAN SWITCH FURNISHED AND INSTALLED BY E.C. AND SHALL BE LABELED WITH PHENOLIC LABEL TO NOTIFY OPERATOR TO RUN CONTINUOUSLY. WIRING BY E.C.

22. ERV (ENERGY RECOVERY VENTILATOR) (1150-L1-ERV-01)

THE ENERGY RECOVERY VENTILATOR (ERV) PROVIDES VENTILATION AND EXHAUST FOR THE L1 AMENITY AREA. ERV UNIT INCLUDES A HEAT RECOVERY CORE, OUTSIDE AIR SUPPLY FAN & EXHAUST FAN. THE ERV UNIT SYSTEM OPERATING PARAMETERS ARE THE FOLLOWING:

A. ERV UNIT SHALL BE SCHEDULED BY THE OPERATOR (ADJUSTABLE)

B. UNOCCUPIED MODE

1. SUPPLY AND EXHAUST FANS ARE STOPPED.

C. OCCUPIED MODE

1. ERV UNIT WILL ENTER THE OCCUPIED MODE ACCORDING TO AN (ADJUSTABLE) OCCUPANCY SCHEDULE.
2. ERV UNIT SUPPLY FAN STARTS AND RUNS CONTINUOUSLY TO MAINTAIN THE SUPPLY DUCT STATIC SETPOINT SET BY THE AIR BALANCE CONTRACTOR.
3. ERV EXHAUST FAN SPEED VARIES BASED ON THE SPEED OF THE SUPPLY FAN.

D. ALARMS:

1. DISCHARGE AIR TEMP FAILURE: TEMPERATURE IS READING A VALUE OUT OF THE EXPECTED RANGE.
2. SUPPLY FAN FAILURE OR IN HAND ALARM: ALARM IF THE EXPECTED FAN STATUS FEEDBACK DOES NOT MATCH THE FAN COMMAND.
3. EXHAUST FAN FAILURE OR IN HAND ALARM: ALARM IF THE EXPECTED FAN STATUS FEEDBACK DOES NOT MATCH THE FAN COMMAND.
4. DISCHARGE AIR TEMP TOO COLD ALARM: ALARM IF THE SUPPLY AIR TEMPERATURE IS BELOW 35°F (ADJUSTABLE) FOR 300 SECONDS (ADJUSTABLE).

23. ENERGY RECOVERY VENTILATOR (1150-L1-ERV-02)

THE ENERGY RECOVERY VENTILATOR (ERV) PROVIDES TEMPERED VENTILATION AIR THE SECURITY OFFICE. ERV UNIT INCLUDES CROSS-FLOW PLATE HX, OUTSIDE AIR SUPPLY FAN, EXHAUST FAN OUTSIDE AIR INTAKE AND EXHAUST DAMPERS.

THE ERV UNIT SYSTEM OPERATING PARAMETERS ARE THE FOLLOWING:

A. ERV UNIT SHALL BE ON AN (ADJUSTABLE) DEDICATED OCCUPANCY SCHEDULE AS REQUIRED FOR THE SECURITY OFFICE.

B. UNOCCUPIED MODE

1. SUPPLY AND EXHAUST FANS ARE STOPPED.
2. OUTSIDE AIR AND EXHAUST AIR BACKDRAFT DAMPERS ARE CLOSED.

C. OCCUPIED MODE

1. ERV UNIT WILL ENTER THE OCCUPIED MODE ACCORDING TO AN (ADJUSTABLE) OCCUPANCY SCHEDULE.
2. ERV UNIT SUPPLY AND EXHAUST FANS START AND RUN CONTINUOUSLY TO SUPPLY A CONSTANT VOLUME OF VENTILATION AIR TO THE SPACES.

24. SPLIT-SYSTEM HEAT PUMPS (1150-P2-AC-01 THRU 04, 1150-L1-AC-01, 03, 04 AND 05)

STANDALONE: SPLIT-SYSTEM HEAT PUMP UNIT IS A SINGLE-ZONE, CONSTANT VOLUME, MINI-SPLIT-SYSTEM, AIR COOLED HEAT PUMP WITH DX HEATING/COOLING.

A. CONTINUOUS OPERATION MODE (NO BACS CONNECTION)

1. SYSTEM STARTS ON A CONTINUOUS OCCUPIED SCHEDULE.
2. FAN STARTS AND RUNS CONTINUOUSLY TO SUPPLY CIRCULATION OF AIR TO THE ZONE.
3. ZONE TEMPERATURE HEATING SETPOINT IS SET TO 65°F (ADJUSTABLE).
4. ZONE TEMPERATURE COOLING SETPOINT IS SET TO 80°F (ADJUSTABLE).
5. WHEN THE ZONE TEMPERATURE IS MEASURED AT A VALUE WITHIN THE DEADBAND, THE FAN OPERATES AT LOW SPEED.
6. THE MINI-SPLIT SYSTEM CONTROLLER SHALL STAGE THE COMPRESSOR, THE THERMAL EXPANSION VALVE, THE REVERSING VALVE AND CONTROL THESE IN DEFROST MODE INDEPENDENT OF THE BACS.

