

SEQUENCE OF OPERATION - CHILLED WATER SYSTEM

SYSTEM GENERAL DESCRIPTION:
THE CHILLED WATER CONTROL SYSTEM SHALL MONITOR AND CONTROL THE SYSTEM'S CHILLERS, PUMPS, AND CONTROL VALVES AS SHOWN ON THE CHILLED WATER SYSTEM P&ID. IN THE CHILLED WATER SYSTEM POINTS LIST AND AS DETAILED IN THE SEQUENCE OF OPERATION LISTED BELOW.

THE CHILLED WATER SYSTEM IS A PRIMARY VARIABLE FLOW DESIGN AND CONSISTS OF THREE AIR-COOLED CHILLERS (N+1) IN PARALLEL CONFIGURATION AND THREE MANIFOLDED VARIABLE SPEED CHILLED WATER PUMPS (N+1) IN PARALLEL, SUPPLYING CHILLED WATER TO THE FACILITY.

THE BUILDING AUTOMATION SYSTEM (BAS) SHALL PROVIDE A REMOTE ENABLE SIGNAL; REMOTE SETPOINT ADJUSTMENTS; AND VISIBILITY OF THE LOCAL FACTORY CHILLER CONTROL OPERATION AT THE OPERATOR'S WORKSTATION AS DEFINED IN THE CHILLED WATER SYSTEM POINTS LIST. THE COMMUNICATION PROTOCOL SHALL BE COORDINATED WITH THE PROVIDED CHILLER. REFERENCE THE POINTS LIST AND CONTROL LOOPS SECTION OF THIS SEQUENCE. THE SCOPE OF WORK SHALL BE COORDINATED BETWEEN THE CONTRACTOR AND EQUIPMENT MANUFACTURER FOR VALVES, SENSORS, AND EQUIPMENT.

THE FACTORY CHILLER CONTROL PANEL SHALL BE RESPONSIBLE FOR CONTROLLING THE CHILLER SUBJECT TO THE ASSOCIATED EQUIPMENT RELATED SAFETIES AND INTERLOCKS TO MAINTAIN THE CHILLER LEAVING WATER TEMPERATURE SETPOINT.

CHILLED WATER SYSTEM ENABLE/DISABLE:
THE CHILLED WATER SYSTEM SHALL BE ENABLED/DISABLED BY THE SYSTEM CONTROLLER AS REQUESTED BY THE BUILDING AUTOMATION SYSTEM (BAS) OPERATOR INTERFACE PANEL OR THE BAS TIME OF DAY SCHEDULE. THE CHILLED WATER CONTROL SYSTEM WILL START AND STOP THE CHILLED WATER PUMPS AND CHILLERS BASED UPON SYSTEM LOAD.

SYSTEM SHALL BE ENABLED WHEN THERE IS A CALL FOR CHILLED WATER AMONG ACTIVE COOLING COIL VALVES. ALL COOLING COIL VALVES SHALL BE INCLUDED IN THE ANALYSIS.

A CALL FOR COOLING IS GENERATED BY THE BAS WHEN ANY ONE ACTIVE COOLING COIL VALVE IS COMMANDED AT LEAST 15% (ADJ.) OPEN FOR GREATER THAN 10 (ADJ.) MINUTES OR ANY ONE COOLING COIL VALVE IS AT LEAST 80% (ADJ.) OPEN FOR 10 (ADJ.) MINUTES.

WHEN THE COOLING SYSTEM IS ENABLED THE SYSTEM SHALL SEND AN ENABLE SIGNAL TO THE LEAD CHILLER. UPON RECEIVING THE ENABLE SIGNAL THE CHILLER SHALL SEND A CHILLED WATER PUMP REQUEST SIGNAL TO THE CONTROL SYSTEM TO ENABLE THE CHILLED WATER PUMPING SEQUENCE. THE SYSTEM SHALL RESPOND TO A CHILLED WATER PUMP REQUEST FROM ANY SYSTEM CHILLER. THE SYSTEM SHALL COMMAND THE ASSOCIATED CHILLER'S CHILLED WATER ISOLATION VALVE OPEN AND ENABLE THE LEAD CHILLED WATER PUMP TO START. AS ADDITIONAL CHILLERS MAKE CHILLED WATER PUMP REQUESTS, OPEN THE ASSOCIATED CHILLED WATER ISOLATION VALVE AND ENABLE THE NEXT CHILLED WATER LAG PUMP TO START IF REQUIRED.

THE CHILLED WATER SYSTEM IS DISABLED WHEN ALL CHILLERS ARE DISABLED AND THERE IS NOT AN ACTIVE CHILLED WATER PUMP REQUEST. WHEN THE SYSTEM IS DISABLED, THE CHILLED WATER PUMPS SHALL BE COMMANDED OFF AND THE CHILLER ISOLATION VALVES SHALL BE CLOSED, OR WHEN THE OPERATOR HAS MANUALLY DISABLED THE CHILLED WATER SYSTEM AT THE OPERATOR'S WORKSTATION.

