

MCS-B Chiller V8 Software Sequence of Operations

- At startup the MCS-B verifies the 'NO RUN CAPACITY CONTROL STATES'. (See Appendix A)
- If any one of the 'NO RUN CAPACITY CONTROL STATES' is not satisfied the following sequence occurs:
 - All compressors are not allowed to run. Any running compressor which has satisfied it's minimum runtime (setpoint #64) will have it's liquid line solenoid turned off and the evaporator pump down and compressor turned off.
 - The chilled water pump continues to run for 60 seconds (setpoint #108 "PMP OFF DELAY") after the last compressor is turned off.
 - If all of the 'NO RUN CAPACITY CONTROL STATES' are satisfied, the capacity control logic is now allowed to run to maintain the Chiller target within the control zone defined by:
 - Setpoint #1 "Supply Temp."
 - Setpoint #2 "Ctrl Zone"
 - Setpoint #3 "Ctrl Zone"
 - The Capacity control logic will increase or decrease the compressors WANTED ON versus ACTUAL ON and maintain the compressors required. Capacity control logic for loading & unloading the chiller is as follows:
 - If the Chilled Water Out temperature is above the target and the Chilled Water Rate Of Change (ROC) is not indicating the water temperature is already decreasing at a sufficient rate the chiller's capacity control logic will ask for more capacity by adding to the "Steps Wanted On" parameter. Once "Step Wanted On" parameter has been increased the capacity control logic has a time delay before allowing the "Steps Wanted On" to be increased again. The time delay is depend on how far away the temperature is from target, setpoints #25 "STEP SENSIT" and setpoint #26 "STEP DELAY"
 - Or if the ROC is indicating a sufficient decrease in Chiller Water Out Temperature (ROC < setpoint #27 "MAX ROC-") the capacity control logic stops loading and holds the current capacity.
 - If the chilled water out temperature is in the control zone special logic functions to keep the chiller within the control zone.
 - If the chilled water out temperature is below the control zone and if the Chilled Water Rate Of Change (ROC) is not indicating the water temperature is already increasing at a sufficient rate the chiller's capacity control logic ask for less capacity by subtracting from the "Steps Wanted On" parameter. Once "Step Wanted On" parameter has been decreased the capacity control logic has a time delay before allowing the "Steps Wanted On" to be decreased again. The time delay is depend on how far away the temperature is from target, setpoints #25 "STEP SENSIT" and setpoint #26 "STEP DELAY"
 - Or if the ROC is indicating a sufficient increase in Chiller Water Out Temperature (ROC < setpoint #27 "MAX ROC-") the capacity control logic stop unloading and holds the current capacity.
 - Once it has been determined that a compressor is wanted on the MCS-B reviews the 'NO RUN CIRCUIT CONTROL STATES' for an available compressor (See Appendix B). The MCS-B Chiller V8 software runs its compressor control logic every second starting with the lead compressor. If the compressor is allowed to run (not locked out or tripped on a safety or disabled by pump down and/or flow switches) and the MCS-B wants the compressor to run ("Steps Turned On" is less than "Steps Wanted On") the compressor is started.
 - The condenser fan control logic runs once every second. Pumps and fans are cycles based on the compressor's discharge pressure and setpoint #45 to #44.
 - The Capacity State & Circuit/Compressor State can be viewed via the 'CONTROL STATUS' option under the 'SERVICE DIAGNOSTIC' key on the LCD display or using PC-Connect on a Windows based computer.

