PART 1 - GENERAL

1.1 WORK OF THIS SECTION

A. This section of the Specifications details the components to be provided by the BMCS subcontractor relating to the following:
   1. Application packages.
   2. Operating sequences.
   3. Field Termination Schedules.
   4. System diagrams.

1.2 APPLICATIONS PACKAGES

A. Provide the following programs for the optimization of energy usage:
   1. Equipment scheduling.
   2. Optimized scheduling.
   3. Night setup/setback.
   4. After hours HVAC/lighting control.

B. Provide the following programs for the restart of building mechanical systems:
   1. Equipment restart following a fire alarm.
   2. Equipment restart following a power failure.

1.3 OPERATING SEQUENCES - GENERAL

A. If the BMCS subcontractor requires additional instrumentation to that indicated in the BMCS Field Termination Schedules and Diagrams in order to implement the operating sequences as detailed in this Part of the Specifications then it shall be provided within the Base Bid. Such instrumentation shall meet the requirements detailed in the Section titled "BMCS Field Instrumentation" or, where specifications are not provided, details of such instrumentation shall be submitted to the Owner for approval.

B. The operating sequences shall be written in a readily understandable high level control language such as a graphical based programming language or equivalent. Provide adequate English language notation in the software to assist the operator understand the intent of the programmed sequences.

C. The BMCS subcontractor shall be responsible for the stable operation of all control loops. If the BMCS subcontractor has not provided self-tuning PID control algorithms then the BMCS subcontractor shall manually tune all control loops. Verify that the control loops are stable whether or not they are self-tuning.

D. If any BMCS or system component should fail during the operation of a system, then the BMCS shall execute the system failure positions for the affected system.

E. Any information required by the BMCS subcontractor for the implementation of the software shall be requested in writing to the Owner at least four weeks prior to the time it is required. Submit the request for information in the form of tables or forms for the Owner’s personnel to complete and return.

F. The operating sequences detailed below shall only apply when the BMCS is controlling and monitoring the system in the BMCS software control mode.

G. The modulation of final control elements by the BMCS in the BMCS software control mode shall be based on a Proportional-Integral-Derivative (PID) or Proportional-Integral (PI) control algorithm suitable to the application. The control constants for the PID algorithm shall be definable by the operator. If self-tuning algorithms are provided, it shall still be possible for the operator to manually tune the control loops. The software shall incorporate facilities to enable the bumpless transfer of a modulating output from BMCS manual control to BMCS software control and vice versa and the prevention of integral wind-up. PID algorithms shall maintain the system operation within the

desired tolerance around the setpoint. Setpoint tolerances shall be as follows:

1. Supply air temperature control, + or - 0.25 Deg. C. (0.5 Deg. F.)
2. Space temperature control, + or - 0.25 Deg. C. (0.5 Deg. F).
3. Duct static pressure control, + or - 15 Pa (0.05 inches w.g).
4. Water differential pressure, + or - 10 kPa (1.5 psig).
5. Space static pressure control, + or - 5 Pa (0.02 inches w.g).
6. Water temperature control, + or - 0.5 Deg. C. (1.0 Deg. F.)
7. Water flowrate control, + or - 2 percent of setpoint.
8. Air flowrate control, + or - 5 percent of setpoint.

H. All setpoints and operating parameters of the sequences of operation shall be easily changeable by any operator with the appropriate access level at the associated system graphical display and controller configuration screen. Setpoints and operating parameter changes shall not be flagged as override states.

I. In cases where air duct cross-sectional area exceeds the specified cross sectional area for a single damper section, multiple damper sections rather than a single section shall be furnished. Refer to the mechanical trade documents to determine the number of damper sections. The modulation of dampers from fully closed to fully open shall involve the modulation of one section from fully closed to fully open followed by the modulation of the next section from fully closed to fully open and so on until all sections are fully open. Each damper section shall have its own actuator and a separate analog output shall be provided for each damper section. The order in which dampers are modulated shall be advised by the Owner, Engineer and Consultant. Multiple sections of two position dampers shall be controlled in unison via one BMCS output point or hardwired interface connection.

J. The BMCS subcontractor shall provide any modifications to the operating sequences as request by the Consultant and/or Owner without additional costs until the final acceptance of the entire BMCS.

1.4 FIELD TERMINATION SCHEDULES - GENERAL

A. The BMCS shall not override any hardwired interlocks including safety interlocks. BMCS control of motors shall only be possible when the HOA selector switch is in the Auto position.

B. Where the code carries the instruction to "provide", the BMCS subcontractor shall furnish and install the components necessary to meet the monitoring (or control) requirements and shall provide cabling, conduit and all other components required to connect the point to the PIM at the DCP or UC and to have the point fully functional on the BMCS.

1.5 SYSTEM DIAGRAMS

A. The system diagrams indicate the general configuration of the systems under BMCS monitoring and control. Locations of sensors and devices are approximately as indicated. Coordinate all final mounting and sensing locations with Owner and other Trades.

PART 2 - PRODUCTS

2.1 EQUIPMENT SCHEDULING

A. Provide a program that will enable the BMCS to automatically schedule an item of equipment on and off.

B. The equipment assigned to this program shall be selected by the operator using an interactive procedure. Any piece of equipment controlled by the BMCS shall be assignable to this program and it shall be possible to have all controlled pieces of equipment concurrently assigned to this program.

C. The operator shall be able to assign a minimum of four start and four stop times to each piece of equipment for each day of the week and for holidays. These schedules shall only be in effect for a piece of equipment when it is in the BMCS software control mode.

D. Provide a means of implementing temporary schedules. The operator shall be able to assign a temporary schedule to any BMCS controlled equipment in accordance with the following:
   1. For a specified date.
   2. For a specified period.
   3. For a specified reoccurring day of the week.

E. The operator shall be able to obtain a report detailing the schedules.

2.2 OPTIMIZED SCHEDULING

A. Provide an adaptive software program that shall:
   1. Start HVAC equipment at the latest possible time while ensuring that space in the building reaches setpoint conditions by the time occupancy commences.
   2. Stop HVAC equipment at the earliest possible time while ensuring that space in the building shall still be within the setpoint deadband at the scheduled end of occupancy.

B. The operator shall be able to implement this function for each group of terminal units and other HVAC equipment using an interactive procedure. A group of terminal units shall comprise all the terminal units on the same floor of the tower served by the same air handling unit. The operator shall be able to assign start of occupancy and end of occupancy times for each day of the week and for holidays. A separate Monday schedule should be provided for earlier start times.

C. This program shall base the determined equipment start and stop times on monitored data such as space temperatures within the area served by the equipment and ambient conditions. If the BMCS subcontractor requires information other than that provided by the monitoring detailed in the Field Termination Schedules, then the necessary additional instrumentation shall be provided within the base bid price.

D. The operator shall be able to assign limits to the start and stop times. Initially these limits shall be set as follows:
   1. BMCS determined start times shall not be more than 3 hours before the scheduled occupancy.
   2. BMCS determined stop times shall not be more than 1 hour before the scheduled end of occupancy.

E. A report shall be available on demand and on a scheduled basis, which provides the following information:
   1. Occupancy schedules
   2. Time of last equipment start and space conditions at scheduled occupancy time
   3. Time of last equipment stop and space conditions at scheduled end of occupancy time

F. This feature shall only be implemented for equipment in the BMCS software control mode.

2.3 NIGHT SETBACK - SETUP

A. Provide a software program that shall:
   1. Start HVAC equipment after normal hours of scheduled operation to maintain building after hour setpoints, while reducing energy consumption.
   2. Night setback space temperatures for heating shall be initially set at 55 Deg. F. to activate the heating equipment and 60 Deg. F. to stop the heating equipment. Once activated, the units involved shall operate as specified in the respective sequence of operation. Coordinate the operation of this program with the requirements for terminal unit controls.
   3. Night setup space temperatures for cooling shall be initially set at 90 Deg. F. to activate the cooling equipment and 85 Deg. F. to stop the cooling equipment. Once activated, the units involved shall operate as specified in the respective sequence of operation. Coordinate the operation of this program with the requirements for terminal unit controls.

B. The operator shall be able to implement this function for all HVAC equipment using an interactive procedure on an individual or group controlled basis.

C. The operator shall be able to assign minimum run times for each piece of equipment.

D. The setpoint reset operation of this program shall be disabled when the outside air temperature is outside operator defined limits, initially set at 35 Deg. F. and 95 Deg. F.

E. A report shall be available on demand and on a scheduled basis, which provides the following information:
   1. Night setback/setup setpoints and associated equipment.

F. This feature shall only be implemented for equipment in the BMCS software control mode.

G. Setpoints for each associated piece of equipment shall be displayed on the associated system display graphics. Setpoints shall be changeable via the graphical display.

H. The current status of night setback – setup modes shall be indicated on the associated system graphic.

2.4 REMOTE AFTER HOUR HVAC AND LIGHTING ACTIVATION

A. Provide programming and associated hardware to allow for the activation of the HVAC system without the intervention of a BMCS operator. The system shall provide, at minimum, the following capabilities:
   1. An ISP data connection static IP address will be provided by the Owner at the engineer's office NDS location.
   2. Any of the tenants, with appropriate remote access, shall be able to access the BMCS Remote After Hours Activation page via an HTML browser. At minimum, this interface shall be compatible with the following PC and mobile based browsers:
      a. Apple Safari.
      b. Google Chrome.
      c. Microsoft Internet Explorer.
   3. Provide a graphical interface that will allow the tenants with appropriate password and upon selecting the proper actions, activate the HVAC and/or lighting for their associated zone(s) of the floor.
   4. The duration of HVAC and light operation shall be individually assignable to each zone and to the systems in that zone.
   5. Provide passwords that can be enabled/disabled at the discretion of the BMCS operator to prevent unauthorized use of the after hour activation program. Passwords shall be defined such that authorized access can be given for the assigned area to be activated.
   6. An email message shall be sent to the individual activating the after hour lighting and HVAC.

B. Provide reporting such that history logs of afterhours activation can be reported. Reports shall include, time, date, duration, systems involved, area, user ID, and email address. Also provide automatic export billing data in Microsoft Excel format on a monthly basis.

C. Coordinate with the Owner for interface to the ISP and final configuration of the control page. The Owner shall provide the ISP connection.

D. Provide tenant user names and password definitions for up to two hundred users. Coordinate all user definitions and requirements with the Owner.

2.5 EQUIPMENT RESTART FOLLOWING A FIRE ALARM

A. Provide a software program that will restart equipment shut down as the result of a fire alarm system following the return to normal conditions. When equipment is shut down by the FDACS the BMCS controlled relay shall be immediately placed in the "OFF" state such that the equipment cannot restart when the FDACS relay enables start up of the equipment. Equipment that has been started by a BMCS command and which stops operation within 30 seconds of a fire alarm annunciation and which was not shut down by the BMCS shall be assumed to have been shut down by the FDACS as a result of the fire alarm.

B. If equipment is shut down by the FDAC system or by the BMCS as the result of a fire alarm, then the shut down shall not be annunciated as an alarm condition.

C. Following the return to normal indication at the FDACS, the BMCS shall automatically initiate the restart of all equipment shut down by the FDACS.

D. The restart of the equipment shall be subject to all the software protection functions such as the minimum "off" time and the operator defined time delay requirements between successive equipment starts. Provide timing delays between equipment restart after a whole building shut down. Coordinate equipment restart order and delay intervals with the Owner.

2.6 EQUIPMENT RESTART FOLLOWING A POWER FAILURE

A. Provide a program that will facilitate the restart of equipment following a power failure.

B. This program shall function in the same manner as the "Equipment Restart Following a Fire Alarm" except that it shall be based on the BMCS detection of a power failure rather than on the BMCS detection of a fire alarm.

C. Equipment restart following a power failure shall be determined by monitoring of the associated automatic transfer switch.

2.7 BMCS FIELD TERMINATION SCHEDULES

A. The following tables define the minimum monitoring and control functions to be undertaken by the BMCS.

B. The column headed **FT** contains the tag that enables cross reference between the Field Termination Sheets and the System Diagrams

C. The column headed **DESCRIPTION** provides an English language description of the point to be monitored or controlled.

D. The column headed **DI** indicates the digital input monitoring requirements. The digital input codes are as follows:

1. Monitor motor status via contacts provided by others at VSD or motor interface terminal strip.
2. Monitor contacts at equipment or instrumentation on equipment.
3. Monitor contacts of the FDACS status at the main FDACS panel.
4. Monitor contacts at the refrigerant leak monitoring panel.
5. Provide and monitor a manual start/stop switch.
6. Monitor fire alarm status.
7. Provide and monitor a manual tank selector switch.
11. Provide and monitor current sensing relay to monitor status.
21. Provide and monitor a water differential pressure switch.
22. Provide and monitor a water presence sensor.
23. Provide and monitor a multi-probe type water level sensor and switches.
24. Provide and monitor a liquid level float switch.
31. Provide and monitor an air differential pressure switch for fan high/low static safety shutdown.
32. Provide and monitor an air differential pressure switch for fan status.
33. Provide and monitor an air differential pressure switch for dirty filter status monitoring.
41. Provide and monitor freezestat assembly.
51. Provide and monitor emergency fan operation switch.
52. Provide and monitor emergency shutdown switch.
53. Provide and monitor an Emergency Refrigerant Leak Detection System.
54. Provide and monitor a lighting zone override wall mounted switch.
61. Provide and monitor a damper position end switch to monitor the full open position.
62. Provide and monitor a damper position end switch to monitor the full closed position.
63. Provide and monitor a valve position end switch to monitor the full open position.
64. Provide and monitor a valve position end switch to monitor the full closed position.

71. Provide and monitor a ceiling mounted motion sensor.

E. The column headed **DO** indicate the digital output control requirements. The digital output codes are as follows:
1. Provide and control a relay across the appropriate terminals at the motor interface terminal strip or VSD controller, as applicable, for the stop/start control of a motor. Provide on/off control point interfaces as required for momentary or latching relays as required by the sequence of operation.
2. Provide enable/disable control of boiler.
3. Provide enable/disable control of steam humidifier.
4. Provide enable/disable control of gas heater.
5. Provide enable/disable control of water filtration system.
6. Provide enable/disable control of self-contained AC unit.
7. Provide enable/disable control of chiller.
8. Provide enable/disable control of packaged water cooled VAV AC unit.
9. Provide enable/disable control of packaged direct expansion roof top AC Unit.
10. Provide enable/disable control of cogen plant.
11. Provide enable/disable of each step of electric heater. Provide one output per stage of heat.
12. Provide enable/disable of gas fired infrared heater.
21. Furnish AD and provide actuator. Provide open/closed signal to damper actuator.
22. Provide actuator on damper provided under the Mechanical Contractor work. Provide open/closed signal to damper actuator.
23. Provide open/closed signal to damper actuator. Damper and actuator provided under the Mechanical Contractor work.
31. Furnish valve and provide actuator. Provide open/closed signal to actuator.
32. Provide open/closed signal to basin cleaning system valve actuator. Valve and actuator provided by others.
33. Furnish pilot operate water makeup valve and actuator. Provide open/closed signal to water makeup valve actuator.
34. Provide open/closed signal to valve and actuator. Valve and actuator by others.
35. Provide open/closed signal to valve and 120 Vac actuator. Valve and actuator by others.
41. Provide alarm notification to the BMCS of any system related alarm condition.
42. Provide and control BMCS critical alarm annunciator.
51. Provide enable/disable control of thermal storage charging mode. Coordinate interface with the thermal storage controller manufacturer.
52. Provide enable/disable control of thermal storage discharging mode. Coordinate interface with the thermal storage controller manufacturer.
53. Provide enable/disable control of thermal storage parallel operation mode. Coordinate interface with the thermal storage controller manufacturer.

F. The column headed **AI** indicates the analog input monitoring requirements. The analog input codes are as follows:
1. Provide and monitor a wall mounted space temperature sensor.
2. Provide and monitor a wall mounted button type space temperature sensor.
3. Provide and monitor a duct mounted averaging temperature sensor.
4. Provide and monitor a duct mounted single point temperature sensor.
5. Provide and monitor a thermowell mounted temperature sensor.
6. Provide and monitor an outside air temperature sensor.
7. Provide ceiling/upper structure mounted infrared based temperature sensor to sense vehicle ramp surface temperature.
8. Provide combined outside air temperature and humidity sensor.
10. Provide and monitor an outside air humidity sensor.
11. Provide and monitor a duct mounted relative humidity sensor.
12. Provide and monitor a wall mounted space humidity sensor.
21. Provide and monitor a water differential pressure sensor across the supply and return lines.
22. Provide and monitor a water pressure sensor.
23. Provide and monitor an insertion turbine water flowmeter.
24. Provide and monitor a bi-directional insertion turbine flowmeter.
25. Provide and monitor an in-line magnetic water flowmeter.

26. Provide and monitor a water sump level sensor.
27. Provide and monitor a zone type water leak detection system.
28. Monitor water pressure sensor provided by others.
29. Provide and monitor water meter/totalizer.
31. Provide and monitor a duct static pressure sensor relative to the return air plenum.
32. Provide and monitor a space static pressure sensor relative to the outside air.
33. Provide and monitor an under floor mounted static pressure sensor relative to the occupied space.
34. Provide and monitor a duct static pressure sensor relative to the adjacent occupied space return air plenum.
35. Provide and monitor a space static pressure sensor relative to the adjacent occupied space.
36. Provide and monitor differential pressure across inline equipment and devices.
41. Provide and monitor fan inlet thermal dispersion air flowrate sensor.
42. Provide and monitor a duct mounted thermal dispersion air flowrate sensor.
43. Provide and monitor a duct mounted differential pressure air flowrate sensor.
51. Provide and monitor a duct mounted carbon dioxide sensor.
52. Provide and monitor an outside air carbon dioxide sensor.
53. Provide and monitor a wall mounted space carbon dioxide sensor.
54. Provide and monitor a carbon monoxide sensor.
55. Provide and monitor a nitrogen dioxide sensor.
56. Provide and monitor a wall mounted space smoke sensor.
61. Provide and monitor an ambient light level sensor.
62. Provide and monitor a ceiling mounted motion sensor.
71. Provide and monitor a valve position sensor.
72. Provide and monitor a damper position sensor.
81. Provide and monitor a wind direction indicator.
82. Provide and monitor a wind speed indicator.
91. Provide and monitor an amp meter/transducer.
92. Provide and monitor a voltage transducer.
93. Provide and monitor a frequency transducer.
94. Monitor KW load at chiller control panel.
95. Monitor amperage load at chiller control panel.
96. Monitor instrumentation on the water chilling unit control panel.
97. Monitor instrumentation on the boiler unit control panel.
101. Monitor chiller condenser circuit head pressure. Coordinate signal sensing type and range will chiller manufacturer.

G. The column headed **AO** indicates the analog output monitoring requirements. The analog output codes are as follows:
1. Provide modulating speed control signal to VSD controlled motor.
11. Furnish two-way valve and provide actuator. Provide a modulating signal to the valve actuator.
12. Furnish three-way valve and provide actuator. Provide a modulating signal to the valve actuator.
21. Furnish AD and provide actuator. Provide a modulating signal to damper actuator.
22. Provide actuator for AD provided by others. Provide a modulating signal to damper actuator.
23. Provide modulating signal to floor diffuser.
31. Provide modulating signal to SCR controller for first stage of heater control. Subsequent stages are controlled via digital output interface.
41. Provide signal to chiller control panel for chilled water supply temperature setpoint reset.
42. Provide signal to chiller control panel for current limit reset.
51. Provide signal to boiler control panel for hot water supply temperature setpoint reset.

H. The column headed **HI** indicates the hardwired interface requirement. These devices are not monitored by the BMCS unless indicated in any of the previous columns. The hardwired interlock codes are as follows:
1. Provide and interlock freezestat assembly to shutdown the associated supply fan if a low temperature condition exists.
2. Install and interlock thermostat provided as part of the unit to the AC unit.

3. Provide and interlock a wall mounted thermostat to control the unit.
4. Interlock the heating coil pump to operate in the event of a freezestat shutdown of the associated unit.
5. Interlock condenser unit to operate when associated air handling unit is commanded on. Coordinate cabling requirements with unit manufacturer.
6. Provide and interlock a line voltage thermostat for associated fan.
11. Provide and interlock water differential pressure switches to indicate water flow through each bundle of the chiller. Coordinate switch range selection with the selected chiller manufacturer.
12. Provide and interlock water presence sensor switch to disable the fan coil unit in the event water is detected in the drain pan.
21. Provide and interlock an air differential pressure switch to disable the fan in the event of high/low static pressure, as appropriate for the application.
22. Provide and interlock a duct static pressure sensor relative to the return air plenum.
31. Provide interlock between the fire/smoke rated damper motor(s) and associated motor starter/VSD terminal strip to prevent the fan(s) from operating until the damper(s) are completely open and to close the dampers once the unit is shut down. Damper and actuator by others.
32. Furnish AD and provide actuator. Provide interlock between the damper motor(s) and associated motor starter/VSD terminal strip to prevent the fan(s) from operating until the damper(s) are completely open and to close the dampers once the unit is shut down. Provide end switches as required.
33. Furnish AD and provide actuator. Provide interlock between the damper motor(s) and associated boiler control panel to open the damper prior to enabling the associated boiler. AD shall close upon boiler disable. Provide end switches as required.
34. Provide interlock between the fire/smoke rated damper motor(s) and associated motor starter/VSD terminal strip to prevent the fan(s) from operating until the damper(s) are completely open and to close the dampers once the unit is shut down. Damper and actuator by others.
35. Furnish AD and provide actuator. Provide interlock between the damper motor(s) and associated condenser unit terminal strip to prevent the fan(s) from operating until the damper(s) are completely open and to close the dampers once the unit is shut down. Provide end switches as required.
41. Interlock pump to operate when associated AC unit is operating.
42. Interlock pump to operate when isolation control valve is open.
43. Provide flowswitch and interlock flowswitch to start the standby pump upon sensing low flowrate.
44. Interlock pump to start if DG sets are running.
45. Interlock pump to stop if water treatment package trips.
46. Interlock the primary pump with the associated boiler to operate when the boiler is enabled to operate. Provide adjustable time delay relays as required per the manufacturer's instructions for delay stopping upon boiler disable.
51. Provide and monitor emergency fan operation switches to activate all ventilation fans serving the central plant room. Mount adjacent to each exit from central plant.
52. Interlock fans to operate upon activation of the refrigerant monitoring system.
61. Interlock the fan vibration alarm to shut down the fan in the event of excessive vibration.
71. Interlock tank high liquid level sensors to shut off main water supply and stop storage water supply pumps.
72. Interlock tank low liquid level sensors to shut off main water supply pumps.
73. Interlock tank low liquid level sensors to start pumps.
74. Interlock tank high liquid level sensors to stop pumps.
75. Furnish valve and provide actuator. Interlock valve actuator to tank level sensors to open and close valve to maintain the liquid level between the valve open and valve closed levels.
76. Interlock pumps to tank level sensors to start and stop to maintain the liquid level between the pump start and pump stop levels.
77. Interlock filter package to operator when associated pump are operating and to disable when associated pumps are not operating.
78. Interlock the pump to operate upon sensing a high level and to stop upon sensing a low level.
81. Interlock isolation valve to open when pumps are running and to close when all pumps are

off.

91. Interlock ultraviolet light to operate when the associated fan is operating.
101. Interlock slave motorized swirl diffusers to master motorized swirl diffuser.

I. The column headed **CI** indicates the digital communications interface requirements to meters or controllers. Refer to the BMCS Software Interfaces section of these specifications for additional details on third party interfaces. The communications interface codes are as follows:
   1. Furnish lighting control relay panels and provide a software interface to the lighting control relay panels at each panel location. Refer to electrical drawings for all relay panel locations.
   2. Provide a software interface of each main switchboards via switchboard metering system at each unit.
   3. Provide a software interface to each generator control panel.
   4. Provide a software interface to the heat trace control panel.
   5. Provide a software interface to the Fire Alarm, Detection and Communication System.
   6. Provide a software interface to the electrical paralleling switchgear.
   7. Provide a software interface to the UPS unit's communication gateway. Provide any cabling required from each UPS unit to the UPS unit manufacturer's provided gateway and from the gateway to the BMCS.
   8. Provide a software interface to the battery monitoring system.
   9. Provide a software interface to each remote power panel.
   10. Provide a software interface to each power distribution unit.
   11. Provide a software interface to each automatic transfer switch.
   12. Provide an electrical submeter and a software interface to each electrical submeter.
   13. Provide a software interface to each electrical submeter provided by electrical.
   14. Provide a software interface to each photovoltaic inverter panel.
   21. Provide a software interface to each chiller control panel.
   22. Provide a software interface to the boiler control panel.
   23. Provide a software interface to each VSD.
   24. Provide a software interface to the CRAC unit's communication gateway. Provide any cabling required from each CRAC unit to the CRAC unit manufacturer's provided gateway and the gateway to the BMCS.
   25. Provide a software interface to water cooled package VAV AC unit.
   26. Provide a software interface to packaged direct expansion roof top AC unit.
   27. Provide a software interface to package water source heat pump unit.
   31. Provide a UC and provide monitoring and control of listed points via UC. Refer to the BMCS Controllers section of these specifications for additional monitoring and control requirements.
   41. Provide a software interface of the Fuel Monitoring and Control System. Obtain all points listed and all other available points on the Fuel Monitoring System.
   42. Provide a zone type leak detection system and provide a software interface to the leak detection system control panel.
   43. Provide a software interface to each zone type leak detection controller provided by others.
   51. Provide a BTUH meter and provide software interface to the meter.
   61. Provide gas meter/totalizer and provide software interface to the meter.

J. The column headed **NOTES** indicates additional information either by description or code. The NOTE codes are:
   1. Refer to the Mechanical Documents for locations and quantities of units.
   2. Refer to the Electrical Documents for locations and quantities of units.
   3. Refer to the Plumbing Documents for locations and quantities of units.
   4. Provide a standalone DCP type controller not connected to the BMCS. The stand alone controller shall be commissioned utilizing the ROW.
   5. Provide button type space temperature sensors in public spaces.
   6. Space temperature sensors to be located at location identified on Mechanical Documents. Provide 50 feet of additional cabling at identified location and plastic wrap enclosure for temperature sensor attached to structure above. Final temperature sensor location to be provided during tenant fit-out.

7. The low pressure reference tubing shall be connected to the outside air reference riser located in the East Mechanical Room. Refer to Mechanical Documents for outside air riser reference location.
8. Stairwell static pressure sensors shall be located at the following locations:
   a. Level P2 for SF-P1-2.
   b. Level 26 for SF-2-(1-3).
   c. Level 43 for SF-63-3 and SF-64-(1-2).
9. Garage motion sensor shall be located as follows for the East and West buildings:
   a. Level P1
      i. 1 sensor adjacent to each stairwell door.
      ii. 1 sensor inside each passenger elevator lobby.
      iii. 1 sensor at the top of the ramp to level 2.
      iv. 1 sensor at the garage entry exit.
   b. Levels P2
      i. 1 sensor adjacent to each stairwell door.
      ii. 1 sensor inside each passenger elevator lobby.
      iii. 1 sensor at the top of the ramp to the level below.
      iv. 1 sensor at the base of the ramp to level above.
   c. Level P3
      i. 1 sensor adjacent to each stairwell door.
      ii. 1 sensor inside each passenger elevator lobby.
      iii. 1 sensor at the bottom of the ramp to the level above.
10. All relief air dampers on a floor shall connect to the DCP with the space pressure sensor for the associated floor.
11. The return temperature sensor, return air humidity sensor, and return air CO2 sensor shall be located in the return air plenum before entering the mechanical room.

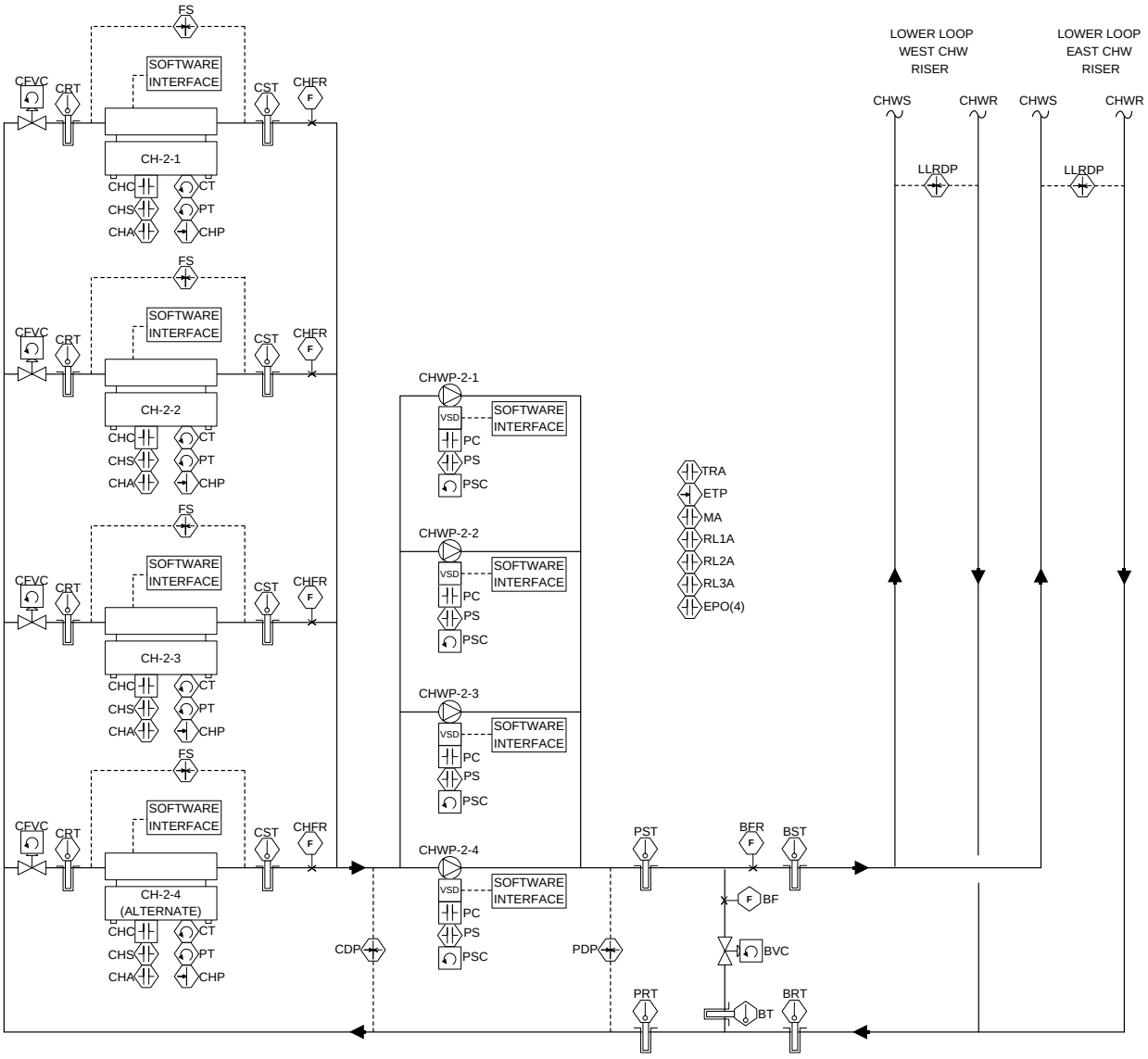
PART 3 - EXECUTION

W-01: LOWER LOOP CHILLED WATER SYSTEM

FT	DESCRIPTION	DI	DO	AI	AO	HI	CI	NOTES
CHC	WCU CONTROL		7					TYPICAL OF 3-BASE BID, TYPICAL OF 4 - ALTERNATE
CHS	WCU STATUS	2						TYPICAL OF 3-BASE BID, TYPICAL OF 4 - ALTERNATE
CHA	CHILLER ALARM	2						TYPICAL OF 3-BASE BID, TYPICAL OF 4 - ALTERNATE
FS	CHILLER FLOW STATUS	21				11		TYPICAL OF 3-BASE BID, TYPICAL OF 4 - ALTERNATE
CL	CURRENT LIMIT						21	TYPICAL OF 3-BASE BID, TYPICAL OF 4 - ALTERNATE
W	WCU WATTS						21	TYPICAL OF 3-BASE BID, TYPICAL OF 4 - ALTERNATE
ECHT	ENTERING CHILLED WATER TEMPERATURE						21	TYPICAL OF 3-BASE BID, TYPICAL OF 4 - ALTERNATE
LCHT	LEAVING CHILLED WATER TEMPERATURE						21	TYPICAL OF 3-BASE BID, TYPICAL OF 4 - ALTERNATE
EP	EVAPORATOR PRESSURE						21	TYPICAL OF 3-BASE BID, TYPICAL OF 4 - ALTERNATE
AOP	AUXILIARY OIL PRESSURE						21	TYPICAL OF 3-BASE BID, TYPICAL OF 4 - ALTERNATE
BP	BEARING PRESSURE						21	TYPICAL OF 3-BASE BID, TYPICAL OF 4 - ALTERNATE
EDP	EVAPORATOR DIFFERENTIAL PRESSURE						21	TYPICAL OF 3-BASE BID, TYPICAL OF 4 - ALTERNATE
ET	EVAPORATOR TEMPERATURE						21	TYPICAL OF 3-BASE BID, TYPICAL OF 4 - ALTERNATE
ST	SUCTION TEMPERATURE						21	TYPICAL OF 3-BASE BID, TYPICAL OF 4 - ALTERNATE
PA	PRE-ALARM						21	TYPICAL OF 3-BASE BID, TYPICAL OF 4 - ALTERNATE
FS	FLOW SAFETY						21	TYPICAL OF 3-BASE BID, TYPICAL OF 4 - ALTERNATE
MS	MOTOR SAFETY						21	TYPICAL OF 3-BASE BID, TYPICAL OF 4 - ALTERNATE
MR	MOTOR RUN						21	TYPICAL OF 3-BASE BID, TYPICAL OF 4 - ALTERNATE
TR	CHILLED WATER SUPPLY TEMPERATURE RESET						21	TYPICAL OF 3-BASE BID, TYPICAL OF 4 - ALTERNATE
ECWT	ENTERING CONDENSER WATER TEMPERATURE						21	TYPICAL OF 3-BASE BID, TYPICAL OF 4 - ALTERNATE
LCWT	LEAVING CONDENSER WATER TEMPERATURE						21	TYPICAL OF 3-BASE BID, TYPICAL OF 4 - ALTERNATE

