



1 CHILLED WATER CONTROL DIAGRAMS
M402 M402 NO SCALE

CHILLED/CONDENSER WATER SEQUENCE OF OPERATION

CHILLED WATER SYSTEM

Zone Air Handling Units (AH-1E, AH-1W, AH-2E, AH-2W, AH-3E, AH-3W, AH-4E, AH-4W)
Chilled water valves shall be 2-way pattern and shall be operated by a DDC actuator to provide a 62.0F (adjustable) dry bulb temperature leaving the unit (after the fan). See Zone Air Handling sequence on M401.

Ventilation Units (VU-E, VU-W)
Chilled water valve shall be 2-way pattern and shall be operated by a DDC actuator to provide a 47.0F (adjustable) dry bulb temperature leaving the coil. Combination of temperature sensor, controller and actuator shall have a repeatable accuracy better than 0.1F. See Ventilation Air Handling sequence on M401.

Zone Unit Flow Valves (ZFU-E and ZFU-W)
These valves pass water from CHS to CHSS in the first floor Mech. Rooms to allow increased flow through the zone units. Zone Flow Valves shall be positioned by a critical zone reset routine based on the position of their associated zone valves (ZFU-W responds to AH-1W, AH-2W, AH-3W and AH-4W; ZFU-E responds to AH-1E, AH-2E, AH-3E and AH-4E). The Zone Flow Valve shall open in 10% increments to respond to any associated zone valve that is 95% open or more. The Zone Flow Valve shall close in 10% increments until at least one associated zone valve is 85% open or more. Zone valve positions shall be sampled at 5 second intervals and Zone Flow Valve position shall be adjusted, if necessary, at 30 second intervals. Zone Flow Valve position shall not be used in the Pump DP reset routine.

OSA Unit Flow Valves (OSAFV-E & OSAFV-W)
These valves pass water from CHSS to CHR in the fourth floor Mech. Rooms to allow increased flow through the OSA unit. OSA Unit Flow Valves shall be positioned by a critical zone reset routine based on the position of their associated zone valves (OSAFV-W responds to OSA-W; OSAFV-E responds to OSA-E). The OSA Unit Flow Valve shall open in 10% increments to respond to any associated zone valve that is 95% open or more. The OSA Unit Flow Valve shall close in 10% increments until at least one associated zone valve is 85% open or more. The OSA Unit Valve positions shall be sampled at 5 second intervals and OSA Unit Flow Valve position shall be adjusted, if necessary, at 30 second intervals. OSA Unit Flow Valve position shall not be used in the Pump DP reset routine.

Chiller Minimum Flow Bypass Valve
Chiller Minimum Flow Bypass Valve shall be DDC controlled. Refer to Project Manual for Specifications of Valve, Actuator. Valve shall be controlled through a DDC Controller to maintain chiller total flow in the range of 105% to 110% of Chiller Manufacturer's required concurrent minimum flow. Valve shall be fully closed whenever the flow exceeds 110% of Chiller Manufacturer's required minimum flow. Valve shall be selected for 105% of Chiller Manufacturer's required minimum flow with a concurrent pressure drop not exceeding 10% of scheduled chilled water pump head.

Flow Meters
Flow meters shall be placed to measure total flow to the load, total flow through the bypass and total flow through the chillers.

Chillers (CH-1)
Chilled water plant shall be controlled to 42F (adjustable) entering the load branch whenever either Ventilation Unit (VU-E, VU-W) chilled water valve is not closed (>0%), and controlled to 54F (adjustable) entering the load branch whenever both Ventilation Units (VU-E, VU-W) chilled water valves are closed (0%). Multiple compressor chillers shall be operated to keep equal operating hours on each compressor. Differential operating time between any two compressors shall not exceed 25 hours. Provide a time delay (30 min., Adj.) before execution of a setpoint reset.

Chilled Water Pumps (CHP-1)
Chilled Water Pump shall be operated to achieve peak wire-to-water operating efficiency. The pump speed shall be controlled to match the differential pressure setpoint. The differential pressure setpoint shall be determined as follows: If at least one chilled water valve (OSA-E, AH-1E, AH-2E, AH-3E, AH-4E, OSA-W, AH-1W, AH-2W, AH-3W, AH-4W) is 85% open or greater, and no chilled water valve is 95% or greater open, the setpoint shall not be changed. If no valve is 85% open, or greater, the setpoint shall be reduced 0.1 ft wg. If any valve is 95% open, or greater, the setpoint shall be increased 0.1 ft wg. Valve positions shall be sampled at 5 second intervals and setpoint adjustments shall be made, if required, at 30 second intervals. The minimum allowable setpoint is XXXX ft wg, and the maximum setpoint is YYYY ft wg. Pressure adjustment shall not be made while the valve setting requiring the change is served by a ZFU and OSAFV pair where either of the flow valves is partially open.

