SEQUENCE OF OPERATION GUIDELINE

STEAM – HOT WATER HEAT EXCHANGER – DUAL

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NOTES:

1. THIS SEQUENCE IS INTENDED TO PROVIDE THE DESIGN PROFESSIONAL WITH A BASIC GUIDELINE OF MINIMUM REQUIREMENTS FOR A TYPICAL STEAM TO HOT WATER CONVERTOR SYSYEM (DUAL EXCHANGERS). THIS SEQUENCE SHALL BE CAREFULLY REVIEWED AND EDITED WITH RESPECT TO APPLICATION-SPECIFIC PROJECT REQUIREMENTS AND PROPOSED MODIFICATIONS SHALL BE REVIEWED WITH FSU STAFF.

2. THE INTENT IS FOR THIS SEQUENCE TO BE INCLUDED IN THE CONTRACT DRAWINGS.

3. THE PUMP CONTROL SEQUENCE HAS BEEN WRITTEN TO ACCOMODATE A TWO PUMP DESIGN. TWO DIFFERENT PUMP CONTROL SEQUENCES ARE SHOWN TO ACCOUNT FOR BOTH THE 100% REDUNDANT CONDITION AND THE CONDITION IN WHICH EACH PUMP IS SIZED FOR 50% OF THE TOTAL LOAD. SELECT THE APPROPRIATE SEQUENCE ACCORDING TO THE SPECIFIC APPLICATION.

4. THE HEAT EXCHANGER CONTROL SEQUENCE HAS BEEN WRITTEN TO ACCOMODATE A DUAL HEAT EXCHANGER DESIGN. TWO DIFFERENT HEAT EXCHANGER CONTROL SEQUENCES ARE SHOWN TO ACCOUNT FOR BOTH THE 100% REDUNDANT CONDITION AND THE CONDITION IN WHICH EACH EXCHANGER IS SIZED FOR 50% OF THE TOTAL LOAD. SELECT THE APPROPRIATE SEQUENCE ACCORDING TO THE SPECIFIC APPLICATION.

5. REFERENCE STANDARD CONTROL DIAGRAM IC-12.

STEAM TO HOT WATER HEAT EXCHANGER - DUAL:

PROVIDE THE FOLLOWING FOR HEAT EXCHANGER SYSTEMS.

1. APPROPRIATE TEMPERATURE, FLOW AND PRESSURE SENSORS.
2. HEAT EXCHANGER ISOLATION VALVES
3. BTU AND STEAM METERS
4. DIFFERENTIAL PRESSURE SENSORS FOR PUMP CONTROL
5. NORMALLY CLOSED- SPRING RETURN STEAM CONTROL VALVES
6. CONDENSATE CONDUCTIVITY METER
7. DOMESTIV HOT WATER MAKEUP FLOW METER
8. SYSTEM ENABLE/DISABLE SHALL BE DETERMINED BY BUILDING OCCUPANCY SCHEDULE AND AHU STATUS.

ENABLE MODE

1. THE BAS SHALL ENABLE THE HOT WATER HEAT EXCHANGER SYSTEM WHEN ANY AHU IS PROVEN ON.
2. ONCE THE SYSTEM IS ENABLED, OPEN THE LEAD/PRIMARY EXCHANGER ISOLATION VALVE, START THE HOT WATER PUMPS AND ENABLE DIFFERENTIAL PRESSURE CONTROL.
3. VERIFY PUMPS ARE RUNNING BY WAY OF PUMP STATUS AND WATER FLOW METER.
4. UPON VERIFICATION THAT PUMP(S) ARE ON AND WATER IS FLOWING THROUGH THE HEAT EXCHANGER, ENABLE THE HEAT EXCHANGER TEMPERATURE CONTROL SEQUENCE, PUMP CONTROL SEQUENCE AND PRESSURE REDUCING VALVE (PRV) CONTROL SEQUENCE. NOTE: MAINTAIN PRV CONTROL IF OTHER BUILDING SYSTEMS REQUIRE CONTINUOUS STEAM SERVICE.

