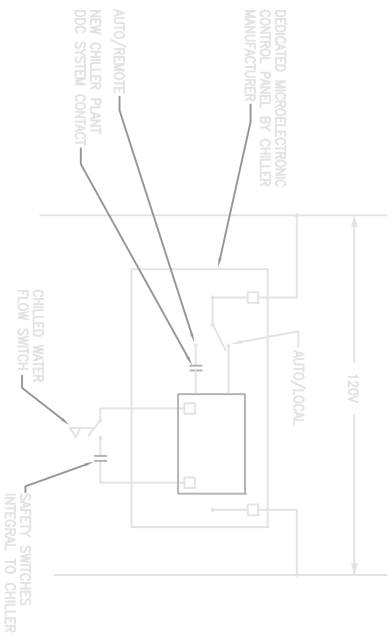


1 CHILLER PLANT DDC SYSTEM CONTROL SCHEMATIC

2 TYPICAL NEW CHILLER CONTROL DIAGRAM



CHILLER PLANT DDC SYSTEM - SEQUENCE OF OPERATION

I. GENERAL

1. THE CHILLER PLANT DDC SYSTEM WILL MONITOR, CALCULATE, AND RECORD ALL TEMPERATURES, FLOWS, LOADS, AND OTHER DATA ON THE CHILLERS AND IN THE CHILLER PLANT AS INDICATED ON THE DDC SYSTEM POINTS LIST. THE SYSTEM SHALL BE CAPABLE OF MONITORING AND RECORDING ALL CHILLED WATER SUPPLY AND RETURN TEMPERATURES, FLOWS, AND LOADS. THE PROCESS LOOP SHALL BE DOWN EVERY MINUTES AND SHALL BE ADJUSTABLE FROM 0 TO 30 MINUTES. ALL ALARM AND TROUBLE CONDITIONS SHALL BE ANNUNCIATED AT THE OPERATOR'S STATION AND LOGGED FOR FUTURE REFERENCE. THE DDC CONTROL SYSTEM SHALL PERFORM AUTOMATIC TROUBLE SHOOTING FROM FLOW, TEMPERATURE, AND PRESSURE SENSORS. THE CHILLER PLANT DDC SYSTEM SHALL BE CAPABLE OF PERFORMING DEMAND LIMITING FUNCTIONS ON BOTH CHILLERS.
2. EACH OF THE CHILLERS SHALL BE EQUIPPED WITH ITS OWN TROUBLE SHOOTING AND TROUBLE ALARMS AND DIAGNOSTICS DEVICES, AND ANNUNCIATE TROUBLE ALARMS AND DIAGNOSTICS INTERVAL TO THE CHILLER. THE PANEL SHALL BE PACKAGED WITH THE CHILLER BY THE CHILLER MANUFACTURER. CHILLER CENTRAL CONTROL PANEL SHALL BE INTEGRATED WITH DDC PANEL AND SHOULD PROVIDE ALL SIGNALS AND CONTROLS FOR PROPER OPERATION OF THE SYSTEM AS A WHOLE.
3. EACH CHILLER SHALL BE PROVIDED WITH ITS OWN H-A-A-0 SWITCH FOR CONTROL. IN THE "AUTO" MODE OF OPERATION, THE CHILLERS SHALL OPERATE VIA A TIME SCHEDULE CONSISTING OF THE HOURS BETWEEN 6:00 P.M. TO 6:00 P.M. DAILY. THE CHILLERS SHALL BE CAPABLE OF OPERATING IN "HAND" MODE WILL BY-PASS THE DDC CONTROLS AND MANUALLY COMMENCE OPERATION OF THE CHILLER.
4. THE CHILLERS SHALL BE PROGRAMMED TO GENERATE 45°F CHILLED WATER SUPPLY AND 55°F CHILLED WATER RETURN TEMPERATURE. THE CHILLERS SHALL BE RESET BASED ON THE SCHEDULE DISCUSSED BELOW. ONLY ONE OF THE TWO SECONDARY PUMPS SHALL OPERATE AT ANY ONE TIME. THE OTHER UNIT SHALL SERVE AS BACK-UP. THE PUMPS SHALL BE ALTERNATED DAILY TO EVEN THE OPERATING TIME ON THE EQUIPMENT. THE SECONDARY PUMP SHALL BE USED TO MAINTAIN THE SECONDARY LOOP PRESSURE OF 15 PSI AS MEASURED BY THE DIFFERENTIAL PRESSURE SENSOR LOCATED ON THE CHILLED WATER PIPING SERVING T1-AHU-4. THE BYPASS CV AT T1-AHU-4 SHALL START TO OPEN WHEN AHU'S CV VALVE IS LESS THAN 15% OPEN AND SHALL MODULATE TO ITS FULLY CLOSED POSITION WHEN AHU-4'S CV IS IN ITS FULLY OPEN POSITION TO MAINTAIN THE SECONDARY LOOP PRESSURE OF 15 PSI. THE CHILLER PLANT DDC SYSTEM SHALL BE ADJUSTED AS REQUIRED AFTER RECEIVING INPUT FROM THE BALANCING CONTRACTOR.