Appendix A

MCS-B Chiller V8 No Run Capacity Control States

There are a number of functions that will not allow the Chiller to run, as follows: (These may be viewed by pressing the 'SERVICE DIAGNOSTIC' key and when the display read 'CONTROL STATUS' pressing the ENTER key)

- UNIT IN POWER UP-
The MCS-B Chiller V8 software utilizes setpoint #23 "Power Up Delay" (Typically 60 seconds) prior to starting the algorithm.
- RUN/STOP SW OFF-
(Optional)- Hard wired to a sensor input.
- NETWORK SW OFF-
(Optional)- This is wired via a communications port from a BMS system.
- OFF- NO EVAP FLOW-
Flow switch input is not made. If the pumps are controlled by the MCS controller the sequence is as follows:
 - The Primary Chilled Water pump, as defined in setpoint #106 "Lead Pump", is turned on (Pump control is an optional feature) and proof of flow is not indicated by the Flow sensor input turning ON within 30 seconds (setpoint #105) of starting the CW pump a "Pump Failure #1" alarm is generated.
 - The backup chilled water pump (optional feature) is started. If the backup Chilled Water Pump fails to establish proof of water flow a "Pump Failure #2" alarm is generated and the chiller is turned off on no flow.
- NO RUN-I/O LOST-
Communications to the Input and Output expansion boards is checked once every second. (Visual verification can be made by viewing the 'MCS I/O' LED next to the communications terminal block.) If communications is lost to any board the entire chiller is shut down & locked out and a "LOST I/O SHUTDOWN" alarm is generated. The user is required to correct the communication lost and press the Lockout Reset button on the MCS-B's Keypad.
- UNIT IN LOCKOUT-
This state is entered whenever a critical situation is encountered that could cause harm to the chiller package. Items such as freeze protect, no flow, invalid critical sensor and emergency stop will force the system into this state. Lockouts can be reset without authorization from the keypad or PC-Connect program; however if the lockout condition has not been corrected, the system will again be forced into the LOCKOUT state. In this state, all RO's except ALARM RO and the oil heater RO for screws with an oil pump are turned OFF & placed in the "LOCKOUT" state.
- SCHEDULED OFF-
This state is entered when THE SCHEDULE IS CALLING FOR THE CHILLER TO BE OFF.
- AMBIENT OFF-
This state is entered whenever THE AMBIENT FALLS BELOW THE low amb off SETPOINT # 24 OR IS ABOVE THE high amb off SETPOINT # 26. The system will remain in this state until the temperature changes + 5.0 F or 2.5 C.

Appendix B

MCS-B Chiller V8 No Run Circuit Control States

There are a number of functions that will not allow a circuit to run, as follows: (These may be viewed by pressing the 'SERVICE DIAGNOSTIC' key and when the display read 'CONTROL STATUS' pressing the ENTER key. Press the INCREASE key to view each circuit. An arrow appears on the circuit that is the current lead.)

1. CMP LOCKED OUT-

This state is entered when the Capacity Control State is LOCK OUT or a safety setpoint for this circuit has indicated that a critical situation has been encountered. Setpoints such as (LOW SUCTION #71) or (HI DISCH PSI #81) are examples of safety setpoints. Lockouts can be reset without authorization from the keypad or PC-Connect program; however if the lockout condition has not been corrected, the circuit will again be forced into the LOCKOUT State.

2. LOST IO LOCKED

This state is entered when the Capacity Control State is LOST IO. Lockout reset key will move the circuit to the OFF state. Lockouts can be reset without authorization from the keypad or PC-Connect program; however if the lockout condition has not been corrected, the circuit will again be forced into the LOCKOUT State.

3. SAFETY TRIPPED

This state is entered when a safety trips but a lockout is not to be generated. An alarm is generated but the system will restart after the delay specified in the corresponding setpoint. If a second trip occurs within the time specified in the setpoint, the circuit will be placed in the CMP LOCK EDOUT State.

4. CMP OFF/READY

This state is entered when no cooling capacity is required from this circuit or the prior state was CMP ANTICYCE, LOST IO LOCKED or SWITCHED OFF. In this state the circuit is ready to provide cooling capacity if needed. The system will remain for a minimum delay of 60 seconds in this state.