FT	DESCRIPTION	DI	DO	AI	AO	HI	CI	NOTES
CRR	CHILLER REFRIGERANT RELIEF						21	TYPICAL OF 3-BASE BID, TYPICAL OF 4 - ALTERNATE
CT	CHILLER CURRENT TRANSFORMER			96				TYPICAL OF 3-BASE BID, TYPICAL OF 4 - ALTERNATE
PT	CHILLER POTENTIAL TRANSFORMER			96				TYPICAL OF 3-BASE BID, TYPICAL OF 4 - ALTERNATE
CHP	CHILLER HEAD PRESSURE			101				TYPICAL OF 3-BASE BID, TYPICAL OF 4 - ALTERNATE
CRT	CHILLED WATER RETURN TEMPERATURE			5				TYPICAL OF 3-BASE BID, TYPICAL OF 4 - ALTERNATE
CST	CHILLED WATER SUPPLY TEMPERATURE			5				TYPICAL OF 3-BASE BID, TYPICAL OF 4 - ALTERNATE
CHFR	CHILLER FLOWRATE			25				TYPICAL OF 3-BASE BID, TYPICAL OF 4 - ALTERNATE
CFVC	CHILLER FLOW VALVE CONTROL				11			TYPICAL OF 3-BASE BID, TYPICAL OF 4 - ALTERNATE
CDP	CHILLER DIFFERENTIAL PRESSURE			21				
PC	CHW PUMP CONTROL		1					TYPICAL OF 4
PS	CHW PUMP STATUS	1						TYPICAL OF 4
PSC	PUMP SPEED CONTROL				1			TYPICAL OF 4
PSR	PUMP VSD SPEED REFERENCE FEEDBACK						23	TYPICAL OF 4
PFS	PUMP VSD MOTOR OPERATING STATUS						23	TYPICAL OF 4
PFF	PUMP FAULT DIAGNOSTICS						23	TYPICAL OF 4
PHP	PUMP MOTOR POWER IN HP						23	TYPICAL OF 4
PKW	PUMP MOTOR POWER IN KW						23	TYPICAL OF 4
PKWH	PUMP MOTOR KWH						23	TYPICAL OF 4
PC	PUMP MOTOR CURRENT						23	TYPICAL OF 4
PV	PUMP MOTOR VOLTAGE						23	TYPICAL OF 4
PRH	PUMP HOURS RUN						23	TYPICAL OF 4
PDCV	PUMP DC LINK VOLTAGE						23	TYPICAL OF 4
PTL	PUMP THERMAL LOAD ON MOTOR						23	TYPICAL OF 4
PTV	PUMP THERMAL LOAD ON VFD						23	TYPICAL OF 4
PHST	PUMP VSD HEATSINK TEMPERATURE						23	TYPICAL OF 4
PST	PLANT CHILLED WATER SUPPLY TEMPERATURE			5				

FT	DESCRIPTION	DI	DO	AI	AO	HI	CI	NOTES
PRT	PLANT CHILLED WATER RETURN TEMPERATURE			5				
PDP	CHILLED WATER PLANT DIFFERENTIAL PRESSURE			21				
BF	CHILLED WATER BYPASS FLOWRATE			25				
BVC	CHW BYPASS VALVE CONTROL				11			
BT	CHILLED WATER BYPASS TEMPERATURE			5				
BST	BUILDING CHILLED WATER SUPPLY TEMPERATURE			5				
BRT	BUILDING CHILLED WATER RETURN TEMPERATURE			5				
BFR	BUILDING CHILLED WATER FLOWRATE			25				
LLRDP	LOWER CHILLED WATER LOOP RISER DIFFERENTIAL PRESSURE			21				TYPICAL OF 2, LOCATED AT LEVEL 29
TRA	CHW EXPANSION TANK RELIEF ALARM	2						
ETP	CHW EXPANSION TANK PRESSURE			22				
MA	CHW EXPANSION TANK MAKE-UP ALARM	2						
RL1A	REFRIGERANT LEVEL 1 ALARM	2						
RL2A	REFRIGERANT LEVEL 2 ALARM	2						
RL3A	REFRIGERANT LEVEL 3 ALARM	2						
RSA	REFRIGERANT SYSTEM LEAK DETECTION ALARM	2						
EPO	EMERGENCY PLANT SHUTDOWN SWITCH	52						TYPICAL OF FOUR. ONE INSIDE AND OUTSIDE OF EACH EXIT DOOR.



Operating Sequences:

A. System Description: The lower loop chilled water system consists of three (four-alternate) variable speed centrifugal water cooled chillers piped in parallel, four variable speed chilled water pumps piped in parallel, four variable speed condenser water pumps piped in parallel and a differential pressure bypass valve.

B. System Off - When the system is off:
   1. The chilled water pumps shall be off.
   2. The condenser water pumps shall be off.
   3. The chilling units shall be disabled.
   4. The chiller condenser and evaporator flow control valves shall be closed.
   5. The chilled water bypass valve shall be open.
   6. All control loops shall be disabled.

C. Initiation of System Start-Up - The system shall be started:
   1. By an operator manually entered command at the BMCS.

2. Automatically when there is a requirement for the chilled water at any of the AHU, FCU, and/or the upper loop chilled water system after an operator defined time delay or without time delay upon primary system failure recovery.

D. System Operation - When system start-up has been initiated, the following sequences shall be implemented:
   1. Lead-Lag equipment selection:
      a. The lead chiller shall be selected by one of the following operator selectable methods:
         i. Operator selection of individual equipment.
         ii. Run times to equalize equipment operations.
         iii. An operator selected staging order sequences. Provide staging sequences for up to three (four-alternate) combinations available.
         iv. During low load conditions the pony chiller (CH-3) shall be selected as the lead chiller. All other operating conditions shall have CH-1 or CH-2 selected as the lead Chiller based on the above mentioned criteria. Low load conditions shall be established on an operator selectable basis.
      b. The lead chilled water pump shall be selected by one of the following operator selectable methods:
         i. Operator selection of individual equipment.
         ii. Run times to equalize equipment operations.
         iii. An operator selected staging order sequences. Provide staging sequences for up to four combinations available. CHWP-2-4 shall only be selectable if CH-2-3 or CH-2-4 is selected as the lead chiller otherwise CHWP-2-4 shall be the last lag pump.
      c. The lead condenser water pump shall be selected by one of the following operator selectable methods:
         i. Operator selection of individual equipment.
         ii. Run times to equalize equipment operations.
         iii. An operator selected staging order sequences. Provide staging sequences for up to four combinations available. CWP-2-4 shall only be selectable if CH-2-3 or CH-2-4 is selected as the lead chiller otherwise CWP-2-4 shall be the last lag pump.
   2. System Start-Up:
      a. The condenser and evaporator flow control valves associated with the lead chiller shall fully open.
      b. The lead condenser water pump shall start, ramp to full speed and then the speed shall be modulated to maintain the condenser water differential pressure setpoint.
      c. The lead chilled water pump shall start and then the speed shall be controlled to maintain the chiller differential pressure setpoint.
      d. The evaporator flow control valve shall modulate to maintain the evaporator maximum flowrate setpoint associated with the lead chiller.
      e. The differential pressure switches across the evaporator and condenser water bundles shall verify proof of flow through each chiller bundle and enable the start control signal at the chiller control panel.
      f. The lead chilling unit shall start under control of the unit-mounted controllers.
      g. The chilled water bypass valve shall close.
   3. System Operation:
      a. Operation of the compressors and variable speed drive units on the chillers to maintain the chilled water supply temperature setpoint shall be by the unit mounted controller provided as part of the chiller.
      b. After an operator defined time delay, the chiller condenser flow control valve shall modulate to maintain the associated chiller condenser flowrate setpoint. The chiller condenser flowrate setpoint shall be reset between the minimum and maximum condenser flowrate limit setpoints at defined increments and defined intervals to maintain the chiller head pressure setpoint.
      c. After an operator defined time delay, the chiller evaporator flow control valves shall modulate to maintain the chiller evaporator flowrate setpoint. The chiller evaporator flowrate setpoint shall be reset between the minimum and maximum evaporator flowrate limit setpoints of each chiller to maintain the lower loop chilled water riser differential pressure setpoint as sensed in the lower loop chilled water risers. The lower loop riser differential pressure sensing for chiller evaporator flowrate reset shall be based on one of the operator selectable methods:

i. Worst case sensor.
ii. Average of the two sensors.
iii. Operator selected sensor.

d. If the chiller evaporator flowrate setpoint for all operating chillers is at the associated chillers minimum flowrate limit setpoint and the lower loop chilled water differential pressure is above setpoint for a defined period, then the chilled water differential pressure bypass valve shall be modulated to maintain the lower loop chilled water riser differential pressure setpoint.

e. After an operator defined time delay, if the operating chiller(s) do not provide adequate cooling to maintain the chilled water supply temperature setpoint, then the condenser water shall be controlled to the maximum condenser flowrate limit(s).

f. After another operator defined time delay, if the lead chiller does not provide adequate cooling to maintain the chilled water supply temperature setpoint, the operating chiller is above an operator defined percentage of full load, the chilled water bypass valve is fully closed, and the chiller evaporator flowrate setpoint is at the maximum evaporator flowrate limit setpoint, then the following shall occur:
i. The operating chiller shall be load limited to 60 percent of full load.
ii. The first lag chilled water pump and first lag condenser water pumps shall start as described above. The pump speed of all operating pumps condenser and chilled water pumps shall be controlled in unison to maintain their respective setpoints.
iii. The condenser and evaporator flow control valves associated with the lead chiller shall fully open
iv. The first lag chiller control shall be enabled as described above.
v. Once the first lag chiller is operational and stable, the lead chiller shall be released to full load operation, the evaporator flow control valves shall return to flowrate control for the associated chiller, and the condenser water flow control valves shall be released for chiller head pressure control.

g. After an operator defined time delay, if multiple chillers are operating below the operator defined load for staging down, and the chilled water supply temperature is at or below setpoint, and the flow in the chilled water bypass is greater than the minimum flowrate for the lead chiller for over an operator defined period, then the following shall occur:
i. The last lag chiller shall be disabled.
ii. The last lag chiller evaporator and condenser flow control valves shall close after the delay shutoff time has expired.
iii. After an operator time delay, the last lag chilled water and condenser water pumps shall stop.
iii. Chiller shutdown sequence and timing shall be coordinated with the chiller manufacturer.
iv. The sequence shall continue as needed until only one chiller is operating.

4. System or Power Failure Operation:
a. If a chiller is lost in service, the next lag chiller shall start without any software time delays. The failed chiller shall be disabled and removed from any lead/lag staging.
b. If a pump is lost in service, the next lag pump shall start without any software time delays. The failed pump shall be disabled and removed from any lead/lag staging.
c. If a valve fails to operate, then the associated equipment shall be deemed failed and removed from the sequence of operation.

5. Emergency Plant Shutdown Operation:
a. If the emergency plant shutdown button is activated, provide for an orderly shutdown of all equipment within the central plant. Coordinate shutdown sequence of chillers with the chiller manufacturer.

6. Refrigerant Leak Detection System Operation:
a. If the refrigerant leak detection system alarm or the emergency ventilation button is activated, provide for an orderly shutdown of all equipment within the central plant, and the central plant ventilation shall operate in emergency ventilation mode. Coordinate shutdown sequence of chillers with the chiller manufacturer.

E. Setpoints - The setpoints shall be operator changeable and shall be set initially by the BMCS subcontractor

as follows:

1. The ramp speed of any variable speed drive shall be set to ramp no faster than two minutes from minimum speed to maximum speed.
2. The condenser water differential pressure setpoint shall be 10 psig.
3. The chiller differential pressure setpoint shall be 10 psig.
4. The maximum chiller evaporator and condenser flowrate setpoints shall be as scheduled for the full design load conditions.
5. The minimum chiller evaporator and condenser water flowrate setpoints shall be coordinated with the chiller manufacturer. Initial setpoints are assumed to be 50% of full design flowrate for the evaporator and 30% of full design flowrate for the condenser.
6. The setpoints of the hardwired chiller bundler proof of flow differential pressure switches shall be coordinated with the chiller manufacturer to correspond to the safety shutdown limit of each bundle.
7. The chilled water supply temperature setpoint shall be 40 deg. F.
8. The optimal chiller head pressure setpoint shall be coordinated with the chiller manufacturer.
9. The time delay for chiller condenser flowrate setpoint reset down shall be set at 5 minutes.
10. The time delay for chiller condenser flowrate setpoint reset up shall be set at 2 minutes.
11. The chiller condenser flowrate reset down interval shall be set at 25 gpm.
12. The chiller condenser flowrate reset up interval shall be set at 50 gpm.
13. The lower loop chilled water riser differential pressure setpoint shall be 12 psig.
14. The time delay for chiller evaporator flowrate setpoint reset down shall be set at 5 minutes.
15. The time delay for chiller evaporator flowrate setpoint reset up shall be set at 2 minutes.
16. The chiller evaporator flowrate reset down interval shall be set at 25 gpm.
17. The chiller evaporator flowrate reset up interval shall be set at 50 gpm.
18. The time period between chilled water minimum flowrate operation and bypass valve modulation shall be 5 minutes.
19. The time period between bypass modulation stopping and chiller flowrate reset up shall be 5 minutes.
20. The time period between inadequate chiller cooling and chiller condenser maximum flowrate operation shall be set at three minutes.
21. The time period between chiller condenser maximum flowrate operation and chiller lag staging up shall be initially set at 15 minutes.
22. The staging up percentage of full load of the operating chiller(s) shall be 80 percent.
23. The time delay for chiller evaporator and condenser flow balancing shall 5 minutes.
24. The staging down percentage of full load of the operating chiller(s) shall be 40 percent.
25. The time period between chillers staging down shall be set at 20 minutes.
26. The chiller evaporator and condenser valve shutoff after a chiller has been disabled shall be coordinated with the chiller manufacturer. Initial setpoint is assumed to be 5 minutes.
27. The time delay for lag chilled water and condenser water pump shutoff shall be 2 minutes.

F. Initiation of System Shutdown - System shutdown shall be initiated:

1. By operator entered manual command.
2. Automatically when there is no longer a requirement for lower loop chilled water or upper loop chilled water.
3. Automatically if the emergency plant shutdown button has been activated.
4. Automatically if the refrigerant monitoring system is in alarm or if the emergency ventilation system has been activated.

G. Alarms - The BMCS shall generate an alarm:

1. Equipment or valve failure.
2. If the chilled water supply temperature is outside the operator established low and high alarm limits, which shall be initially set at + or - 4 Deg. F. around the setpoint.
3. If the chiller condenser flowrate is outside the operator established low and high alarm limits, which shall be initially set at + or - 5% around the flowrate setpoint.
4. If the chiller head pressure is outside the operator established low and high alarm limits, which shall be set at + or - 5% around the pressure setpoint.
5. If the chiller evaporator flowrate is outside the operator established low and high alarm limits, which shall be initially set at + or - 5% around the flowrate setpoint.
6. If the lower loop chilled water riser differential pressure is + or - 5 psig around the setpoint.
7. If a chiller is operating and there is flow below the minimum manufacturers recommended limits.
8. If the condenser water differential pressure is + or - 3 psig around the setpoint.
9. If the chiller differential pressure is + or - 3 psig around the setpoint.

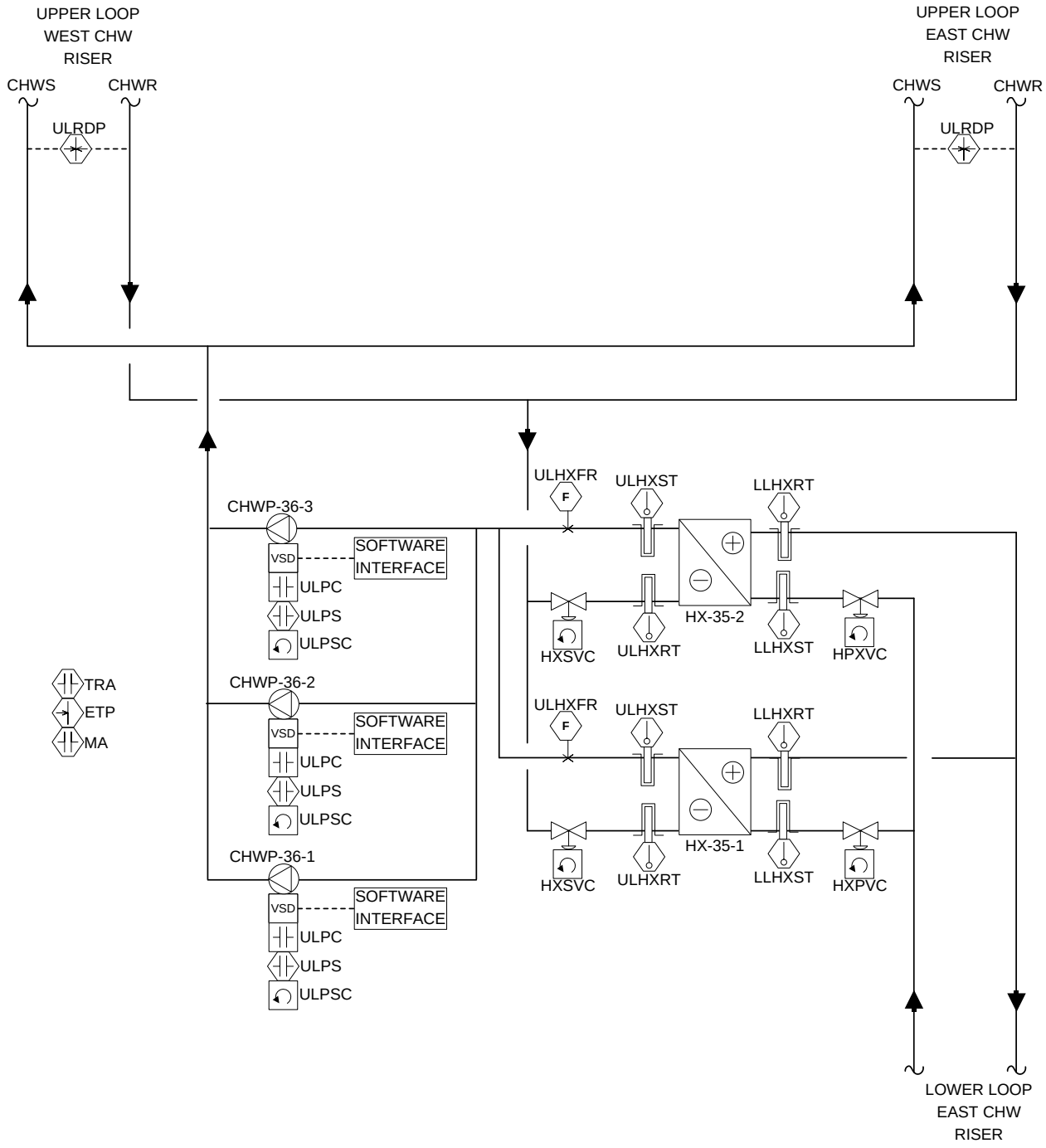
10. All alarms shall be inhibited when the system is not operating. The alarms, except the unit failure to start and failure in service alarms, shall remain inhibited following startup of the unit for an operator-defined period of time initially set at 10 minutes.

H. Failure positions - When a BMCS component failure occurs:
1. Pumps shall remain at the last commanded state.
2. Chilling units shall remain at the last commanded state.
3. Valves shall remain in the last commanded position.

W-02: UPPER LOOP CHILLED WATER SYSTEM

FT	DESCRIPTION	DI	DO	AI	AO	HI	CI	NOTES
LLHXST	LOWER CHILLED WATER LOOP HEAT EXCHANGER SUPPLY TEMPERATURE			5				TYPICAL OF 2
LLHXRT	LOWER CHILLED WATER LOOP HEAT EXCHANGER RETURN TEMPERATURE			5				TYPICAL OF 2
HXPVC	HEAT EXCHANGER PRIMARY VALVE CONTROL				11			TYPICAL OF 2
HXSVC	HEAT EXCHANGER SECONDARY VALVE CONTROL				11			TYPICAL OF 2
ULHXST	UPPER CHILLED WATER LOOP HEAT EXCHANGER SUPPLY TEMPERATURE			5				TYPICAL OF 2
ULHXRT	UPPER CHILLED WATER LOOP HEAT EXCHANGER RETURN TEMPERATURE			5				TYPICAL OF 2
ULHXFR	UPPER CHILLED WATER LOOP HEAT EXCHANGER FLOWRATE			25				TYPICAL OF 2
ULPC	CHW PUMP CONTROL		1					TYPICAL OF 3
ULPS	CHW PUMP STATUS	1						TYPICAL OF 3
ULPSC	PUMP SPEED CONTROL				1			TYPICAL OF 3
ULPSR	PUMP VSD SPEED REFERENCE FEEDBACK						23	TYPICAL OF 3
ULPFS	PUMP VSD MOTOR OPERATING STATUS						23	TYPICAL OF 3
ULPFF	PUMP FAULT DIAGNOSTICS						23	TYPICAL OF 3
ULPHP	PUMP MOTOR POWER IN HP						23	TYPICAL OF 3
ULPKW	PUMP MOTOR POWER IN KW						23	TYPICAL OF 3
ULPKWH	PUMP MOTOR KWH						23	TYPICAL OF 3
ULPC	PUMP MOTOR CURRENT						23	TYPICAL OF 3
ULPV	PUMP MOTOR VOLTAGE						23	TYPICAL OF 3
ULPRH	PUMP HOURS RUN						23	TYPICAL OF 3
ULPDCV	PUMP DC LINK VOLTAGE						23	TYPICAL OF 3
ULPTL	PUMP THERMAL LOAD ON MOTOR						23	TYPICAL OF 3
ULPTV	PUMP THERMAL LOAD ON VFD						23	TYPICAL OF 3
ULPHST	PUMP VSD HEATSINK TEMPERATURE						23	TYPICAL OF 3

FT	DESCRIPTION	DI	DO	AI	AO	HI	CI	NOTES
ULRDP	UPPER CHILLED WATER LOOP RISER DIFFERENTIAL PRESSURE			21				TYPICAL OF 2, LOCATED AT LEVEL 58
TRA	CHW EXPANSION TANK RELIEF ALARM	2						
ETP	CHW EXPANSION TANK PRESSURE			22				
MA	CHW EXPANSION TANK MAKE-UP ALARM	2						



Operating Sequences:

A. System Description: The upper loop chilled water system consists of two heat exchangers piped in parallel and three variable speed chilled water pumps piped in parallel.

B. System Off - When the system is off:
   1. The heat exchanger isolation valves shall be closed.
   2. The upper loop chilled water pumps shall be off.
   3. All control loops shall be disabled.

C. Initiation of System Start-Up - The system shall be started:
   1. By an operator manually entered command at the BMCS.
   2. Automatically when there is a requirement for the chilled water at any of the upper loop AHU, and/or FCU after an operator defined time delay or without time delay upon primary system failure recovery.

D. System Operation - When system start-up has been initiated, the following sequences shall be implemented:
   1. Lead-Lag equipment selection:
      a. The lead upper loop chilled water pump shall be selected by one of the following operator selectable methods:
         i. Operator selection of individual equipment.
         ii. Run times to equalize equipment operations.
         iii. An operator selected staging order sequences. Provide staging sequences for up to three combinations available.
      b. The lead upper loop heat exchanger shall be selected by one of the following operator selectable methods:
         i. Operator selection of individual equipment.
         ii. Run times to equalize equipment operations.
   2. System Start-Up:
      a. The primary and secondary heat exchanger valves for the lead heat exchanger shall fully open.
      b. The lead upper loop chilled water pump shall start at minimum speed.
   3. System Operation:
      a. After an operator defined time delay, the primary heat exchanger valve for the lead heat exchanger shall modulate to maintain the heat exchanger secondary supply temperature setpoint.
      b. If the lead heat exchanger primary valve has been open more than the stage up position for an operator defined time delay, the lag heat exchanger secondary valve shall fully open and the primary valves for the lead and lag heat exchanger shall be controlled in unison to maintain the heat exchanger supply temperature setpoint. The heat exchanger supply temperature sensing shall be based on one of the operator selectable methods:
         i. Worst case sensor.
         ii. Average of the two sensors.
         iii. Operator selected sensor.
      c. If both heat exchangers are operating the secondary valves shall modulate to maintain balanced flow through the secondary side of the heat exchangers.
      d. If both heat exchangers are operating and the heat exchanger primary valve has been open less than the stage down position for an operator defined time delay, the lag heat exchanger primary and secondary valves shall close.
      e. After an operator defined time delay, the upper loop chilled water pump speed shall be controlled to maintain the upper loop chilled water riser differential pressure setpoint. If multiple pumps are operating, the chilled water pump speed of all operating pumps shall be controlled in unison to maintain the riser differential pressure setpoint. The upper loop riser differential pressure sensing for riser differential pressure shall be based on one of the operator selectable methods:
         i. Worst case sensor.
         ii. Average of the two sensors.
         iii. Operator selected sensor.
      f. After an operator defined time delay, if the upper loop chilled water riser differential pressure is below setpoint and the lead upper loop chilled water pump is above the stage up speed setpoint, then the following shall occur:
         i. The lead upper loop chilled water pump shall be ramped to minimum speed.
         ii. Once the lead upper loop chilled water pump is at minimum speed, the first lag upper loop chilled water pump shall start at minimum speed.
         iii. Once the lead and first lag upper loop chilled water pumps are operating at minimum speed, the pump speeds shall be controlled to maintain the upper loop chilled water riser differential pressure as described above.
         iv. The sequence shall continue as needed for all pumps.
      g. After an operator defined time delay, if multiple upper loop chilled water pumps are operating, the upper loop chilled water riser differential pressure is at or above setpoint and the operating pumps are operating below the stage down speed setpoint, then the

following shall occur:
i. The last lag upper loop chilled water pump shall stop.
ii. The operating upper loop chilled water pump speeds shall be controlled to maintain the upper loop chilled water riser differential pressure as described above.
iii. The sequence shall continue as needed until only one pump is operating.

4. System or Power Failure Operation:
   a. If a pump is lost in service, the next lag pump shall start without any software time delays. The failed pump shall be disabled and removed from any lead/lag staging.
   b. If a valve fails to operate, then the associated equipment shall be deemed failed and removed from the sequence of operation.

E. Setpoints - The setpoints shall be operator changeable and shall be set initially by the BMCS subcontractor as follows:
1. The time period for primary valve control shall be one minute.
2. The heat exchanger secondary supply temperature setpoint shall be the lower loop chilled water supply temperature setpoint plus a heat exchanger approach temperature. The heat exchanger approach temperature shall be coordinated with the manufacturer and shall initially be set at 3 Deg. F.
3. The stage up valve position shall be 90% open.
4. The time period for heat exchanger staging up shall be 10 minutes.
5. The stage down valve position shall be 20% open.
6. The time period for heat exchanger staging down shall be 30 minutes.
7. The ramp speed of any variable speed drive shall be set to ramp no faster than two minutes from minimum speed to maximum speed.
8. The time period for pump speed control shall be one minute.
9. The upper loop chilled water riser differential pressure setpoint shall be 12 psig.
10. The pump stage up speed setpoint shall be 80% of full speed.
11. The time period for pump staging up shall be 15 minutes.
12. The pump stage down speed setpoint shall be 40% of full speed.
13. The time period for pump staging down shall be 30 minutes.

F. Initiation of System Shutdown - System shutdown shall be initiated:
1. By operator entered manual command.
2. Automatically when there is no longer a requirement for upper loop chilled water.

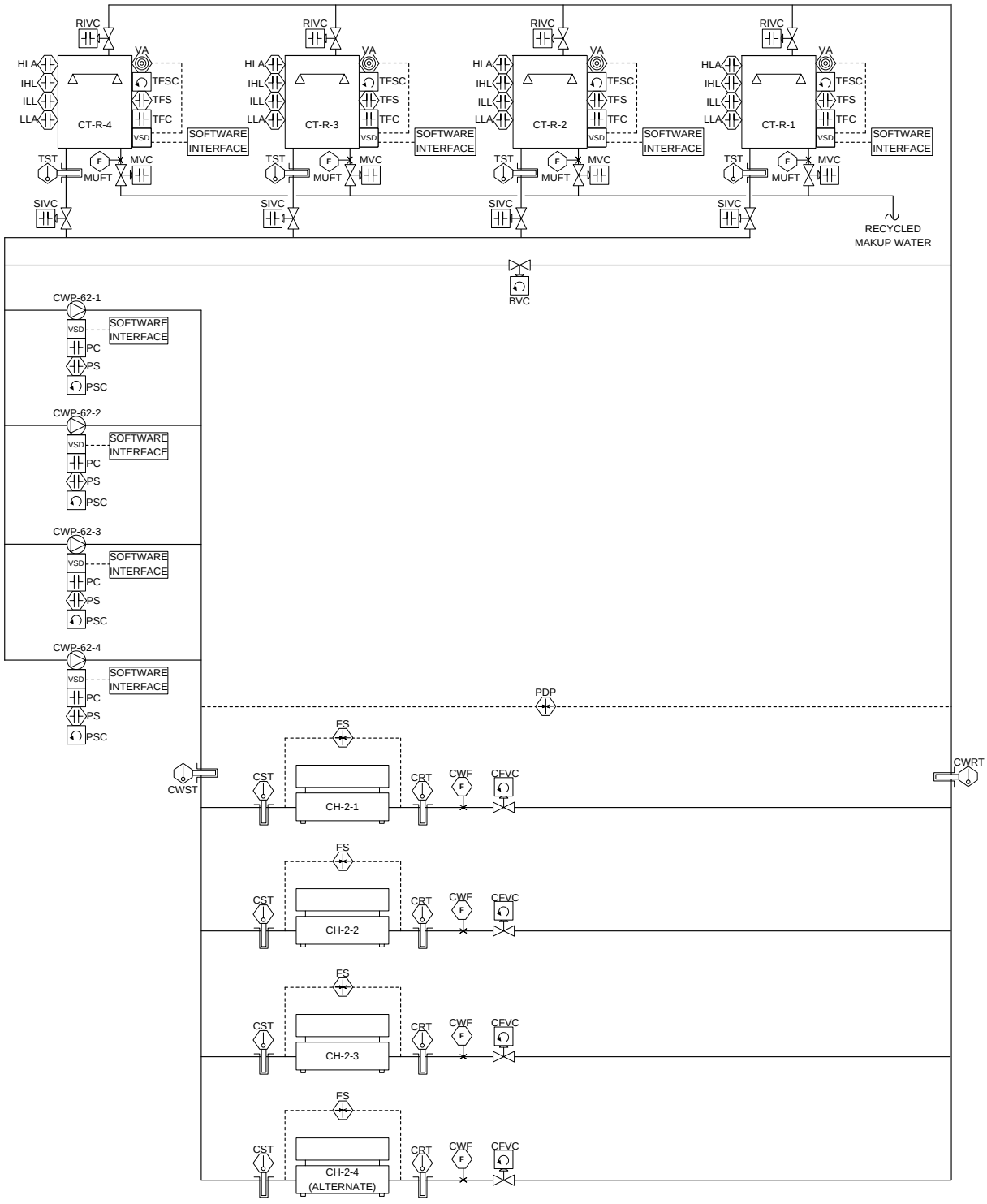
G. Alarms - The BMCS shall generate an alarm:
1. Equipment or valve failure.
2. If the upper loop chilled water riser differential pressure is + or - 5 psig around the setpoint.
3. If the upper loop chilled water supply temperature is more than + or - 4 Deg. around the upper loop chilled water supply temperature setpoint.
4. All alarms shall be inhibited when the system is not operating. The alarms, except the pump failure alarms, shall remain inhibited following startup of the unit for an operator-defined period of time initially set at 10 minutes.

H. Failure positions - When a BMCS component failure occurs:
1. Pumps shall remain at the last commanded state.
2. Valves shall remain in the last commanded position.