II. CHILLER PLANT OPERATION

- A. THE CHILLERS SHALL BE PROGRAMMED TO GENERATE 45°F CHILLED WATER SUPPLY AND 55°F CHILLED WATER RETURN TEMPERATURE. THE CHILLERS SHALL BE RESET BASED ON THE SCHEDULE DISCUSSED BELOW. ONLY ONE OF THE TWO SECONDARY PUMPS SHALL OPERATE AT ANY ONE TIME. THE OTHER UNIT SHALL SERVE AS BACK-UP. THE PUMPS SHALL BE ALTERNATED DAILY TO EVEN THE OPERATING TIME ON THE EQUIPMENT. THE SECONDARY PUMP SHALL BE USED TO MAINTAIN THE SECONDARY LOOP PRESSURE OF 15 PSI AS MEASURED BY THE DIFFERENTIAL PRESSURE SENSOR LOCATED ON THE CHILLED WATER PIPING SERVING T1-AHU-4. THE BYPASS CV AT T1-AHU-4 SHALL START TO OPEN WHEN AHU'S CV VALVE IS LESS THAN 15% OPEN AND SHALL MODULATE TO ITS FULLY CLOSED POSITION WHEN AHU-4'S CV IS IN ITS FULLY OPEN POSITION TO MAINTAIN THE SECONDARY LOOP PRESSURE OF 15 PSI. THE CHILLER PLANT DDC SYSTEM SHALL BE ADJUSTED AS REQUIRED AFTER RECEIVING INPUT FROM THE BALANCING CONTRACTOR.
- B. IF THE CHILLED WATER LOAD IN THE BUILDING BREAKS, THE TWO WAY VALVES ON THE AIR HANDLERS WILL CLOSE, WHICH WILL RESULT IN A REDUCED CHILLED WATER FLOW INCREASES. THE TWO WAY VALVES ON THE AIR HANDLERS WILL OPEN WHICH WILL RESULT IN AN INCREASE IN CHILLED WATER FLOW. THE UNLOADING OF T1-ACRCU-1 AND 2 SHALL BE ACCOMPLISHED BY CLOSING THE FLOW USING THE TEMPERATURES AT T1-ACRCU-1 AND 2. THE CHILLER PLANT DDC SYSTEM SHALL BE ADJUSTED AS REQUIRED AFTER RECEIVING INPUT FROM THE BALANCING CONTRACTOR.
- C. THE CHILLER PLANT DDC CONTROL SYSTEM SHALL START AND STOP THE CHILLERS TO DETERMINE A LOAD/UNLOAD DECISION AS A FUNCTION OF PIPING LOOP TEMPERATURES. THE CHILLER DDC SYSTEM SHALL CALCULATE THE DIRECTION AND QUANTITY OF FLOW IN THE BYPASS PIPE BASED ON THE TEMPERATURE READINGS IN THE PIPING LOOP. THE SYSTEM SHALL BE CAPABLE OF MONITORING AND RECORDING ALL CHILLED WATER SUPPLY AND RETURN TEMPERATURES, FLOWS, AND LOADS. THE PROCESS LOOP SHALL BE DOWN EVERY MINUTES AND SHALL BE ADJUSTABLE FROM 0 TO 30 MINUTES. ALL ALARM AND TROUBLE CONDITIONS SHALL BE ANNUNCIATED AT THE OPERATOR'S STATION AND LOGGED FOR FUTURE REFERENCE. THE DDC CONTROL SYSTEM SHALL PERFORM AUTOMATIC TROUBLE SHOOTING FROM FLOW, TEMPERATURE, AND PRESSURE SENSORS. THE CHILLER PLANT DDC SYSTEM SHALL BE CAPABLE OF PERFORMING DEMAND LIMITING FUNCTIONS ON BOTH CHILLERS.
- D. AT MINIMUM LOAD AND START UP AT EACH DAY THE CHILLER PLANT SHALL BE OPERATING WITH ONE CHILLER AND ONE PRIMARY PUMP. THE LEAD CHILLER AND PUMP SHALL BE DETERMINED BY THE CHILLER PLANT DDC SYSTEM. IF THE LOAD INCREASES, THE CHILLER PLANT DDC SYSTEM SHALL AUTOMATICALLY START-UP THE LAG CHILLER & PRIMARY PUMP AS DETERMINED BY THE CHILLER PLANT CONTROL ALGORITHM.
- E. AS THE LOAD DECREASES FROM A FULLY LOADED CONDITION, THE CHILLER PLANT CONTROL ALGORITHM WILL TURN OFF THE LAG CHILLER AND LAG PRIMARY PUMP.