5. CMP PMP DOWN

This state is entered whenever the pump down switch has been turned on or if this circuit is no longer wanted on. The compressor is on and the liquid line solenoid is closed. This state is active until the suction pressure reaches the value in the setpoint 61, PMP DWN OFF or the time has exceeded the value in the setpoint 62, PMP DWN DELT. The circuit will then move to the ANTICYC State.

6. CMP ANTICYCE

This state exists when the PMP DWN State has been completed. The circuit will stay in this state with all circuit points off for the period of time contained in setpoint 54, ACYC ON TO ON or setpoint # 63 ACYC OFF TO ON. The circuit will then move to the OFF State.

7. SWITCHED OFF

This state is entered after the circuit has been pumped down due to the circuit pump down / disable switch being on or if the circuit flow switch is off. In this state the compressor, and all related points, plus the liquid line are off. The circuit will not leave this state unless the pump down switch is turned off. If the pump down switch is turned off, the circuit-state will be changed to the OFF State.

Appendix C

MCS-B Chiller V8 Run Chiller Control States

The loading & unloading logic in the MCS-B is as follows: (These may be viewed by pressing the 'SERVICE DIAGNOSTIC' key and when the display read 'CONTROL STATUS' pressing the ENTER key. Press the INCREASE key to view each circuit. An arrow appears on the circuit that is the current lead.)

1. UNIT IS OFF

This state is entered when the system has moved from a STARTUP, DISABLE, LOCKOUT or LOST I/O state. The chiller is now ready to move into an active state to meet the capacity required.

2. UNIT IS HOLDING

This state is entered when one of three conditions exists:

- The control sensor reading is being maintained with in the control zone.
- Control sensor reading is above the control zone but the Rate of Change is less than the value in the (MAX ROC-, #27) setpoint. This indicates that the temperature is decreasing toward the target at an acceptable speed. Therefore, no additional cooling is needed at this time.
- The temperature is below the control zone but the Rate of Change is greater than the (MAX ROC+, #28) setpoint. This indicates that the temperature is increasing toward the target. Therefore, no reduction in cooling is needed at this time.

This state indicates that there is no need to add or subtract the cooling capacity of the chiller package. This state will be exited when more or less capacity is required.

3. UNIT IS LOADING

This state is entered when more capacity is required. Every second an adjustment is made to the step delay. When the delay reaches zero, the counter 'steps wanted on' is increased by 1.

4. UNIT IS LOADED

This state is entered when all of the systems available capacity steps are on. The package is providing the maximum amount of cooling capacity.

5. UNIT UNLOADING

This state is entered when less capacity is required. Every second an adjustment is made to the step delay. When the delay reaches zero, the counter 'steps wanted' on is decreased by 1.

6. UNIT IS UNLOADED

This state is entered when all of the systems available capacity steps are off. The package is providing no cooling capacity, as none is required. The system is ready to react to cooling needs.

Appendix D

MCS-B Chiller V8 Run Circuit Control States

The loading & unloading logic in the MCS-B is as follows: (These may be viewed by pressing the 'SERVICE DIAGNOSTIC' key and when the display read 'CONTROL STATUS' pressing the ENTER key. Press the INCREASE key to view each circuit. An arrow appears on the circuit that is the current lead.)

1. CMP ANTICYCE

This state is entered when the PMP DWN State has been completed. The circuit will stay in this state with all circuit points off for the period of time contained in setpoint 54, ACYC OFF TO ON and setpoint 63, ACYC ON TO ON. The circuit will then move to the OFF State.

2. SWITCHED OFF

This state is entered after the circuit has been pumped down due to the pump down switch being on or if the circuit flow switch is off. In this state the compressor, and all related points, plus the liquid line are off. The circuit will not leave this state unless the pump down switch is turned off. If the pump down switch is turned off, the circuit-state will be changed to the OFF State.