W-03: CONDENSER WATER SYSTEM

FT	DESCRIPTION	DI	DO	AI	AO	HI	CI	NOTES
TFC	TOWER FAN VSD START AND STOP CONTROL		1					TYPICAL OF 4
TFS	TOWER FAN STATUS	1						TYPICAL OF 4
TFSC	TOWER FAN VSD SPEED CONTROL SIGNAL				1			TYPICAL OF 4
VA	TOWER VIBRATION ALARM	2				61		TYPICAL OF 4
TFSR	TOWER FAN VSD SPEED REFERENCE FEEDBACK						23	TYPICAL OF 4
TFF	TOWER FAN FAULT DIAGNOSTICS						23	TYPICAL OF 4
TFHP	TOWER FAN MOTOR POWER IN HP						23	TYPICAL OF 4
TFKW	TOWER FAN MOTOR POWER IN KW						23	TYPICAL OF 4
TFKWH	TOWER FAN MOTOR KWH						23	TYPICAL OF 4
TFC	TOWER FAN MOTOR CURRENT						23	TYPICAL OF 4
TFV	TOWER FAN MOTOR VOLTAGE						23	TYPICAL OF 4
TFRH	TOWER FAN HOURS RUN						23	TYPICAL OF 4
TFDCV	TOWER FAN DC LINK VOLTAGE						23	TYPICAL OF 4
TFTL	TOWER FAN THERMAL LOAD ON MOTOR						23	TYPICAL OF 4
TFTV	TOWER FAN THERMAL LOAD ON VFD						23	TYPICAL OF 4
TFHST	TOWER FAN VSD HEATSINK TEMPERATURE						23	TYPICAL OF 4
TST	CONDENSER WATER SUPPLY TEMPERATURE			5				TYPICAL OF 4
RIVC	TOWER RETURN ISOLATION VALVE CONTROL		31					TYPICAL OF 4
SIVC	TOWER SUPPLY ISOLATION VALVE CONTROL		31					TYPICAL OF 4
MVC	MAKEUP VALVE CONTROL		31					TYPICAL OF 4
MUFT	COOLING TOWER MAKEUP FLOW TOTALIZER			29				TYPICAL OF 4
BVC	CONDENSER WATER BYPASS VALVE CONTROL				11			
PC	CW PUMP CONTROL		1					TYPICAL OF 4
PS	CW PUMP STATUS	1						TYPICAL OF 4
PSC	CW PUMP SPEED CONTROL				1			TYPICAL OF 4

FT	DESCRIPTION	DI	DO	AI	AO	HI	CI	NOTES
PSR	CW PUMP FAN VSD SPEED REFERENCE FEEDBACK						23	TYPICAL OF 4
PF	CW PUMP FAN FAULT DIAGNOSTICS						23	TYPICAL OF 4
PHP	CW PUMP FAN MOTOR POWER IN HP						23	TYPICAL OF 4
PKW	CW PUMP FAN MOTOR POWER IN KW						23	TYPICAL OF 4
PKWH	CW PUMP FAN MOTOR KWH						23	TYPICAL OF 4
PC	CW PUMP FAN MOTOR CURRENT						23	TYPICAL OF 4
PV	CW PUMP FAN MOTOR VOLTAGE						23	TYPICAL OF 4
PRH	CW PUMP FAN HOURS RUN						23	TYPICAL OF 4
PDCV	CW PUMP FAN DC LINK VOLTAGE						23	TYPICAL OF 4
PTL	CW PUMP FAN THERMAL LOAD ON MOTOR						23	TYPICAL OF 4
PTV	CW PUMP FAN THERMAL LOAD ON VFD						23	TYPICAL OF 4
PHST	CW PUMP FAN VSD HEATSINK TEMPERATURE						23	TYPICAL OF 4
CWST	CONDENSER WATER SUPPLY TEMPERATURE			5				
CWRT	CONDENSER WATER RETURN TEMPERATURE			5				
PDP	PLANT DIFFERENTIAL PRESSURE			21				
CST	CHILLER CONDENSER WATER SUPPLY TEMPERATURE			5				TYPICAL OF 3-BASE BID, TYPICAL OF 4 - ALTERNATE
CRT	CHILLER CONDENSER WATER RETURN TEMPERATURE			5				TYPICAL OF 3-BASE BID, TYPICAL OF 4 - ALTERNATE
FS	CW FLOW SAFETY	21				11		TYPICAL OF 3-BASE BID, TYPICAL OF 4 - ALTERNATE
CWF	CHILLER CW FLOW RATE			25				TYPICAL OF 3-BASE BID, TYPICAL OF 4 - ALTERNATE
CFVC	CHILLER FLOW VALVE CONTROL				11			TYPICAL OF 3-BASE BID, TYPICAL OF 4 - ALTERNATE
HLA	TOWER BASIN HIGH LEVEL ALARM	2						TYPICAL OF 4
IHL	INTERMEDIATE HIGH LEVEL	2						TYPICAL OF 4
ILL	INTERMEDIATE LOW LEVEL	2						TYPICAL OF 4
LLA	TOWER BASIN LOW LEVEL ALARM	2						TYPICAL OF 4


RIVC
VA
HLA
IHL
ILL
LLA
TFSC
TFS
TFC
VSD
CT-R-4
CT-R-3
CT-R-2
CT-R-1
SOFTWARE INTERFACE
TST
F
MUFT
MVC
SIVC
RECYCLED MAKUP WATER
BVC
CWP-62-1
CWP-62-2
CWP-62-3
CWP-62-4
PC
PS
PSC
PDP
FS
CWST
CST
CRT
CWF
CEVC
CWRT
CH-2-1
CH-2-2
CH-2-3
CH-2-4 (ALTERNATE)

Operating Sequences:

A. System Description: The condenser water system consists of four cooling tower cells, each with variable speed fans, and a condenser water bypass to provide condenser water cooling for the central plant chillers.

B. System Off - When the system is off:
1. The cooling tower fans shall be disabled.
2. The cooling tower cell isolation valves shall be closed.
3. The cooling tower bypass valves shall be closed.
4. The makeup water valves shall be closed.
5. All control loops shall be disabled.

C. Initiation of System Start-Up - The system shall be started:
1. By an operator manually entered command at the BMCS.
2. Automatically when a chiller is in operation.

D. System Operation - When system start-up has been initiated, the following sequences shall be implemented:
1. Lead-Lag equipment selection:
   a. The lead tower shall be selected by one of the following operator selectable methods:
      i. Operator selection of individual equipment.
      ii. Run times to equalize equipment operations.
      iii. An operator selected staging order sequences. Provide staging sequences for up to four combinations
2. System startup and operation:
   a. The condenser water pumps and flow control valves associated with the chillers shall be controlled as described in the chilled water sequence of operation.
   b. If the outside air temperature is below an operator defined setpoint for free cooling at the cooling towers, then the towers shall operate in free cooling mode:
      i. The supply and return isolation valves shall open on the lead and first lag cooling tower cells and the fans shall remain off to allow for free cooling.
      ii. If the condenser water supply temperature setpoint cannot be maintained by free cooling over the cells, then supply and return isolation valves on all cells shall close except the lead cell and that cell shall operate as describe below.
   c. During the normal operating mode, the lead cell supply and return isolation valves shall open, and the lead cell fan shall start on minimum speed. The speed of the operating fan shall be controlled to maintain the condenser water supply temperature setpoint.
   d. The lead/lag staging up and down of additional tower cells shall be based on the summation of flowrates of the operating condenser water pump flowrates and condenser water supply temperature.
      i. If one tower cell fan is operating, the condenser water supply temperature cannot be maintained, and the condenser water system flowrate exceeds the design minimum flowrate for two cells for a defined period, then the supply and return isolation valves on the first lag tower cell shall be opened and the associated tower cell fan shall be enabled to operate. The speed of all operating cell fans shall be controlled in unison to maintain the condenser water supply temperature setpoint.
      ii. If two tower cells are operating, the condenser water supply temperature cannot be maintained, and the condenser water system flowrate exceeds the design minimum flowrate for three cells for a defined period, then the supply and return isolation valves on the second lag tower cell shall be opened and the associated tower cell fan shall be started. The speed of all operating cell fans shall be controlled in unison to maintain the condenser water supply temperature setpoint.
      iii. If three tower cells are operating, the condenser water supply temperature cannot be maintained, and the condenser water system flowrate exceeds the design minimum flowrate for four cells for a defined period, then the supply and return isolation valves on the third lag tower cell shall be opened and the associated tower cell fan shall be started. The speed of all operating cell fans shall be controlled in unison to maintain the condenser water supply temperature setpoint.
      iv. If four tower cells are operating and the condenser water system flowrate is

below the design minimum flowrate for four cells for a defined period, then the third lag tower cell shall stop and its associated cell supply and return isolation valves shall close.

v. If three tower cells are operating and the condenser water system flowrate is below the design minimum flowrate for three cells for a defined period, then the second lag tower cell shall stop and its associated cell supply and return isolation valves shall close.

vi. If two tower cells are operating and the condenser water system flowrate is below the design minimum flowrate for two cells for a defined period, then the first lag tower cell shall stop and its associated cell supply and return isolation valves shall close.

e. When any chiller is operating, the condenser water plant bypass valve shall be modulated to maintain the minimum plant condenser water supply temperature setpoint.

f. Provide condenser water temperature setpoint reset via a control algorithm to optimize the energy usage as follows:

i. The condenser water supply temperature setpoint shall be based on the wet bulb temperature and cooling tower approach performance.

ii. The condenser water supply temperature should be set to be the outside air wet bulb temperature plus the cooling tower approach temperature.

iii. Provide high and low limit setpoint limits.

3. Cooling Tower Basin Makeup Operation:

a. If the water level in any cooling tower basin is below the Intermediate Low Level, the makeup water valve for the associated basin shall open.

b. Once the basin water level is above the Intermediate High Level, the makeup water valve for the associated basin shall close.

4. System or Power Failure Operation:

a. If a tower cell is lost in service, the next lag tower cell shall start without any software time delays and the failed cell shall be disabled and removed from any lead/lag staging.

b. If a valve fails to operate, then the associated piece of equipment is considered failed.

E. Setpoints - The setpoints shall be operator changeable and shall be set initially by the BMCS subcontractor as follows:

1. The outside air temperature for tower cell free cooling operation shall be confirmed with the cooling tower manufacturer. Initial setpoint shall be 55 Deg. F.
2. The ramp speed of any variable speed drive shall be set to ramp no faster than two minutes from minimum speed to maximum speed.
3. The condenser water supply temperature upper limit setpoint shall be 85 Deg. F.
4. The condenser water minimum flowrate shall be confirmed with the cooling tower manufacturer. Initial setpoint shall be 50% of the design flowrate.
5. The time period for staging tower cells on shall be 5 minutes.
6. The time period for staging tower cells off shall be 10 minutes.
7. The minimum condenser water supply temperature setpoint at the towers shall be 55 Deg. F.
8. The minimum plant condenser water supply temperature setpoint shall be 55 Deg. F.
9. The cooling tower approach temperature shall be confirmed with the cooling tower manufacturer. The initial approach shall be 6 Deg. F.
10. The time period for tenant condenser water pump speed control shall be one minute.

F. Initiation of System Shutdown - System shutdown shall be initiated:

1. By operator entered manual command.
2. Automatically by the BMCS if none of the chilling units are operating or condenser water is not required.

G. Alarm setpoints - The BMCS shall generate an alarm:

1. If the condenser water supply temperature is outside the operator established low and high alarm limits, which shall be initially set at 4 Deg. F. around the current setpoint for more than 15 minutes.
2. If the sump levels are above the high level alarm level or below the low level alarm level as determined by the cooling tower manufacturer.

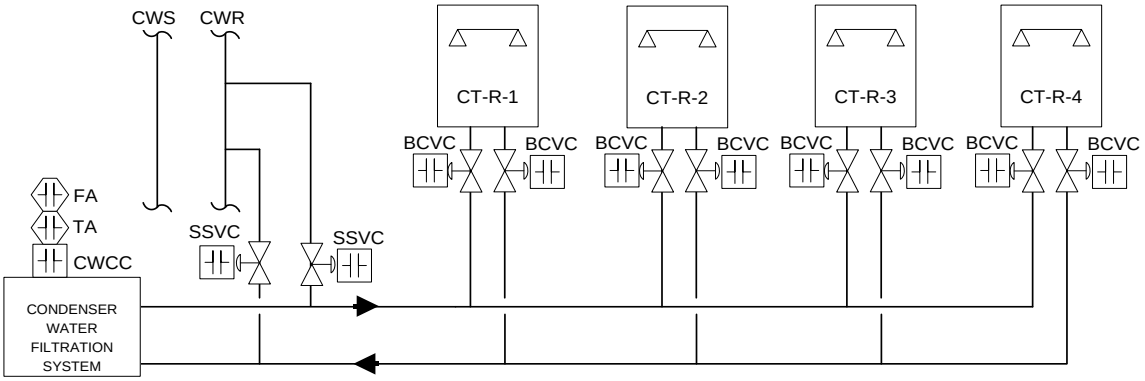
H. Failure positions - When a BMCS component or power failure occurs:

1. Pumps shall remain in the last commanded state.
2. Cooling tower fans shall remain in the last commanded state.

3. Control valves shall remain in the last commanded position.

W-04: CONDENSER WATER CLEANING SYSTEM

FT	DESCRIPTION	DI	DO	AI	AO	HI	CI	NOTES
CWCC	CONDENSER WATER CLEANING SYSTEM CONTROL		5					
TA	CONDENSER WATER SYSTEM TREATMENT ALARM	2						
FA	CONDENSER WATER FILTER ALARM	2						
BCVC	BASIN CLEANING VALVE CONTROL		31					TYPICAL OF 8
SSVC	SIDE STREAM VALVE CONTROL		31					TYPICAL OF 2



Operating Sequences:

A. System Description: The condenser water cleaning system consist of a water filtration system, supply and return isolation valves, and supply and return side-stream isolation valves that tie into the condenser water return line back to the towers.

B. System Off - When the system is off:
   1. The condenser water filtration system shall be off.
   2. The basin cleaning supply and return isolation valves shall be closed.
   3. The side-stream valves shall be closed.
   4. All control loops shall be disabled.

C. Initiation of System Start-Up - The system shall be started:
   1. By an operator manually entered command at the BMCS.
   2. Automatically when a cooling tower is in operation.

D. System Operation - When system start-up has been initiated, the following sequences shall be implemented:
   1. System startup and operation:
      a. When any cooling tower is operating, the basin cleaning supply and return isolation valves for the next lag cooling tower shall be opened, and the condenser water filtration system shall be enabled.
      b. If all cooling towers are operating, then the side-stream supply and return isolation valves shall be opened and all the basin cleaning valves shall be closed.

E. Setpoints - There are not setpoints for this system:

F. Initiation of System Shutdown - System shutdown shall be initiated:

1. By operator entered manual command.
2. Automatically by the BMCS if none of the cooling towers are in operation.

G. Alarm setpoints - The BMCS shall generate an alarm:
1. If the valves do not open.
2. Equipment failure.

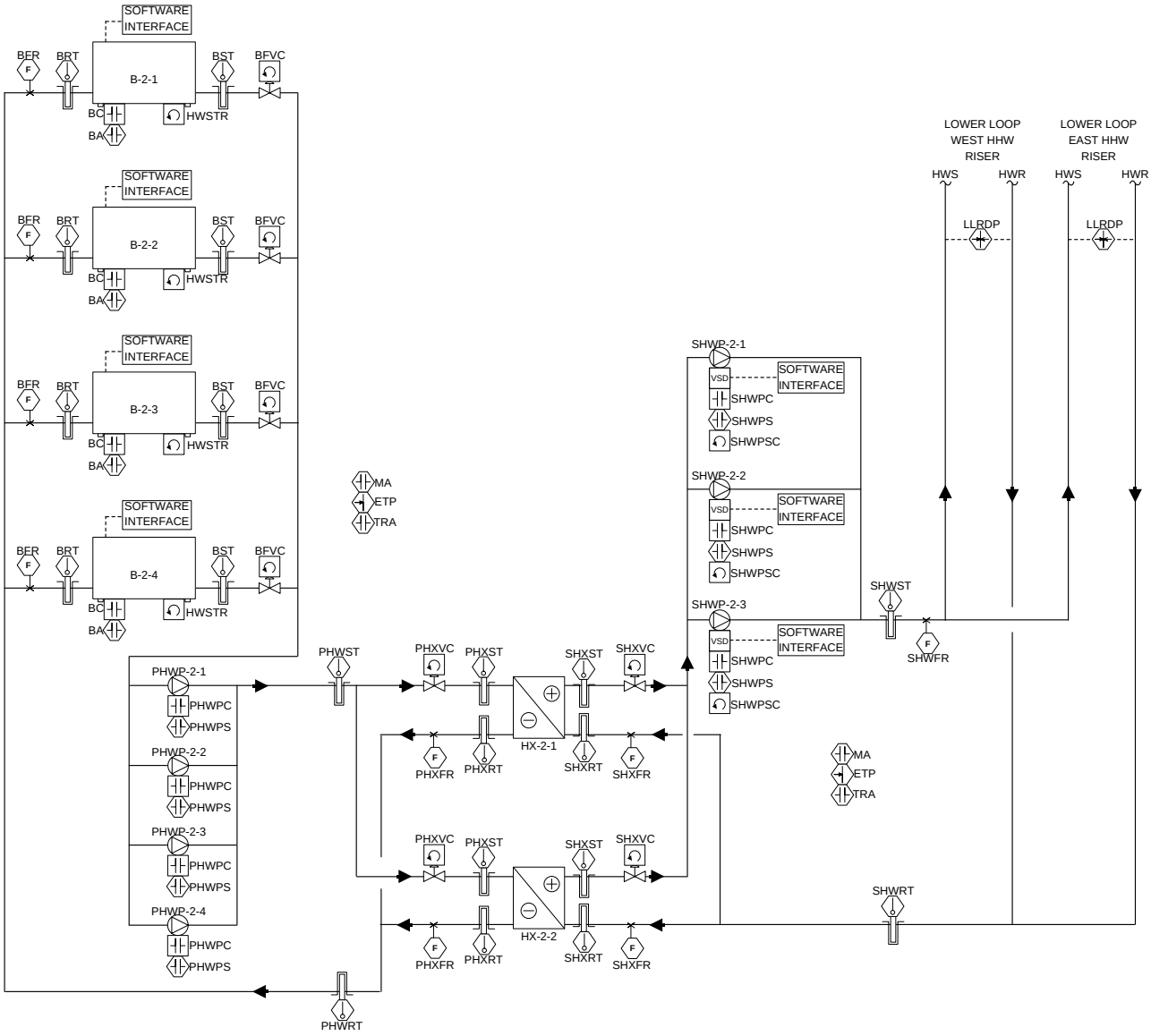
H. Failure positions - When a BMCS component or power failure occurs:
1. Basin cleaning supply and return valves shall fail closed.
2. Side-stream valves shall fail closed.

W-05: LOWER LOOP HOT WATER SYSTEM

FT	DESCRIPTION	DI	DO	AI	AO	HI	CI	NOTES
BFVC	BOILER FLOW VALVE CONTROL				11			TYPICAL OF 4
BC	BOILER ENABLE/DISABLE CONTROL		2					TYPICAL OF 4
BA	BOILER ALARM	2						TYPICAL OF 4
HWSTR	HOT WATER SUPPLY TEMPERATURE RESET				51			TYPICAL OF 4
EWT	BOILER ENTERING WATER TEMPERATURE						22	TYPICAL OF 4
LWT	BOILER LEAVING WATER TEMEPRATURE						22	TYPICAL OF 4
PA	BOILER PRE-ALARM						22	TYPICAL OF 4
FLFA	FLAME FAILURE ALARM						22	TYPICAL OF 4
STSP	SUPPLY TEMPERATURE SETPOINT						22	TYPICAL OF 4
GSVS	GAS SAFETY SHUT OFF VALVE STATUS						22	TYPICAL OF 4
BST	BOILER SUPPLY TEMPERATURE			5				TYPICAL OF 4
BRT	BOILER RETURN TEMPERATURE			5				TYPICAL OF 4
BFR	BOILER HOT WATER FLOWRATE			25				TYPICAL OF 4
PHWST	PRIMARY HOT WATER SUPPLY TEMPERATURE			5				
PHWRT	PRIMARY HOT WATER RETURN TEMPERTURE			5				
PHWPC	PRIMARY HOT WATER PUMP CONTROL		1					TYPICAL OF 4
PHWPS	PRIMARY HOT WATER PUMP STATUS	11						TYPICAL OF 4
PHXST	PRIMARY HOT WATER HEAT EXCHANGER SUPPLY TEMPERATURE			5				TYPICAL OF 2
PHXRT	PRIMARY HOT WATER HEAT EXCHANGER RETURN TEMPERATURE			5				TYPICAL OF 2
PHXFR	PRIMARY HOT WATER HEAT EXCHANGER FLOWRATE			25				TYPICAL OF 2
PHXVC	PRIMARY HOT WATER HEAT EXCHANGER VALVE CONTROL				11			TYPICAL OF 2

FT	DESCRIPTION	DI	DO	AI	AO	HI	CI	NOTES
SHXST	SECONDARY HOT WATER HEAT EXCHANGER SUPPLY TEMPERATURE			5				TYPICAL OF 2
SHXRT	SECONDARY HOT WATER HEAT EXCHANGER RETURN TEMPERATURE			5				TYPICAL OF 2
SHXFR	SECONDARY HOT WATER HEAT EXCHANGER FLOWRATE			25				TYPICAL OF 2
SHXVC	SECONDARY HOT WATER HEAT EXCHANGER VALVE CONTROL				11			TYPICAL OF 2
SHWST	SECONDARY HOT WATER SUPPLY TEMPERATURE			5				
SHWRT	SECONDARY HOT WATER RETURN TEMPERTURE			5				
SHWFR	SECONDARY HOT WATER FLOWRATE			25				
SHWPC	SECONDARY HOT WATER PUMP CONTROL		1					TYPICAL OF 3
SHWPS	SECONDARY HOT WATER PUMP STATUS	1						TYPICAL OF 3
SHWPSC	SECONDARY HOT WATER PUMP VSD SPEED CONTROL				1			TYPICAL OF 3
SPSR	SECONDARY HOT WATER PUMP VSD SPEED REFERENCE FEEDBACK						23	TYPICAL OF 3
SPF	SECONDARY HOT WATER PUMP FAULT DIAGNOSTICS						23	TYPICAL OF 3
SPHP	SECONDARY HOT WATER PUMP MOTOR POWER IN HP						23	TYPICAL OF 3
SPKW	SECONDARY HOT WATER PUMP MOTOR POWER IN KW						23	TYPICAL OF 3
SPKWH	SECONDARY HOT WATER PUMP MOTOR KWH						23	TYPICAL OF 3
SPC	SECONDARY HOT WATER PUMP MOTOR CURRENT						23	TYPICAL OF 3
SPV	SECONDARY HOT WATER PUMP MOTOR VOLTAGE						23	TYPICAL OF 3
SPRH	SECONDARY HOT WATER PUMP HOURS RUN						23	TYPICAL OF 3
SPDCV	SECONDARY HOT WATER PUMP DC LINK VOLTAGE						23	TYPICAL OF 3
SPTL	SECONDARY HOT WATER PUMP THERMAL LOAD ON MOTOR						23	TYPICAL OF 3
SPTV	SECONDARY HOT WATER PUMP THERMAL LOAD ON VFD						23	TYPICAL OF 3

FT	DESCRIPTION	DI	DO	AI	AO	HI	CI	NOTES
SPHST	SECONDARY HOT WATER PUMP VSD HEATSINK TEMPERATURE						23	TYPICAL OF 3
LLRDP	LOWER HOT WATER LOOP RISER DIFFERENTIAL PRESSURE			21				TYPICAL OF 2, LOCATED ON LEVEL 29
MA	HHW EXPANSION TANK MAKE-UP ALARM	2						TYPICAL OF 2
TRA	HHW EXPANSION TANK RELIEF ALARM	2						TYPICAL OF 2
ETP	HHW EXPANSION TANK PRESSURE			22				TYPICAL OF 2



Operating Sequences:

A. System Description: The lower loop hot water system consists of four parallel piped gas fired boilers with four constant speed primary hot water pumps serving two heat exchangers and three variable speed secondary hot water pumps piped in parallel serving the lower hot water loop.

B. System Off - When the system is off:
1. The boiler units shall be disabled.
2. The boiler flow control valves shall be closed.
3. The primary hot water pumps shall be off
4. The secondary hot water pumps shall be off.
5. The primary and secondary heat exchanger valves shall be closed.
6. All control loops shall be disabled.

C. Initiation of System Start-Up - The system shall be started:
1. By an operator manually entered command at the BMCS.
2. Automatically when there is a requirement for lower loop or upper loop hot water heating after an operator defined time delay or without time delay upon primary system failure recovery.

D. System Operation - When system start-up has been initiated, the following sequences shall be implemented:
1. Lead-Lag equipment selection:
   a. The lead boiler shall be selected by one of the following operator selectable methods:
      i. Operator selection of individual equipment.
      ii. Run times to equalize equipment operations.
      iii. An operator selected staging order sequences. Provide staging sequences for up to four combinations available.
   b. The lead primary hot water pump shall be selected by one of the following operator selectable methods:
      i. Operator selection of individual equipment.
      ii. Run times to equalize equipment operations.
      iii. An operator selected staging order sequences. Provide staging sequences for up to four combinations available.
   c. The lead secondary hot water pump shall be selected by one of the following operator selectable methods:
      i. Operator selection of individual equipment.
      ii. Run times to equalize equipment operations.
      iii. An operator selected staging order sequences. Provide staging sequences for up to three combinations available.
   d. The lead heat exchanger shall be selected by one of the following operator selectable methods:
      i. Operator selection of individual equipment.
      ii. Run times to equalize equipment operations.
2. System Start-Up:
   a. The lead heat exchanger primary valves shall fully open.
   b. The lead boiler flow control valve shall fully open.
   c. The lead primary hot water pump shall start.
   d. The lead heat exchanger secondary valves shall fully open.
   e. The lead secondary hot water pump shall start at minimum speed.
   f. The lead boiler unit shall start under control of the unit-mounted controllers.
3. System Operation:
   a. Operation of the burners on the boilers to maintain the hot water supply temperature setpoint shall be by the unit mounted controller provided as part of the boiler.
   b. After an operator defined time delay, the secondary hot water pump speed shall be controlled to maintain lower loop hot water riser differential pressure setpoint as sensed in the hot water riser. If multiple secondary pumps are operating, the speed of all operating pumps shall be controlled in unison. The sensor(s) utilized for pressure control shall be based on one of the following operator selectable methods:
      i. Worst case sensor.
      ii. Average of the sensors.
      iii. Operator selected sensor.
   c. The secondary valves shall modulate to maintain balanced flow through the secondary

side of the heat exchangers.

d. After another operator defined time delay, if the lead boiler does not provide adequate heating to maintain the hot water supply temperature setpoint, then the following shall occur:
   i. The first lag boiler flow control valve shall fully open as described above.
   ii. The first lag primary hot water pump shall start as described above.
   iii. The first lag boiler control shall be enabled as described above.
   iv. After an operator defined time delay the boiler flow control valves shall modulate to maintain flow through the associated boiler below the design flowrate.
   v. If there are more than two boilers commanded on, the primary and secondary valves for the lag heat exchanger shall open.
   vi. The sequence shall continue as needed for all boilers.

e. After an operator defined time delay, if multiple boilers are operating, the hot water supply temperature is at or above setpoint, and the plant hot water differential temperature is below the boiler stage down differential temperature setpoint for an operator defined period, then the following shall occur:
   i. The lag boiler shall be disabled.
   ii. The lag boiler flow control valve shall close after the delay shutdown time has expired.
   iii. The lag primary hot water pump shall stop.
   iv. Boiler shutdown sequence and timing shall be coordinated with the boiler manufacturer.
   v. If there are less than three boilers commanded on, the primary and secondary valves for the lag heat exchanger shall close.
   vi. The sequence shall continue as needed until only the lead boiler is operating.

f. After an operator defined time delay, if the lower loop hot water riser differential pressure is below setpoint and the lead secondary hot water pump is above the secondary hot water pump speed stage up setpoint, then the following shall occur:
   i. The lead secondary hot water pump shall be ramped to minimum speed.
   ii. Once the lead secondary hot water pump is at minimum speed, the first lag secondary hot water pump shall start at minimum speed.
   iii. Once the lead and first lag hot water pumps are operating at minimum speed, the pump speeds shall be controlled to maintain the lower loop chilled water riser differential pressure as described above.
   iv. The sequence shall continue as needed for all pumps.

g. After an operator defined time delay, if multiple secondary hot water pumps are operating, the lower loop hot water riser differential pressure is at or above setpoint and the operating pumps are operating below the secondary hot water pump speed stage down setpoint, then the following shall occur:
   i. The last lag secondary hot water pump shall stop.
   ii. The operating secondary hot water pump speeds shall be controlled to maintain the lower loop hot water riser differential pressure as described above.
   iii. The sequence shall continue as needed until only one pump is operating.

h. Provide a hot water supply temperature setpoint reset schedule based on outside air temperature. The reset schedule shall be linear between the following operator adjustable limits:

OAT	HWST Setpoint
50 Deg. F	145 Deg. F.
70 Deg. F.	110 Deg. F.

6. System or Power Failure Operation:
   a. If a boiler is lost in service, the lag boiler shall start without any software time delays. The failed boiler shall be disabled and removed from any lead/lag staging.
   b. If a pump is lost in service, the lag pump shall start without any software time delays. The failed pump shall be disabled and removed from any lead/lag staging.
   c. If a valve fails to operate, then the associated sequence of operation shall be disabled.
7. Emergency Plant Shutdown Operation:
   a. If the emergency plant shutdown button is activated, provide for an orderly shutdown of all equipment within the boiler plant. Coordinate shutdown sequence of boilers with the boiler manufacturer.

E. Setpoints - The setpoints shall be operator changeable and shall be set initially by the BMCS subcontractor as follows:
1. The hot water supply temperature setpoint shall be 145 Deg. F.
2. The ramp speed of any variable speed drive shall be set to ramp no faster than two minutes from minimum speed to maximum speed.
3. The time period for secondary hot water pump speed control shall be one minute.
4. The lower loop hot water riser differential pressure setpoint shall be 8.0 psig.
5. The time period for boiler staging up shall be 30 minutes.
6. The time period for boiler staging down shall be set at 30 minutes.
7. The boiler stage down differential temperature setpoint shall be 15 Deg. F.
8. The boiler flow control valve shutoff delay after a boiler has been disabled shall be coordinated with the boiler manufacturer. Initial setpoint is assumed to be 5 minutes.
9. The time period for secondary pump staging up shall be 15 minutes.
10. The secondary hot water pump speed stage up setpoint shall be 90% of full speed.
11. The time period for secondary pump staging down shall be set at 15 minutes.
12. The secondary hot water pump speed stage down setpoint shall be 40% of full speed.

F. Initiation of System Shutdown - System shutdown shall be initiated:
1. By operator entered manual command.
2. Automatically by the BMCS when lower loop or upper loop heating hot water is not required.

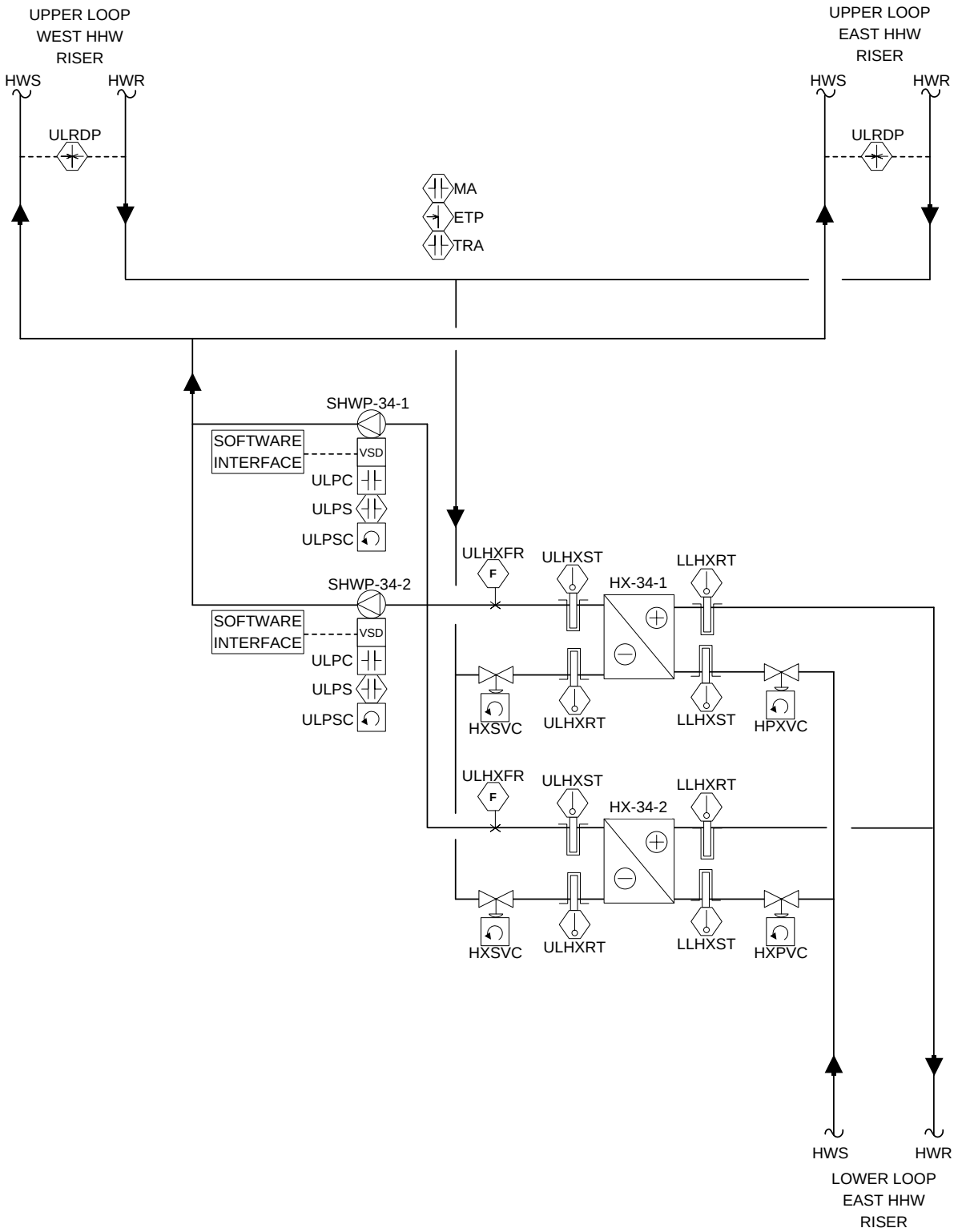
G. Alarms - The BMCS shall generate an alarm:
1. Equipment failure.
2. If the primary hot water supply temperature is outside the operator established low and high alarm limits, which shall be initially set at + or - 8 Deg. F. around the setpoint.
3. If the secondary hot water supply temperature is more than + or - 4 Deg. around the primary hot water supply temperature setpoint plus a heat exchanger approach temperature setpoint. The heat exchanger approach setpoint shall be 5 Deg. F.
4. If the lower loop hot water differential pressure is + or - 5 psig around the setpoint.
5. All alarms shall be inhibited when the system is not operating. The alarms, except the unit failure to start and failure in service alarms, shall remain inhibited following startup of the unit for an operator defined period of time initially set at 10 minutes.