III. BASIC OPERATION OF A SINGLE CHILLER

- A. UPON A SIGNAL TO START THE CHILLER PLANT, THE PACKAGED DDC CONTROLS LOCATED ON THE CHILLER WILL FIRST TEST THE INCOMING POWER TO ENSURE THAT THERE ARE NO PROBLEMS WITH SINGLE PHASING, PHASE REVERSAL, OR UNBALANCED VOLTAGES.
- B. THE PACKAGED CONTROLS ON EACH CHILLER SHALL ALSO MONITOR THE CHILLED WATER SUPPLY AND RETURN TEMPERATURES. THE CHILLER SHALL START TO DECREASE THE CHILLED WATER SUPPLY SET POINT 1°F EVERY 30 MINUTES UNTIL THE LOAD IS SATISFIED AND THE RETURN WATER TEMPERATURE DECREASES TO 55°F.
- C. UPON CONFIRMATION OF A AND B, THE SYSTEM WILL ACTIVATE THE CHILLER'S ASSOCIATED CHILLED WATER PUMP IN THE PRIMARY LOOP AND THE INTERNAL CHILLER CONTROLS SHALL OPERATE AND WATER IS PASSING THROUGH THE CHILLER PRIOR TO STARTING.
- D. THE CHILLER WILL THEN START THE FANS ON ITS AIR COOLED CONDENSER AND INITIATE ITS PUMP OUT SEQUENCE TO AVOID SLUGGING IN THE COMPRESSOR AT START-UP. AFTER A 60 SECOND TIME DELAY AND IF THE CHILLER HAS NOT STARTED, THE CHILLER WILL THEN START ITS COMPRESSORS SEQUENTIALLY, ONE CIRCUIT AT A TIME. THE START-UP CYCLE FROM THE INITIAL START SIGNAL TO THE ACTUAL START OF THE COMPRESSOR MOTORS SHALL BE ACCOMPLISHED WITHIN A MAXIMUM OF 2 MINUTES.
- E. ONCE THE CHILLER HAS INITIATED ITS STARTING SEQUENCE, MONITORING CIRCUITS WILL THEN MONITOR CURRENT LIMITS, CONDENSER LIMITS, AND EVAPORATOR LIMITS. THE INTERNAL CHILLER DDC CONTROLS SHALL STOP AND START THE COMPRESSORS AND LOAD/UNLOAD THE SUPPLY SETPOINT.
- F. SAFETY CONTROLS: THE CHILLERS INTERNAL DDC CONTROLS SHALL SHUTDOWN THE CHILLER IN THE EVENT ANY OF THE INTERNAL SAFETY DEVICES ARE ACTIVATED.
- G. THE CHILLER INTERNAL DDC CONTROL SYSTEM WILL STOP THE CHILLER ONLY FOR THE FOLLOWING REASONS: LOW LOAD, SET POINT DEVIATION, LATCHING SAFETY, OR MANUAL SHUT-OFF.
- H. EVAPORATOR AND CONDENSER REFRIGERANT TEMPERATURES: THE INTERNAL CONTROL SYSTEM WILL MONITOR THESE TEMPERATURES AND SHUT DOWN THE CHILLER IF THE TEMPERATURE BETWEEN THE WATER AND THE REFRIGERANT FOR THE EVAPORATOR OR AMBIENT AIR AND THE REFRIGERANT FOR THE CONDENSER TO INDICATE HEAT EXCHANGER EFFICIENCY.