CHILLER CONTROL:
THE CHILLERS SHALL BE CONTROLLED VIA THEIR OWN INTERNAL CONTROLS TO MAINTAIN A CHILLED WATER SUPPLY TEMPERATURE OF 38°F (ADJ.). EACH CHILLER WILL BE STAGED ON AND OFF IN ORDER TO MEET THE CHILLER LOAD AS MEASURED BY THE PERCENT OF FULL LOAD AMPS.

CHILLER STAGING:
CHILLERS WILL OPERATE IN A LEAD/LAG SEQUENCE, SO THAT THE LAST CHILLER ENABLED IS THE FIRST TO BE DISABLED.

THE CHILLED WATER SYSTEM SHALL INITIATE THE START OF THE NEXT CHILLER IN THE SEQUENCE WHENEVER:
1. ADDING THE NEXT CHILLER IN THE SEQUENCE WILL RESULT IN LOWER TOTAL POWER, AS DETERMINED BY CHILLER CHARACTERISTICS, SYSTEM LOAD, AND OPERATING CONDITIONS, AND THIS CONDITION IS SATISFIED FOR 20 MINUTES (ADJ.), OR
2. THE CHILLED WATER LOAD, AS DETERMINED BY THE SYSTEM SUPPLY WATER TEMPERATURE, IS NOT MET FOR 20 MINUTES (ADJ.)

THE CHILLED WATER SYSTEM SHALL INITIATE THE SHUTDOWN OF THE NEXT CHILLER IN THE SEQUENCE WHENEVER:
1. EXCESS CHILLED WATER CAPACITY EXISTS, AS DETERMINED BY A REAL TIME LOAD CALCULATION, AND
2. THE SHUTDOWN OF THE NEXT CHILLER IN THE SEQUENCE WILL RESULT IN LOWER TOTAL POWER, AS DETERMINED BY CHILLER CHARACTERISTICS, PLANT LOAD, AND OPERATING CONDITIONS, HAVE BEEN SATISFIED FOR 20 MINUTES (ADJ.)

CHILLER LEAD/LAG SEQUENCE ORDER WILL BE BASED ON A ROUND ROBIN LOGIC. (ROUND ROBIN LOGIC EXAMPLE: 1-2-3, THEN 2-3-1, THEN 3-1-2, THEN 1-2-3, ETC.)

THE CHILLER SEQUENCE ORDER CAN BE ROTATED ON A SCHEDULE. CHILLER ROTATIONS WILL BE PROGRAMMED TO OCCUR AT ONE OF THE FOLLOWING OPERATOR-DEFINED INTERVALS:

- NEVER: CHILLERS WILL ALWAYS HAVE THE SAME SEQUENCE NUMBER.
- DAY OF WEEK: CHILLERS WILL ROTATE ON A USER-SPECIFIED DAY AND TIME ONCE PER WEEK.
- FIXED NUMBER OF DAYS: CHILLERS WILL ROTATE AFTER THE NUMBER OF DAYS SPECIFIED HAS ELAPSED.
- RUN HOURS: CHILLERS ROTATE TO ATTEMPT TO EVEN OUT THE AMOUNT OF TIME EACH CHILLER RUNS. WHEN ANY CHILLER REACHES THE USER-DEFINED RUN HOURS SETPOINT (WHICH IS MEASURED ONLY FROM THE LAST ROTATION), THE SYSTEM CONTROLLER CAN RE-SEQUENCE THE CHILLERS. IF NECESSARY, TO PUT THE CHILLER WITH THE LEAST TOTAL RUN HOURS INTO A HIGHER-USE POSITION IN THE SEQUENCE.
- ROTATIONAL INPUT: CHILLERS WILL ROTATE WHEN THE SPECIFIED REFERENCE COMMANDS THEM TO ROTATE. FROM THE BAS OPERATOR INTERFACE, AN OPERATOR SHALL BE ABLE TO MANUALLY CHANGE THE LEAD/LAG SEQUENCE OR REQUEST ANY CHILLER TO BE UNAVAILABLE WHICH WOULD REMOVE IT FROM THE ROTATION SEQUENCE.

CHILLER ISOLATION VALVES:
CHILLER ISOLATION VALVES SHALL PREVENT THE FLOW OF FLUID THROUGH NON-OPERATING CHILLERS. WHEN THE SYSTEM RECEIVES A CHILLER WATER PUMP REQUEST FROM A CHILLER, THE CHILLER ISOLATION VALVE WILL BE CONTROLLED TO 100% OPEN. CHILLER ISOLATION VALVE STROKE TIME SHALL BE (60-120) SECONDS (ADJ.) TO REDUCE OPERATING CHILLER FLOW TRANSIENTS. WHEN THE VALVE IS CONFIRMED TO BE 100% OPEN THE SYSTEM WILL START THE RESPECTIVE CHILLED WATER PUMP. IF THE CHILLER'S ISOLATION VALVE IS NOT CONFIRMED OPEN AFTER (VALVE STROKE TIME PLUS 60 SEC) 180 SECONDS (ADJ.), THE SYSTEM SHALL ANNUNCIATE A CHILLER ISOLATION VALVE FAILURE ALARM TO THE BAS OPERATOR INTERFACE.