PRV PRESSURE CONTROL

1. ONCE THE PRV SYSTEM IS ENABLED, BEGIN MODULATING THE 1/3 AND 2/3 PRESSURE REDUCING VALVES IN SEQUENCE TO MAINTAIN A CONSTANT STEAM PRESSURE INITIALLY SET AT 75 PSIG (ADJ).
2. THE 1/3 VALVE SHALL MODULATE FIRST LEAVING THE 2/3 VALVE CLOSED. OPEN THE 1/3 PRV AS THE PRESSURE DECREASES AND MODULATE CLOSED AS THE PRESSURE INCREASES.
3. ONCE THE 1/3 VALVE HAS REACHED 100%, BEGING MODULATING OPEN THE 2/3 PRV UNTIL THE SETPOINT HAS BEEN ACHIVEDED.

HEAT EXCHANGER TEMPERATURE CONTROL (LEAD/LAG EACH HEAT EXCHANGER SIZED AT 50%)

1. SOFTWARE LEAD/LAG FUNCTION SHALL ALLOW EITHER OF THE HEAT EXCHANGERS TO ACT AS THE LEAD EXCHANGER.
2. PROVIDE TEMPERATURE SENSORS IN THE HEATING HOT WATER SUPPLY PIPING (EACH HEAT EXCHANGER) AND OUTDOOR AIR. RESET THE HEATING HOT WATER SUPPLY TEMPERATURE FROM [180ºF] AT [30ºF] OUTDOOR AIR TEMPERATURE TO [140ºF] HEATING HOT WATER SUPPLY TEMPERATURE AT [90ºF] OUTDOOR AIR TEMPERATURE. ALL SETPOINTS SHALL BE ADJUSTABLE. LIMIT RESET FREQUENCY TO NO MORE THAN ONCE EVERY 15 MINUTES (ADJ)
3. ONCE THE TEMPERATURE SETPOINT HAS BEEN ESTABLISHED BEGIN MODULATING THE LEAD EXCHANGER STEAM CONTROL VALVES AS FOLLOWS: MODULATE THE 1/3 STEAM CONTROL VALVE TO MAINTAIN HOT WATER SUPPLY SETPOINT. OPEN THE 1/3 VALVE AS THE TEMPERATURE DECREASES AND MODULATE CLOSED AS THE TEMPERATURE INCREASES.
4. ONCE THE 1/3 VALVE HAS REACHED 100%, AND REMAINS THERE FOR AT LEAST 5 MINUTES, ENABLE THE 2/3 VALVE. ONCE THE 2/3 VALVE HAS BEEN ENABLED, REVERT PRIMARY CONTROL OVER TO THE 2/3 VALVE AND CLOSE THE 1/3 VALVE.
5. ONCE THE 2/3 VALVE HAS REACHED 100%, BEGIN MODULATING THE 1/3 VALVE OPEN TO MAINTAIN SUPPLY WATER TEMPERATURE SETPOINT.
6. REVERSE THE SEQUENCE AS THE DEMAND DECREASES. RE-ESTABLISH PRIMARY CONTROL OF THE 1/3 VALVE, ONCE THE 2/3 VALVE COMMAND HAS REACHED 15% (ADJ) OR LESS FOR MORE THAN 5 MINUTES (ADJ).

7. IN THE EVENT THE LEAD HEAT EXCHANGER HAS REACHED ITS MAXIMUM CAPACITY (AS INDICATED BY A 100% COMMAND TO BOTH THE 1/3 AND 2/3 VALVES) FOR MORE THAN 15 MINUTES (ADJ), ENABLE THE LAG HEAT EXCHANGER.
8. ONCE ENABLED, THE LAG HEAT EXCHANGER ISOLATION VALVE SHALL OPEN.
9. THE LAG SUPPLY SETPOINT SHALL MATCH THE LEAD HEAT EXCHANGER SETPOINT. TEMPERATURE CONTROL SHALL BE AS DESCRIBED ABOVE.
10. DISABLE THE LAG HEAT EXCHANGER WHEN BOTH THE LEAD AND LAG HEAT EXCHANGER 1/3 VALVE IS COMMANDED TO LESS THAN 50% AND THE 2/3 VALVES ARE 0% FOR MORE THAN 15 MINUTES (ADJ).
11. CLOSE THE LAG HEAT EXCHANGER ISOLATION VALVE AND CLOSE THE LAG STEAM CONTROL VALVES.
12. LEAD HEAT EXCHANGER DESIGNATION SHALL BE ROTATED WEEKLY (ADJ) IN ACCORDANCE WITH THE BAS SCHEDULE.