H. Failure positions - When a BMCS component failure occurs:
1. Pumps shall remain at the last commanded state.
2. Boiler units shall remain at the last commanded state.
3. Valves shall remain in the last commanded position.

W-06: UPPER LOOP HOT WATER SYSTEM

FT	DESCRIPTION	DI	DO	AI	AO	HI	CI	NOTES
LLHXST	LOWER HOT WATER LOOP HEAT EXCHANGER SUPPLY TEMPERATURE			5				TYPICAL OF 2
LLHXRT	LOWER HOT WATER LOOP HEAT EXCHANGER RETURN TEMPERATURE			5				TYPICAL OF 2
HXPVC	HEAT EXCHANGER PRIMARY VALVE CONTROL				11			TYPICAL OF 2
HXSVC	HEAT EXCHANGER SECONDARY VALVE CONTROL				11			TYPICAL OF 2
ULHXST	UPPER HOT WATER LOOP HEAT EXCHANGER SUPPLY TEMPERATURE			5				TYPICAL OF 2
ULHXRT	UPPER HOT WATER LOOP HEAT EXCHANGER RETURN TEMPERATURE			5				TYPICAL OF 2
ULHXFR	UPPER HOT WATER LOOP HEAT EXCHANGER			25				TYPICAL OF 2
ULPC	HW PUMP CONTROL		1					TYPICAL OF 2
ULPS	HW PUMP STATUS	1						TYPICAL OF 2
ULPSC	PUMP SPEED CONTROL				1			TYPICAL OF 2
ULPSR	PUMP VSD SPEED REFERENCE FEEDBACK						23	TYPICAL OF 2
ULPFS	PUMP VSD MOTOR OPERATING STATUS						23	TYPICAL OF 2
ULPFF	PUMP FAULT DIAGNOSTICS						23	TYPICAL OF 2
ULPHP	PUMP MOTOR POWER IN HP						23	TYPICAL OF 2
ULPKW	PUMP MOTOR POWER IN KW						23	TYPICAL OF 2
ULPKWH	PUMP MOTOR KWH						23	TYPICAL OF 2
ULPC	PUMP MOTOR CURRENT						23	TYPICAL OF 2
ULPV	PUMP MOTOR VOLTAGE						23	TYPICAL OF 2
ULPRH	PUMP HOURS RUN						23	TYPICAL OF 2
ULPDCV	PUMP DC LINK VOLTAGE						23	TYPICAL OF 2
ULPTL	PUMP THERMAL LOAD ON MOTOR						23	TYPICAL OF 2
ULPTV	PUMP THERMAL LOAD ON VFD						23	TYPICAL OF 2
ULPHST	PUMP VSD HEATSINK TEMPERATURE						23	TYPICAL OF 2
ULRDP	UPPER HOT WATER LOOP RISER DIFFERENTIAL PRESSURE			21				TYPICAL OF 2, LOCATED AT LEVEL 58

FT	DESCRIPTION	DI	DO	AI	AO	HI	CI	NOTES
MA	HHW EXPANSION TANK MAKE-UP ALARM	2						
TRA	HHW EXPANSION TANK RELIEF ALARM	2						
ETP	HHW EXPANSION TANK PRESSURE			22				



Operating Sequences:

A. System Description: The upper loop hot water system consists of two heat exchangers piped in parallel and two variable speed hot water pumps piped in parallel serving the upper hot water loop.

B. System Off - When the system is off:
   1. The upper loop hot water pumps shall be off.
   2. The heat exchanger isolation valves shall be closed.
   3. All control loops shall be disabled.

C. Initiation of System Start-Up - The system shall be started:
   1. By an operator manually entered command at the BMCS.
   2. Automatically when there is a requirement for upper loop hot water heating after an operator defined time delay or without time delay upon primary system failure recovery.

D. System Operation - When system start-up has been initiated, the following sequences shall be implemented:
   1. Lead-Lag equipment selection:
      a. The lead upper loop hot water pump shall be selected by one of the following operator selectable methods:
         i. Operator selection of individual equipment.
         ii. Run times to equalize equipment operations.
      b. The lead upper loop heat exchanger shall be selected by one of the following operator selectable methods:
         i. Operator selection of individual equipment.
         ii. Run times to equalize equipment operations.
   2. System Start-Up:
      a. The primary and secondary heat exchanger valves for the lead heat exchanger shall fully open.
      b. The lead upper loop hot water pump shall start at minimum speed.
   3. System Operation – Boiler Control:
      a. After an operator defined time delay, the primary heat exchanger valve for the lead heat exchanger shall modulate to maintain the heat exchanger secondary supply temperature setpoint.
      b. If the lead heat exchanger primary valve has been open more than the stage up position for an operator defined time delay, the lag heat exchanger secondary valve shall fully open and the primary valves for the lead and lag heat exchanger shall be controlled in unison to maintain the heat exchanger supply temperature setpoint. The heat exchanger supply temperature sensing shall be based on one of the operator selectable methods:
         i. Worst case sensor.
         ii. Average of the two sensors.
         iii. Operator selected sensor.
      c. If both heat exchangers are operating the secondary valves shall modulate to maintain balanced flow through the secondary side of the heat exchangers.
      d. If both heat exchangers are operating and the heat exchanger primary valve has been open less than the stage down position for an operator defined time delay, the lag heat exchanger primary and secondary valves shall close.
      e. After an operator defined time delay, the lead upper loop hot water pump speed shall be controlled to maintain upper loop hot water riser differential pressure setpoint as sensed in the upper loop hot water riser. If multiple secondary pumps are operating, the speed of all operating pumps shall be controlled in unison. The sensor(s) utilized for pressure control shall be based on one of the following operator selectable methods:
         i. Worst case sensor.
         ii. Average of the sensors.
         iii. Operator selected sensor.
      f. After an operator defined time delay, if the upper loop hot water riser differential pressure is below setpoint and the lead upper loop hot water pump is above the upper loop hot water pump speed stage up setpoint, then the following shall occur:
         i. The lead upper loop hot water pump shall be ramped to minimum speed.
         ii. Once the lead upper loop hot water pump is at minimum speed, the first lag upper loop hot water pump shall start at minimum speed.
         iii. Once the lead and first lag upper loop hot water pumps are operating at minimum speed, the pump speeds shall be controlled to maintain the upper loop chilled water riser differential pressure as described above.
      g. After an operator defined time delay, if multiple secondary hot water pumps are operating, the upper loop hot water riser differential pressure is at or above setpoint and the operating pumps are operating below the upper loop hot water pump speed stage down

setpoint, then the following shall occur:
i. The last lag upper loop hot water pump shall stop.
ii. The operating secondary hot water pump speeds shall be controlled to maintain the upper loop hot water riser differential pressure as described above.

4. System or Power Failure Operation:
   a. If a pump is lost in service, the lag pump shall start without any software time delays. The failed pump shall be disabled and removed from any lead/lag staging.
   b. If a valve fails to operate, then the associated sequence of operation shall be disabled.

E. Setpoints - The setpoints shall be operator changeable and shall be set initially by the BMCS subcontractor as follows:
1. The time period for primary valve control shall be one minute.
2. The heat exchanger secondary supply temperature setpoint shall be the lower loop hot water supply temperature setpoint minus a heat exchanger approach temperature. The heat exchanger approach temperature shall be coordinated with the manufacturer and shall initially be set at 5 Deg. F.
3. The stage up valve position shall be 90% open.
4. The time period for heat exchanger staging up shall be 10 minutes.
5. The stage down valve position shall be 20% open.
6. The time period for heat exchanger staging down shall be 30 minutes.
7. The ramp speed of any variable speed drive shall be set to ramp no faster than two minutes from minimum speed to maximum speed.
8. The time period for secondary hot water pump speed control shall be one minute.
9. The upper loop hot water riser differential pressure setpoint shall be 8.0 psig.
10. The time period for upper loop pump staging up shall be 15 minutes.
11. The upper loop hot water pump speed stage up setpoint shall be 90% of full speed.
12. The time period for upper loop hot water pump down shall be set at 30 minutes.
13. The secondary hot water pump speed stage down setpoint shall be 40% of full speed.

F. Initiation of System Shutdown - System shutdown shall be initiated:
1. By operator entered manual command.
2. Automatically if the emergency plant shutdown button has been activated.
3. Automatically by the BMCS when upper loop hot water is not required.

G. Alarms - The BMCS shall generate an alarm:
1. Equipment failure.
2. If the upper loop hot water supply temperature is outside the operator established low and high alarm limits, which shall be initially set at + or - 4 Deg. F. around the upper loop secondary hot water temperature setpoint.
3. If the upper loop hot water differential pressure is + or - 5 psig around the setpoint.
4. All alarms shall be inhibited when the system is not operating. The alarms, except the unit failure to start and failure in service alarms, shall remain inhibited following startup of the unit for an operator defined period of time initially set at 10 minutes.

H. Failure positions - When a BMCS component failure occurs:
1. Pumps shall remain at the last commanded state.
2. Valves shall remain in the last commanded position.

A-01: TRI-PATH AIR HANDLING UNITS SERVING UNDERFLOOR AND PERIMETER WITH ECOMONIZER (TYPICAL FOR AHU-(6-61)-(1-2))

FT	DESCRIPTION	DI	DO	AI	AO	HI	CI	NOTES
ONDFC	OVERHEAD NUETRAL DECK SUPPLY FAN CONTROL		1					MULTIPLE FAN ARRAY WITH SINGLE VSD
ONDFS	OVERHEAD NUETRAL DECK SUPPLY FAN STATUS	1						MULTIPLE FAN ARRAY WITH SINGLE VSD
ONDFSC	OVERHEAD NUETRAL DECK SUPPLY FAN SPEED CONTROL				1			MULTIPLE FAN ARRAY WITH SINGLE VSD
SFRFB	OVERHEAD NUETRAL DECK SUPPLY FAN VSD SPEED REFERENCE FEEDBACK						23	MULTIPLE FAN ARRAY WITH SINGLE VSD
SFF	OVERHEAD NUETRAL DECK SUPPLY FAN FAULT DIAGNOSTICS						23	MULTIPLE FAN ARRAY WITH SINGLE VSD
SFHP	OVERHEAD NUETRAL DECK SUPPLY FAN MOTOR POWER IN HP						23	MULTIPLE FAN ARRAY WITH SINGLE VSD
SFKW	OVERHEAD NUETRAL DECK SUPPLY FAN MOTOR POWER IN KW						23	MULTIPLE FAN ARRAY WITH SINGLE VSD
SFKWH	OVERHEAD NUETRAL DECK SUPPLY FAN MOTOR KWH						23	MULTIPLE FAN ARRAY WITH SINGLE VSD
SFMC	OVERHEAD NUETRAL DECK SUPPLY FAN MOTOR CURRENT						23	MULTIPLE FAN ARRAY WITH SINGLE VSD
OSFV	OVERHEAD NUETRAL DECK SUPPLY FAN MOTOR VOLTAGE						23	MULTIPLE FAN ARRAY WITH SINGLE VSD
OSFRH	OVERHEAD NUETRAL DECK SUPPLY FAN HOURS RUN						23	MULTIPLE FAN ARRAY WITH SINGLE VSD
SFDCV	OVERHEAD NUETRAL DECK SUPPLY FAN DC LINK VOLTAGE						23	MULTIPLE FAN ARRAY WITH SINGLE VSD
SFTL	OVERHEAD NUETRAL DECK SUPPLY FAN THERMAL LOAD ON MOTOR						23	MULTIPLE FAN ARRAY WITH SINGLE VSD
SFHST	OVERHEAD NUETRAL DECK SUPPLY FAN VSD HEATSINK TEMPERATURE						23	MULTIPLE FAN ARRAY WITH SINGLE VSD
ONDHSS	OVERHEAD NUETRAL DECK FAN HIGH STATIC SHUTDOWN	31				21		
ONDSPP	OVERHEAD NUETRAL DECK SUPPLY PLENUM PRESSURE			31				
RACO2	RETURN AIR CO2			51				NOTE 11
RAT	RETURN AIR TEMPERATURE			3				NOTE 11

FT	DESCRIPTION	DI	DO	AI	AO	HI	CI	NOTES
RAH	UPPER RETURN AIR HUMIDITY			11				NOTE 11
RADC	RETURN AIR DAMPER CONTROL				22			
RADP	RETURN AIR DAMPER POSITION			72				
OAF	OUTSIDE AIR FLOWRATE			43				
OADC	OUTSIDE AIR DAMPER CONTROL				22			
OADP	OUTSIDE AIR DAMPER POSITION			72				
MAPLSS	MIXED AIR PLENUM LOW STATIC SHUTDOWN	31				21		
MAPP	MIXED AIR PLENUM PRESSUIRE			31				
MAT	MIXED AIR TEMPERATURE			3				
CDFC	COLD DECK SUPPLY FAN CONTROL		1					MULTIPLE FAN ARRAY WITH SINGLE VSD
CDFS	COLD DECK SUPPLY FAN STATUS	1						MULTIPLE FAN ARRAY WITH SINGLE VSD
CDSC	COLD DECK SUPPLY FAN SPEED CONTROL				1			MULTIPLE FAN ARRAY WITH SINGLE VSD
SFRFB	COLD DECK SUPPLY FAN VSD SPEED REFERENCE FEEDBACK						23	MULTIPLE FAN ARRAY WITH SINGLE VSD
SFF	COLD DECK SUPPLY FAN FAULT DIAGNOSTICS						23	MULTIPLE FAN ARRAY WITH SINGLE VSD
SFHP	COLD DECK SUPPLY FAN MOTOR POWER IN HP						23	MULTIPLE FAN ARRAY WITH SINGLE VSD
SFKW	COLD DECK SUPPLY FAN MOTOR POWER IN KW						23	MULTIPLE FAN ARRAY WITH SINGLE VSD
SFKWH	COLD DECK SUPPLY FAN MOTOR KWH						23	MULTIPLE FAN ARRAY WITH SINGLE VSD
SFMC	COLD DECK SUPPLY FAN MOTOR CURRENT						23	MULTIPLE FAN ARRAY WITH SINGLE VSD
OSFV	COLD DECK SUPPLY FAN MOTOR VOLTAGE						23	MULTIPLE FAN ARRAY WITH SINGLE VSD
OSFRH	COLD DECK SUPPLY FAN HOURS RUN						23	MULTIPLE FAN ARRAY WITH SINGLE VSD
SFDCV	COLD DECK SUPPLY FAN DC LINK VOLTAGE						23	MULTIPLE FAN ARRAY WITH SINGLE VSD
SFTL	COLD DECK SUPPLY FAN THERMAL LOAD ON MOTOR						23	MULTIPLE FAN ARRAY WITH SINGLE VSD
SFHST	COLD DECK SUPPLY FAN VSD HEATSINK TEMPERATURE						23	MULTIPLE FAN ARRAY WITH SINGLE VSD

FT	DESCRIPTION	DI	DO	AI	AO	HI	CI	NOTES
CDHSS	COLD DECK FAN HIGH STATIC SHUTDOWN	31				21		
CCVC	COOLING COIL VALVE CONTROL				11			
CDT	COLD DECK TEMPERATURE			3				
CDSPP	COLD DECK SUPPLY PLENUM PRESSURE			31				
TADC	TRANSFER AIR DAMPER CONTROL				22			TYPICAL OF ONE PER AHU
TADP	TRANSFER AIR DAMPER POSITION			72				TYPICAL OF ONE PER AHU
USFC	UNDERFLOOR SUPPLY FAN CONTROL		1					MULTIPLE FAN ARRAY WITH SINGLE VSD
USFS	UNDERFLOOR SUPPLY FAN STATUS	1						MULTIPLE FAN ARRAY WITH SINGLE VSD
USFSC	UNDERFLOOR SUPPLY FAN SPEED CONTROL				1			MULTIPLE FAN ARRAY WITH SINGLE VSD
SFRFB	UNDERFLOOR SUPPLY FAN VSD SPEED REFERENCE FEEDBACK						23	MULTIPLE FAN ARRAY WITH SINGLE VSD
SFF	UNDERFLOOR SUPPLY FAN FAULT DIAGNOSTICS						23	MULTIPLE FAN ARRAY WITH SINGLE VSD
SFHP	UNDERFLOOR SUPPLY FAN MOTOR POWER IN HP						23	MULTIPLE FAN ARRAY WITH SINGLE VSD
SFKW	UNDERFLOOR SUPPLY FAN MOTOR POWER IN KW						23	MULTIPLE FAN ARRAY WITH SINGLE VSD
SFKWH	UNDERFLOOR SUPPLY FAN MOTOR KWH						23	MULTIPLE FAN ARRAY WITH SINGLE VSD
SFMC	UNDERFLOOR SUPPLY FAN MOTOR CURRENT						23	MULTIPLE FAN ARRAY WITH SINGLE VSD
SFV	UNDERFLOOR SUPPLY FAN MOTOR VOLTAGE						23	MULTIPLE FAN ARRAY WITH SINGLE VSD
SFRH	UNDERFLOOR SUPPLY FAN HOURS RUN						23	MULTIPLE FAN ARRAY WITH SINGLE VSD
SFDCV	UNDERFLOOR SUPPLY FAN DC LINK VOLTAGE						23	MULTIPLE FAN ARRAY WITH SINGLE VSD
SFTL	UNDERFLOOR SUPPLY FAN THERMAL LOAD ON MOTOR						23	MULTIPLE FAN ARRAY WITH SINGLE VSD
SFHST	UNDERFLOOR SUPPLY FAN VSD HEATSINK TEMPERATURE						23	MULTIPLE FAN ARRAY WITH SINGLE VSD
USAT	UNDERFLOOR SUPPLY AIR TEMPERATURE			3				

FT	DESCRIPTION	DI	DO	AI	AO	HI	CI	NOTES
UP	UNDERFLOOR PRESSURE			33				TYPICAL OF 1 PER UNIT. LOCATE IN THE UNDERFLOOR PLENUM AT COLUMN LINES D.5 X 1.5 FOR AHU-X-1 AND A.5 X 4.5 FOR AHU-X-2.
LD	LEAK DETECTION SENSOR	22						TYPICAL OF ONE PER AHU MOUNTED TO THE SLAB DIRECTL Y BELOW THE AHU.
ST	SPACE TEMPERATURE			1				TYPICAL OF 1 PER UNIT, LOCATED ON INTERIOR CORE WALL NEAR AHU AT COLOUMN LINES B.2 X 3.4 AND C.8 X 2.6
SH	SPACE HUMIDITY			12				TYPICAL OF 1 PER FLOOR, LOCATED ON INTERIOR CORE WALL NEAR AHU AT COLUMN LINES B.2 X 3.4
SP	SPACE PRESSURE			32				ONLY ONE PER FLOOR, LOCATED ON INTERIOR CORE WALL NEAR AT COLUMN LINES C X 2. NOTE 7
ZNDDC	OVERHEAD ZONE NUETRAL DECK DAMPER CONTROL				22			NOTE 1
ZCDDC	OVERHEAD ZONE COLD DECK DAMPER CONTROL				22			NOTE 1
ZHVC	OVERHEAD ZONE HOT WATER VALVE CONTROL				11			NOTE 1
ZFR	OVERHEAD ZONE TOTAL FLOWRATE			43				NOTE 1
ZSAT	ZONE SUPPLY AIR TEMPERATURE			4				NOTE 1
ZST	ZONE SPACE TEMPERATURE			1				NOTE 1, NOTE 6
* RDC	RELIEF AIR DAMPER CONTROL				21			TYPICAL OF 4 SECTIONS PER FLOOR. NOTE 10.

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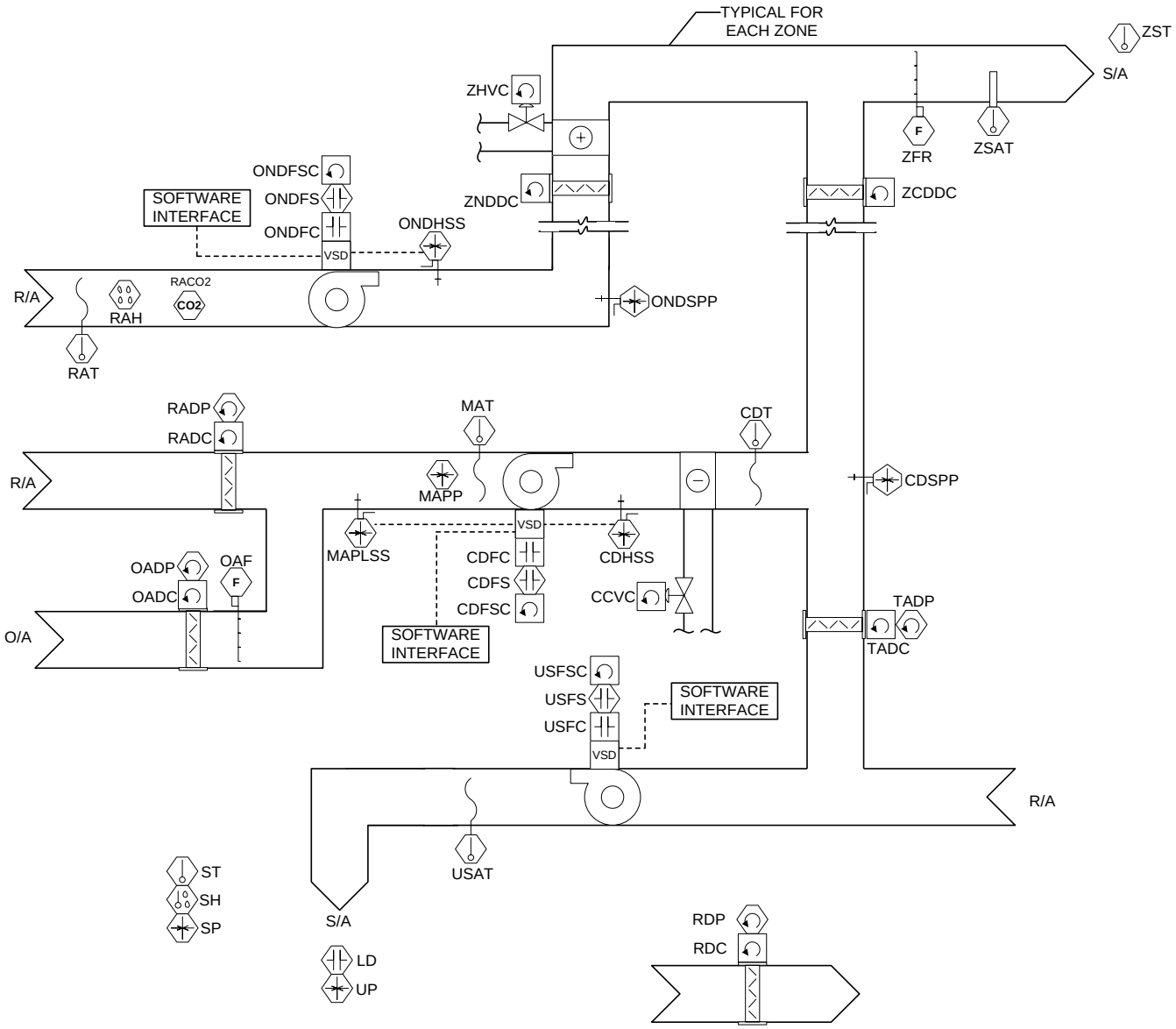


Operating Sequences:

A. System Description – This system consist of triple air chamber AHU, each with supply fan arrays utilizing a common VSD for each chamber. One chamber serves an overhead neutral deck variable air volume chamber serving the overhead zone neutral deck of the multizone configuration with zone hot water heating providing heating to the perimeter skin zones of the floor. One chamber serves a cold deck variable air volume chamber serving the overhead zone cold deck of the multizone configuration and the underfloor primary air. The underfloor chamber is ducted downstream of the cold deck supply fan chamber and serves the underfloor air distribution for the interior spaces of the floor. Outside air is ducted to the cold deck chamber for minimum outside air and economizer operation. Floor pressurization is maintained via multiple relief air dampers on each floor.

B. System Off - When the system is off:
   1. The neutral deck supply fans shall be off.
   2. The relief air dampers shall be closed.
   3. The outside air dampers shall be closed.
   4. The return air dampers shall be open.

5. The cold deck supply fans shall be off.
6. The cooling coil control valve shall be closed.
7. The primary transfer cooling damper serving the underfloor chamber shall be open.
8. The underfloor supply fans shall be off.
9. The overhead zone cold deck dampers shall be open.
10. The overhead zone neutral deck dampers shall be closed.
11. The overhead zone hot water heating valves shall be closed.
12. All control loops shall be disabled.

C. Initiation of System Start-up - System start-up shall be initiated as follows:
1. By a single manually entered command.
2. Automatically whenever the space is requiring cooling, morning warm-up, night setback/setup, time schedule, or optimal start.
3. Automatically as required for a System Restart following a building power failure and a System Restart following a building fire alarm.

D. System Operation - When system start-up has been initiated, the following sequences shall be implemented:
1. System Startup:
   a. The neutral deck supply air fans shall start at its minimum speed.
   b. The cold deck supply air fans shall start at its minimum speed.
   c. The underfloor supply air fans shall start at its minimum speed.
2. System Operation - Neutral Deck Chamber:
   a. The neutral deck supply fan speeds shall be modulated to maintain the neutral deck supply chamber plenum pressure setpoint.
3. System Operation - Cold Deck Chamber - Mechanical Cooling:
   a. The cold deck supply fan speed shall be modulated to maintain the cold deck supply chamber plenum pressure setpoint.
   b. The chilled water control valve shall be modulated to maintain the cold deck temperature setpoint.
   c. Once the AHU is operating during normal occupied times, then the outside air damper shall be modulated to maintain the minimum outside air flowrate setpoint and the return air dampers shall be in sequence to maintain the mixed air plenum pressure setpoint.
   d. The outside air flowrate setpoint shall be reset via a control algorithm to optimize energy as follows:
      i. If the return air CO2 (or space CO2 supplied by a tenant) is above the high limit, then the minimum outside air flowrate setpoint for that associated AHU shall be reset up. The minimum outside air flowrate setpoint shall be reset up in defined increments at defined intervals until such time as the return air CO2 is below the upper limit for more than a defined period or the outside air flowrate reached the maximum flowrate setpoint.
      ii. If the return air CO2 has been below the high limit for more than a defined time period, then the minimum outside air flowrate setpoint shall be reset down in defined increments at defined intervals until such time as the return air CO2 is above the high limit or the minimum flowrate setpoint limit has been reached.
   e. If, during non-economizer modes of operation, the minimum outside air flowrate is not maintained and the outside air damper is fully open, the mixed air plenum pressure shall be reset downward within operator defined limits. The return air damper shall be modulated as described above to maintain the mixed plenum pressure setpoint. The minimum closed position for this operation shall be initially set at 40 percent of full open position. This reset sequence shall be disabled during full economizer operation.
4. System Operation - Cold Deck Chamber Economizer:
   a. The BMCS shall monitor return air temperature and return air relative humidity and shall calculate the return air enthalpy. The BMCS shall monitor the outside air temperature and the outside air relative humidity and shall calculate the outside air enthalpy via the common outside air temperature and humidity sensor. The BMCS shall compare the outside air enthalpy with the return air enthalpy at least once every 10 minutes. The outside air temperature and humidity sensing for enthalpy shall be based on one of the operator selectable methods:
      i. Highest enthalpy value.
      ii. Lowest enthalpy value.
      iii. Average of all sensors.

iv. Operator selected sensor.

b. If the outside air temperature is between operator defined limits and if the outside air enthalpy is lower than the return air enthalpy the following shall occur:
   i. The outside air damper shall be modulated in sequence to maintain the cold deck temperature setpoint. If the outside air damper is fully open and cannot maintain the cold deck temperature setpoint, then the chilled water control valve shall be enabled to modulate to maintain the cold deck supply temperature setpoint.
   ii. The alarming of the minimum outside air flowrate setpoint shall be disabled during the economizer operation.

c. Once the economizer operation is enabled; it shall remain in effect for a minimum operator defined time period. If the outside air enthalpy is equal to or greater than the return air and the minimum operational time period has expired, then the unit the economizer mode of operation shall be disabled.

5. System Operation - Overhead Perimeter Zones:
   a. Zone Cooling:
      i. Each overhead zone cold deck damper shall be modulated between the maximum zone cooling flowrate setpoint and fully closed to maintain the zone space temperature cooling setpoint. The flowrate setpoint shall be based on using a pressure independent control algorithm based on the deviation of the monitored space temperature from the space temperature cooling setpoint. Upon a decrease in cooling volume, if the cold deck damper is closed enough to not provide the minimum zone flowrate, then the neutral deck damper shall modulated to maintain the minimum zone flowrate setpoint.
   b. Zone Heating:
      i. The cold deck zone damper shall be fully closed.
      ii. The neutral deck damper shall be modulated to between the fully closed and maximum heating flowrate setpoint to maintain the zone space temperature heating setpoint. The flowrate setpoint shall be based on using a pressure independent control algorithm based on the deviation of the monitored space temperature from the space temperature heating setpoint.
      iii. If the heating flowrate has reached the maximum heating flowrate setpoint and the zone space heating space temperature setpoint cannot be maintained for a defined time period, then the associated zone hot water valve shall be modulated to maintain the heating space temperature setpoint.
      iv. The reverse sequence shall occur upon a decrease in heating requirements.
      v. The start of the overhead zone heating mode of operation shall not occur until an operator determined minimum time period has elapsed since the overhead zone was in the cooling mode of operation and vice versa.
6. System Operation - Underfloor Chamber:
   a. The underfloor supply fan speed shall be modulated to maintain the underfloor static pressure setpoint. The underfloor pressure sensor used for underfloor static pressure control shall be based on one of the operator selected methods for each AHU on the associated graphical screen:
      i. The sensor closest to the associated AHU.
      ii. The average of the two sensors on a floor.
      iii. One of the two sensors, selected by the operator.
      iv. Worst case sensor, selected automatically.
   b. The underfloor primary transfer air cooling air damper shall be modulated to maintain the underfloor supply air temperature setpoint.
   c. Provide an underfloor supply air temperature setpoint reset sequence to reset the underfloor supply air temperature setpoint based on the associated interior space temperature sensors at defined intervals by defined increments. If the space temperature is below the operator defined reset up setpoint, the underfloor supply temperature setpoint shall be raised by a defined increment. If the space temperature is above the operator defined reset down setpoint, the underfloor supply temperature setpoint shall be lowered by a defined increment. If the space humidity exceeds the maximum defined limit setpoint, then the supply air temperature reset up program shall be disabled and the minimum supply air temperature setpoint limit shall be maintained until the humidity is below the maximum limit setpoint for a defined period.
7. System Operation - Floor Pressurization:

a. The floor relief air dampers shall be modulated in sequence to maintain the floor pressure setpoint. The first damper shall open fully before the next damper in the bank is allowed to modulate and shall be staged from East to West. This sequence shall continue as required. Upon a need for fewer dampers, the last damper modulated shall be completely closed prior to the next damper beginning to modulate.
b. If the condenser unit exhaust damper is open (Levels 31 and 32 only) the associated relief dampers shall be closed and removed from sequencing.

8. System or Power Failure Operation:
a. If a fan is lost in service, the associated neutral deck fan, cold deck fan, and underfloor fan shall be disabled, the associated outside air damper shall close if possible, the chilled water valve shall close if possible, the zone neutral deck damper shall close if possible, the cold deck damper shall open if possible, and the zone hot water valve shall close.
b. If a valve fails to operate, then the associated sequence of operation for the valve shall be disabled.
c. If a damper fails to operate, then the associated sequence of operation for the damper shall be disabled.