CHILLED WATER PUMP COMMANDS:
WHEN THE COOLING PLANT SYSTEM IS ENABLED, THE SYSTEM SHALL RESPOND TO A CHILLED WATER PUMP REQUEST FROM A CHILLER. THE SYSTEM SHALL START A CHILLED WATER PUMP THROUGH A CONTACT CLOSURE OF THE PUMPS VARIABLE SPEED DRIVE RUN-ENABLE CONTACTS. THE SYSTEM SHALL DETECT THE CHILLED WATER PUMP RUN STATUS BY A VARIABLE SPEED DRIVE CURRENT SWITCH. THE MANIFOLDED CHILLED WATER PUMPS WILL OPERATE IN A LEAD/LAG SEQUENCE THAT SHALL BE ROTATED ON A WEEKLY SCHEDULE. THE ROTATION SEQUENCE SHALL BE BASED ON CALCULATED RUN TIME WITH THE PUMP HAVING THE LEAST RUN TIME DESIGNATED AS LEAD. THE PUMP WITH THE NEXT LOWEST RUN TIME WILL BE THE SECOND IN THE SEQUENCE (OR LAG PUMP) AND SO ON. FROM THE BAS OPERATOR INTERFACE, AN OPERATOR SHALL BE ABLE TO MANUALLY CHANGE THE LEAD/LAG SEQUENCE OR REQUEST ANY PUMP TO BE UNAVAILABLE WHICH WOULD REMOVE IT FROM THE ROTATION SEQUENCE.

IF THE CHILLED WATER SYSTEM DIFFERENTIAL PRESSURE FALLS 0.5 PSIG (ADJ.) BELOW SETPOINT AND THE LEAD PUMP IS AT 100% (ADJ.) FOR MORE THAN 5 MINUTES (ADJ.), THE NEXT PUMP IN THE SEQUENCE SHALL START. IF THE PUMP SPEED CONTROL OUTPUT IS BELOW 65% (ADJ.) FOR MORE THAN 5 MINUTES (ADJ.), THE LAST OPERATING PUMP IN THE SEQUENCE SHALL BE DISABLED.

WHEN THE CHILLER IS COMMANDED OFF, THE PUMP WILL CONTINUE TO RUN FOR A SHORT TIME TO ALLOW THE EQUIPMENT TO COAST DOWN.

CHILLED WATER PUMP SPEED:
THE SYSTEM SHALL MONITOR THE CHILLED WATER SYSTEM DIFFERENTIAL PRESSURE SENSOR. WHEN THE PUMP VARIABLE SPEED DRIVE IS ENABLED, THE SYSTEM SHALL CONTROL THE ANALOG SPEED SIGNAL THAT IS SENT TO THE PUMP VARIABLE SPEED DRIVE TO MAINTAIN THE CHILLED WATER DIFFERENTIAL PRESSURE TO ITS SETPOINT OF 15 PSIG (ADJ.).

CHILLED WATER PUMP FAILURE:
IF THE LEAD START/STOP RELAY IS ENABLED AND THE PUMP'S RUNNING STATUS IS OFF FOR MORE THAN 30 SECONDS (ADJ.), THE SYSTEM SHALL ANNUNCIATE A CHILLED WATER PUMP FAILURE ALARM TO THE BAS AND START THE NEXT PUMP IN THE SEQUENCE. ONCE THE PROBLEM HAS BEEN CORRECTED, THE OPERATOR SHALL BE ABLE TO CLEAR THE ALARM FAILURE FROM THE BAS OPERATOR INTERFACE OR BY MANUALLY OVERRIDING THE PUMP ON. THIS SHALL RE-ENABLE THE LEAD/STANDBY SEQUENCE.

CHILLED WATER MINIMUM FLOW BYPASS VALVE:
THE SYSTEM SHALL MONITOR THE EVAPORATOR DIFFERENTIAL PRESSURE OF THE CHILLER. WHEN THE PRESSURE OF THE OPERATING CHILLER INDICATES A LOW PRESSURE (FLOW), THE SYSTEM SHALL CONTROL THE ANALOG SIGNAL THAT IS SENT TO THE CHILLED WATER BYPASS VALVE TO MAINTAIN THE MINIMUM PRESSURE (FLOW) FOR ALL OPERATING CHILLERS.

CHILLED WATER PUMP DIFFERENTIAL PRESSURE RESET:
THE PRIMARY CHILLED WATER DIFFERENTIAL PRESSURE SETPOINT SHALL BE RESET USING VALVE COMMAND POSITION WITHIN THE RANGE LIMITS 12-18 PSIG (ADJ.) VIA TRIM AND RESPOND LOGIC. THE TRIM AND RESPOND FUNCTION SHALL RESET THE SETPOINT INCREMENTALLY DOWNWARD TO MAINTAIN ONE ACTIVE CONTROL VALVE OUTPUT SIGNAL GREATER THAN 90% OPEN.