- I. DIAGNOSTICS: THE CHILLER'S INTERNAL DDC CONTROL SYSTEM WILL MONITOR DIAGNOSTIC POINTS WITHIN THE CHILLER ITSELF TO DETERMINE IF ANY PROBLEMS EXISTS IN ITS OPERATION. THESE SHALL INCLUDE: HIGH AND LOW CHILLED WATER TEMPERATURES, CONDENSER PRESSURE, PHASE IMBALANCE, REVERSAL, LOSS AND HIGH AND LOW AMPERAGES, AND GENERAL SENSOR FAILURE.
- J. UPON A SIGNAL TO SHUT DOWN, THE CHILLER WILL START ITS PACKAGE SHUT-DOWN PROCEDURE. ONCE IT IS CONFIRMED THAT THE CHILLER IS OFF, THE PRIMARY LOOP CHILLED WATER PUMP SERVING THE CHILLER WILL THEN SHUT-DOWN. THE CHILLER INTERNAL DDC CONTROL PANEL WILL THEN SEND A SIGNAL TO THE MAIN DDC SYSTEM TO SHUT-DOWN THE CHILLER PLANT. THE CHILLER PLANT DDC SYSTEM SHALL BE ADJUSTED AS REQUIRED AFTER RECEIVING INPUT FROM THE BALANCING CONTRACTOR.

1. IT IS A MANUFACTURER'S STANDARD CHILLER SEQUENCING ALGORITHM.
2. IT IS REVIEWED AND APPROVED BY THE CONTRACTING OFFICER.
3. IT SATISFIES THE PERFORMANCE CRITERIA FOR THE OPERATION OF THE CHILLER PLANT AS CONTAINED HEREIN.
4. AT MINIMUM LOAD AND START UP AT EACH DAY THE CHILLER PLANT SHALL BE OPERATING WITH ONE CHILLER AND ONE PRIMARY PUMP. THE LEAD CHILLER AND PUMP SHALL BE DETERMINED BY THE CHILLER PLANT DDC SYSTEM. IF THE LOAD INCREASES, THE CHILLER PLANT DDC SYSTEM SHALL AUTOMATICALLY START-UP THE LAG CHILLER & PRIMARY PUMP AS DETERMINED BY THE CHILLER PLANT CONTROL ALGORITHM.
5. AS THE LOAD DECREASES FROM A FULLY LOADED CONDITION, THE CHILLER PLANT CONTROL ALGORITHM WILL TURN OFF THE LAG CHILLER AND LAG PRIMARY PUMP.

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This work was prepared by me or under my supervision and I am a duly licensed professional engineer in the State of Hawaii. I am not providing any services in any other state. I am not providing any services in any other state. I am not providing any services in any other state.



**CHILLER PLANT CONTROL**  
**SEQUENCING CONTROL DIAGRAM**  
**AND SEQUENCE OF OPERATION**

**DESIGNED BY**  
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