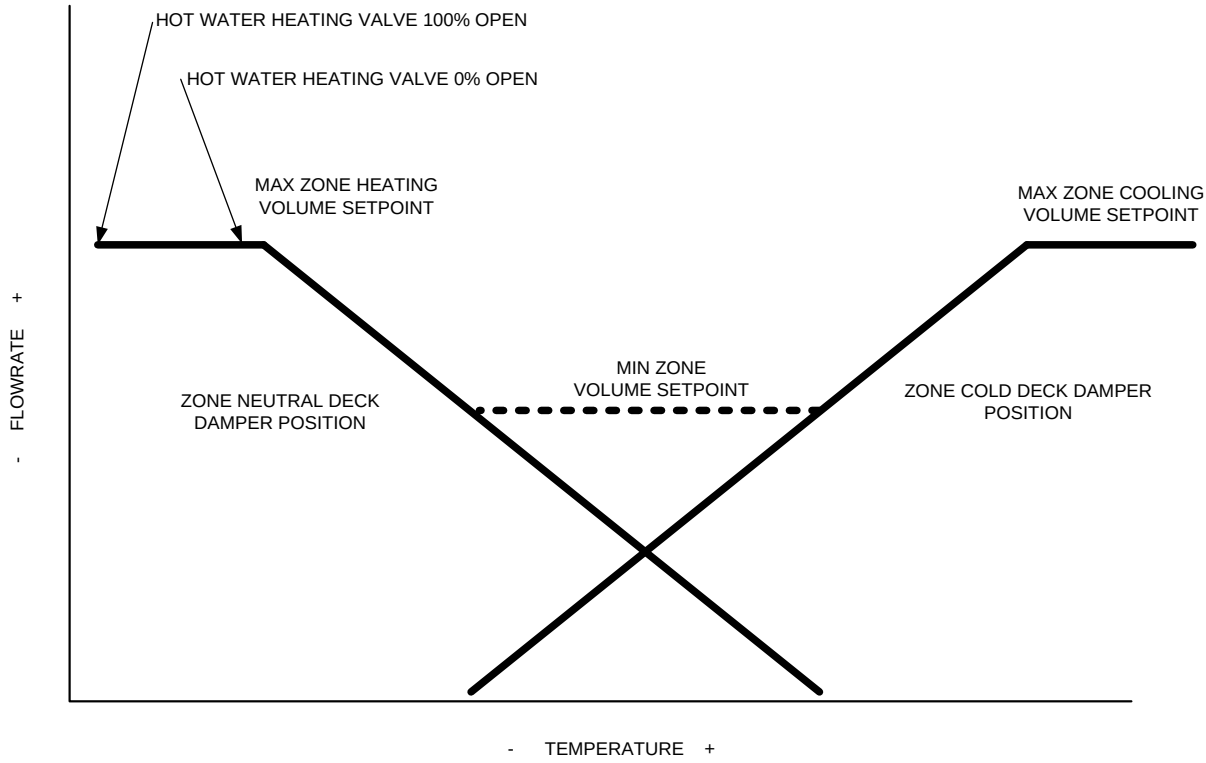
E. Setpoints - The setpoints shall be operator changeable and shall be set initially by the BMCS subcontractor as follows:
1. The ramp speed of any variable speed drive shall be set to ramp no faster than two minutes from minimum speed to maximum speed. The ramp time at the drive shall be matched to the BMCS ramp time.
2. The neutral deck supply chamber plenum pressure setpoint shall be 0.5 inches w.g.
3. The cold deck supply chamber plenum pressure setpoint shall be 0.5 inches w.g.
4. The cold deck temperature setpoint shall be 50 Deg. F.
5. The initial outside air flowrate shall be set at the 60% of the minimum design flowrate as scheduled in the Mechanical Documents.
6. The initial mixed air plenum pressure setpoint shall be -0.25 inches w.g.
7. The time delay for outside air flowrate reset down shall be initially set at 30 minutes.
8. The time delay for outside air flowrate reset up shall be initially set at 5 minutes.
9. The outside air flowrate reset down interval shall be initially set at 250 cfm.
10. The outside air flowrate reset up interval shall be initially set at 1,000 cfm.
11. The return air and/or space carbon dioxide high limit shall be initially set to 500 ppm above the outside air CO2 for 15 minutes.
12. The mixed plenum pressure setpoint shall be set by the balancing contractor, but initially set at -0.25 inches w.g. with reset limits of –0.5 and –0.05 inches w.g.
13. The mixed air plenum pressure setpoint reset increments of 0.05 inches w.g.
14. The time delay for mixed air plenum pressure setpoint reset down shall be initially set at 5 minutes.
15. The time delay for mixed air plenum pressure setpoint reset up shall be initially set at 10 minutes.
16. The economizer enthalpy calculation shall occur every 10 minutes.
17. The outside air temperature limits of economizer operations shall be set 68 Deg. F. and 30 Deg. F.
18. The minimum time period for economizer operation shall be 60 minutes.
19. The overhead zone maximum cooling flowrate setpoint shall be as scheduled on the Mechanical Documents.
20. The overhead zone minimum flowrate setpoint (deadband) shall be as scheduled on the Mechanical Documents.
21. The overhead zone maximum heating flowrate setpoint shall be as scheduled on the Mechanical Documents.
22. The overhead zone space temperature setpoint shall be 71 Deg. F. for heating and 74 Deg. F. for cooling.
23. The time delay for between cooling mode and heating mode shall be two minutes.
24. The under floor static pressure setpoint shall be 0.06 inches w.g.
25. The underfloor supply air temperature shall be 65 Deg. F. with reset limits of 62 Deg. F. to 68 Deg. F.
26. The interior space temperature lower limit setpoint for underfloor supply air temperature setpoint reset up shall be 70 Deg. F.
27. The interior space temperature upper limit setpoint for underfloor supply air temperature setpoint reset down shall be 75 Deg. F.
28. The time interval for underfloor supply air temperature setpoint reset up shall be initially set at 30 minutes.

29. The time interval for underfloor supply air temperature setpoint reset down shall be initially set at 15 minutes.
30. The underfloor supply air temperature setpoint reset up increment shall be initially set at 0.5 Deg. F.
31. The underfloor supply air temperature setpoint reset down increment shall be initially set at 1.0 Deg. F.
32. The interior zone space humidity high limit for disabling the underfloor supply air temperature setpoint reset shall be 60% RH.
33. The time period for enabling the underfloor supply air temperature setpoint reset shall be 30 minutes of operation below the high limit RH setpoint.
34. The floor pressure setpoint shall initially be 0.1 inches w.g. relative to the outside. The final setpoint for each floor shall be set by the TAB contractor.
35. The setpoint for supply fan high static shutdown shall be set at the device for 2.5 inches w.g.
36. The setpoint for mixed air plenum low static shutdown shall be set at the device for -2.5" w.g.

F. Initiation of System Shutdown - System shutdown shall be initiated as follows:
1. By Operator entered manual entered command.
2. Automatically by the BMCS whenever cooling or heating is no longer required.
3. High/low static pressure switch trip.
4. Automatic in the event of component failure.
5. Automatic in the event of a building power failure of fire alarm.

G. Alarms - The BMCS shall generate an alarm:
1. If the cold deck temperature is + or - 4 Deg. F. around the current setpoint.
2. If the underfloor supply air temperature is + or - 4 Deg. F. around the current setpoint.
3. If a zone temperature is + or - 4 Deg. F. around the current setpoints.
4. If the overhead neutral deck chamber supply plenum static pressure is + or - 0.25 inches around the current setpoint.
5. If the cold deck chamber supply plenum static pressure is + or - 0.25 inches around the current setpoint.
6. If the mixed air plenum pressure is + or - 0.05 inches around the current setpoint.
7. If the underfloor supply plenum static pressure is + or - 0.05 inches around the current setpoint.
8. If the floor pressure is + or - 0.05 inches around the current setpoint.
9. If the minimum outside air flowrate is + or - 10% around the current setpoint.
10. If the overhead zone total flowrate is + or - 10% around the current setpoint.
11. If the space humidity is above the high limit for more than 15 minutes.
12. In the event of a static pressure limit device trip condition.
13. If the return air carbon dioxide is above the high limit for more than 60 minutes.
14. If the leak detection sensor senses moisture.
15. If equipment fails in service.
16. All alarms shall be inhibited when the associated supply fan is not in operation. The alarms, except the fan failure to start and failure in service alarms, shall remain inhibited following startup of the unit for an operator-determined period of time initially set at 5 minutes.

H. Failure positions - When a BMCS component failure occurs:
1. The fans shall remain in the last commanded state.
2. The outside air dampers and relief air dampers shall fail closed. All other dampers shall remain in the last commanded position.
3. The cooling coil control valve shall remain in the last commanded position.
4. The overhead zone heating coil control valve shall remain in the last commanded position.



DDC CONTROL LOOP OF OVERHEAD ZONE NEUTRAL AND COLD DECK WITH HOT WATER HEAT

A-02: VAV AIR HANDLING UNITS WITH ECONOMIZER SERVING OVERHEAD FAN POWERED TERMINAL UNITS (TYPICAL FOR AHU-(3-5)-(1-2) (BASE BID) AND AHU-61-(1-2) (ALTENATE))

FT	POINT	DI	DO	AI	AO	HI	CI	NOTES
OAF	OUTSIDE AIR FLOWRATE			43				
OADC	OUTSIDE AIR DAMPER CONTROL				22			
OADP	OUTSIDE AIR DAMPER POSITION			72				
RACO2	RETURN AIR CARBON DIOXIDE LEVEL			51				
RAT	RETURN AIR TEMPERATURE			3				
RAH	RETURN AIR HUMIDITY			11				
RADC	RETURN AIR DAMPER CONTROL				22			
RADP	RETURN AIR DAMPER POSITION			72				
MAT	MIXED AIR TEMPERATURE			3				
MPP	MIXED PLENUM PRESSURE			31				
MPPLSS	MIXED AIR PLENUM LOW STATIC SHUTDOWN	31				21		
SFC	SUPPLY AIR FAN CONTROL		1					
SFS	SUPPLY AIR FAN STATUS	1						
SFSC	SUPPLY AIR FAN SPEED CONTROL				1			
SFSR	FAN VSD SPEED REFERENCE FEEDBACK						23	
SFF	FAN FAULT DIAGNOSTICS						23	
SFHP	FAN MOTOR POWER IN HP						23	
SFKW	FAN MOTOR POWER IN KW						23	
SFKWH	FAN MOTOR KWH						23	
SFC	FAN MOTOR CURRENT						23	
SFV	FAN MOTOR VOLTAGE						23	
SFRH	FAN HOURS RUN						23	
SFDCV	FAN DC LINK VOLTAGE						23	
SFTL	FAN THERMAL LOAD ON MOTOR						23	
SFTV	FAN THERMAL LOAD ON VFD						23	
SFHST	FAN VSD HEATSINK TEMPERATURE						23	
SAHSS	SUPPLY AIR HIGH STATIC SHUTDOWN	31				21		

FT	POINT	DI	DO	AI	AO	HI	CI	NOTES
CCVC	COOLING COIL VALVE CONTROL				11			
SAT	SUPPLY AIR TEMPERATURE			3				
SSP	SUPPLY RISER STATIC PRESSURE			31				
SP	SPACE PRESSURE			32				ONLY ONE PER FLOOR, NOTE 7
* RDC	RELIEF AIR DAMPER CONTROL				21			TYPICAL OF 4 SECTIONS PER FLOOR. NOTE 10.

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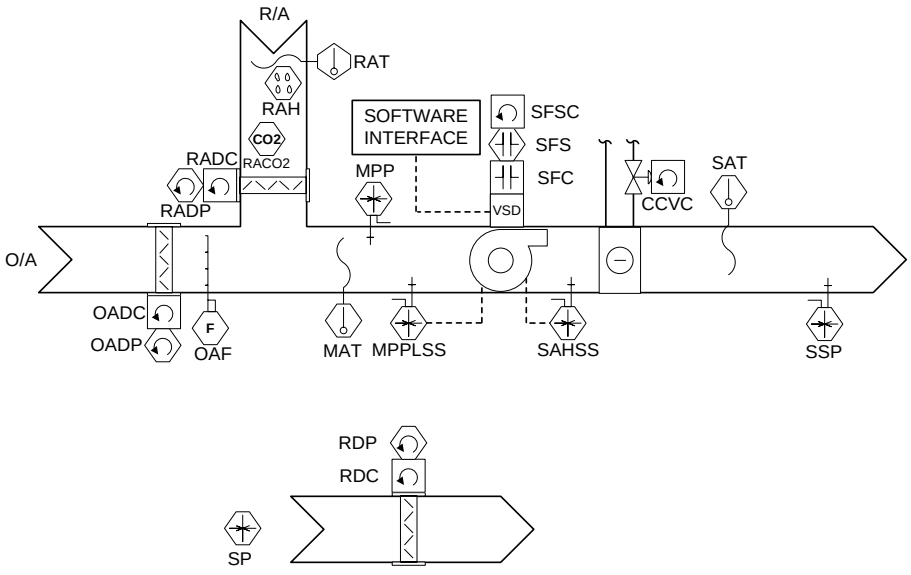


Operating Sequences:

A. System Description – This system consist of VAV AHU each with supply fan arrays utilizing a common VSD with chilled water cooling coil and economizer. Floor pressurization is maintained via multiple relief air dampers on each floor.

B. System Off - When the system is off:
1. The outside air damper shall be closed.
2. The return air damper shall be open.
3. The supply air fan shall be off.
4. The chilled water control valve shall be closed.
5. The relief air dampers shall be closed
6. Automatic control loops shall be disabled.

C. Initiation of System Start-up - System start-up shall be initiated as follows:
1. By a single manually entered command.
2. Automatically whenever the space is requiring cooling, morning warm-up, night setback/setup, time schedule, or optimal start.
3. Automatically as required for a System Restart following a building power failure and a System Restart following a building fire alarm.

D. System Operation - When system start-up has been initiated, the following sequences shall be implemented:
1. System Startup:
   a. The associated terminal units shall be enabled.
   b. The supply fan shall start at minimum speed.
2. System Operation - Mechanical Cooling:
   a. After an operator defined time period, the supply fan shall be enabled for automatic volume control.
   b. Once the supply fan is released for volume control, the supply fan speed shall be modulated maintain the supply riser static pressure setpoint. The supply static pressure setpoint shall be reset via a control algorithm to optimize the energy usage as follows:
      i. The supply static pressure setpoint shall be reset down in defined increments at defined intervals until such time as the primary air flowrate to one of the associated terminal units has been below the required value for more than a defined period.
      ii. If the primary air flowrate has been below the required value for more than the defined period, then the supply static pressure setpoint shall be reset up in

defined increments at defined intervals until such time as the required primary air flowrate to all of the associated terminal units has been achieved.

iii. Provide the ability within the associated graphic to remove operator selected terminal units from this reset sequence.

c. The return air damper shall be in sequence to maintain the mixed air plenum pressure setpoint for the associated AHU.

d. The chilled water control valve shall be modulated to maintain the supply air temperature setpoint.

e. Once the AHU is operating during normal occupied times, then the outside air damper shall be modulated to maintain the minimum outside air flowrate setpoint.

f. The outside air flowrate setpoint shall be reset via a control algorithm to optimize energy as follows:

i. If the return air CO2 (or space CO2 supplied by a tenant) is above the high limit, then the minimum outside air flowrate setpoint for that associated AHU shall be reset up. The minimum outside air flowrate setpoint shall be reset up in defined increments at defined intervals until such time as the return air CO2 is below the upper limit for more than a defined period or the outside air flowrate reached the maximum flowrate setpoint.

ii. If the return air CO2 has been below the high limit for more than a defined time period, then the minimum outside air flowrate setpoint shall be reset down in defined increments at defined intervals until such time as the return air CO2 is above the high limit or the minimum flowrate setpoint limit has been reached.

g. If, during non-economizer modes of operation, the minimum outside air flowrate is not maintained and the outside air damper is fully open, the mixed air plenum pressure shall be reset downward within operator defined limits. The return air damper shall be modulated as described above to maintain the mixed plenum pressure setpoint. The minimum closed position for this operation shall be initially set at 40 percent of full open position. This reset sequence shall be disabled during full economizer operation.

3. System Operation - Economizer Cooling:

a. The BMCS shall monitor return air temperature and return air relative humidity and shall calculate the return air enthalpy. The BMCS shall monitor the outside air temperature and the outside air relative humidity and shall calculate the outside air enthalpy via the common outside air temperature and humidity sensor. The BMCS shall compare the outside air enthalpy with the return air enthalpy at least once every 10 minutes. The outside air temperature and humidity sensing for enthalpy shall be based on one of the operator selectable methods:

i. Highest enthalpy value.

ii. Lowest enthalpy value.

iii. Average of all sensors.

iv. Operator selected sensor.

b. If the outside air is between operator defined limits and if the outside air enthalpy is lower than the return air enthalpy the following shall occur:

i. The outside air damper shall be modulated to maintain the supply air temperature setpoint. If the outside air damper is fully open and the AHU cannot maintain the supply air temperature setpoint, then the chilled water control valve shall be modulated to maintain the supply air temperature setpoint.

ii. The alarming of the minimum outside air flowrate setpoint shall be disabled during the economizer operation.

c. If the supply static pressure setpoint is at the lower limit, the supply air temperature setpoint shall be reset via a control algorithm to optimize the energy usage:

i. If the zone reheat valves are not fully closed for all associated zones and the zone temperatures are at or below the zone temperature setpoint then the supply air temperature setpoint shall be reset up in operator defined increments at operator defined intervals.

ii. If the zone temperature for any zone is above the zone temperature setpoint and the reheat valve for that zone is commanded fully closed, the supply air temperature setpoint shall be reset down in operator defined increments, at operator defined intervals.

d. Once the economizer operation is enabled; it shall remain in effect for a minimum operator defined time period. If the outside air enthalpy is equal to or greater than the return air

and the minimum operational time period has expired, then the unit the economizer mode of operation shall be disabled.

4. System Operation - Floor Pressurization:
   a. The floor relief air dampers shall be modulated in sequence to maintain the floor pressure setpoint. The first damper shall open fully before the next damper in the bank is allowed to modulate and shall be staged from East to West. This sequence shall continue as required. Upon a need for fewer dampers, the last damper modulated shall be completely closed prior to the next damper beginning to modulate.
5. System or Power Failure Operation:
   a. If a fan is lost in service, the supply fan shall be disabled, the outside air and relief air dampers shall close, the return air damper shall open and the chilled water control valve shall close if possible.
   b. If a valve fails to operate, then the associated sequence of operation for the valve shall be disabled.
   c. If a damper fails to operate, then the associated sequence of operation for the damper shall be disabled.

E. Setpoints - The setpoints shall be operator changeable and shall be set initially by the BMCS subcontractor as follows:
1. The time delay for fan speed control shall be 1 minute.
2. The ramp speed of any variable speed drive shall be set to ramp no faster than two minutes from minimum speed to maximum speed. The ramp time at the drive shall be matched to the BMCS ramp time.
3. Supply air riser static pressure setpoint shall be 0.5 inches w.g. and shall have reset limits of 0.1 to 1.0 inches w.g.
4. The time interval for static pressure setpoint reset down shall be 10 minutes.
5. The time interval for static pressures setpoint reset up shall be 5 minutes.
6. The static pressure setpoint reset down increment shall be 0.05 inches w.g.
7. The static pressure setpoint reset up increment shall be 0.1 inches w.g.
8. The mixed plenum pressure setpoint shall be set by the balancing contractor, but initially set at -0.25 inches w.g. with reset limits of –0.5 and –0.05 inches w.g. and reset increments of 0.05 inches w.g.
9. The supply air temperature setpoint shall be 49 Deg. F.
10. The minimum outside air flowrate setpoint shall be as schedule on the Mechanical Drawings, but shall be based on the areas of the building operating under occupied mode on a floor served basis.
11. The return air and space CO2 high limit shall be 500 ppm above the outside air CO2 reading.
12. The time delay for outside air flowrate reset down shall be 30 minutes.
13. The time delay for outside air flowrate reset up shall be 5 minutes.
14. The outside air flowrate reset down interval shall be at 500 cfm.
15. The outside air flowrate reset up interval shall be 1,000 cfm.
16. The outside air temperature limits of economizer operations shall be 68 Deg. F. and 30 Deg. F.
17. The supply air temperature reset up position setpoint shall be 10% open.
18. The minimum time period for economizer operation shall be 60 minutes.
19. The supply air temperature reset up increment shall be 1 Deg. F.
20. The floor pressure setpoint shall initially be 0.1 inches w.g. relative to the outside. The final setpoint for each floor shall be set by the TAB contractor.
21. Supply air duct static pressure high limit device setpoint shall be set at the device for 2.5 inches w.g.
22. Mixed air plenum static pressure low limit device setpoint shall be set at the device for -2.5 inches w.g.

F. Initiation of System Shutdown - System shutdown shall be initiated as follows:
1. By Operator entered manual entered command.
2. Automatically by the BMCS whenever cooling or heating is no longer required.
3. High/low static pressure switch trip.
4. Automatic in the event of component failure.
5. Automatic in the event of a building power failure of fire alarm.

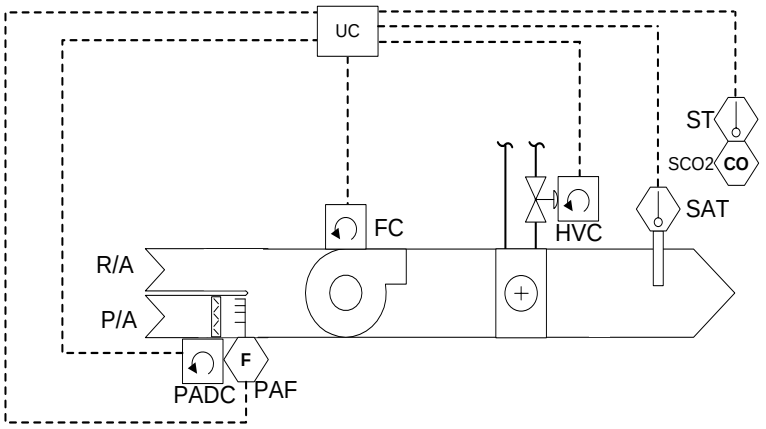
G. Alarms - The BMCS shall generate an alarm:
1. Equipment failure.
2. If the supply air temperature is + or - 4 Deg. F. around the current setpoint.

3. If the supply air static pressure is more than 0.5 in. w.g. above or below the setpoint for a period of more than one minute.
4. If the mixed air plenum pressure is + or - 0.05 inches around the current setpoint.
5. If the floor pressure is + or - 0.05 inches around the current setpoint.
6. If the outside air flowrate is + or - 10% around the current setpoint.
7. In the event of a static pressure limit device trip condition.
8. If the return air carbon dioxide is above the high limit for more than 60 minutes.
9. All alarms shall be inhibited when the associated supply/return fan is not in operation. The alarms, except the fan failure to start and failure in service alarms, shall remain inhibited following startup of the unit for an operator determined period of time initially set at 2 minutes.

H. Failure positions - When a BMCS component failure occurs:
1. The fans shall remain in the last commanded state.
2. The outside air dampers and relief air dampers shall fail closed. All other dampers shall remain in the last commanded position.
3. The cooling coil control valve shall remain in the last commanded position.

A-03: FAN POWERED TERMINAL UNITS (TYPICAL, REFER TO MECHANICAL DRAWINGS FOR QUANTITIES)

FT	DESCRIPTION	DI	DO	AI	AO	HI	CI	NOTES
PAF	PRIMARY AIR FLOWRATE						31	
PADC	PRIMARY AIR DAMPER CONTROL						31	
FC	FAN VOLUME AND START/STOP CONTROL						31	
HVC	HOT WATER VALVE CONTROL				11		31	HEATING UNITS ONLY
SAT	SUPPLY AIR TEMPERATURE			4			31	
ST	SPACE TEMPERATURE			1,2			31	NOTE 1, NOTE 5
SCO2	SPACE CO2			53			31	NOTE 1



Operating Sequences:

A. System Description – This system consist of a fan powered terminal unit in a series flow configuration, ECM fan motor, primary air flowrate multipoint sensor, primary air flowrate damper and hot water heating coil.

B. System Off - When the system is off:
1. The fan shall be off.
2. The primary air damper shall be closed.
3. The hot water valve shall be closed.
4. All control loops shall be disabled.

C. Initiation of System Start-up - System start-up shall be initiated as follows:
1. By a manually entered command for individual and/or groups of terminal units.
2. Automatically whenever the space is requiring cooling or heating via time schedule, optimal start/stop night setback/setup, or After Hours HVAC Activation programs.
3. Automatically as required for a System Restart following a building power failure and a System Restart following a building fire alarm.

D. System Operation - When system start-up has been initiated, the following sequences shall be implemented:
1. System Operation – Cooling:

a. The start of the FPTU cooling mode of operation shall not occur until an operator determined minimum time period has elapsed since the FPTU was in the heating mode of operation.
b. The primary air damper shall be modulated between the minimum and maximum cooling flowrate setpoints. The flowrate setpoint shall be based on using a pressure independent control algorithm based on the deviation of the monitored space temperature from the space temperature cooling setpoint.
c. The fan discharge flowrate shall be controlled between the minimum and maximum fan flowrate setpoints. The fan flowrate setpoint shall track with the primary air flowrate. When the primary air is at the maximum cooling flowrate, the fan shall operate at the maximum cooling discharge flowrate. When the primary air is at the minimum cooling flowrate, the fan shall operate at the minimum cooling discharge flowrate.
d. During unoccupied time periods, the terminal unit shall operate as described above to maintain the unoccupied space temperature cooling setpoint.

2. System Operation – Heating:
a. The start of the FPTU heating mode of operation shall not occur until an operator determined minimum time period has elapsed since the FPTU was in the cooling mode of operation.
b. The primary air damper shall be modulated to maintain the minimum cooling primary air flowrate setpoint.
c. The fan discharge flowrate shall be modulated between minimum cooling and maximum heating fan flowrate setpoints. The flowrate setpoint shall be based on using a pressure independent control algorithm based on the deviation of the monitored space temperature from the space temperature heating setpoint.
d. If the heating flowrate has reached the maximum heating flowrate setpoint and the space heating space temperature setpoint cannot be maintained for a defined time period, then the hot water heating valve shall be controlled to maintain the heating space temperature setpoint.
e. The reverse sequence shall occur upon a decrease in heating requirements.
f. During unoccupied time periods, the terminal unit shall operate as described above to maintain the unoccupied space temperature heating setpoint.

3. System or Power Failure Operation:
a. If a terminal unit is lost in service, the failed unit fan shall be disabled and the primary air damper shall remain in the last commanded position.
b. If the associated AHU is shut down due to a fire alarm signal sensed by the general building alarm and associated shutdown of the unit, then the associated FPTU shall be disabled and the primary air damper closed.

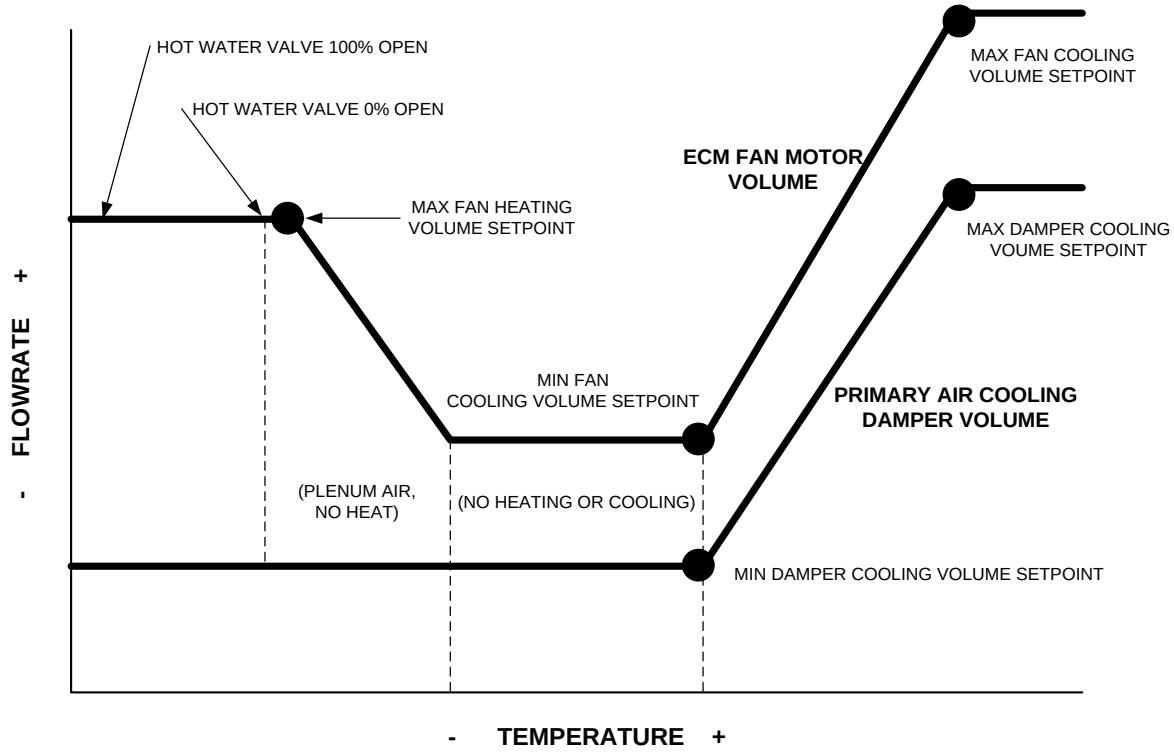
E. Setpoints - The setpoints shall be operator changeable and shall be set initially by the BMCS subcontractor as follows:
1. The minimum time period between the switch from cooling to heating and vice versa, shall be 4 minutes.
2. The occupied space temperature cooling setpoint shall be 74 Deg. F.
3. The unoccupied space temperature cooling setpoint shall be 85 Deg. F.
4. The maximum and minimum primary air flowrates shall set as scheduled.
5. The maximum and minimum cooling fan discharge flowrates and the maximum heating fan discharge flowrates shall be as scheduled.
6. The occupied space temperature heating setpoint shall be 71 Deg. F.
7. The unoccupied space temperature heating setpoint shall be 55 Deg. F.
8. The deadband on the space temperature setpoints shall be set at 0.25 Deg. F.

F. Initiation of System Shutdown - System shutdown shall be initiated:
1. By Operator entered manual command.
2. Automatically whenever the space no longer is requiring cooling or heating via time schedule, optimal start/stop night setback/setup, or After Hours HVAC Activation programs.

G. Alarms - The BMCS shall generate an alarm:
1. If the space temperature in the occupied mode is + or - 4 Deg. F. around the setpoints.
2. If the space temperature in the unoccupied mode is + or – 10 Deg. F. around the setpoints.
3. If the space carbon dioxide is above the high limit for more than 30 minutes.

4. The primary air flowrate has been below setpoint by more than 25 percent and the space temperature has been above the occupied space temperature cooling setpoint for a minimum period of time, which shall be set initially at 15 minutes.

H. Failure positions - When a BMCS component failure occurs or a power failure occurs:
1. The fan shall stop.
2. The primary air damper shall remain in the last commanded position.
3. The hot water heating valves shall close.

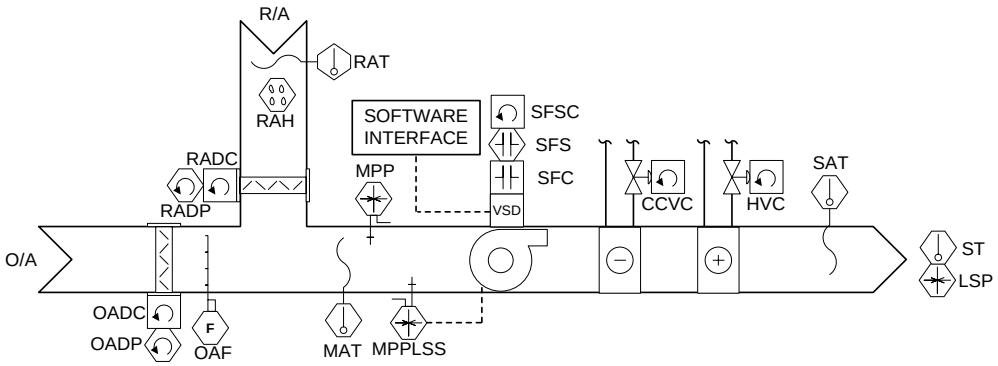


DDC CONTROL LOOP OF FAN POWERED TERMINAL UNIT
WITH ECM MOTOR, SERIES FLOW FAN AND ELECTRIC HEAT

A-04: LOBBY VAV AIR HANDLING UNITS WITH ECONOMIZER (TYPICAL FOR AHU-2-2)

FT	POINT	DI	DO	AI	AO	HI	CI	NOTES
OAF	OUTSIDE AIR FLOWRATE			43				
OADC	OUTSIDE AIR DAMPER CONTROL				21			
OADP	OUTSIDE AIR DAMPER POSITION			72				
RAT	RETURN AIR TEMPERATURE			3				
RAH	RETURN AIR HUMIDITY			11				
RADC	RETURN AIR DAMPER CONTROL				21			
RADP	RETURN AIR DAMPER POSITION			72				
MAT	MIXED AIR TEMPERATURE			3				
MPP	MIXED PLENUM PRESSURE			31				
MPPLSS	MIXED AIR PLENUM LOW STATIC SHUTDOWN	31				21		
SFC	SUPPLY AIR FAN CONTROL		1					
SFS	SUPPLY AIR FAN STATUS	1						
SFSC	SUPPLY AIR FAN SPEED CONTROL				1			
SFSR	FAN VSD SPEED REFERENCE FEEDBACK						23	
SFF	FAN FAULT DIAGNOSTICS						23	
SFHP	FAN MOTOR POWER IN HP						23	
SFKW	FAN MOTOR POWER IN KW						23	
SFKWH	FAN MOTOR KWH						23	
SFC	FAN MOTOR CURRENT						23	
SFV	FAN MOTOR VOLTAGE						23	
SFRH	FAN HOURS RUN						23	
SFDCV	FAN DC LINK VOLTAGE						23	
SFTL	FAN THERMAL LOAD ON MOTOR						23	
SFTV	FAN THERMAL LOAD ON VFD						23	
SFHST	FAN VSD HEATSINK TEMPERATURE						23	
CCVC	COOLING COIL VALVE CONTROL				11			
HVC	HEATING COIL VALVE CONTROL				11			
SAT	SUPPLY AIR TEMPERATURE			3				

FT	POINT	DI	DO	AI	AO	HI	CI	NOTES
ST	SPACE TEMPERATURE			2				
LSP	LOBBY PRESSURE SENSOR			32				NOTE 7



Operating Sequences:

A. System Description – This system consist of VAV AHU with chilled water cooling coil, hot water cooling coil, and economizer.