TRIM AND RESPOND LOGIC: WHEN PUMP IS OFF, RESET SETPOINT TO THE DEFAULT VALUE. WHILE THE PUMP IS ON: IF ALL CONTROL VALVES INCLUDED IN THE ANALYSIS ARE LESS THAN 90% OPEN (ADJ.), EVERY 2 MINUTES (ADJ.) DECREASE SETPOINT BY 0.5 PSIG (ADJ.). REPEAT TRIM AND RESPOND LOGIC UNTIL AT LEAST ONE (ADJ.) CONTROL VALVE IS GREATER THAN 90% OPEN. IF AT LEAST ONE CONTROL VALVE IS GREATER THAN 90% OPEN (ADJ.), EVERY 2 MINUTES (ADJ.) INCREASE SETPOINT BY 0.5 PSIG.

CHILLED WATER PLANT TEMPERATURE RESET:
THE PRIMARY CHILLED WATER SUPPLY TEMPERATURE SHALL BE RESET WITHIN THE TEMPERATURE RANGE LIMITS 38° F- 42° F (ADJ.) USING TRIM AND RESPOND LOGIC. THE TRIM AND RESPOND FUNCTION SHALL RESET THE SETPOINT INCREMENTALLY UPWARD TO MAINTAIN ONE CONTROL VALVE SERVING AN AIR HANDLING UNIT GREATER THAN 90% OPEN. BAS SHALL BE CAPABLE OF EXCLUDING ZONE VALVES FROM THE TEMPERATURE RESET ANALYSIS SUBJECT TO A FEEDBACK SIGNAL ENABLE/DISABLE SWITCH.

TRIM AND RESPOND LOGIC: WHEN PUMP IS OFF, RESET SETPOINT TO THE DEFAULT VALUE. WHILE PUMP IS ON IF ALL CONTROL VALVES INCLUDED IN THE ANALYSIS ARE LESS THAN 90% OPEN (ADJ.), EVERY 2 MINUTES (ADJ.) INCREASE SETPOINT BY 0.5° F (ADJ.). REPEAT TRIM AND RESPOND LOGIC UNTIL AT LEAST ONE (ADJ.) CONTROL VALVE IS GREATER THAN 90% OPEN. IF AT LEAST ONE CONTROL VALVE IS GREATER THAN 90% OPEN (ADJ.), EVERY 2 MINUTES (ADJ.) DECREASE SETPOINT BY 0.5° F (ADJ.).

WHEN USING BOTH A PRESSURE RESET AND TEMPERATURE RESET AND THE PRESSURE RESET IS PROGRAMMED TO BE ENABLED FIRST, THE TEMPERATURE RESET SEQUENCE SHALL NOT BE ENABLED UNTIL THE PRIMARY CHILLED WATER DIFFERENTIAL PRESSURE SETPOINT HAS REACHED ITS MINIMUM RESET VALUE FOR 10 MINUTES (ADJ.) AND ALL ACTIVE CONTROL VALVE INCLUDED IN THE RESET ANALYSIS ARE LESS THAN 90% OPEN.

WHILE THE TEMPERATURE RESET SEQUENCE IS ENABLED, THE PRIMARY CHILLED WATER DIFFERENTIAL PRESSURE SETPOINT SHALL BE HELD CONSTANT AT ITS MINIMUM RESET VALUE. THE RESET SEQUENCE SHALL BE DISABLED WHEN THE PRIMARY CHILLED WATER SUPPLY TEMPERATURE HAS REACHED ITS MINIMUM RESET VALUES FOR 10 MINUTES (ADJ.) AND WHEN ANY 3 (ADJ.) ACTIVE COOLING VALVES INCLUDED IN THE RESET ANALYSIS ARE GREATER THAN 90% OPEN.

AIR-COOLED CHILLER FREEZE PROTECTION:
IF REQUIRED BY THE CHILLER MANUFACTURER, THE CHILLER PLANT CONTROL SYSTEM SHALL MONITOR EACH CHILLER'S CALL FOR CHILLED WATER PUMP OPERATION AND UPON SUCH A CALL FOR FLOW SHALL OPEN THE CHILLER EVAPORATOR ISOLATION VALVE AND START A SYSTEM PUMP TO PROVIDE FOR FREEZE PROTECTIVE WATER FLOW TO THE CHILLER.

AIR COOLED CHILLER STAGING SEQUENCE				
% TOTAL LOAD (580T)	CHILLER PARTIAL LOAD	CHILLER 1	CHILLER 2	CHILLER 3
0 - 52% (0-300)	0 - 100% (0 - 1x300T)	ON	OFF	OFF
52 - 100% (300-580T)	50 - 96% (2x150T - 2x290T)	ON	ON	OFF

- NOTES:
- THE STAGING SEQUENCE IS BASED ON THE BOD CHILLER (NOM. 410T, ACTUAL 301T AT 100%).
 - CHILLER CAPACITY AND PARTIAL LOAD SHALL BE CONFIRMED WITH MANUFACTURER.
 - UTILIZE CHILLER ROTATION IN ORDER TO EQUALIZE RUN HOURS.