B. SPACE TEMPERATURE MONITORING BY BACS

1. C.C. TO FURNISH, INSTALL AND WIRE A TEMPERATURE SENSOR WITHIN THE SPACE FOR TEMPERATURE MONITORING ONLY. TEMP SENSOR TO CONNECTED TO THE BAS SYSTEM AND AN ALARM SHALL BE GENERATED WHEN THE SPACE TEMPERATURE EXCEEDS 90°F (ADJUSTABLE).

25. SPLIT-SYSTEM HEAT PUMPS (1150-P1-AC-01 THRU 04, 1150-L1-AC-02)

STANDALONE: SPLIT-SYSTEM HEAT PUMP UNIT IS A SINGLE-ZONE, CONSTANT VOLUME, MINI-SPLIT-SYSTEM, AIR COOLED HEAT PUMP WITH DX HEATING/COOLING.

A. CONTINUOUS OPERATION MODE (NO BACS CONNECTION)

1. SYSTEM STARTS ON A CONTINUOUS OCCUPIED SCHEDULE.
2. FAN STARTS AND RUNS CONTINUOUSLY TO SUPPLY CIRCULATION OF AIR TO THE ZONE.
3. ZONE TEMPERATURE HEATING SETPOINT IS SET TO 65°F (ADJUSTABLE).
4. ZONE TEMPERATURE COOLING SETPOINT IS SET TO 80°F (ADJUSTABLE).
5. WHEN THE ZONE TEMPERATURE IS MEASURED AT A VALUE WITHIN THE DEADBAND, THE FAN OPERATES AT LOW SPEED.
6. THE MINI-SPLIT SYSTEM CONTROLLER SHALL STAGE THE COMPRESSOR, THE THERMAL EXPANSION VALVE, THE

REVERSING VALVE AND CONTROL THESE IN DEFROST MODE INDEPENDENT OF THE BACS.

26. STACK EFFECT FAN AND HEATER (1150-L1-SF-01 & 1150-L1-HDH-01)

- A. IF LEVEL 1 SPACE PRESSURE IS BELOW (NEGATIVE) -.01 INWC (ADJUSTABLE) BELOW THE REFERENCE PRESSURE TUBE, THEN OPEN 1150-L1-MD-01 AND START FAN 1150-SF-01 TO OPERATE AT MINIMUM SPEED.
- B. MODULATE THE CONTROL VALVE ON 1150-L1-HDH-01 TO MAINTAIN DISCHARGE AIR TEMPERATURE OF 75°F.
- C. MODULATE FAN SPEED TO MAINTAIN LEVEL 1 SPACE PRESSURE AT (POSITIVE) 0.01 INWC (ADJUSTABLE).
- D. IF FAN SPEED IS AT MINIMUM, AND LEVEL 1 SPACE PRESSURE IS ABOVE (POSITIVE) 0.015 INWC (ADJUSTABLE), TURN OFF FAN 1150-SF-01 AND CLOSE 1150-L1-MD-01.

27. LOADING DOCK VENTILATION EXHAUST FAN (1150-L1-EF-02)

IN ORDER TO CONTROL THE LEVEL OF CARBON MONOXIDE (CO) AND NITROGEN DIOXIDE (NO2) IN THE LOADING DOCK, VENTILATION IS PROVIDED BY AN EXHAUST FAN, AND AIR ENTERS THROUGH THE VEHICLE OPENING. THE EXHAUST FAN IS EQUIPPED WITH A VFD FOR SPEED MODULATION. ONE CO AND NO2 GAS SENSOR. THE EXHAUST FAN IS CONTROLLED THROUGH A BACNET COMMUNICATION NETWORK INTERFACE.

A. FAN RUN-STOP

1. FANS ARE REQUIRED TO OPERATE 24 HOURS PER DAY, 365 DAYS PER YEAR.
 - a. FANS SHALL OPERATE NO LOWER THAN A MINIMUM SPEED TO ACHIEVE THE MINIMUM AIRFLOW SHOWN IN THE FAN SCHEDULE.
 - b. FANS SHALL MODULATE ABOVE THE MINIMUM SPEED TO A MAXIMUM SPEED TO ACHIEVE THE MAXIMUM AIRFLOW SHOWN IN THE FAN SCHEDULE FOR NORMAL OPERATION.
 - c. THE MINIMUM AND MAXIMUM FAN SPEEDS SHALL BE FIELD ADJUSTED BY THE TEST AND BALANCE TECHNICIAN IN COORDINATION WITH THE CONTROL SYSTEM TECHNICIAN.
 - d. FANS MAY BE STOPPED FOR THE MAINTENANCE SCHEDULED BY THE BUILDING OPERATOR.