B. System Off - When the system is off:
1. The outside air damper shall be closed.
2. The return air damper shall be open.
3. The supply air fan shall be off.
4. The chilled water control valve shall be closed.
5. The hot water control valve shall be closed.
6. Automatic control loops shall be disabled.

C. Initiation of System Start-up - System start-up shall be initiated as follows:
1. By a single manually entered command.
2. Automatically whenever the space is requiring heating or cooling.
3. Automatically as required for a System Restart following a building power failure and a System Restart following a building fire alarm.

D. System Operation - When system start-up has been initiated, the following sequences shall be implemented:
1. System Startup:
   a. The supply fan shall start and ramp to full speed.
2. System Operation - Mechanical Cooling:
   a. The outside air damper shall modulate to maintain the outside air flowrate setpoint.
   b. The return air damper shall be in sequence to maintain the mixed air plenum pressure setpoint for the associated AHU.
   c. If, during non-economizer modes of operation, the minimum outside air flowrate is not maintained and the outside air damper is fully open, the mixed air plenum pressure shall be reset downward within operator defined limits. The return air damper shall be modulated as described above to maintain the mixed plenum pressure setpoint. The minimum closed position for this operation shall be initially set at 40 percent of full open.
   d. The chilled water valve and hot water valve shall be modulated to maintain the respective space temperature cooling and heating setpoints.
3. System Operation - Economizer Cooling:
   a. The BMCS shall monitor return air temperature and return air relative humidity and shall calculate the return air enthalpy. The BMCS shall monitor the outside air temperature and

the outside air relative humidity and shall calculate the outside air enthalpy via the common outside air temperature and humidity sensor. The BMCS shall compare the outside air enthalpy with the return air enthalpy at least once every 10 minutes. The outside air temperature and humidity sensing for enthalpy shall be based on one of the operator selectable methods:

i. Highest enthalpy value.
ii. Lowest enthalpy value.
iii. Average of all sensors.
iv. Operator selected sensor.

b. If the outside air is between operator defined limits and if the outside air enthalpy is lower than the return air enthalpy the following shall occur:
   i. The outside air damper shall be modulated to maintain the space cooling temperature setpoint. If the outside air damper is fully open and the AHU cannot maintain the space cooling temperature setpoint, then the chilled water control valve shall be modulated to maintain the space temperature setpoint.
   ii. The alarming of the minimum outside air flowrate setpoint shall be disabled during the economizer operation.
c. Once the economizer operation is enabled; it shall remain in effect for a minimum operator defined time period. If the outside air enthalpy is equal to or greater than the return air and the minimum operational time period has expired, then the unit the economizer mode of operation shall be disabled.

4. System or Power Failure Operation:
   a. If a fan is lost in service, the supply fan shall be disabled, the outside air dampers shall close, the return air damper shall open and the chilled water control valve shall close if possible.
   b. If a valve fails to operate, then the associated sequence of operation for the valve shall be disabled.
   c. If a damper fails to operate, then the associated sequence of operation for the damper shall be disabled.

E. Setpoints - The setpoints shall be operator changeable and shall be set initially by the BMCS subcontractor as follows:
1. The minimum outside air flowrate setpoint shall be set as required per the schedule in the Mechanical Drawings.
2. The mixed plenum pressure setpoint shall be set by the balancing contractor, but initially set at -0.25 inches w.g. with reset limits of –0.5 and –0.05 inches w.g. and reset increments of 0.05 inches w.g.
3. The space the space heating and cooling setpoints shall be 65 Deg. F. and 74 Deg. F. respectively.
4. Mixed air plenum static pressure low limit device setpoint shall be set at the device for -2.5 inches w.g.

F. Initiation of System Shutdown - System shutdown shall be initiated as follows:
1. By Operator entered manual entered command.
2. Automatically by the BMCS whenever cooling or heating is no longer required.
3. Low static pressure switch trip.
4. Automatic in the event of component failure.
5. Automatic in the event of a building power failure of fire alarm.

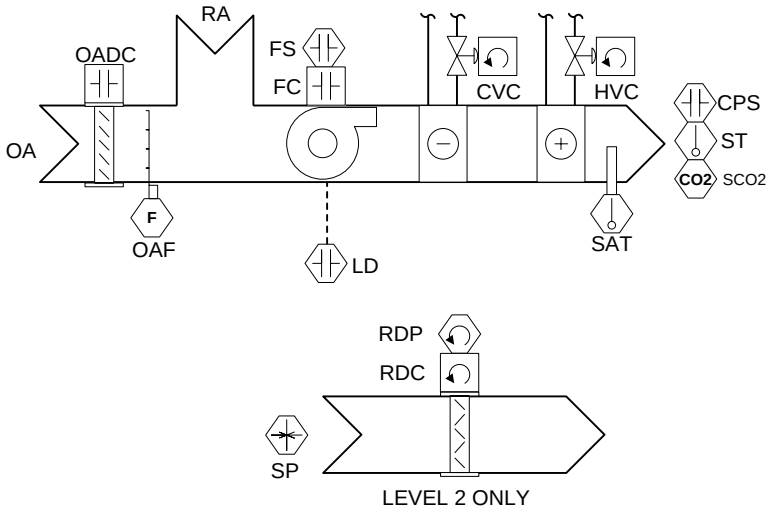
G. Alarms - The BMCS shall generate an alarm:
1. Equipment failure.
2. If the space temperature is + or - 4 Deg. F. around the current setpoint.
3. If the mixed air plenum pressure is + or - 0.05 inches around the current setpoint.
4. If the outside air flowrate is + or - 10% around the current setpoint.
5. In the event of a static pressure limit device trip condition.
6. All alarms shall be inhibited when the associated supply/return fan is not in operation. The alarms, except the fan failure to start and failure in service alarms, shall remain inhibited following startup of the unit for an operator determined period of time initially set at 2 minutes.

H. Failure positions - When a BMCS component failure occurs:
1. The fans shall remain in the last commanded state.
2. Dampers shall remain in the last commanded position.

3. The cooling coil and heating coil control valve shall remain in the last commanded position.

A-05A: FAN/BLOWER COIL UNITS WITH OUTSIDE AIR (TYPICAL, REFER TO MECHANICAL DRAWINGS FOR QUANTITIES)

FT	DESCRIPTION	DI	DO	AI	AO	HI	CI	NOTES
OADC	OUTSIDE AIR DAMPER CONTROL		21					
OAF	OUTSIDE AIR FLOWRATE			43				
FC	SUPPLY FAN CONTROL		1					
FS	SUPPLY FAN STATUS	11						
CVC	COOLING VALVE CONTROL				11			
HVC	HEATING VALVE CONTROL				11			HEATING UNITS ONLY
SAT	SUPPLY AIR TEMPERATURE			4				
LD	LEAK DETECTOR					12		LOCATE IN THE FCU DRAIN PAN.
CPS	CONDENSATE PUMP STATUS	11						NOTE 1
ST	SPACE TEMPERATURE			1,2				NOTE 5
SCO2	SPACE CO2			53				NOTE 1
SP	SPACE PRESSURE			32				TYPICAL OF 2 FOR LEVEL 2 ONLY.
RDC	RELIEF AIR DAMPER CONTROL				21			TYPICAL OF 8 SECTIONS FOR LEVEL 2 ONLY.
RDP	RELIEF AIR DAMPER POSITION			72				TYPICAL OF 8 SECTIONS FOR LEVEL 2 ONLY.



Operating Sequences:

A. System Description – This system consist of a fan coil unit with constant speed fan, outside air damper with two position actuators, and heating and cooling coils with modulating actuators.

B. System Off - When the system is off:
1. The outside air damper shall be closed.
2. The supply fan shall be off.
3. The cooling coil control valve shall be closed.
4. The heating coil control valve shall be closed.
5. The relief air dampers shall be closed.
6. Automatic control loops shall be disabled.

C. Initiation of System Start-up - System start-up shall be initiated as follows:
1. By a single manually entered command.
2. Automatically whenever the space is requiring cooling or heating.
3. Automatically as required for a System Restart following a building power failure and a System Restart following a building fire alarm.

D. System Operation - When system start-up has been initiated, the following sequences shall be implemented:
1. System Startup:
   a. The supply fan shall start.
2. System Operation:
   a. The chilled water valve and hot water valve shall be modulated to maintain the respective space temperature cooling and heating setpoints.
   b. Once the FCU is operating during normal occupied times, then the outside air damper shall open.
3. System Operation - Floor Pressurization - Level 2 Only:
   a. The east relief air dampers shall be modulated in sequence to maintain the east pressure setpoint. The first damper shall open fully before the next damper in the bank is allowed to modulate. This sequence shall continue as required. Upon a need for fewer dampers, the last damper modulated shall be completely closed prior to the next damper beginning to modulate.
   b. The west relief air dampers shall be modulated in sequence to maintain the west pressure setpoint. The first damper shall open fully before the next damper in the bank is allowed to modulate. This sequence shall continue as required. Upon a need for fewer dampers, the last damper modulated shall be completely closed prior to the next damper beginning to modulate.
4. System or Power Failure Operation:
   a. If a fan is lost in service, the failed fan shall be disabled, the associated chilled water and hot water valves shall close if possible.
   b. If a valve fails to operate, then the associated sequence of operation for the valve shall be disabled.

E. Setpoints - The setpoints shall be operator changeable and shall be set initially by the BMCS subcontractor as follows:
1. The space the space heating and cooling setpoints shall be 65 Deg. F. and 74 Deg. F. respectively.
2. The east and west pressure setpoint shall initially be 0.1 inches w.g. relative to the outside. The final setpoint for each floor shall be set by the TAB contractor.

F. Initiation of System Shutdown - System shutdown shall be initiated as follows:
1. By Operator manually entered System shutdown command.
2. Automatically if heating or cooling is no longer required.
3. Automatic in the event of component failure.
4. Automatic in the event of a building power failure of fire alarm.

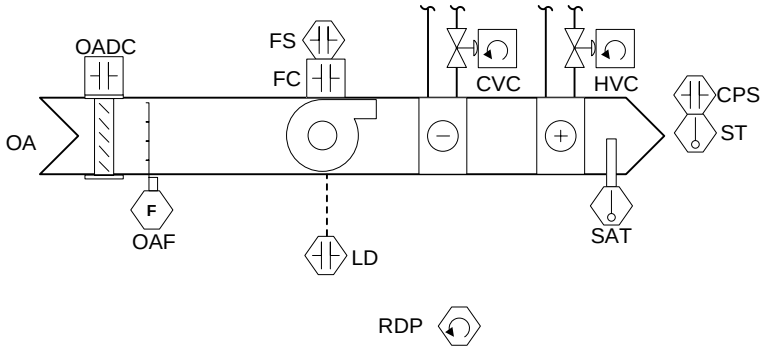
G. Alarms - The BMCS shall generate an alarm:
1. Equipment failure.
2. If the space temperature is outside the operator established low and high limits, which shall be set initially at + or - 5 Deg. F. below and above the setpoint respectively.
3. If the outside air flowrate is + or - 10% around the design flowrate.
4. If the space carbon dioxide is above the high limit for more than 30 minutes.
5. If the floor pressure is + or - 0.05 inches around the current setpoint.

6. All alarms shall be inhibited when the associated supply fan is not in operation. The alarms, except the fan failure to start and failure in service alarms, shall remain inhibited following startup of the unit for an operator-determined period of time initially set at 2 minutes.

H. Failure positions - When a BMCS component failure occurs or a power failure occurs:
1. The supply air fan shall remain in the last commanded state.
2. The damper shall fail closed.
3. The cooling coil control valves shall remain in the last commanded position.
4. The heating coil control valves shall remain in the last commanded position.

A-05B: FAN/BLOWER COIL UNITS WITH 100% OUTSIDE AIR (TYPICAL, REFER TO MECHANICAL DRAWINGS FOR QUANTITIES)

FT	DESCRIPTION	DI	DO	AI	AO	HI	CI	NOTES
OADC	OUTSIDE AIR DAMPER CONTROL		21			32		
OAF	OUTSIDE AIR FLOWRATE			43				
FC	SUPPLY FAN CONTROL		1					
FS	SUPPLY FAN STATUS	11						
CVC	COOLING VALVE CONTROL				11			
HVC	HEATING VALVE CONTROL				11			HEATING UNITS ONLY
SAT	SUPPLY AIR TEMPERATURE			4				
LD	LEAK DETECTOR					12		LOCATE IN THE FCU DRAIN PAN.
CPS	CONDENSATE PUMP STATUS	11						NOTE 1
ST	SPACE TEMPERATURE			1,2				NOTE 5



Operating Sequences:

A. System Description – This system consist of a 100% outside air fan coil unit with constant speed fan and heating and cooling coils with modulating actuators.

B. System Off - When the system is off:
1. The outside air damper shall be closed.
2. The supply fan shall be off.
3. The cooling coil control valve shall be closed.
4. The heating coil control valve shall be closed.
5. Automatic control loops shall be disabled.

C. Initiation of System Start-up - System start-up shall be initiated as follows:

1. By a single manually entered command.
2. Automatically whenever the space is requiring cooling or heating.
3. Automatically as required for a System Restart following a building power failure and a System Restart following a building fire alarm.

D. System Operation - When system start-up has been initiated, the following sequences shall be implemented:
   1. System Startup:
      a. The hardwired interlocked inlet damper(s) shall open.
      b. Once the intake dampers are proven open the supply fan shall start.
   2. System Operation:
      a. The chilled water valve and hot water valve shall be modulated to maintain the respective space temperature cooling and heating setpoints.
   3. System or Power Failure Operation:
      a. If a fan is lost in service, the failed fan shall be disabled, the associated chilled water and hot water valves shall close if possible.
      b. If a valve fails to operate, then the associated sequence of operation for the valve shall be disabled.

E. Setpoints - The setpoints shall be operator changeable and shall be set initially by the BMCS subcontractor as follows:
   1. The space the space heating and cooling setpoints shall be 65 Deg. F. and 74 Deg. F. respectively.

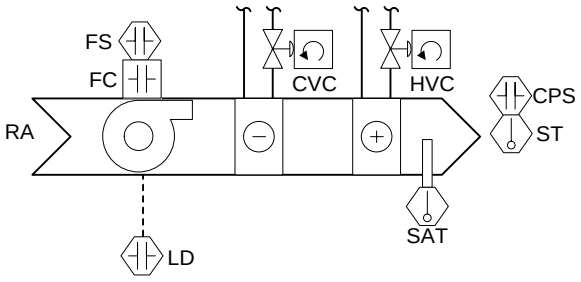
F. Initiation of System Shutdown - System shutdown shall be initiated as follows:
   1. By Operator manually entered System shutdown command.
   2. Automatically if heating or cooling is no longer required.
   3. Automatic in the event of component failure.
   4. Automatic in the event of a building power failure of fire alarm.

G. Alarms - The BMCS shall generate an alarm:
   1. Equipment failure.
   2. If the space temperature is outside the operator established low and high limits, which shall be set initially at + or - 5 Deg. F. below and above the setpoint respectively.
   3. All alarms shall be inhibited when the associated supply fan is not in operation. The alarms, except the fan failure to start and failure in service alarms, shall remain inhibited following startup of the unit for an operator-determined period of time initially set at 2 minutes.

H. Failure positions - When a BMCS component failure occurs or a power failure occurs:
   1. The supply air fan shall remain in the last commanded state.
   2. The damper shall fail closed.
   3. The cooling coil control valves shall remain in the last commanded position.
   4. The heating coil control valves shall remain in the last commanded position.

A-06: FAN/BLOWER COIL UNITS (TYPICAL, REFER TO MECHANICAL DRAWINGS FOR QUANTITIES)

FT	DESCRIPTION	DI	DO	AI	AO	HI	CI	NOTES
FC	SUPPLY FAN CONTROL		1					
FS	SUPPLY FAN STATUS	11						
CVC	COOLING VALVE CONTROL				11			
HVC	HEATING VALVE CONTROL				11			HEATING UNITS ONLY
SAT	SUPPLY AIR TEMPERATURE			4				
LD	LEAK DETECTOR					12		LOCATE IN THE FCU DRAIN PAN.
CPS	CONDENSATE PUMP STATUS	11						NOTE 1
ST	SPACE TEMPERATURE			1,2				NOTE 5
SCO2	SPACE CO2			53				NOTE 1



Operating Sequences:

A. System Description – This system consist of a fan coil unit with constant speed fan and heating and cooling coils with modulating actuators.

B. System Off - When the system is off:
1. The supply fan shall be off.
2. The cooling coil control valve shall be closed.
3. The heating coil control valve shall be closed.
4. Automatic control loops shall be disabled.

C. Initiation of System Start-up - System start-up shall be initiated as follows:
1. By a single manually entered command.
2. Automatically whenever the space is requiring cooling or heating.
3. Automatically as required for a System Restart following a building power failure and a System Restart following a building fire alarm.

D. System Operation - When system start-up has been initiated, the following sequences shall be implemented:
1. System Startup:
   a. The supply fan shall start.
2. System Operation:
   a. The chilled water valve and hot water valve shall be modulated to maintain the respective space temperature cooling and heating setpoints.
3. System or Power Failure Operation:
   a. If a fan is lost in service, the failed fan shall be disabled, the associated chilled water and

hot water valves shall close if possible.

b. If a valve fails to operate, then the associated sequence of operation for the valve shall be disabled.

E. Setpoints - The setpoints shall be operator changeable and shall be set initially by the BMCS subcontractor as follows:

1. The space the space heating and cooling setpoints shall be 65 Deg. F. and 74 Deg. F. respectively.

F. Initiation of System Shutdown - System shutdown shall be initiated as follows:

1. By Operator manually entered System shutdown command.
2. Automatically if heating or cooling is no longer required.
3. Automatic in the event of component failure.
4. Automatic in the event of a building power failure of fire alarm.

G. Alarms - The BMCS shall generate an alarm:

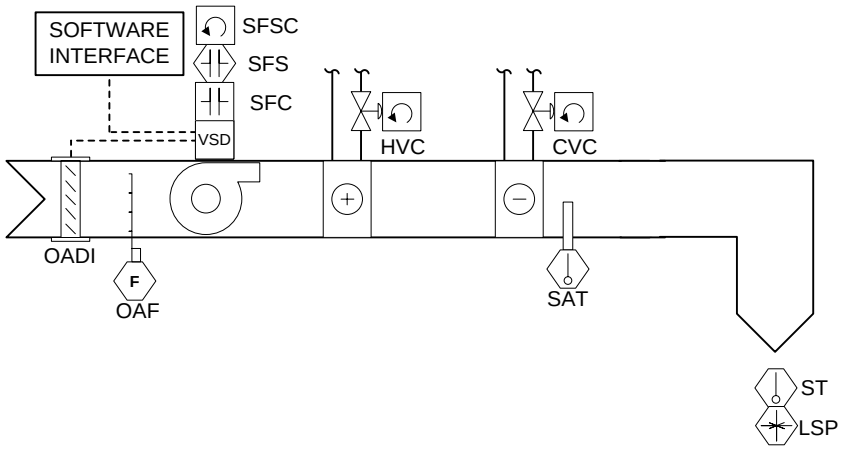
1. Equipment failure.
2. If the space temperature is outside the operator established low and high limits, which shall be set initially at + or - 5 Deg. F. below and above the setpoint respectively.
3. All alarms shall be inhibited when the associated supply fan is not in operation. The alarms, except the fan failure to start and failure in service alarms, shall remain inhibited following startup of the unit for an operator-determined period of time initially set at 2 minutes.

H. Failure positions - When a BMCS component failure occurs or a power failure occurs:

1. The supply air fan shall remain in the last commanded state.
2. The cooling coil control valves shall remain in the last commanded position.
3. The heating coil control valves shall remain in the last commanded position.

A-07: SERVICE ELEVATOR LOBBY AIR HANDLING UNIT (TYPICAL FOR AHU-2-1 AND AHU-62-1)

FT	DESCRIPTION	DI	DO	AI	AO	HI	CI	NOTES
OADI	OUTSIDE AIR DAMPER INTERLOCK					32		
OAF	OUTSIDE AIR FLOWRATE			43				
SFC	SUPPLY AIR FAN CONTROL		1					
SFS	SUPPLY AIR FAN STATUS	1						
SFSC	SUPPLY AIR FAN SPEED CONTROL				1			
SFSR	FAN VSD SPEED REFERENCE FEEDBACK						23	
SFF	FAN FAULT DIAGNOSTICS						23	
SFHP	FAN MOTOR POWER IN HP						23	
SFKW	FAN MOTOR POWER IN KW						23	
SFKWH	FAN MOTOR KWH						23	
SFC	FAN MOTOR CURRENT						23	
SFV	FAN MOTOR VOLTAGE						23	
SFRH	FAN HOURS RUN						23	
SFDCV	FAN DC LINK VOLTAGE						23	
SFTL	FAN THERMAL LOAD ON MOTOR						23	
SFTV	FAN THERMAL LOAD ON VFD						23	
SFHST	FAN VSD HEATSINK TEMPERATURE						23	
HVC	HEATING VALVE CONTROL				11			
CVC	COOLING VALVE CONTROL				11			
SAT	SUPPLY AIR TEMPERATURE			4				
LSP	LOBBY STATIC PRESSURE			35				
ST	SPACE TEMPERATURE			1				



Operating Sequences:

A. System Description – This system consist of a 100% outside air handling unit with variable speed fan, hot water coil, and chilled water coil modulating actuators.

B. System Off - When the system is off:
1. The inlet air damper shall be closed
2. The supply fan shall be off.
3. The cooling coil control valve shall be closed.
4. The heating coil control valve shall be closed.
5. Automatic control loops shall be disabled.

C. Initiation of System Start-up - System start-up shall be initiated as follows:
1. By a single manually entered command.
2. Automatically by the BMCS.
3. Automatically as required for a System Restart following a building power failure and a System Restart following a building fire alarm.

D. System Operation - When system start-up has been initiated, the following sequences shall be implemented:
1. System Startup:
   a. The hardwired interlocked inlet damper(s) shall open.
   b. Once the intake dampers are proven open the supply fan shall start at minimum speed.
2. System Operation:
   a. The supply fan shall modulate to maintain the lobby space pressure setpoint.
   b. The chilled water valve and hot water valve shall be modulated to maintain the respective space temperature cooling and heating setpoints.
3. System or Power Failure Operation:
   a. If a fan is lost in service, the failed fan shall be disabled, the associated chilled water and hot water valves shall close if possible.
   b. If a valve fails to operate, then the associated sequence of operation for the valve shall be disabled.
   c. If the freezestat assembly trips, the supply fan shall shut down, the associated intake dampers shall close, the preheat coil shall be disabled, the cooling coil valves shall open, and the chilled water pumps shall operate.

E. Setpoints - The setpoints shall be operator changeable and shall be set initially by the BMCS subcontractor as follows:

1. The lobby space pressure setpoint shall be 0.06" w.c.
2. The space the space heating and cooling setpoints shall be 65 Deg. F. and 74 Deg. F. respectively.

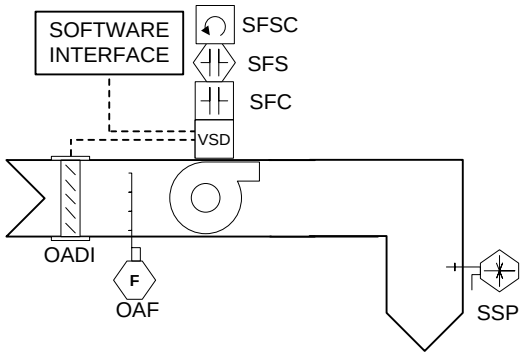
F. Initiation of System Shutdown - System shutdown shall be initiated as follows:
1. By Operator manually entered System shutdown command.
2. Automatically by the BMCS.
3. Automatic in the event of component failure.
4. Automatic in the event of a building power failure of fire alarm.

G. Alarms - The BMCS shall generate an alarm:
1. Equipment failure.
2. If the lobby space pressure is outside the operator established low and high limits, which shall be set initially at + or 0 0.005" w.c. below and above setpoint respectively.
3. If the space temperature is outside the operator established low and high limits, which shall be set initially at + or - 5 Deg. F. below and above the setpoint respectively.
4. All alarms shall be inhibited when the associated supply fan is not in operation. The alarms, except the fan failure to start and failure in service alarms, shall remain inhibited following startup of the unit for an operator-determined period of time initially set at 2 minutes.

H. Failure positions - When a BMCS component failure occurs or a power failure occurs:
1. The damper shall remain in the last commanded state.
2. The supply air fan shall remain in the last commanded state.
3. The cooling coil control valves shall remain in the last commanded position.
4. The heating coil control valves shall remain in the last commanded position.

A-08: OUTSIDE AIR FANS (TYPICAL FOR SF-P1-3)

FT	DESCRIPTION	DI	DO	AI	AO	HI	CI	NOTES
OADI	OUTSIDE AIR DAMPER INTERLOCK					32		
OAF	OUTSIDE AIR FLOWRATE			43				
SFC	SUPPLY AIR FAN CONTROL		1					
SFS	SUPPLY AIR FAN STATUS	1						
SFSC	SUPPLY AIR FAN SPEED CONTROL				1			
SFSR	FAN VSD SPEED REFERENCE FEEDBACK						23	
SFF	FAN FAULT DIAGNOSTICS						23	
SFHP	FAN MOTOR POWER IN HP						23	
SFKW	FAN MOTOR POWER IN KW						23	
SFKWH	FAN MOTOR KWH						23	
SFC	FAN MOTOR CURRENT						23	
SFV	FAN MOTOR VOLTAGE						23	
SFRH	FAN HOURS RUN						23	
SFDCV	FAN DC LINK VOLTAGE						23	
SFTL	FAN THERMAL LOAD ON MOTOR						23	
SFTV	FAN THERMAL LOAD ON VFD						23	
SFHST	FAN VSD HEATSINK TEMPERATURE						23	
SSP	SUPPLY DUCT STATIC PRESSURE			34				



Operating Sequences:

A. System Description – This system consist of a VAV supply fan serving fan coil units.

B. System Off - When the system is off:
   1. The inlet air damper shall be closed
   2. The supply fan shall be off.
   3. Automatic control loops shall be disabled.

C. Initiation of System Start-up - System start-up shall be initiated as follows:
   1. By a single manually entered command.
   2. Automatically by the BMCS when any of the associated FCU require outside air.
   3. Automatically as required for a System Restart following a building power failure and a System Restart following a building fire alarm.

D. System Operation - When system start-up has been initiated, the following sequences shall be implemented:
   1. System Startup:
      a. The hardwired interlocked inlet damper(s) shall open.
      b. Once the intake dampers are proven open the supply fan shall start at minimum speed.
   2. System Operation:
      a. The supply fan shall modulate to maintain the lobby space pressure setpoint.
   3. System or Power Failure Operation:
      a. If a fan is lost in service, the failed fan shall be disabled and the outside air damper shall close if possible.

E. Setpoints - The setpoints shall be operator changeable and shall be set initially by the BMCS subcontractor as follows:
   1. The time delay for fan speed control shall be 1 minute.
   2. The ramp speed of any variable speed drive shall be set to ramp no faster than two minutes from minimum speed to maximum speed. The ramp time at the drive shall be matched to the BMCS ramp time.
   3. Supply air riser static pressure setpoint shall be 1.0 inches w.g.

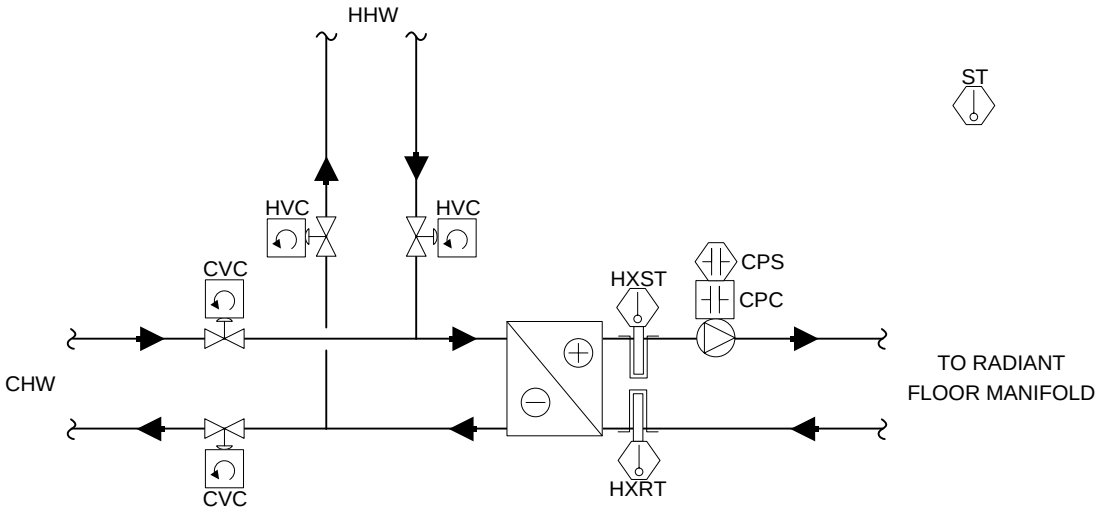
F. Initiation of System Shutdown - System shutdown shall be initiated as follows:
   1. By Operator manually entered System shutdown command.
   2. Automatically by the BMCS when outside air is no longer required.
   3. Automatic in the event of component failure.
   4. Automatic in the event of a building power failure of fire alarm.

G. Alarms - The BMCS shall generate an alarm:
   1. Equipment failure.
   2. If the supply air static pressure is more than 0.5 in. w.g. above or below the setpoint for a period of more than one minute.
   3. All alarms shall be inhibited when the associated supply fan is not in operation. The alarms, except the fan failure to start and failure in service alarms, shall remain inhibited following startup of the unit for an operator-determined period of time initially set at 2 minutes.

H. Failure positions - When a BMCS component failure occurs or a power failure occurs:
   1. The damper shall remain in the last commanded state.
   2. The supply air fan shall remain in the last commanded state.

A-09: RADIANT FLOOR SYSTEM (TYPICAL OF THREE RADIANT FLOOR SYSTEMS)

FT	DESCRIPTION	DI	DO	AI	AO	HI	CI	NOTES
CVC	COOLING VALVE CONTROL				11			TYPICAL OF 2
HVC	HEATING VALVE CONTROL				11			TYPICAL OF 2
CPC	CIRCULATION PUMP CONTROL		1					
CPS	CIRCULATION PUMP STATUS	11						
HXRT	HEAT EXCHANGER RETURN TEMPERATURE			5				
HXST	HEAT EXCHANGER SUPPLY TEMPERATURE			5				
ST	SPACE TEMPERATURE			2				



Operating Sequences:

A. System Description - This system consist of a radiant floor system with control valves, heat exchanger, and circulation pump.

B. System Off - When the system is off:
   1. The cooling coil control valve shall be closed.
   2. The heating coil control valve shall be closed.
   3. The circulation pump shall be off.
   4. Automatic control loops shall be disabled.

C. Initiation of System Start-up - System start-up shall be initiated as follows:
   1. By a single manually entered command.
   2. Automatically whenever the space is requiring cooling or heating.

D. System Operation - When system start-up has been initiated, the following sequences shall be implemented:
   1. System Startup:
      a. The circulation pump shall start.
   2. System Operation – Cooling:
      a. The chilled water control valve on the supply line shall fully open.

b. The chilled water control valve on the return line shall modulate to maintain the space cooling setpoint.

3. System Operation – Heating:
   a. The heating hot water control valve on the supply line shall fully open.
   b. The heating hot water control valve on the return line shall modulate to maintain the space heating setpoint.
4. System or Power Failure Operation:
   a. If a valve fails to operate, then the associated sequence of operation for the valve shall be disabled.

E. Setpoints - The setpoints shall be operator changeable and shall be set initially by the BMCS subcontractor as follows:
1. The space the space cooling setpoint shall be 74 Deg. F.
2. The space the space heating setpoint shall be 65 Deg. F.

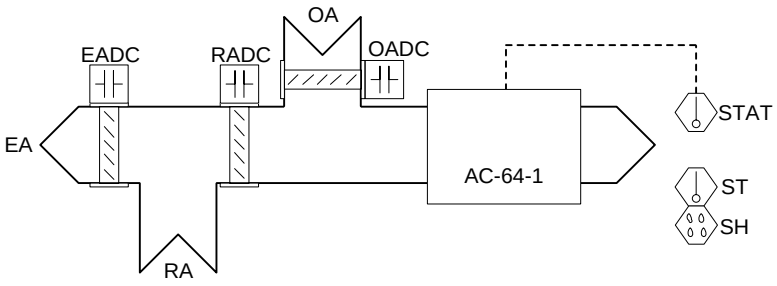
F. Initiation of System Shutdown - System shutdown shall be initiated as follows:
1. By Operator manually entered System shutdown command.
2. Automatically if heating or cooling is no longer required.
3. Automatic in the event of component failure.

G. Alarms - The BMCS shall generate an alarm:
1. Equipment failure.
2. If the space temperature is outside the operator established low and high limits, which shall be set initially at + or - 5 Deg. F. below and above the setpoint respectively.