CONTROL POINTS LIST - CHILLED WATER SYSTEM											
SYSTEM POINT DESCRIPTION	POINTS								ALARMS		
	GRAPHIC	ANALOG HARDWARE INPUT (AI)	BINARY HARDWARE INPUT (BI)	ANALOG HARDWARE OUTPUT (AO)	BINARY HARDWARE OUTPUT (BO)	SOFTWARE POINT (SFT)	HARDWARE INTERLOCK (HDI)	WIRELESS (WLS)	NETWORK (NET)	LOW ANALOG LIMIT	HIGH ANALOG LIMIT
CHILLED WATER FLOW METER	X	X								X	X
CHILLED WATER BYPASS VALVE OUTPUT	X			X							
CHILLED WATER PUMP (X) START STOP	X				X						
CHILLED WATER PUMP (X) STATUS	X		X								
CHILLED WATER PUMP (X) SPEED	X			X							
CHILLED WATER RETURN TEMPERATURE	X	X								X	X
CHILLED WATER SUPPLY TEMPERATURE	X	X								X	X
CHILLED WATER SUPPLY DIFFERENTIAL PRESSURE	X	X								X	X
CHILLER (X) CHILLED WATER FLOW DIFF. PRESSURE	X	X								X	X
CHILLER (X) CHILLED WATER FLOW STATUS	X	X									
CHILLER (X) CHILLED WATER ISO VALVE OUTPUT	X			X							
CHILLER (X) CHILLED WATER ISO VALVE OPEN STATUS	X	X									
CHILLER (X) CHILLED WATER PUMP REQUEST FROM CHILLER	X	X									
OUTDOOR AIR RELATIVE HUMIDITY LOCAL	X	X									X
OUTDOOR AIR TEMPERATURE LOCAL	X	X									X
BAS COMMUNICATION STATE	X								X		X
CHILLER PLANT ENABLE					X						
CHILLED WATER PUMP (X) FAILURE	X			X						X	
CHILLED WATER SUPPLY TEMPERATURE SETPOINT				X							
OUTDOOR AIR TEMP ENABLE SETPOINT				X							
PUMP START REQUEST TO SYSTEM				X							
CHILLER ALARM	X	X	X	X	X	X	X	X	X	X	X
CHILLER AUTO/STOP COMMAND	X	X	X	X	X	X	X	X	X	X	X
CHILLER COMMUNICATION	X	X	X	X	X	X	X	X	X	X	X
COMPRESSOR STATUS (PER COMPRESSOR)	X	X	X	X	X	X	X	X	X	X	X
COMPRESSOR RUN TIME (PER COMPRESSOR)	X	X	X	X	X	X	X	X	X	X	X
HEAD PRESSURE CONTROL OUTPUT	X	X	X	X	X	X	X	X	X	X	X
CURRENT LIMIT SETPOINT	X	X	X	X	X	X	X	X	X	X	X
CHILLER LOW SUPPLY WATER TEMPERATURE	X	X	X	X	X	X	X	X	X	X	X
CHILLER HIGH SUPPLY WATER TEMPERATURE	X	X	X	X	X	X	X	X	X	X	X
CHILLER LOW WATER FLOW	X	X									
CHILLED WATER SETPOINT	X	X	X	X	X	X	X	X	X	X	X
COMPRESSOR ENABLE (PER COMPRESSOR)	X	X	X	X	X	X	X	X	X	X	X
CONDENSER REFRIGERANT PRESSURE (PER CIRCUIT)	X	X	X	X	X	X	X	X	X	X	X
EVAPORATOR REFRIGERANT PRESSURE (PER CIRCUIT)	X	X	X	X	X	X	X	X	X	X	X
EVAPORATOR ENTERING WATER TEMPERATURE	X	X	X	X	X	X	X	X	X	X	X
EVAPORATOR LEAVING WATER TEMPERATURE	X	X	X	X	X	X	X	X	X	X	X
OPERATING MODE	X	X	X	X	X	X	X	X	X	X	X
AVERAGE LINE CURRENT %RLA	X	X	X	X	X	X	X	X	X	X	X
HEAD RELIEF REQUEST	X	X	X	X	X	X	X	X	X	X	X
-----	X	X	X	X	X	X	X	X	X	X	X

SEQUENCE OF OPERATION - AIR HANDLING UNITS

START/STOP OPERATIONS:
THE AIR HANDLING UNIT (AHU) SHALL BE ENERGIZED AND CONTROLLED BY THE INTEGRATED BUILDING SYSTEM (IBS) BASED ON A TIME OF DAY (T.O.D.) SCHEDULE.

THE AHU FAN SHALL START AT MINIMUM SPEED. THE FAN SPEED SHALL INCREASE IN RESPONSE TO THE DUCT PRESSURE SENSOR LOCATED 25' OF THE WAY DOWN THE LONGEST DUCT MAIN. THE FAN SHALL RUN CONTINUOUSLY WHEN THE UNIT IS ENERGIZED.