HEAT EXCHANGER TEMPERATURE CONTROL (PRIMARY/STANDBY EACH HEAT EXCHANGER SIZED AT 100%)

1. SOFTWARE PRIMARY/STANDBY FUNCTION SHALL ALLOW EITHER OF THE HEAT EXCHANGERS TO ACT AS THE PRIMARY EXCHANGER.
2. PROVIDE TEMPERATURE SENSORS IN THE HEATING HOT WATER SUPPLY PIPING (EACH HEAT EXCHANGER) AND OUTDOOR AIR. RESET THE HEATING HOT WATER SUPPLY TEMPERATURE FROM [180ºF] AT [30ºF] OUTDOOR AIR TEMPERATURE TO [140ºF] HEATING HOT WATER SUPPLY TEMPERATURE AT [90ºF] OUTDOOR AIR TEMPERATURE. ALL SETPOINTS SHALL BE ADJUSTABLE. LIMIT RESET FREQUENCY TO NO MORE THAN ONCE EVERY 15 MINUTES (ADJ)
3. ONCE THE TEMPERATURE SETPOINT HAS BEEN ESTABLISHED BEGIN MODULATING THE PRIMARY EXCHANGER STEAM CONTROL VALVES AS FOLLOWS: MODULATE THE 1/3 STEAM CONTROL VALVE TO MAINTAIN HOT WATER SUPPLY SETPOINT. OPEN THE 1/3 VALVE AS THE TEMPERATURE DECREASES AND MODULATE CLOSED AS THE TEMPERATURE INCREASES.
4. ONCE THE 1/3 VALVE HAS REACHED 100%, AND REMAINS THERE FOR AT LEAST 5 MINUTES, ENABLE THE 2/3 VALVE. ONCE THE 2/3 VALVE HAS BEEN ENABLED, REVERT PRIMARY CONTROL OVER TO THE 2/3 VALVE AND CLOSE THE 1/3 VALVE.
5. ONCE THE 2/3 VALVE HAS REACHED 100%, BEGIN MODULATING THE 1/3 VALVE OPEN TO MAINTAIN SUPPLY WATER TEMPERATURE SETPOINT.
6. REVERSE THE SEQUENCE AS THE DEMAND DECREASES. RE-ESTABLISH PRIMARY CONTROL OF THE 1/3 VALVE, ONCE THE 2/3 VALVE COMMAND HAS REACHED 15% (ADJ) OR LESS FOR MORE THAN 5 MINUTES (ADJ).
7. CLOSE THE LAG HEAT EXCHANGER ISOLATION VALVE AND CLOSE THE LAG STEAM CONTROL VALVES.
8. THE BAS SHALL CONTINUE MONITORING THE SUPPLY WATER TEMPERATURE AND SETPOINT AT THE PRIMARY HEAT EXCHANGER. IN THE EVENT THE SUPPLY WATER TEMPERATURE DIFFERS FROM THE SUPPLY SETPOINT BY MORE THAN 10 DEGF (ADJ) FOR MORE THAN 5 MINUTES (ADJ), ALARM THE PRIMARY HEAT EXCHANGER AND CLOSE THE PRIMARY STEAM CONTROL VALVES. OPEN THE STANDBY EXCHANGER ISOLATION VALVE AND RE-ESTABLISH TEMPERATURE CONTROL USING THE STANDBY HEAT EXCHANGER STEAM CONTROL VALVES.
9. THE BAS SHALL LOCKOUT THE PRIMARY HEAT EXCHANGER UNTIL A MANUAL RESET IS INITIATED BY AN OPERATOR.