2. FAN CONTROL SETPOINTS:

THE FOLLOWING CONTROL SETPOINTS APPLY TO THE LOADING DOCK, THE SENSOR WITH THE HIGHEST READING SHALL BE USED TO CONTROL THE SPEED AND CAPACITY OF THE EXHAUST FAN ON EACH LEVEL. A STEP CONTROL ALGORITHM IS USED TO ADJUST THE SPEED OF THE MOTOR AND CAPACITY OF THE FAN. THE FAN MINIMUM AND MAXIMUM SPEEDS SHALL STEP THROUGH A SCALE WHICH IS PROPORTIONED WITH THE MINIMUM AND MAXIMUM CO (PPM) READINGS AND NO2 (PPM) READINGS.

a. LOADING DOCK AND ASSOCIATED EXHAUST FAN.

- 1) LOADING DOCK LEVEL 1 IS VENTILATED WITH GARAGE EXHAUST FAN 1150-L1-EF-02.

b. CO CONTROL SETPOINTS (PPM)

- 1) CO LEVEL IS LESS THAN OR EQUAL TO 9 PPM: FAN OPERATES AT MINIMUM SPEED.
- 2) CO LEVEL IS GREATER THAN 9 PPM BUT LESS THAN OR

EQUAL TO 50 PPM: FAN MODULATES BETWEEN THE MINIMUM SPEED SETPOINT AND MAXIMUM SPEED SETPOINT.

- a) THE FAN SPEED IS INCREMENTED LINEARLY IN PROPORTION WITH THE CO SENSOR READING.
- b) FAN SPEED SHALL BE DECREMENTED IN STEPS ON TIME INTERVALS OF 5 MINS (ADJ).

c. NO2 CONTROL SETPOINTS (PPM)

- 1) NO2 LEVEL IS LESS THAN OR EQUAL TO 0.5 PPM: FAN OPERATES AT MINIMUM SPEED.
- 2) NO2 LEVEL IS GREATER THAN 0.5 PPM BUT LESS THAN OR EQUAL TO 4 PPM: FAN MODULATES BETWEEN THE MINIMUM SPEED SETPOINT AND MAXIMUM SPEED SETPOINT.
 - a) THE FAN SPEED IS INCREMENTED LINEARLY IN PROPORTION WITH THE NO2 SENSOR READING.
 - i. FAN SPEED SHALL BE DECREMENTED IN STEPS ON TIME INTERVALS OF 5 MINS (ADJ).

3. EMERGENCY GENERATOR OPERATION:

- a. LOADING DOCK FAN IS TO BE HARDWIRE INTERLOCKED BY E.C. WITH EMERGENCY GENERATORS VIA THE VFD'S. WHEN THE EMERGENCY GENERATOR IS RUNNING DURING AN EMERGENCY EVENT OR DURING TESTING, THE FANS ARE TO BE INTERLOCKED TO RUN AT FULL SPEED ON EMERGENCY POWER. THIS IS TO HELP REDUCE THE POSSIBILITY OF THE GENERATOR RADIATOR COOLING EXHAUST AIR SHORT CYCLING BACK TO THE GENERATOR ROOM INTAKE AIR.
- b. THE BACS SHALL USE THE GENERATOR RUN SIGNAL TO OPERATE THE LOADING DOCK FAN AT FULL SPEED FOR 30 MINUTES AFTER THE GENERATORS ARE OFF TO REMOVE HEAT FROM THE GARAGE AREA UPSTERAM OF THE TRANSFORMER VAULT FAN.

B. SAFETIES

- 1. IF THE FAN IS NOT ENABLED, OR A RUN STATUS IS NOT PROVEN WITHIN 30 SECONDS, AN ALARM WILL BE GENERATED AT THE FRONT END, AND THE OPERATOR SHALL BE NOTIFIED.
- 2. ANY TIME THE CO LEVEL EXCEEDS 100 PPM CONTINUOUSLY FOR 15 MINUTES, AN ALARM WILL BE GENERATED AT THE FRONT END, AND THE OPERATOR SHALL BE NOTIFIED.
- 3. ANY TIME THE NO2 LEVEL EXCEEDS 5 PPM CONTINUOUSLY FOR 15 MINUTES, AN ALARM WILL BE GENERATED AT THE FRONT END, AND THE OPERATOR SHALL BE NOTIFIED.