H. Failure positions - When a BMCS component failure occurs or a power failure occurs:
1. The cooling coil control valves shall remain in the last commanded position.
2. The heating coil control valves shall remain in the last commanded position.
3. The circulation pump shall remain in the last commanded state.

A-10: SERVICE ELEVATOR EMR SELF CONTAINED DX SYSTEM (TYPICAL FOR AC-64-1)

FT	DESCRIPTION	DI	DO	AI	AO	HI	CI	NOTES
STAT	THERMOSTAT INTERLOCK					2		
OADC	OUTSIDE AIR DAMPER CONTROL		21					
RADC	RETURN AIR DAMPER CONTROL		21					
EADC	EXHAUST AIR DAMPER CONTROL		21					
ST	SPACE TEMPERATURE			1				
SH	SPACE HUMIDITY			12				



Operating Sequences:

A. System Description – This system consist of self-contained DX system with economizer dampers.

B. System Off - When the system is off:
1. The outside air damper shall be closed.
2. The return air damper shall be open.
3. The exhaust air damper shall be closed.
4. The supply air fan shall be on (via the unit controller).
5. Automatic control loops shall be disabled.

C. Initiation of System Start-up - System start-up shall be initiated as follows:
1. By a single manually entered command.
2. Automatically by the BMCS based on time schedule.

D. System Operation - When system start-up has been initiated, the following sequences shall be implemented:
1. System Operation:
   a. If the outside air is between operator defined limits, the space humidity is below the economizer enable setpoint, and if the outside air temperature is below the space temperature setpoint the following shall occur:
      i. The outside air damper and exhaust air damper shall open.
      ii. The return air damper shall close.

E. Setpoints - The setpoints shall be operator changeable and shall be set initially by the BMCS subcontractor as follows:
1. The outside air temperature limits of economizer operations shall be 65 Deg. F. and 40 Deg. F.
2. The space humidity economizer enable setpoint shall be 50% RH.
3. The space temperature setpoint shall be 5 Deg. F. below the DX thermostat setpoint.

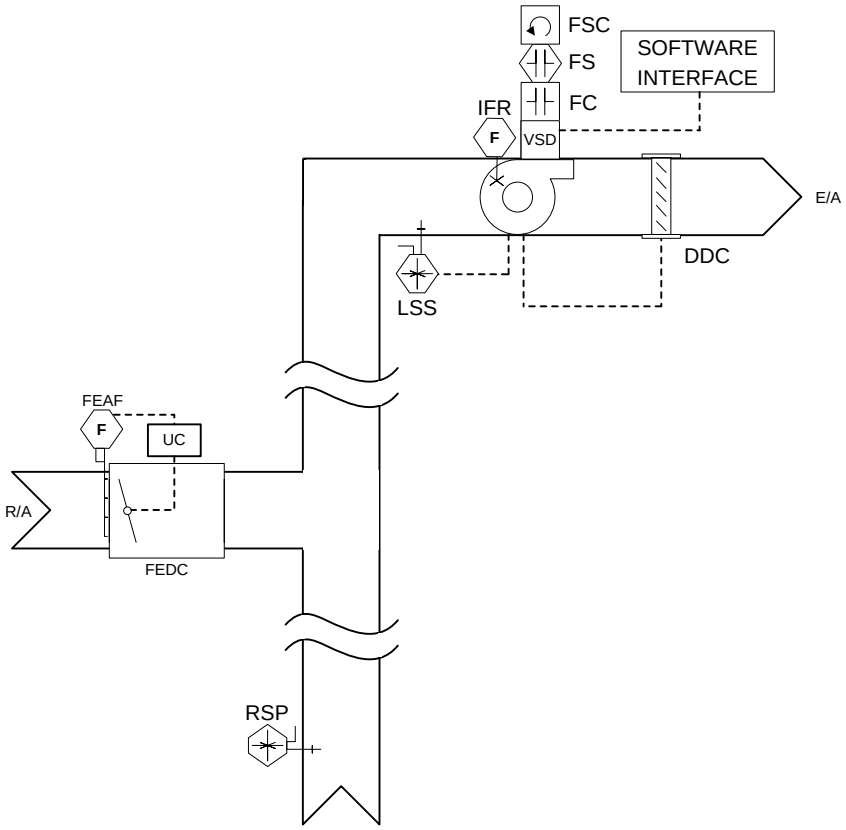
F. Initiation of System Shutdown - System shutdown shall be initiated as follows:
   1. By Operator entered manual entered command.
   2. Automatically by the BMCS.

G. Alarms - The BMCS shall generate an alarm:
   1. Equipment failure.
   2. If the supply air temperature is + or - 10 Deg. F. around the current setpoint.
   3. If the space humidity is above 50% RH for a period of more than ten minutes.

H. Failure positions - When a BMCS component failure occurs:
   1. The outside air and exhaust air dampers shall fail closed.
   2. The return air damper shall fail open.

A-11: TOILET EXHAUST/SMOKE CONTROL SYSTEM (TYPICAL FOR EF-2-3 AND EF-62-1)

FT	DESCRIPTION	DI	DO	AI	AO	HI	CI	NOTES
RSP	RISER STATIC PRESSURE			34				TYPICAL OF 3 TOTAL. LOCATED AT LEVEL 25 FOR EF-2-3 AND LEVEL 35 FOR EF-62-2.
LSS	LOW STATIC SHUTDOWN	31				21		TYPICAL OF EF-2-3 AND EF-62-2
IFR	INLET FLOWRATE			41				TYPICAL OF EF-2-3 AND EF-62-2
DDC	DISCHARGE DAMPER CONTROL					31		TYPICAL OF EF-2-3 AND EF-62-2
FC	EXHAUST AIR CONTROL		1					TYPICAL OF EF-2-3 AND EF-62-2
FS	EXHAUST AIR STATUS	1						TYPICAL OF EF-2-3 AND EF-62-2
FSC	FAN SPEED CONTROL				1			TYPICAL OF EF-2-3 AND EF-62-2
SR	EXHAUST FAN VSD SPEED REFERENCE FEEDBACK						23	TYPICAL OF EF-2-3 AND EF-62-2
FF	EXHAUST FAN FAULT DIAGNOSTICS						23	TYPICAL OF EF-2-3 AND EF-62-2
FVA	EXHAUST FAN VSD FAULT ALARM						23	TYPICAL OF EF-2-3 AND EF-62-2
FHP	EXHAUST FAN MOTOR POWER IN HP						23	TYPICAL OF EF-2-3 AND EF-62-2
FKW	EXHAUST FAN MOTOR POWER IN KW						23	TYPICAL OF EF-2-3 AND EF-62-2
FKWH	EXHAUST FAN MOTOR KWH						23	TYPICAL OF EF-2-3 AND EF-62-2
FMC	EXHAUST FAN MOTOR CURRENT						23	TYPICAL OF EF-2-3 AND EF-62-2
FV	EXHAUST FAN MOTOR VOLTAGE						23	TYPICAL OF EF-2-3 AND EF-62-2
FRH	EXHAUST FAN HOURS RUN						23	TYPICAL OF EF-2-3 AND EF-62-2
FDCV	EXHAUST FAN DC LINK VOLTAGE						23	TYPICAL OF EF-2-3 AND EF-62-2
FTL	EXHAUST FAN THERMAL LOAD ON MOTOR						23	TYPICAL OF EF-2-3 AND EF-62-2
FHST	EXHAUST FAN VSD HEATSINK TEMPERATURE						23	TYPICAL OF EF-2-3 AND EF-62-2
FEAF	FLOOR EXHAUST AIR FLOWRATE						31	TYPICAL FOR VAV-(2-34)-1, VAV-(2-61)-2, AND VAV-2-3
FEDC	FLOOR EXHAUST DAMPER CONTROL				22		31	TYPICAL FOR VAV-(2-34)-1, VAV-(2-61)-2, AND VAV-2-3



Operating Sequences:

A. System Description – These units consist of a variable speed fan with interlocked discharge damper serving risers with constant volume terminal units on each floor.

B. System Off - When the system is off:
1. The fan shall be off.
2. The associated discharge dampers shall be closed.
3. The on floor constant volume terminal unit dampers shall be closed.
4. All control loops shall be disabled.

C. Initiation of System Start-Up - System start-up shall be initiated:
1. By an operator manually entered command at the BMCS.
2. Automatically by the BMCS based on time schedule or occupancy mode of the associated air handling units.
3. Automatically by the fire alarm system.

D. System Operation -When system start-up has been initiated, the following sequences shall be implemented:
1. System Startup:
   a. The discharge damper shall open fully.
   b. The toilet exhaust fan shall start at minimum speed whenever one or more of the floors associated with it are in the occupied mode.
   c. The on floor constant volume toilet exhaust terminal units shall be enabled on a floor by floor basis with the occupancy schedule.
2. System Operation:

a. The fan speed shall be modulated to the riser static pressure setpoint.
b. The on floor constant volume toilet exhaust terminal units shall be controlled via UC to maintain the operator defined toilet exhaust air flowrate setpoint.

3. System Operation - Smoke Control:
   a. The toilet exhaust fan shall start and shall ramp to the smoke control flowrate set at the VSD.

E. Setpoints - The setpoints shall be operator changeable and shall be set initially by the BMCS subcontractor as follows:
1. The exhaust riser static pressure setpoint shall be -0.75 inches w.g.
2. The air flow rate setpoints for toilet exhaust terminal units shall be as scheduled on the mechanical drawings.
3. The setpoint for low static shutdown shall be -2.0 inches w.g.

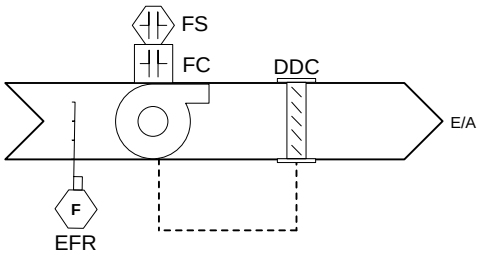
F. Initiation of System Shutdown - System shutdown shall be initiated:
1. By operator entered manual command.
2. Automatically by the BMCS.
3. Automatically by the fire alarm system.
4. Low static pressure switch trip.

G. Alarms - The BMCS shall generate an alarm:
1. Equipment failure.
2. If the duct static pressure is outside the setpoint by + or – 0.25 inches w.g. for 10 minutes.
3. If any terminal unit flowrates are below setpoint for more than 15 minutes.
4. In the event of a static pressure limit device trip condition.

H. Failure positions - When a BMCS component failure occurs:
1. Fan shall remain in the last commanded state.
2. The discharge damper shall remain in the last commanded position.
3. Terminal unit dampers shall remain in the last commanded position.

A-12: TOILET EXHAUST FAN (TYPICAL FOR EF-P1-9)

FT	DESCRIPTION	DI	DO	AI	AO	HI	CI	NOTES
EFR	EXHAUST FLOWRATE			43				
DDC	DISCHARGE DAMPER CONTROL					32		
FC	EXHAUST AIR CONTROL		1					
FS	EXHAUST AIR STATUS	11						



Operating Sequences:

A. System Description – The unit consists of an interlocked discharge damper and constant speed fan.

B. System Off - When the system is off:
1. The fan shall be off.
2. The associated discharge dampers shall be closed.
3. All control loops shall be disabled.

C. Initiation of System Start-Up - System start-up shall be initiated:
1. By an operator manually entered command at the BMCS.
2. Automatically by the BMCS based on time schedule.

D. System Operation -When system start-up has been initiated, the following sequences shall be implemented:
1. System Startup:
   a. The interlocked damper shall open fully and the exhaust fan shall start

E. Setpoints - There are no setpoints for this system.

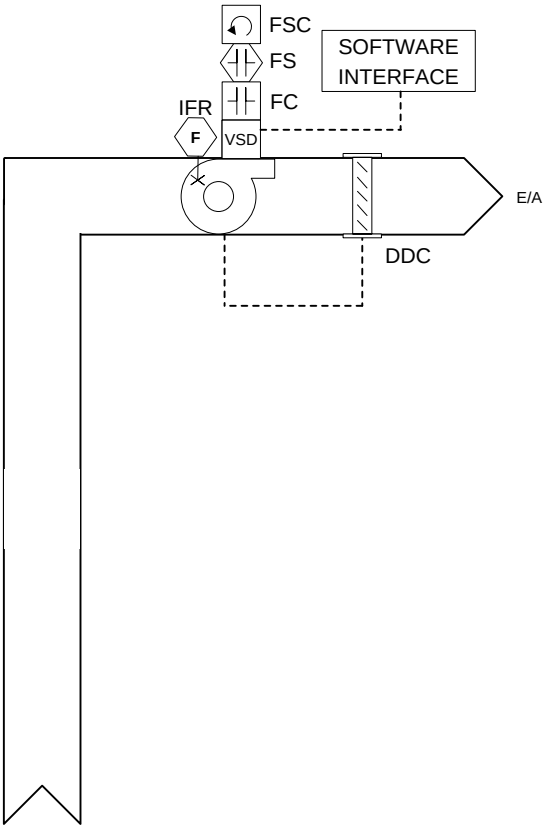
F. Initiation of System Shutdown - System shutdown shall be initiated:
1. By operator entered manual command.
2. Automatically by the BMCS.

G. Alarms - The BMCS shall generate an alarm:
1. Equipment failure.

H. Failure positions - When a BMCS component failure occurs:
1. Fan shall remain in the last commanded state.
2. The discharge damper shall remain in the last commanded position.

A-13: SMOKE CONTROL SYSTEM (TYPICAL FOR EF-64-1)

FT	DESCRIPTION	DI	DO	AI	AO	HI	CI	NOTES
DDC	DISCHARGE DAMPER CONTROL					32		
FS	EXHAUST AIR STATUS	1						
SR	EXHAUST FAN VSD SPEED REFERENCE FEEDBACK						23	
FF	EXHAUST FAN FAULT DIAGNOSTICS						23	
FVA	EXHAUST FAN VSD FAULT ALARM						23	
FHP	EXHAUST FAN MOTOR POWER IN HP						23	
FKW	EXHAUST FAN MOTOR POWER IN KW						23	
FKWH	EXHAUST FAN MOTOR KWH						23	
FMC	EXHAUST FAN MOTOR CURRENT						23	
FV	EXHAUST FAN MOTOR VOLTAGE						23	
FRH	EXHAUST FAN HOURS RUN						23	
FDCV	EXHAUST FAN DC LINK VOLTAGE						23	
FTL	EXHAUST FAN THERMAL LOAD ON MOTOR						23	
FHST	EXHAUST FAN VSD HEATSINK TEMPERATURE						23	



Operating Sequences:

A. System Description – These units consist of a variable speed fan with interlocked discharge damper serving the smoke exhaust riser.

B. System Off - When the system is off:
1. The fan shall be off.
2. The associated discharge dampers shall be closed.
3. All control loops shall be disabled.

C. Initiation of System Start-Up - System start-up shall be initiated:
1. By an operator manually entered command at the BMCS.
2. Automatically by the fire alarm system.

D. System Operation -When system start-up has been initiated, the following sequences shall be implemented:
1. System Startup:
   a. The discharge damper shall open fully.
   b. The smoke control fan shall and shall ramp to the smoke control flowrate set at the VSD.

E. Setpoints - There are no setpoints for this system.

F. Initiation of System Shutdown - System shutdown shall be initiated:
1. By operator entered manual command.
2. Automatically by the fire alarm system.

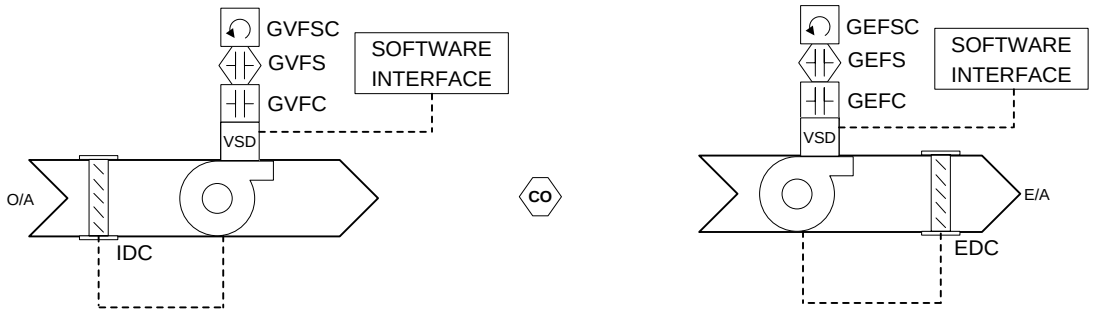
G. Alarms - The BMCS shall generate an alarm:
1. Equipment failure.

H. Failure positions - When a BMCS component failure occurs:
   1. Fan shall remain in the last commanded state.
   2. The discharge damper shall remain in the last commanded position.

A-14: GARAGE VENTILATION

FT	DESCRIPTION	DI	DO	AI	AO	HI	CI	NOTES
IDC	INTAKE DAMPER INTERLOCK					32		TYPICAL FOR SF-P1-1, SF-P2-(1-3), AND SF-P3-(1-3)
GVFC	GARAGE VENTILATION FAN CONTROL		1					TYPICAL FOR SF-P1-1, SF-P2-(1-3), AND SF-P3-(1-3)
GVFS	GARAGE VENTILATION FAN STATUS	1						TYPICAL FOR SF-P1-1, SF-P2-(1-3), AND SF-P3-(1-3)
GVFSC	GARAGE VENTILATION FAN SPEED CONTROL				1			TYPICAL FOR SF-P1-1, SF-P2-(1-3), AND SF-P3-(1-3)
GFSR	VENTILATION FAN VSD SPEED REFERENCE FEEDBACK						23	TYPICAL FOR SF-P1-1, SF-P2-(1-3), AND SF-P3-(1-3)
GFF	VENTILATION FAN FAULT DIAGNOSTICS						23	TYPICAL FOR SF-P1-1, SF-P2-(1-3), AND SF-P3-(1-3)
GFVA	VENTILATION FAN VSD FAULT ALARM						23	TYPICAL FOR SF-P1-1, SF-P2-(1-3), AND SF-P3-(1-3)
GFHP	VENTILATION FAN MOTOR POWER IN HP						23	TYPICAL FOR SF-P1-1, SF-P2-(1-3), AND SF-P3-(1-3)
GFKW	VENTILATION FAN MOTOR POWER IN KW						23	TYPICAL FOR SF-P1-1, SF-P2-(1-3), AND SF-P3-(1-3)
GFKWH	VENTILATION FAN MOTOR KWH						23	TYPICAL FOR SF-P1-1, SF-P2-(1-3), AND SF-P3-(1-3)
GFMC	VENTILATION FAN MOTOR CURRENT						23	TYPICAL FOR SF-P1-1, SF-P2-(1-3), AND SF-P3-(1-3)
GFV	VENTILATION FAN MOTOR VOLTAGE						23	TYPICAL FOR SF-P1-1, SF-P2-(1-3), AND SF-P3-(1-3)
GFRH	VENTILATION FAN HOURS RUN						23	TYPICAL FOR SF-P1-1, SF-P2-(1-3), AND SF-P3-(1-3)
GFDCV	VENTILATION FAN DC LINK VOLTAGE						23	TYPICAL FOR SF-P1-1, SF-P2-(1-3), AND SF-P3-(1-3)
GFTL	VENTILATION FAN THERMAL LOAD ON MOTOR						23	TYPICAL FOR SF-P1-1, SF-P2-(1-3), AND SF-P3-(1-3)
GFTV	VENTILATION FAN THERMAL LOAD ON VFD						23	TYPICAL FOR SF-P1-1, SF-P2-(1-3), AND SF-P3-(1-3)
GFHST	VENTILATION FAN VSD HEATSINK TEMPERATURE						23	TYPICAL FOR SF-P1-1, SF-P2-(1-3), AND SF-P3-(1-3)
GEFC	GARAGE EXHAUST FAN CONTROL		1					TYPICAL FOR EF-P1-(1-2), EF-P2-(1-2), AND EF-P3-(1-2)
GEFS	GARAGE EXHAUST FAN STATUS	1						TYPICAL FOR EF-P1-(1-2), EF-P2-(1-2), AND EF-P3-(1-2)

FT	DESCRIPTION	DI	DO	AI	AO	HI	CI	NOTES
GEFSC	GARAGE EXHAUST FAN SPEED CONTROL				1			TYPICAL FOR EF-P1-(1-2), EF-P2-(1-2), AND EF-P3-(1-2)
GFSR	EXHAUST FAN VSD SPEED REFERENCE FEEDBACK						23	TYPICAL FOR EF-P1-(1-2), EF-P2-(1-2), AND EF-P3-(1-2)
GFF	EXHAUST FAN FAULT DIAGNOSTICS						23	TYPICAL FOR EF-P1-(1-2), EF-P2-(1-2), AND EF-P3-(1-2)
GFVA	EXHAUST FAN VSD FAULT ALARM						23	TYPICAL FOR EF-P1-(1-2), EF-P2-(1-2), AND EF-P3-(1-2)
GFHP	EXHAUST FAN MOTOR POWER IN HP						23	TYPICAL FOR EF-P1-(1-2), EF-P2-(1-2), AND EF-P3-(1-2)
GFKW	EXHAUST FAN MOTOR POWER IN KW						23	TYPICAL FOR EF-P1-(1-2), EF-P2-(1-2), AND EF-P3-(1-2)
GFKWH	EXHAUST FAN MOTOR KWH						23	TYPICAL FOR EF-P1-(1-2), EF-P2-(1-2), AND EF-P3-(1-2)
GFMC	EXHAUST FAN MOTOR CURRENT						23	TYPICAL FOR EF-P1-(1-2), EF-P2-(1-2), AND EF-P3-(1-2)
GFV	EXHAUST FAN MOTOR VOLTAGE						23	TYPICAL FOR EF-P1-(1-2), EF-P2-(1-2), AND EF-P3-(1-2)
GFRH	EXHAUST FAN HOURS RUN						23	TYPICAL FOR EF-P1-(1-2), EF-P2-(1-2), AND EF-P3-(1-2)
GFDCV	EXHAUST FAN DC LINK VOLTAGE						23	TYPICAL FOR EF-P1-(1-2), EF-P2-(1-2), AND EF-P3-(1-2)
GFTL	EXHAUST FAN THERMAL LOAD ON MOTOR						23	TYPICAL FOR EF-P1-(1-2), EF-P2-(1-2), AND EF-P3-(1-2)
GFTV	EXHAUST FAN THERMAL LOAD ON VFD						23	TYPICAL FOR EF-P1-(1-2), EF-P2-(1-2), AND EF-P3-(1-2)
GFHST	EXHAUST FAN VSD HEATSINK TEMPERATURE						23	TYPICAL FOR EF-P1-(1-2), EF-P2-(1-2), AND EF-P3-(1-2)
EDC	EXHAUST DAMPER INTERLOCK					32		TYPICAL FOR EF-P1-(1-2), EF-P2-(1-2), AND EF-P3-(1-2)
CO	GARAGE CARBON MONOXIDE			54				NOTE 1



Operating Sequences:

A. System description: This system consists of variable speed supply fans with interlocked intake dampers and variable speed exhaust fans with interlocked discharge dampers.

B. System Off - When the system is off:
1. The supply fans shall be off.
2. The exhaust fans shall be off.
3. The fan intake dampers associated with each supply fan shall be closed.
4. The fan exhaust dampers associated with each exhaust fan shall be closed.
5. All control loops shall be disabled.

C. Initiation of System Start-Up - System start-up shall be initiated:
1. By a manually entered command at the BMCS.
2. Automatically by the BMCS base on time schedule and/or carbon monoxide levels.

D. System Operation -When system start-up has been initiated, the following sequences shall be implemented:
1. System Operation - Time Schedule:
   a. The exhaust fans shall operate on a time scheduled basis. When operating on a time schedule basis, the following shall occur:
      i. The interlocked intake damper shall open and the supply fan shall start at minimum speed.
      ii. The interlocked discharge damper shall open and the exhaust fans shall start at minimum speed.
      iii. The supply fan speed and the exhaust fan speed shall be controlled in unison to maintain the CO setpoint
2. System Operation - CO Control:
   a. If the garage floor CO is above the setpoint for a defined period, then the following shall occur:
      i. The interlocked intake damper shall open for supply fan one and two, the associated supply fans shall start at minimum speed, the interlocked discharge damper shall open for exhaust fan one, and the associated exhaust fans shall start at minimum speed.
      ii. After an operator defined time delay, if the garage CO is above setpoint the operating supply and exhaust fan speed shall be controlled in unison to maintain the CO setpoint.
      iii. After another operator defined time delay, the interlocked intake damper shall open for supply fan three, the associated supply fan shall start at minimum speed, the interlocked discharge damper shall open for exhaust fan two, and the associated exhaust fans shall start at minimum speed. The fan speed for all operating fans shall be controlled in unison to maintain the CO setpoint.
3. System or Power Failure Operation:
   a. If a fan is lost in service, the failed fan shall be disabled.

E. Setpoints - The setpoints shall be operator changeable and shall be set initially by the BMCS subcontractor as follows:
1. Garage floor CO setpoint shall be 50 ppm.
2. The defined period for delay starting shall be 10 minutes.
3. The defined period for fan speed control shall be 10 minutes.
4. The defined period for fan staging shall be 15 minutes.
5. The defined period for delay shutdown shall be 30 minutes.

F. Initiation of System Shutdown - System shutdown shall be initiated:
1. By Operator entered manual command.
2. Automatically by the BMCS based on time schedule.
3. Automatically by the BMCS if the CO level is below setpoint and the supply and exhaust fan speeds have been operating at minimum speed for a defined period.

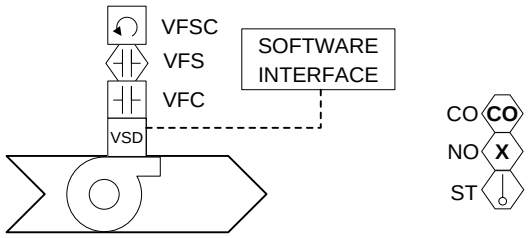
G. The BMCS shall generate an alarm:

1. Equipment failure.
2. If the garage CO level rises above 100 ppm for 20 continuous minutes.

H. Failure positions - When a BMCS component failure occurs:
1. Fan shall fail off and the associated discharge damper shall close.

A-15: TRUCK DOCK VENTILATION (TYPICAL FOR EF-P1-2)

FT	DESCRIPTION	DI	DO	AI	AO	HI	CI	NOTES
VFC	VENTILATION FAN CONTROL		1					
VFS	VENTILATION FAN STATUS	1						
VFSC	VENTILATION FAN SPEED CONTROL				1			
FSR	VENTILATION FAN VSD SPEED REFERENCE FEEDBACK						23	
FF	VENTILATION FAN FAULT DIAGNOSTICS						23	
FVA	VENTILATION FAN VSD FAULT ALARM						23	
FHP	VENTILATION FAN MOTOR POWER IN HP						23	
FKW	VENTILATION FAN MOTOR POWER IN KW						23	
FKWH	VENTILATION FAN MOTOR KWH						23	
FMC	VENTILATION FAN MOTOR CURRENT						23	
FV	VENTILATION FAN MOTOR VOLTAGE						23	
FRH	VENTILATION FAN HOURS RUN						23	
FDCV	VENTILATION FAN DC LINK VOLTAGE						23	
FTL	VENTILATION FAN THERMAL LOAD ON MOTOR						23	
FTV	VENTILATION FAN THERMAL LOAD ON VFD						23	
FHST	VENTILATION FAN VSD HEATSINK TEMPERATURE						23	
CO	TRUCK DOCK CARBON MONOXIDE			54				
NO	TRUCK DOCK NITROGEN DIOXIDE			55				
ST	SPACE TEMPERATURE			1				



Operating Sequences:

A. System description: This system consists of a variable speed exhaust fan.

B. System Off - When the system is off:
1. The supply fan shall be off.
2. All control loops shall be disabled.

C. Initiation of System Start-Up - System start-up shall be initiated:
1. By a manually entered command at the BMCS.
2. Automatically by the BMCS base on time schedule, space temperature, and/or carbon monoxide/nitrogen dioxide levels.

D. System Operation -When system start-up has been initiated, the following sequences shall be implemented:
1. System Operation – Time Schedule:
   a. The supply fan shall operate on a time scheduled basis. When operating on a time schedule basis, the following shall occur:
      i. The supply fan shall start at minimum speed.
2. System Operation – Space temperature and/or CO/NO Control:
   a. If the truck dock space temperature, CO or NO is above the setpoint for a defined period, then the following shall occur:
      i. The supply fan shall start at minimum speed.
      ii. The supply fan speed shall be controlled to maintain the space temperature, CO, and NO setpoints.
      iii. If the space temperature, CO, and NO levels are below their respective setpoint for a defined time period, the supply fan shall be disabled.
3. System or Power Failure Operation:
   a. If a fan is lost in service, the failed fan shall be disabled.

E. Setpoints - The setpoints shall be operator changeable and shall be set initially by the BMCS subcontractor as follows:
1. The space temperature setpoint shall be 80 Deg. F.
2. Truck dock floor CO setpoint shall be 50 ppm.
3. Truck dock floor NO setpoint shall be 1 ppm.
4. The defined period for delay starting shall be 10 minutes.
5. The defined period for delay shutdown shall be 30 minutes.

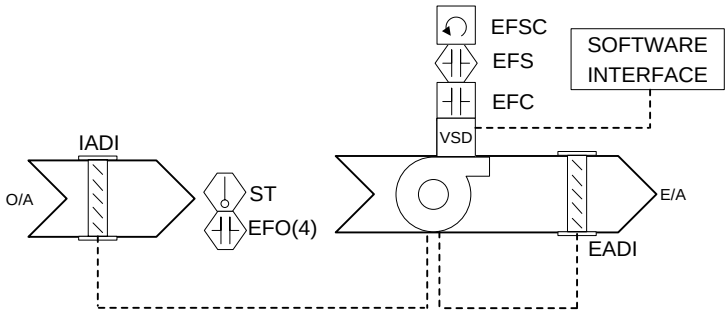
F. Initiation of System Shutdown - System shutdown shall be initiated:
1. By Operator entered manual command.
2. Automatically by the BMCS.

G. The BMCS shall generate an alarm:
1. If the truck dock CO level rises above 100 ppm for 20 continuous minutes.
2. If the truck dock NO level rises above 1 ppm for 20 continuous minutes.
3. Equipment failure.

H. Failure positions - When a BMCS component failure occurs:
1. Fan shall fail in the last commanded state.

A-16: CENTRAL PLANT VENTILATION (TYPICAL FOR EF-2-2)

FT	DESCRIPTION	DI	DO	AI	AO	HI	CI	NOTES
IADI	INTAKE DAMPER INTERLOCK					32		
EFC	EXHAUST FAN CONTROL		1					
EFS	EXHAUST FAN STATUS	1						
EFSC	GARAGE EXHAUST FAN SPEED CONTROL				1			
FSR	EXHAUST FAN VSD SPEED REFERENCE FEEDBACK						23	
FF	EXHAUST FAN FAULT DIAGNOSTICS						23	
FVA	EXHAUST FAN VSD FAULT ALARM						23	
FHP	EXHAUST FAN MOTOR POWER IN HP						23	
FKW	EXHAUST FAN MOTOR POWER IN KW						23	
FKWH	EXHAUST FAN MOTOR KWH						23	
FMC	EXHAUST FAN MOTOR CURRENT						23	
FV	EXHAUST FAN MOTOR VOLTAGE						23	
FRH	EXHAUST FAN HOURS RUN						23	
FDCV	EXHAUST FAN DC LINK VOLTAGE						23	
FTL	EXHAUST FAN THERMAL LOAD ON MOTOR						23	
FTV	EXHAUST FAN THERMAL LOAD ON VFD						23	
FHST	EXHAUST FAN VSD HEATSINK TEMPERATURE						23	
EADI	EXHAUST DAMPER INTERLOCK					32		
ST	SPACE TEMPERATURE			1				
EFO	EMERGENCY FAN OPERATION BUTTON	51						TYPICAL OF FOUR. ONE INSIDE AND OUTSIDE OF EACH EXIT DOOR.



Operating Sequences:

A. System Description – This system consist of a variable speed exhaust fan with interlocked intake and discharge damper.

B. System Off - When the system is off:
1. The exhaust fan shall be off.
2. The interlocked intake and exhaust dampers shall be closed.
3. Automatic control loops shall be disabled.

C. Initiation of System Start-up - System start-up shall be initiated as follows:
1. By a single manually entered command.
2. Automatically whenever the space is requiring cooling.
3. Automatically whenever emergency ventilation is required.
4. Automatically as required for a System Restart following a building power failure and a System Restart following a building fire alarm.

D. System Operation - When system start-up has been initiated, the following sequences shall be implemented:
1. System Startup:
   a. The interlocked intake and exhaust damper shall open and the exhaust fan shall ramp to minimum speed.
2. System Operation:
   a. The exhaust fan shall modulate to maintain the space temperature setpoint.
3. System Operation - Emergency Ventilation:
   a. If emergency ventilation is required for plant ventilation, the exhaust fan shall ramp to full speed.
4. System or Power Failure Operation:
   a. If the exhaust fan is lost in service, the failed fan shall be disabled and the interlocked dampers shall close.

E. Setpoints - The setpoints shall be operator changeable and shall be set initially by the BMCS subcontractor as follows:
1. Space temperature setpoint shall be 75 Deg. F.

F. Initiation of System Shutdown - System shutdown shall be initiated as follows:
1. By Operator manually entered System shutdown command.
2. Automatic in the event of component failure.
3. Automatic in the event of a building power failure of fire alarm.
4. Automatic based on time schedule or when emergency ventilation is not required.