10. PRIMARY HEAT EXCHANGER DESIGNATION SHALL BE ROTATED WEEKLY (ADJ) IN ACCORDANCE WITH THE BAS SCHEDULE.

PUMP CONTROL (LEAD/LAG EACH PUMP SIZED AT 50%)

1. ONCE ENABLED THE PUMP SPEED SHALL BE MODULATED TO MAINTAIN THE CALCULATED DIFFERENTIAL SETPOINT.
2. SOFTWARE LEAD/LAG FUNCTION SHALL ALLOW EITHER OF THE HOT WATER PUMPS TO ACT AS THE LEAD PUMP.
3. DIFFERENTIAL PRESSURE CONTROL. THE OBJECTIVE IS TO ALWAYS HAVE ONE HEATING CONTROL VALVE 80% OPEN SO THE PUMPS OPERATE AT THE LOWEST SPEED AND PRESSURE POSSIBLE TO SATISFY THE CURRENT LOAD. EVERY 5 MINUTES THE HEATING VALVES SHALL BE POLLED. WHEN THE MOST OPEN HEATING VALVE IS MORE THAN 80% OPEN, THE BAS SHALL RESET THE DIFFERENTIAL PRESSURE SETPOINT UP BY .50 PSID (ADJ). WHEN ALL HEATING CONTROL VALVES ARE 60% (ADJ) OR BELOW, THE BAS SHALL RESET THE DIFFERENTIAL PRESSURE SETPOINT DOWN BY .25 PSID.
4. THE REMOTE DP SETPOINT SHALL BE MAINTAINED BETWEEN MAXIMUM AND MINIMUM PRESSURES. THE MAXIMUM PRESSURE LIMIT IS THE PRESSURE REQUIRED TO PROVIDE FULL FLOW TO ALL HEATING CONTROL VALVES SIMULTANEOUSLY (PER TAB). THE MINIMUM PRESSURE LIMIT IS THE PRESSURE CORRELATING TO THE LOWEST SPEED THE PUMP MOTOR IS ALLOWED TO BE OPERATED AT (PER MOTOR MANUF. AND TAB). MAXIMUM PRESSURE LIMIT:_____PSI. MININUM PRESSURE LIMIT:_____PSI. THE VFD INTERNAL SETTINGS WILL ALLOW THE VFD TO RUN THE PUMPS TO THEIR MINIMUMS.
5. WHEN TWO REMOTE DIFFERENTIAL PRESSURE SENSORS ARE USED, CONTROL TO THE SENSOR THAT IS FARTHEST FROM SETPOINT.
6. PUMP STAGING: WITH ONE PUMP RUNNING, WHEN THE PUMP COMMAND REACHES 100% AND THE DIFFERENTIAL PRESSURE DROPS MORE THAN 2 PSI BELOW THE SETPOINT FOR 10 MINUTES (ALL ADJUSTABLE), START THE LAG PUMP. BOTH PUMPS SHALL CONVERGE AND RUN IN PARALLEL TO MAINTAIN THE DIFFERENTIAL PRESSURE SETPOINT AND THE REMOTE DP SETPOINTS.
7. DURING REDUCING LOAD AS THE DP INCREASES: WHEN THE TWO PUMPS DROP BELOW 20% FOR 10 MINUTES (ADJUSTABLE), THE LAG PUMP SHUTS OFF AND THE LEAD PUMP RESUMES CONTROL.
1. ALARM ON PUMP FAILURE DETECTED VIA CURRENT SENSING SWITCH. UPON FAILURE OF THE LEAD PUMP, THE LAG PUMP SHALL START AUTOMATICALLY. THE BAS SHALL MAINTAIN A START COMMAND AT THE LEAD PUMP AND RESUME CONTROL WITH THE LEAD PUMP UPON CONFIRMATION THAT THE LEAD PUMP HAS RETURNED TO NORMAL OPERATION. THE LAG PUMP SHALL BE DISABLED IF THE LOAD ONLY REQUIRES A SINGLE PUMP TO RUN..
8. LEAD PUMP DESIGNATION SHALL BE ROTATED WEEKLY (ADJ) IN ACCORDANCE WITH THE BAS SCHEDULE.