THE CHILLED WATER COIL CONTROL VALVE SHALL BE TIGHTLY CLOSED TO FLOW THROUGH THE COIL WHEN THE UNIT IS "OFF".
WHEN THE UNIT IS "OFF" THE OUTSIDE AIR DAMPER SHALL BE FULLY CLOSED AND THE RETURN AIR DAMPER SHALL BE FULLY OPEN.

THE AHU SHALL HAVE A NIGHT-SETBACK CAPABILITY WHEN THE AHU IS SHUT DOWN. DURING THE COOLING SEASON AFTER HOURS AND WHEN THE SPACE TEMPERATURE RISES ABOVE 85°F (ADJ.) THE AHU SHALL BE ENERGIZED AND THE COOLING CONTROL VALVE SHALL BE MODULATED TO PROVIDE COOLING TO THE ZONE UNTIL THE SPACE TEMPERATURE RETURNS BELOW THE NIGHT-SETBACK TEMPERATURE FOR A PERIOD OF NO LESS THAN 20 MINUTES (ADJ.).

DURING THE HEATING SEASON AFTER HOURS WHEN THE AHU SHUTS DOWN AND THE SPACE TEMPERATURE DROPS BELOW 65°F (ADJ.) THE AHU SHALL BE ENERGIZED TO MINIMUM FLOW AND THE HOT WATER COIL SHALL BE MODULATED UNTIL SPACE TEMPERATURE RETURNS ABOVE THE NIGHT-SETBACK HEATING CONDITION FOR A PERIOD OF NO LESS THAN 20 MINUTES (ADJ.).

UNIT OPERATION:
COOLING MODE: UPON A CALL FOR COOLING, A SPACE TEMPERATURE SENSOR SHALL, ACTING THROUGH THE AHU CONTROLLER, MODULATE THE VARIABLE FREQUENCY DRIVES (VFDs) ON THE AHU FAN MOTORS TOWARD MAXIMUM COOLING AIRFLOW SETPOINT.

HEATING MODE: UPON A CALL FOR HEATING, A SPACE TEMPERATURE SENSOR SHALL, ACTING THROUGH THE AHU CONTROLLER, MODULATE THE VFDs ON THE AHU FAN MOTORS TOWARD MINIMUM AIRFLOW SETPOINT (~30% OF MAXIMUM COOLING AIRFLOW BUT WITHOUT OPERATING AT AN UNSTABLE POINT ON THEIR RESPECTIVE FAN CURVES). ONCE AT MINIMUM AIRFLOW SETPOINT IF THERE IS STILL A CALL FOR HEATING, THE AHU CHILLED WATER VALVE SHALL, ACTING THROUGH THE AHU CONTROLLER, MODULATE THE TWO-WAY CHILLED WATER VALVE TOWARDS THE CLOSED POSITION. IF AND ONLY IF THE CHILLED WATER VALVE IS FULLY CLOSED AND THERE IS STILL A CALL FOR HEATING, THE AHU HEATING HOT WATER VALVE SHALL, ACTING THROUGH THE AHU CONTROLLER, MODULATE THE TWO-WAY HEATING HOT WATER VALVE OPEN. IF SUPPLY AIR TEMPERATURE REACHES 85°F (ADJ.) AND THERE IS STILL A CALL FOR HEATING, THE VFDs SHALL, ACTING THROUGH THE AHU CONTROLLER, MODULATE TOWARD MAXIMUM AIRFLOW SETPOINT WHILE MAINTAINING 85°F SUPPLY AIR TEMPERATURE.

THE REVERSE OF THE HEATING SEQUENCE ABOVE SHALL BE USED AS THE CALL FOR HEATING IS REDUCED.

CHILLED AND HEATING HOT WATER COILS SHALL BE INTERLOCKED TO ENSURE ONLY ONE OF THE TWO IS OPEN AT A TIME. UNIT SHALL NOT BE CAPABLE OF SIMULTANEOUSLY HEATING AND COOLING.

AN AVERAGING TYPE TEMPERATURE SENSOR (INSTALLED IN A SERPENTINE TYPE PATTERN IN THE AHU DISCHARGE) SHALL, ACTING THROUGH THE AHU CONTROLLER, MODULATE THE 2-WAY CHILLED WATER CONTROL VALVE TO MAINTAIN THE SCHEDULED LEAVING AIR TEMPERATURE (SEE EQUIPMENT SCHEDULE -ADJ.) IF LEAVING AIR TEMPERATURE DROPS BELOW 42°F (ADJ.), THE IBS SHALL DE-ENERGIZE THE SUPPLY FAN AND ACTIVATE TROUBLE ALARM AT THE IBS CONTROL CONSOLE.

UNIT SAFETIES:
A HIGH STATIC PRESSURE SWITCH LOCATED DOWNSTREAM OF THE SUPPLY FAN SHALL, THROUGH THE DDC CONTROLLER, SHUT DOWN THE UNIT AND GENERATE A "HIGH STATIC PRESSURE" ALARM AT THE OPERATOR'S WORKSTATION(S) IF THE STATIC PRESSURE DIFFERENTIAL BETWEEN THE UNIT AND THE ROOM EXCEEDS SETPOINT (5 INCHES OF WATER, ADJ.).
A SMOKE DETECTOR LOCATED IN THE UNIT DISCHARGE DUCTWORK SHALL, THROUGH THE BUILDING FIRE ALARM SYSTEM AND IBS, DE-ENERGIZE THE UNIT UPON DETECTION OF PRODUCTS OF COMBUSTION.