Plate Frame Heat Exchanger (HX-1)
Whenever the outdoor wet bulb is 5F (adjustable) or more below the return chilled water temperature, the Plate Frame Heat Exchanger shall be enabled. Operation of the heat exchanger shall be started by fully opening the heat exchanger isolation valve and partially closing the bypass valve. The valves shall be positioned as necessary to maximize the tonnage contribution of the heat exchanger until but not greater than the capacity required to meet the current chilled water setpoint. Whenever the heat exchanger is operating, the heat exchanger performance shall be calculated by multiplying Load Branch flow times the difference between the temperature in the load branch main line before the heat exchanger diversion and the temperature in the main line before the pumps. This value shall be divided by 24 to determine tons of capacity contribution by the heat exchanger. If the contribution is less than ZZZZ tons, the heat exchanger shall be bypassed, and operation of the heat exchanger not re-attempted until the difference between the wet bulb temperature, and load branch main line temperature has increased by 2F (adjustable). Once the heat exchanger operation is initiated, it shall continue until the contributed capacity falls below ZZZZ tons, regardless of temperatures unless the chiller is off. The difference between the wet bulb temperature, and load branch main line temperature at the time of heat exchanger shut-down plus 1F (adjustable) shall become the new difference required to re-initiate heat exchanger operation.

Fan Coil Units
Fan coil units shall have a two-way two-position chilled water valve. A modulating valve or an analog output as fan coil unit chilled water valve control is not acceptable. On a rise above cooling setpoint of the room thermostat, open the chilled water valve. On a fall to cooling setpoint of the room thermostat, close the chilled water valve.

CONDENSER WATER SYSTEM

Condenser Water Pumps (CWP-1, CWP-2)
CWP-1 is designated as the primary pump to serve CH-1. CWP-2 is designated as the primary pump to serve HX-1.

Pump Variable Frequency Drives shall be modulated to provide the flow required by the Heat Exchanger Loop or the Chiller Condenser Loop. The Heat Exchanger Loop flow is the cold side flow scheduled for HX-1 in approved submittals for the heat exchanger. The Chiller Condenser Loop flow is the sum of the flows of the operating condensers as scheduled in the approved submittals for the chiller.

Head Pressure Control Valves
Head Pressure Control Valves shall modulate as required to maintain chiller head pressure as low as possible and above the chiller manufacturer's required minimum pressure. Measure head pressure or differential pressure between evaporator and condenser as required to provide satisfactory high efficiency operation. On a fall in head pressure, the valves shall modulate to allow more bypass loop water. On a rise in head pressure, the valves shall modulate to allow more lower loop water.

Cooling Towers (CT-1, CT-2)
When HX-1 is not operating, the cooling tower fans shall operate and modulate as required to maintain chiller head pressure as low as possible and above the chiller manufacturer's required minimum pressure. Measure head pressure or differential pressure between evaporator and condenser as required to provide satisfactory high efficiency operation. On a fall in head pressure, the fans shall modulate slower, or turn off. On a rise in head pressure, the fans shall modulate faster.

When HX-1 is operating, the cooling tower fan or fans shall operate to maintain the lowest leaving water temperature that does not cause operation of the tower coil basin heaters, or that supplies the required leaving chilled water temperature, whichever is warmer.

Both tower cells shall operate for CH-1 and one tower cell shall operate for HX-1.
On a call for tower operation, the isolation valves associated with the cell, shall open and remain open while there is flow to the cell. Valves shall be closed while the cell is idle. An automatic lead-lag sequencing routine shall equalize running time between the cells. Hours of operation shall be recorded.
Bleed solenoid valve shall open whenever its associated cell is in use.

Valve Timing
Controls contractor shall submit, for approval by the Engineer, a detailed, timed sequence of events for opening and closing valves in coordination with starting and stopping of pumps, chiller, heat exchanger, and cooling towers. Sequence shall include: start of chiller, shutting down chiller plant. This sequence shall include each discrete event, control action and expected feedback, and be approved by the manufacturers of the controlled devices, in writing, before submission to the Engineer.

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 - MECH., ELEC., PLUMB. ENGINEER: CROMWELL ENGINEERS INC.
 - SUSTAINABLE CONSULTANT: BNIM / ELEMENTS
 - GLOBAL VILLAGE CONSULTANT: CAMBRIDGE SEVEN ASSOCIATES
 - INTERIOR DESIGNER: POLK STANLEY YEARY
 - GENERAL CONTRACTOR: CDI

GENERAL NOTES:

NOTES:

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CORE/SHELL PACKAGE #5

REVISIONS:

#	DATE	DESCRIPTION
A	1-16-04	ADDENDUM #1
A	7-1-04	PACKAGE 7, 100% ROLL UP

HEIFER INTERNATIONAL CENTER OFFICE BUILDING
LITTLE ROCK, ARKANSAS

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