PUMP CONTROL (PRIMARY/STANDBY EACH PUMP SIZED AT 100%)

2. ONCE ENALBLED THE PUMP SPEED SHALL BE MODULATED TO MAINTAIN THE CALCULATED DIFFERENTIAL SETPOINT.

3. SOFTWARE PRIMARY/STANDBY FUNCTION SHALL ALLOW EITHER OF THE HOT WATER PUMPS TO ACT AS THE PRIMARY PUMP.
4. DIFFERENTIAL PRESSURE CONTROL. THE OBJECTIVE IS TO ALWAYS HAVE ONE HEATING CONTROL VALVE 80% OPEN SO THE PUMP OPERATES AT THE LOWEST SPEED AND PRESSURE POSSIBLE TO SATISFY THE CURRENT LOAD. EVERY 5 MINUTES THE HEATING VALVES SHALL BE POLLED. WHEN THE MOST OPEN HEATING VALVE IS MORE THAN 80% OPEN, THE BAS SHALL RESET THE DIFFERENTIAL PRESSURE SETPOINT UP BY .50 PSID (ADJ). WHEN ALL HEATING CONTROL VALVES ARE 60% (ADJ) OR BELOW, THE BAS SHALL RESET THE DIFFERENTIAL PRESSURE SETPOINT DOWN BY .25 PSID.
5. THE REMOTE DP SETPOINT SHALL BE MAINTAINED BETWEEN MAXIMUM AND MINIMUM PRESSURES. THE MAXIMUM PRESSURE LIMIT IS THE PRESSURE REQUIRED TO PROVIDE FULL FLOW TO ALL HEATING CONTROL VALVES SIMULTANEOUSLY (PER TAB). THE MINIMUM PRESSURE LIMIT IS THE PRESSURE CORRELATING TO THE LOWEST SPEED THE PUMP MOTOR IS ALLOWED TO BE OPERATED AT (PER MOTOR MANUF. AND TAB). MAXIMUM PRESSURE LIMIT:_____PSI. MININUM PRESSURE LIMIT:_____PSI. THE VFD INTERNAL SETTINGS WILL ALLOW THE VFD TO RUN THE PUMP TO ITS MINIMUM.
6. WHEN TWO REMOTE DIFFERENTIAL PRESSURE SENSORS ARE USED, CONTROL TO THE SENSOR THAT IS FARTHEST FROM SETPOINT.
7. ALARM ON PRIMARY PUMP FAILURE DETECTED VIA CURRENT SENSING SWITCH. UPON FAILURE OF THE PRIMARY PUMP, THE STANDBY PUMP SHALL START AUTOMATICALLY. THE BAS SHALL MAINTAIN A START COMMAND AT THE PRIMARY PUMP AND RESUME CONTROL WITH THE PRIMARY PUMP UPON CONFIRMATION THAT THE LEAD PUMP HAS RETURNED TO NORMAL OPERATION. THE STANDBY PUMP SHALL BE DISABLED ONCE THE PRIMARY PUMP RESTARTS.
8. LEAD PUMP DESIGNATION SHALL BE ROTATED WEEKLY (ADJ) IN ACCORDANCE WITH THE BAS SCHEDULE.