A CURRENT SENSING RELAY ON THE FAN MOTORS SHALL INDICATE FAN FAILURE (WHEN THE FAN IS COMMANDED "ON" AFTER A TIME DELAY OR IS OPERATING) AND SHALL INITIATE A "FAN FAILURE ALARM" AT THE OPERATOR WORKSTATION(S).

FILTER DP SWITCH: DIFFERENTIAL PRESSURE AIRFLOW SWITCHES ACROSS EACH FILTER SECTION SHALL, THROUGH THE DDC CONTROLLER, MONITOR THE PRESSURE AND ACTIVATE A "FILTER ALARM" WHEN THE FILTER PRESSURE LOSS EXCEEDS THE HIGH LIMIT SETPOINT (ADJ.).

AN AUTOMATIC RESET FREEZE STAT HARD WIRED TO A TWO MINUTE TIME-DELAY RELAY SHALL, AFTER THE TIME DELAY, GENERATE AN ALARM IF THE COOLING COIL INLET TEMPERATURE DROPS BELOW 40°F (ADJ.) AND SHALL SHUT DOWN THE UNIT IF THE TEMPERATURE DROPS BELOW 38°F (ADJ.).
FIRE ALARM OVERRIDE.

SEQUENCE OF OPERATION - DOAS AIR HANDLING UNITS

START/STOP OPERATIONS:
THE OUTSIDE AIR HANDLING UNIT (OAHU) SHALL BE ENERGIZED AND CONTROLLED BY THE IBS. WHEN COMMANDED "ON" THE OAHU SHALL START AFTER THE O.A. DAMPER IS FULLY OPEN. THE VFD SHALL MODULATE FROM MINIMUM SPEED TO THE TsrGET AIRFLOW. WHEN OAHU SHUTS DOWN, THE O.A. DAMPER SHALL TIGHTLY CLOSE.

THE OAHU SHALL BE COMMANDED "ON" BY THE BAS IN THE EVENT THAT THE BUILDING DIFFERENTIAL PRESSURE TO THE OUTDOORS HAS DROPPED BELOW +0.005 INCHES OF WATER (ADJ.) FOR A PERIOD OF 3 MINUTES (ADJ.) OR ON A CALL FOR HEATING, COOLING, OR HUMIDITY CONTROL.

THE CHILLED WATER COIL CONTROL VALVE SHALL TIGHTLY CLOSE WHEN THE UNIT IS "OFF".
THE HEATING HOT WATER COIL CONTROL VALVE SHALL TIGHTLY CLOSE WHEN THE UNIT IS "OFF".

THE MOTORIZED DAMPER IN THE OAHU INLET SHALL BE TIGHTLY CLOSED (15 SECOND TIME DELAY -ADJ.) AFTER THE UNIT IS DEACTIVATED AND FULLY "OPEN" BEFORE THE UNIT IS ACTIVATED. A DAMPER END SWITCH IN THE MOTORIZED INLET DAMPER SHALL PROVE DAMPER POSITION.

UNIT OPERATION:
WHEN COMMANDED "ON" BY THE IBS, OAHU SHALL, THROUGH THEIR RESPECTIVE OAHU CONTROLLERS, MODULATE VFDs TO SLOWLY INCREASE AIRFLOW TO ACHIEVE BUILDING DIFFERENTIAL PRESSURE OF +0.01 INCHES OF WATER (ADJ.) AND SHALL RUN FOR NO LESS THAN 30 MINUTES (ADJ.). IF OAHU HAVE TURNED DOWN TO MINIMUM AIRFLOW (APPROX. 30% OF FULL FLOW, ADJ.) FOR A PERIOD OF 10 MINUTES (ADJ.) AND BUILDING DIFFERENTIAL PRESSURE EXCEEDS +0.02 INCHES OF WATER (ADJ.), UNITS SHALL BE COMMANDED TO OPERATE BASED ON HEATING, COOLING OR HUMIDITY CONTROL DEMAND.

IF OAHUS ARE OPERATING AT MAXIMUM AIRFLOW SETPOINT FOR A PERIOD OF 30 MINUTES (ADJ.) AND BUILDING PRESSURE IS STILL BELOW + 0.005 INCHES OF WATER (ADJ.) THEN AN ALARM SHALL BE SENT TO IBS.

ON A CALL FOR HEATING (DROP IN OUTSIDE AIR TEMPERATURE BELOW 45°F (ADJ.)) THE PRE-HEAT COIL CONTROL VALVE SHALL MODULATE OPEN. AN AVERAGING TYPE TEMPERATURE SENSOR LOCATED DOWNSTREAM OF THE PRE-HEAT COIL (INSTALLED IN A SERPENTINE PATTERN) SHALL, ACTING THROUGH THE OAHU CONTROLLER, MODULATE THE PRE-HEAT COIL CONTROL VALVE AS REQUIRED TO MEET THE UNIT LEAVING AIR TEMPERATURE (ADJ.).