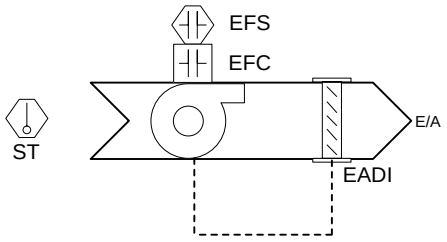
G. Alarms - The BMCS shall generate an alarm:
1. Equipment failure.
2. If the space temperature is outside the operator established low and high limits, which shall be set initially at + or - 5 Deg. F. below and above the setpoint respectively.

H. Failure positions - When a BMCS component failure occurs or a power failure occurs:

1. The exhaust air fans shall remain in the last commanded state.
2. The intake and exhaust air dampers shall fail open.

A-17: GENERATOR VENTILATION (TYPICAL FOR EF-3-1)

FT	DESCRIPTION	DI	DO	AI	AO	HI	CI	NOTES
EFC	EXHAUST FAN CONTROL		1					
EFS	EXHAUST FAN STATUS	11						
EADI	EXHAUST DAMPER INTERLOCK					32		
ST	SPACE TEMPERATURE			1				



Operating Sequences:

A. System Description – This system consist of a constant speed exhaust fan with interlocked discharge damper.

B. System Off - When the system is off:
1. The exhaust fan shall be off.
2. The interlocked exhaust dampers shall be closed.
3. Automatic control loops shall be disabled.

C. Initiation of System Start-up - System start-up shall be initiated as follows:
1. By a single manually entered command.
2. Automatically based on time schedule or whenever the space is requiring cooling.
3. Automatically as required for a System Restart following a building power failure and a System Restart following a building fire alarm.

D. System Operation - When system start-up has been initiated, the following sequences shall be implemented:
1. System Startup:
   a. The interlocked exhaust damper shall open and the exhaust fan shall start.
2. System or Power Failure Operation:
   a. If the exhaust fan is lost in service, the failed fan shall be disabled and the interlocked dampers shall close.

E. Setpoints - The setpoints shall be operator changeable and shall be set initially by the BMCS subcontractor as follows:
1. Space temperature setpoint shall be 75 Deg. F.

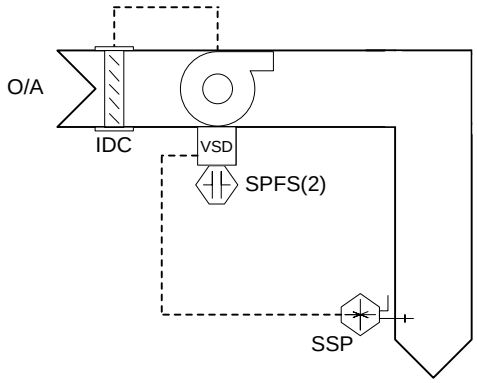
F. Initiation of System Shutdown - System shutdown shall be initiated as follows:
1. By Operator manually entered System shutdown command.
2. Automatic in the event of component failure.
3. Automatic in the event of a building power failure of fire alarm.
4. Automatic based on time schedule or when cooling is not required.

G. Alarms - The BMCS shall generate an alarm:
   1. Equipment failure.
   2. If the space temperature is outside the operator established high limit, which shall be set initially at 5 Deg. F. above the setpoint.

H. Failure positions - When a BMCS component failure occurs or a power failure occurs:
   1. The exhaust air fans shall remain in the last commanded state.
   2. The exhaust air dampers shall fail closed.

A-18: STAIRWELL PRESSURIZATION FANS (TYPICAL FOR SF-P1-2, SF-2-(1-3), SF-63-3, AND SF-64-(1-2))

FT	DESCRIPTION	DI	DO	AI	AO	HI	CI	NOTES
IDC	INTAKE DAMPER INTERLOCK CONTROL					32		
SPFS	STAIR PRESSURIZATION FAN STATUS	32						PROVIDE TWO DIFFERENTIAL STATUS SWITCHES. ONE SHALL BE USED BY THE FDACS.
SSP	STAIRWELL STATIC PRESSURE					22		THERE SHALL BE ONE SENSOR FOR EACH STAIR PRESSURIZATION FAN. REFER TO NOTE 8 FOR LOCATIONS.



Operating Sequences:

A. System Description: This system consists of a variable speed fan and intake damper.

B. System Off - When the system is off:
1. The fan shall be off.
2. The intake and relief dampers shall be closed.

C. Initiation of System Start-Up - System start-up shall be initiated:
1. Automatically by the Fire Alarm System.

D. System Operation - When system start-up has been initiated, the following sequences shall be implemented:
1. Upon receiving a signal from the FDACS, the intake damper shall open and the fan shall start.
2. The fan speed shall be modulated by the VSD controller to maintain a stairwell static pressure setpoint of the stair relative to the floor. Provide a differential pressure sensor for each fan system and wire the sensor directly to the controller serving that system. Provide two floor reference points for each sensor on different floors.

E. Setpoints – There are no BMCS setpoints associated with this system.

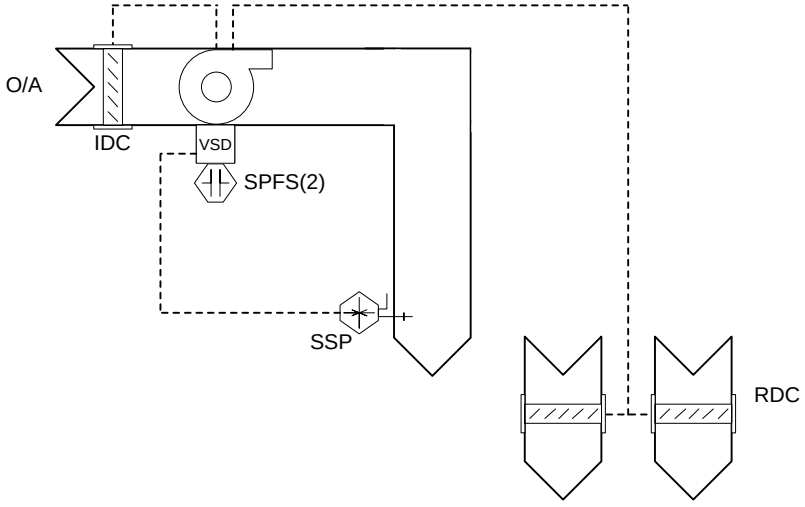
F. Initiation of System Shutdown - System shutdown shall be initiated:
   1. Automatically by the Fire Alarm System.

G. Failure positions - When a BMCS component failure occurs:
   1. Fan shall remain in the last commanded state.
   2. Damper shall remain in the last commanded position.

A-19: ELEVATOR MACHINE ROOM PRESSURIZATION FANS (TYPICAL FOR SF-62-(1-3) and SF-63-(1-2))

FT	DESCRIPTION	DI	DO	AI	AO	HI	CI	NOTES
IDC	INTAKE DAMPER INTERLOCK CONTROL					32		
RDC	RELIEF DAMPER INTERLOCK CONTROL					32		TYPICAL OF 2
EPFS	ELEVATOR MACHINE ROOM PRESSURIZATION FAN STATUS	32						PROVIDE TWO DIFFERENTIAL STATUS SWITCHES. ONE SHALL BE USED BY THE FDACS.
ESP	ELEVATOR MACHINE ROOM STATIC PRESSURE					5		THERE SHALL BE ONE SENSOR FOR EACH ELEVATOR MACHINE ROOM.

*



Operating Sequences:

A. System Description: This system consists of a variable speed fan and intake damper.

B. System Off - When the system is off:
   1. The fan shall be off.
   2. The intake damper shall be closed.

C. Initiation of System Start-Up - System start-up shall be initiated:
   1. Automatically by the Fire Alarm System.

D. System Operation - When system start-up has been initiated, the following sequences shall be implemented:
   1. Upon receiving a signal from the FDACS, the intake dampers shall open and the fan shall start.

2. The fan speed shall be modulated by the VSD controller to maintain an elevator machine room static pressure setpoint of the stair relative to the floor. Provide a differential pressure sensor for each fan system and wire the sensor directly to the controller serving that system.

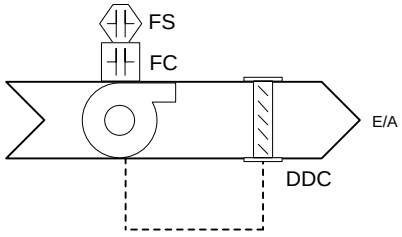
E. Setpoints – There are no BMCS setpoints associated with this system.

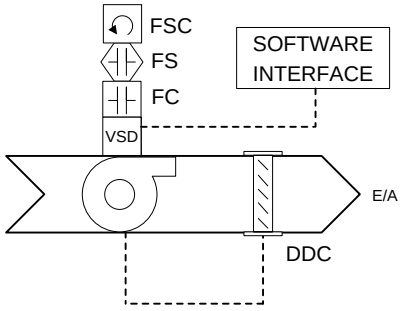
F. Initiation of System Shutdown - System shutdown shall be initiated:
1. Automatically by the Fire Alarm System.

G. Failure positions - When a BMCS component failure occurs:
1. Fan shall remain in the last commanded state.
2. Dampers shall remain in the last commanded position.

A-20: EXHAUST FANS (TYPICAL FOR EF-2-1, EF-2-4, AND EF-3-2)

FT	DESCRIPTION	DI	DO	AI	AO	HI	CI	NOTES
DDC	DISCHARGE DAMPER CONTROL					32		
FC	EXHAUST AIR CONTROL		1					
FS	EXHAUST AIR STATUS	11						
FSC	EXHAUST FAN SPEED CONTROL				1			TYPICAL FOR EF-2-1 ONLY.
FSR	EXHAUST FAN VSD SPEED REFERENCE FEEDBACK						23	TYPICAL FOR EF-2-1 ONLY.
FF	EXHAUST FAN FAULT DIAGNOSTICS						23	TYPICAL FOR EF-2-1 ONLY.
FVA	EXHAUST FAN VSD FAULT ALARM						23	TYPICAL FOR EF-2-1 ONLY.
FHP	EXHAUST FAN MOTOR POWER IN HP						23	TYPICAL FOR EF-2-1 ONLY.
FKW	EXHAUST FAN MOTOR POWER IN KW						23	TYPICAL FOR EF-2-1 ONLY.
FKWH	EXHAUST FAN MOTOR KWH						23	TYPICAL FOR EF-2-1 ONLY.
FMC	EXHAUST FAN MOTOR CURRENT						23	TYPICAL FOR EF-2-1 ONLY.
FV	EXHAUST FAN MOTOR VOLTAGE						23	TYPICAL FOR EF-2-1 ONLY.
FRH	EXHAUST FAN HOURS RUN						23	TYPICAL FOR EF-2-1 ONLY.
FDCV	EXHAUST FAN DC LINK VOLTAGE						23	TYPICAL FOR EF-2-1 ONLY.
FTL	EXHAUST FAN THERMAL LOAD ON MOTOR						23	TYPICAL FOR EF-2-1 ONLY.
FTV	EXHAUST FAN THERMAL LOAD ON VFD						23	TYPICAL FOR EF-2-1 ONLY.
FHST	EXHAUST FAN VSD HEATSINK TEMPERATURE						23	TYPICAL FOR EF-2-1 ONLY.





EF-2-1

Operating Sequences:

A. System Description – The unit consists of an interlocked discharge damper and constant speed fan.

B. System Off - When the system is off:
1. The fan shall be off.
2. The associated discharge dampers shall be closed.
3. All control loops shall be disabled.

C. Initiation of System Start-Up - System start-up shall be initiated:
1. By an operator manually entered command at the BMCS.
2. Automatically by the BMCS based on time schedule or occupancy mode of the building.
3. Automatically by the Fire Alarm System.

D. System Operation -When system start-up has been initiated, the following sequences shall be implemented:
1. System Startup:
a. The interlocked damper shall open fully and the exhaust fan shall start.

E. Setpoints - There are no setpoints for this system.

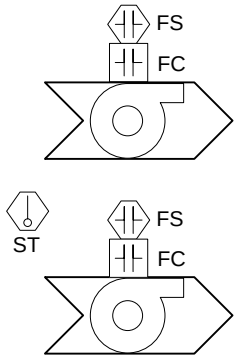
F. Initiation of System Shutdown - System shutdown shall be initiated:
1. By operator entered manual command.
2. Automatically by the BMCS.

G. Alarms - The BMCS shall generate an alarm:
1. Equipment failure.

H. Failure positions - When a BMCS component failure occurs:
1. Fan shall remain in the last commanded state.

A-21: ELECTRICAL VAULT EXHAUST FANS (TYPICAL FOR SF-P1-(4-11))

FT	DESCRIPTION	DI	DO	AI	AO	HI	CI	NOTES
FC	EXHAUST AIR CONTROL		1					
FS	EXHAUST AIR STATUS	11						
ST	SPACE TEMPERATURE			1				TYPICAL OF ONE PER TWO FANS. PROVIDE WITH LOCAL OVERRIDE



Operating Sequences:

A. System Description – The unit consists of constant speed fans.

B. System Off - When the system is off:
   1. The fan shall be off.
   2. All control loops shall be disabled.

C. Initiation of System Start-Up - System start-up shall be initiated:
   1. By an operator manually entered command at the BMCS.
   2. Automatically by the BMCS based on time schedule, space temperature, or local override.
   3. Automatically by the Fire Alarm System.

D. System Operation -When system start-up has been initiated, the following sequences shall be implemented:
   1. System Operation - Time Schedule:
      a. The exhaust fan shall start.
   2. System Operation - Space Temperature:
      a. If the space temperature is above the space temperature setpoint, the exhaust fan shall start and remain operating until the space temperature has been below setpoint for an operator defined time delay.
   3. System Operation - Local Override:
      a. If the local override switch is activated, the exhaust fan shall start and remain operating for an operator defined time delay.

E. Setpoints - The setpoints shall be operator changeable and shall be set initially by the BMCS subcontractor as follows:
   1. The space temperature setpoint shall be 80 Deg. F.
   2. The time delay for space temperature fan shutdown shall be 15 minutes.
   3. The time delay for local override shall be 15 minutes.

F. Initiation of System Shutdown - System shutdown shall be initiated:
   1. By operator entered manual command.
   2. Automatically by the BMCS based on time schedule or space temperature.

G. Alarms - The BMCS shall generate an alarm:
   1. Equipment failure.

H. Failure positions - When a BMCS component failure occurs:
   1. Fan shall remain in the last commanded state.

A-22: DX SPLIT SYSTEMS (TYPICAL, REFER TO MECHANICAL FOR QUANTITIES)

FT	DESCRIPTION	DI	DO	AI	AO	HI	CI	NOTES
STAT	THERMOSTAT INTERLOCK					2		
CUI	CONDENSER UNIT INTERLOCK					5		
CEDI	CONDENSER EXHAUST DAMPER INTERLOCK					35		TYPICAL FOR ACCU-31-1 AND ACCU-32-1 ONLY
CEDP	CONDENSER UNIT DAMPER POSITION	61						TYPICAL FOR ACCU-31-1 AND ACCU-32-1 ONLY
ST	SPACE TEMPERATURE			1				
CPS	CONDENSATE PUMP STATUS	11						NOTE 1

Operating Sequences:

A. The BMCS shall generate an alarm:
   1. If the space temperature is above 85 Deg. F.

B. Failure positions - When a BMCS component failure occurs:
   1. Dampers shall fail open.

A-23: MOTORIZED SWIRL DIFFUSERS (REFER TO MECHANICAL DRAWINGS FOR LOCATIONS AND QUANTITIES)

FT	DESCRIPTION	DI	DO	AI	AO	HI	CI	NOTES
MDC	MOTORIZED SWIRL DAMPER CONTROL				23		31	
SMDC	SLAVE MOTORIZED DAMPER CONTROL					101		
ZST	ZONE SPACE TEMPERATURE			1			31	LOCAL TEMPERATURE SETPOINT OVERRIDE
SCO2	SPACE CO2			53			31	NOTE 1

Operating Sequences:

A. System Description – This system consists of motorized floor diffusers. Each group of diffusers is provided with a master diffuser with a transformer and input signal from the BMCS. The slave diffusers are connected to the master and mimic the operation of the master.

B. System Off - When the system is off:
1. The floor diffusers shall be closed.
2. All control loops shall be disabled.

C. Initiation of System Start-Up - System start-up shall be initiated:
1. By an operator manually entered command at the BMCS.
2. Automatically by the BMCS based on temperature demands of the space when the associated AHU is operational.

D. System Operation -When system start-up has been initiated, the following sequences shall be implemented:
1. The master and slave swirl diffusers shall modulate as required to maintain the associated space temperature setpoint.

E. Setpoints - The setpoints for the system shall be determined as follows:
1. The space temperature setpoint shall be initially set at 74 Deg. F.

F. Initiation of System Shutdown - System shutdown shall be initiated:
1. By operator entered manual command.
2. Automatically by the BMCS.

G. Failure positions - When a BMCS component failure occurs:
1. Floor diffusers shall remain in the last commanded position.

A-24: TRANSFER FAN (TYPICAL FOR TF-P2-(1-2) AND TF-3-1)

FT	DESCRIPTION	DI	DO	AI	AO	HI	CI	NOTES
STAT	THERMOSTAT INTERLOCK					6		
ST	SPACE TEMPERATURE			1				

Operating Sequences:

A. System Description – The unit consists of constant speed fan controlled by a line voltage thermostat.

B. Alarms - The BMCS shall generate an alarm:
   1. If the space temperature is above the alarm level setpoint initially set at 80 Deg. F.

E-01: BUILDING LIGHTING CONTROL

FT	DESCRIPTION	DI	DO	AI	AO	HI	CI	NOTES
ALL	AMBIENT LIGHT LEVEL			61				TYPICAL OF ONE FOR THE BUILDING
EZC	EXTERIOR ZONE LIGHTING ON/OFF CONTROL						1	TYPICAL FOR 6 ZONES
EZS	EXTERIOR ZONE STATUS						1	TYPICAL FOR 6 ZONES
LZC	LOBBY ZONE LIGHTING ON/OFF CONTROL						1	TYPICAL FOR 4 ZONES
LZS	LOBBYZONE STATUS						1	TYPICAL FOR 4 ZONES
TFLC	TYPICAL FLOOR LIGHTING ON/OFF CONTROL						1	
TFLS	TYPICAL FLOOR LIGHTING STATUS						1	
TFOS	TYPICAL FLOOR LIGHTING OVERRIDE SWITCH	54						TYPICAL OF 1 PER FLOOR (LEVELS 3-61)

Operating Sequences:

A. System description: This system consists of lighting control relay panels with communications interface at each lighting control relay panel.

B. System Off - When the system is off:
   1. The lights shall be off.
   2. All control loops shall be disabled.

C. Initiation of System Start-Up - System start-up shall be initiated:
   1. By an operator manually entered command at the BMCS.
   2. Automatically by the BMCS based on ambient light level or time schedule.

D. System Operation:
   1. Exterior lighting shall be controlled as follows:
      a. Lighting zones shall be assignable to an ambient light level start level, time schedule, or both.
      b. Ambient light levels shall be definable on a zone-by-zone basis.
      c. Provide programming such that start and stop times can be scheduled based on offset time periods from sunrise / sunset. Utilize the ambient light level sensor to determine sunrise / sunset.
   2. Lobby lighting shall be controlled as follows:
      a. Lighting zones shall be assigned to time schedule.
      b. During the normal operating hours the Lobby lighting shall be at 100% light level.
      c. After normal operating hours, the Lobby lighting shall be at 50% lighting level.
   3. Typical Floor lighting shall be controlled as follows:
      a. Lighting zones shall be assignable to a time schedule.
      b. After normal hours, lighting activation shall be as defined by the AFTER HOURS LIGHTING ACTIVATION program.
      c. If a zone override switch is activated after normal scheduled hours the associated core lighting zone shall also activate for an operator defined time delay.

E. Setpoints - The system shall have the following setpoints:
   1. The time delay for return to normal operation after motion is sensed shall be 10 minutes.
   2. The time delay for zone override shall be 30 minutes.

F. Initiation of System Shutdown - System shutdown shall be initiated:
   1. By operator entered manual command.
   2. Automatically by the BMCS.

G. Failure positions - When a BMCS component failure occurs:
   1. Relays shall remain in the last commanded state.

E-02: GARAGE LIGHTING CONTROL

FT	DESCRIPTION	DI	DO	AI	AO	HI	CI	NOTES
ZC	ZONE LIGHTING ON/OFF CONTROL						1	TYPICAL OF TWO PER ZONE. EACH LEVEL OF THE GARAGE REPRESENTS A SINGLE LIGHTING ZONE.
ZS	ZONE STATUS						1	TYPICAL OF TWO PER ZONE. EACH LEVEL OF THE GARAGE REPRESENTS A SINGLE LIGHTING ZONE.
ZMS	ZONE MOTION DETECTION	71						REFER TO NOTE 9 FOR MOTION SENSOR QUANTITIES AND LOCATIONS

Operating Sequences:

A. System description: This system consists of lighting control relay panels with communications interface at each lighting control relay panel.

B. System Off - When the system is off:
   1. The lights shall be off.
   2. All control loops shall be disabled.

C. Initiation of System Start-Up - System start-up shall be initiated:
   1. By an operator manually entered command at the BMCS.
   2. Automatically by the BMCS based on time schedule or motion detection.

D. System Operation:
   1. Garage parking area lighting shall be controlled as follows:
      a. Lighting zones shall be assignable to a time schedule.
      b. Each garage level shall be defined as a single zone.
      c. Garage lighting shall be assignable to a time schedule and/or motion control.
      d. During the occupied mode of operation, the garage lighting shall be at 50% lighting level unless the following occurs.
         i. Activation of a building core (Parking Elevator Lobby or Stairwell) motion sensor shall enable all lighting on the associated floor to 100% light level.
         ii. Activation of a motion sensor at the base of the drive ramp shall enable lighting of the level above to 100% light level.
         iii. Activation of a motion sensor at the top of the drive ramp shall enable lighting of the level below to 100% light level.
         iv. After an operator defined time delay after motion is detected the associated level Garage lights shall be 50% lighting level.
      e. During the unoccupied mode of operation the garage lighting shall be at 0% lighting level unless the following occurs:
         i. Activation of a building core (Parking Elevator Lobby or Stairwell) motion sensor shall enable all lighting on the associated floor to 100% light level.
         ii. Activation of a motion sensor at the base of the drive ramp shall enable lighting of the level above to 100% light level.
         iii. Activation of a motion sensor at the top of the drive ramp shall enable lighting of the level below to 100% light level.
         iv. After an operator defined time delay after motion is detected the associated level Garage lights shall be disabled.

E. Setpoints - The system shall have the following setpoints:
   1. The time delay for return to normal operation after motion is sensed shall be 10 minutes.

F. Initiation of System Shutdown - System shutdown shall be initiated:
   1. By operator entered manual command.
   2. Automatically by the BMCS.

G. Failure positions - When a BMCS component failure occurs:
   1. Relays shall remain in the last commanded state.

E-03: MAIN ELECTRICAL SWITCHBOARD (TYPICAL, REFER TO ELECTRICAL DRAWINGS FOR QUANTITIES)

FT	DESCRIPTION	DI	DO	AI	AO	HI	CI	NOTES
KW	KW DEMAND						2	
KVA	KVA DEMAND						2	
KWH	KILOWATT HOUR						2	
VP-P	VOLTAGE PHASE TO PHASE						2	
VP-L	VOLTAGE PHASE TO LINE						2	
I	CURRENT						2	
ID	CURRENT DEMAND						2	
PI	PEAK CURRENT						2	
KVAP	KVA PHASE						2	
KVAT	KVA 3 PHASE TOTAL						2	
KVARP	KVAR PHASE						2	
KVART	KVAR 3 PHASE TOTAL						2	
PFP	POWER FACTOR PHASE						2	
PFT	POWER FACTOR TOTAL						2	
PFA	POWER FACTOR AVERAGE						2	
F	FREQUENCY						2	
PKW	PEAK KW						2	
PKVA	PEAK KVA						2	
PKVAR	PEAK KVAR						2	
THD	TOTAL VOLTAGE HARMONIC DISTORTION						2	
IH	INDIVIDUAL HARMONICS						2	
TVSSA	TRANSIENT VOLTAGE SURGE SUPPRESSION ALARM						2	

E-04: STANDBY ELECTRICAL SYSTEM (TYPICAL OF ONE)

FT	DESCRIPTION	DI	DO	AI	AO	HI	CI	NOTES
SA	GEN SET SUMMARY ALARM						3	
GS	GENERATOR STATUS						3	
FOFA	FUEL OVER FLOW ALARM						3	
SA	GEN SET SUMMARY ALARM						3	
LOILP	GEN SET ENGINE LOW OIL PRESSURE						3	
HWT	GEN SET HIGH WATER TEMPERATURE						3	
LFUEL	GEN SET LOW FUEL LEVEL						3	
LBV	GEN SET LOW BATTERY VOLTAGE						3	
OC	GEN SET OVERCRANK						3	
OS	GEN SET OVERSPEED						3	
CBT	GEN SET CIRCUIT BREAKER TRIPPED						3	
HAND	GEN SET CONTROLS NOT IN AUTOMATIC						3	
LOCK	GEN SET LOCKOUT						3	
CBO	GEN SET CIRCUIT BREAKER OPEN						3	
ER	GEN SET ENGINE RUN						3	
FS	ENCLOSURE FAN STATUS						3	
OV	GEN SET OUTPUT VOLTAGE						3	
OA	GEN SET OUTPUT AMPS						3	
OKW	GEN SET OUTPUT KW						3	
CCHF	CRANK CASE HEATER FAILURE						3	
LD	GENERATOR LOAD						3	
ODP	OWNER DEFINED POINTS						3	

E-05: ELECTRICAL SUBMETERS (TYPICAL, REFER TO ELECTRICAL FOR QUANTITIES)

FT	DESCRIPTION	DI	DO	AI	AO	HI	CI	NOTES
KW	KW DEMAND						13	
KVA	KVA DEMAND						13	
KWH	KILOWATT HOUR						13	
VP-P	VOLTAGE PHASE TO PHASE						13	
VP-L	VOLTAGE PHASE TO LINE						13	
I	CURRENT						13	
ID	CURRENT DEMAND						13	
PI	PEAK CURRENT						13	
KVAP	KVA PHASE						13	
KVAT	KVA 3 PHASE TOTAL						13	
KVARP	KVAR PHASE						13	
KVART	KVAR 3 PHASE TOTAL						13	
PFP	POWER FACTOR PHASE						13	
F	FREQUENCY						13	
PKW	PEAK KW						13	
PKVA	PEAK KVA						13	
PKVAR	PEAK KVAR						13	

E-06: AUTOMATIC TRANSFER SWITCHES (TYPICAL, REFER TO ELECTRICAL FOR QUANTITIES AND LOCATIONS)

FT	DESCRIPTION	DI	DO	AI	AO	HI	CI	NOTES
NPP	NORMAL POWER POSITION	2						
EPP	EMERGENCY POWER POSITION	2						

E-07: FIRE ALARM SYSTEM

FT	DESCRIPTION	DI	DO	AI	AO	HI	CI	NOTES
BFA	BUILDING GENERAL FIRE ALARM	3						
BFAT	BUILDING FIRE ALARM TROUBLE	3						
GFA	GARAGE GENERAL FIRE ALARM	3						
GFAT	GARAGE FIRE ALARM TROUBLE	3						

F-01: FUEL OIL SYSTEMS (TYPICAL OF ONE)

FT	DESCRIPTION	DI	DO	AI	AO	HI	CI	NOTES
FFA	FUEL FILTER ALARM						41	
TV	TANK VOLUME						41	
HI	HIGH LEVEL ALARM						41	
LO	LOW LEVEL ALARM						41	
ILDA	INTERSTITIAL LEAK DETECTION ALARM						41	
TLA	TANK LEAK ALARM						41	
STFT	STORAGE TANK FUEL TEMPERATURE						41	

P-01: FIRE PROTECTION SYSTEMS

FT	DESCRIPTION	DI	DO	AI	AO	HI	CI	NOTES
FPR	FIRE PUMP RUN STATUS	2						TYPICAL OF 4
FPPF	FIRE PUMP POWER FAILURE	2						TYPICAL OF 4
FPPD	FIRE PUMP POWER DISCONNECT ALARM	2						TYPICAL OF 4
JPS	JOCKEY PUMP STATUS	2						TYPICAL OF 4

P-02: PLUMBING SYSTEMS

FT	DESCRIPTION	DI	DO	AI	AO	HI	CI	NOTES
SEPHA	SEWAGE EJECTOR PUMP HIGH LEVEL ALARM	2						TYPICAL OF 4
ESMA	ELEVATOR SUMP MOISTURE ALARM	22						TYPICAL OF 11
SPHA	SUMP PUMP HIGH LEVEL ALARM	2						TYPICAL OF4

P-03: PLUMBING PRV

FT	DESCRIPTION	DI	DO	AI	AO	HI	CI	NOTES
PRVP	DOMESTIC WATER PRV DOWSTREAM WATER PRESSURE			22				NOTE 3
PRVVC	PRV ISOLATION VALVE CONTROL		31					NOTE 3

Operating Sequences:

A. System Description: This system consists of a pressure reducing valve provided by the Mechanical subcontractor, discharge pressure sensor and isolation valve.

B. System Operation:
   1. If the high pressure setpoint is reached, the solenoid block valve shall be closed.

C. Setpoints:
   1. The high pressure setpoint shall be 20 PSI over the PRV setting.

D. The BMCS shall generate an alarm:
   1. If the high pressure setpoint is reached.

P-04: DOMESTIC WATER PUMPING SYSTEMS

FT	DESCRIPTION	DI	DO	AI	AO	HI	CI	NOTES
DWP	DOMESTIC WATER CITY PRESSURE			22				
DWLP	DOMESTIC WATER PUMP LOW PRESSURE	2						
DWFT	DOMESTIC WATER FLOW TOTALIZER			29				
PSR	PUMP VFD SPEED REFERENCE FEEDBACK						23	TYPICAL OF 4
PFS	PUMP VFD MOTOR OPERATING STATUS						23	TYPICAL OF 4
PFF	PUMP FAULT DIAGNOSTICS						23	TYPICAL OF 4
PHP	PUMP MOTOR POWER IN HP						23	TYPICAL OF 4
PKW	PUMP MOTOR POWER IN KW						23	TYPICAL OF 4
PKWH	PUMP MOTOR KWH						23	TYPICAL OF 4
PC	PUMP MOTOR CURRENT						23	TYPICAL OF 4
PV	PUMP MOTOR VOLTAGE						23	TYPICAL OF 4
PRH	PUMP HOURS RUN						23	TYPICAL OF 4
PDCV	PUMP DC LINK VOLTAGE						23	TYPICAL OF 4
PTL	PUMP THERMAL LOAD ON MOTOR						23	TYPICAL OF 4
PTV	PUMP THERMAL LOAD ON VFD						23	TYPICAL OF 4
PHST	PUMP VFD HEATSINK TEMPERATURE						23	TYPICAL OF 4

P-05: RECYCLED WATER PUMPING SYSTEMS

FT	DESCRIPTION	DI	DO	AI	AO	HI	CI	NOTES
RWP	RECYCLED WATER CITY PRESSURE			22				
RWLP	RECYCLED WATER PUMP LOW PRESSURE	2						
RWFT	RECYCLED WATER FLOW TOTALIZER			29				
PSR	PUMP VFD SPEED REFERENCE FEEDBACK						23	TYPICAL OF 6
PFS	PUMP VFD MOTOR OPERATING STATUS						23	TYPICAL OF 6
PFF	PUMP FAULT DIAGNOSTICS						23	TYPICAL OF 6
PHP	PUMP MOTOR POWER IN HP						23	TYPICAL OF 6
PKW	PUMP MOTOR POWER IN KW						23	TYPICAL OF 6
PKWH	PUMP MOTOR KWH						23	TYPICAL OF 6
PC	PUMP MOTOR CURRENT						23	TYPICAL OF 6
PV	PUMP MOTOR VOLTAGE						23	TYPICAL OF 6
PRH	PUMP HOURS RUN						23	TYPICAL OF 6
PDCV	PUMP DC LINK VOLTAGE						23	TYPICAL OF 6
PTL	PUMP THERMAL LOAD ON MOTOR						23	TYPICAL OF 6
PTV	PUMP THERMAL LOAD ON VFD						23	TYPICAL OF 6
PHST	PUMP VFD HEATSINK TEMPERATURE						23	TYPICAL OF 6

M-01: MISCELLANEOUS

FT	DESCRIPTION	DI	DO	AI	AO	HI	CI	NOTES
OAT-H	OUTSIDE AIR TEMPERATURE AND HUMIDITY			8				TYPICAL OF 4. LOCATE AT OUTSIDE AIR INTAKE TO CENTRAL PLANT, LEVEL 20 OUTSIDE AIR INTAKE, LEVEL 40 OUTSIDE AIR INTAKE, AND ROOF LEVEL.
OACO2	OUTSIDE AIR CARBON DIOXIDE			52				LOCATE AT ROOF LEVEL.
WS	WIND SPEED			82				LOCATE AT ROOF LEVEL.
WD	WIND DIRECTION			81				LOCATE AT ROOF LEVEL.
NGFT	NATURAL GAS FLOW TOTALIZER						61	TYPICAL OF TWO. ONE FOR DOMESTIC HOT WATER AND ONE FOR HEATING HOT WATER.
BCA	BMCS CRITICAL ALARM		42					LOCATED IN THE LEVEL 2 SECURITY ROOM

END OF SECTION