HOT WATER HEAT EXCHANGER - DUAL TYPE: IC-12			POINT TYPE		ALARM CONDITION			INTEGRATED POINT	NOTES
SHORT NAME	POINT DESCRIPTION	UNITS	ANALOG	DIGITAL	EQUIP ALARM	HIGH LIMIT	LOW LIMIT		
bbb_HWP1_SS	HOT WATER PUMP-1 START/STOP	ON/OFF		X	X				
bbb_HWP1_S	HOT WATER PUMP-1 STATUS	ON/OFF		X	X				
bbb_HWP1_VFD	HOT WATER PUMP-1 VFD	%	X						
bbb_HWP2_SS	HOT WATER PUMP-2 START/STOP	ON/OFF		X	X				
bbb_HWP2_S	HOT WATER PUMP-2 STATUS	ON/OFF		X	X				
bbb_HWP2_VFD	HOT WATER PUMP-2 VFD	%	X						
bbb_MAIN_STM_T	CAMPUS STEAM TEMPERATURE	DEG F	X			X	X		
bbb_MAIN_STM_P	CAMPUS STEAM PRESSURE	PSI	X			X	X		
bbb_MAIN_STM_FLW	CAMPUS STEAM FLOW	GPM	X			X	X		
bbb_BLDG_DP1	BUILDING HOT WATER DIFFERENTIAL PRESSURE-1	PSID	X						
bbb_BLDG_DP2	BUILDING HOT WATER DIFFERENTIAL PRESSURE-2	PSID	X						
bbb_PRV_1/3_VLV	STEAM 1/3 PRV VALVE	%OPEN	X						
bbb_PRV_1/3_VLV_FBK	STEAM 1/3 PRV VALVE FEEDBACK	%OPEN	X						
bbb_PRV_2/3_VLV	STEAM 2/3 PRV VALVE	%OPEN	X						
bbb_PRV_2/3_VLV_FBK	STEAM 2/3 PRV VALVE FEEDBACK	%OPEN	X						
bbb_PRV_STM_P	STEAM PRESSURE AFTER PRV	PSI	X			X	X		
bbb_HX1_1/3_VLV	1/3 HX1 VALVE	%OPEN	X						
bbb_HX1_1/3_VLV_FBK	1/3 HX1 VALVE FEEDBACK	%OPEN	X						
bbb_HX1_2/3_VLV	2/3 HX1 VALVE	%OPEN	X						
bbb_HX1_2/3_VLV_FBK	2/3 HX1 VALVE FEEDBACK	%OPEN	X						
bbb_HX1_HWS	HX1 HOT WATER SUPPLY TEMPERATURE	DEG F	X						
bbb_HX2_1/3_VLV	1/3 HX2 VALVE	%OPEN	X						
bbb_HX2_1/3_VLV_FBK	1/3 HX2 VALVE FEEDBACK	%OPEN	X						
bbb_HX2_2/3_VLV	2/3 HX2 VALVE	%OPEN	X						
bbb_HX2_2/3_VLV_FBK	2/3 HX2 VALVE FEEDBACK	%OPEN	X						
bbb_HX2_HWS	HX2 HOT WATER SUPPLY TEMPERATURE	DEG F	X						
bbb_COND_T	CONDENSATE TEMPERATURE FROM HX	DEG F	X			X			
bbb_COND_P1	CONDENSATE PUMP-1 CURRENT	%	X						
bbb_COND_P2	CONDENSATE PUMP-2 CURRENT	%	X						
bbb_COND_R	CONDENSATE RETURN TEMPERATURE	DEG F	X			X			
bbb_COND_A	CONDENSATE HIGH LEVEL ALARM	NML/ALM		X	X				
bbb_COND_CM	CONDENSATE CONDUCTIVITY LEVEL	PPM	X			X	X		
bbb_MUW_FLW	MAKE UP WATER FLOW	GPM	X						
bbb_MUW_P	MAKE UP WATER PRESSURE	PSI	X						
bbb_HWP1_HZ	HOT WATER PUMP-1 VFD HERTZ	HZ	X					X	
bbb_HWP1_KW	HOT WATER PUMP-1VFD KW DEMAND	KW	X					X	
bbb_HWP1_A	HOT WATER PUMP-1 VFD ALARM	KW		X	X			X	
bbb_HWP2_HZ	HOT WATER PUMP-2 VFD HERTZ	HZ	X					X	
bbb_HWP2_KW	HOT WATER PUMP-2VFD KW DEMAND	KW	X					X	
bbb_HWP2_A	HOT WATER PUMP-2 VFD ALARM	KW		X	X			X	
bbb_BLDG_HWS	BUILDING HOT WATER SUPPLY	DEG F	X					X	
bbb_BLDG_HWR	BUILDING HOT WATER RETURN	DEG F	X					X	
bbb_BLDG_FLW	BUILDING HOT WATER FLOW	GPM	X			X	X	X	
bbb_MER_T	MER SPACE TEMPERATURE	DEG F	X			X	X		
bbb_MER_RH	MER SPACE HUMIDITY SENSOR	%RH	X			X	X		
bbb_MER_DC	MER DOOR CONTACT STATUS	OPN/CLO		X					