ON A CALL FOR COOLING, AN AVERAGING TYPE SENSOR LOCATED IN THE UNIT DISCHARGE DOWNSTREAM OF FAN ARRAY SHALL, THROUGH THE DDC CONTROLLER, MODULATE THE COOLING COIL CONTROL VALVE AS REQUIRED TO MAINTAIN THE SCHEDULED UNIT LEAVING AIR TEMPERATURE SETPOINT (ADJ.).

IN THE EVENT OF AN INDIVIDUAL FAN FAILURE IN THE FAN ARRAY, THE REMAINING FAN(S) VFD(S) SHALL, ACTING THROUGH THE OAHU CONTROLLER, MODULATE TO COMPENSATE FOR DROPPED FAN TO MAINTAIN AIRFLOW.

OAHU LEAD/LAG SEQUENCE ORDER WILL BE BASED ON A ROUND ROBIN LOGIC. (ROUND ROBIN LOGIC EXAMPLE: 1-2-3, THEN 2-3-1, THEN 3-1-2, THEN 1-2-3, ETC.) AND ABLE TO BE PROGRAMMED TO OCCUR AT OPERATOR-DEFINED INTERVALS.

UNIT SAFETIES:
A HIGH STATIC PRESSURE SWITCH LOCATED DOWNSTREAM OF THE SUPPLY FAN SHALL, THROUGH THE DDC CONTROLLER, SHUT DOWN THE UNIT AND GENERATE A "HIGH STATIC PRESSURE" ALARM AT THE OPERATOR'S WORKSTATION(S) IF THE STATIC PRESSURE DIFFERENTIAL BETWEEN THE UNIT AND THE ROOM EXCEEDS SETPOINT (5 INCHES OF WATER, ADJ.).

A SMOKE DETECTOR LOCATED IN THE UNIT DISCHARGE DUCTWORK SHALL, THROUGH THE BUILDING FIRE ALARM SYSTEM AND IBS, DE-ENERGIZE THE UNIT UPON DETECTION OF PRODUCTS OF COMBUSTION.

A CURRENT SENSING RELAY ON THE FAN MOTORS SHALL INDICATE FAN FAILURE (WHEN THE FAN IS COMMANDED "ON" AFTER A TIME DELAY OR IS OPERATING) AND SHALL INITIATE A "FAN FAILURE ALARM" AT THE OPERATOR WORKSTATION(S).

FILTER DP SWITCH: DIFFERENTIAL PRESSURE AIRFLOW SWITCHES ACROSS EACH FILTER SECTION SHALL, THROUGH THE DDC CONTROLLER, MONITOR THE PRESSURE AND ACTIVATE A "FILTER ALARM" WHEN THE FILTER PRESSURE LOSS EXCEEDS THE HIGH LIMIT SETPOINT (SEE EQUIPMENT SCHEDULE -ADJ.).

AN AUTOMATIC RESET FREEZE STAT HARD WIRED TO A TWO MINUTE TIME-DELAY RELAY SHALL, AFTER THE TIME DELAY, GENERATE AN ALARM IF THE COOLING COIL INLET TEMPERATURE DROPS BELOW 40°F (ADJ.) AND SHALL SHUT DOWN THE UNIT IF THE TEMPERATURE DROPS BELOW 38°F (ADJ.).

FIRE ALARM OVERRIDE.

GENERAL SHEET NOTES

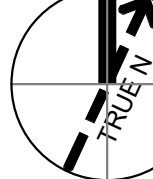
SEQUENCE OF OPERATIONS ARE FOR REFERENCE ONLY. FINAL SEQUENCES WILL BE DEVELOPED BY L&H AIRCO AND APPROVED BY AR.

SHEET KEYNOTES

LEGEND

GRAPHIC SCALE(S)

PLAN NORTH



1818 Bryan Ross Drive, Suite 3000
Ft. Worth, TX 76104
Entity: Jacobs Engineering Group Inc.
License # 178
License Exp. Date: 12/31/2024

1	10/03/2024	100% ISSUED FOR CONSTRUCTION - EXPANSION	JWG	BY	AP/D	S/G
0	09/18/2024	100% ISSUED FOR CONSTRUCTION - EXPANSION	JWG	BY	AP/D	S/G
DR	DATE	REVISION	CHK	ASM	DR	ASM

GMLRS
Camden OSD
Calhoun County, Arkansas
Aerjet Rocketdyne

MECHANICAL
CONTROL SEQUENCE

SHEET NO
MH621

SCALE As indicated
DATE 09/18/2024
PROJ D3754502
DWG CDR002,DR004,SH001

Autodesk Docs:JUS_D3754500_FED_Aerjet Rocketdyne/D3754500_CMDN_OSD_GMLRS_MECH.rvt

PLOT DATE/TIME: 10/2/2024 3:09:06 PM