3. FAST UNLOADING SCREEN ONLY (M P S)

For screw compressors, this state is entered when the compressor is turned on. The system will remain in this state for 30 seconds or if CHL M for the time contained in setpoint #15 while the "fast unloader" and unload points are on. This is to ensure that the screw is unloaded.

4. OIL PUMP LUBING SCREEN ONLY (C H O P S)

Only screw compressors with oil systems use this state. The following conditions must be meant within the time allocated in the setpoint LUBE DELAY or an alarm will be generated and the CMP LOCKED OUT state is entered: The oil pump is started and the unload solenoid is turned on.

If a fast unloader is available it is turned on.
If a fast unloader is available the compressor is turned on, 30 seconds later if the oil temperature is > than the LUBE OIL TMP, setpoint #34 and the oil pressure is > than the LUBE OIL PSI, setpoint #40.
If there is not a fast unloader, the compressor is turned on 120 seconds later if the oil temperature is > than the LUBE OIL TMP, setpoint #34 and the oil pressure is > than the LUBE OIL PSI, setpoint #40.
The oil heater will be turned on if needed.

When the above conditions have been satisfied, the screw compressor will be started and the state will be moved to the CMP IS HOLDING State.

5. UNLD/HGBP OFF (R)

This state can only be entered for fixed step capacity compressors with a HOT GAS BYPASS solenoid. In this state the HOT GAS BYPASS solenoid is off and all unloaders in the circuit are on.

6. CMP IS LOADING SCREEN ONLY (C O S P)

For infinite step compressors, this state is when the load solenoid is being pulsed to increase the cooling capacity of the circuit. The duration of the pulse is specified in the setpoint 37, LOAD PULSE.

7. PART LOADED (I R)

This state only exists for fixed step compressors with two unloaders. This state is when the HOT GAS BYPASS solenoid, if it exists, is off, the first unloader solenoid is off and the second unloader solenoid is on.

8. CMP IS HOLDING SCREEN ONLY (C H O P S)

This state only exists for infinite step compressors. In this state, the required refrigeration capacity of system is being meant; no movement of the slide valve is required.

9. CMP IS AT 40% SCREEN ONLY (M)

This state is when the compressor is providing 40% of its capacity. In this state, the relay output to activate the 40% valve is turned on.

10. CMP IS AT 70% SCREEN ONLY (M)

This state is when the compressor is providing 70% of its capacity. In this state, the relay output to activate the 70% valve is turned on.

11. CMP IS AT 100% (all software releases)

This state is when the compressor is fully loaded. In this state, the circuit is providing the maximum amount of cooling capacity.

12. CMP IS UNLDING SCREEN ONLY (C H O P S)

For infinite step compressors, this state is when the unload solenoid is being pulsed to reduce the cooling capacity of the circuit by moving the slide valve. The duration of the pulse is specified in setpoint 38, UNLOAD PULSE.

13. CMP UNLOADED (all software releases)

For infinite step compressors, this state is when the slide is fully unloaded (indicated by unloaded input or after the unloader is pulsed 30 seconds with no change). For fixed step compressors, this state is when the compressor is on and fully unloaded. In this state the compressor is supplying its minimum cooling capacity.

14. HI DISC UNLOAD SCREEN ONLY (C H O P S)

Refer to setpoints numbers 81, HI DISCH PSI; 82, HI DISC UNLD; 83, HI DISC RELD; 87, HI DISCH TMP; 88, HI DISCH UNLD; and 84, HI DISCH RELD.

Infinite step compressors only: The capacity is being unloaded due to a high discharge pressure or high discharge temperature. The compressor will stay in this state until the pressure or temperature has dropped below the corresponding setpoint. The system will then move to the HI DISC HOLD state.

15. HI DISC HOLD (all software releases)

Refer to setpoints numbers 81, HI DISCH PSI; 82, HI DISC UNLD; 83, HI DISC RELD; 87, HI DISCH TMP; 88, HI DISCH UNLD; and 84, HI DISCH RELD.

Fixed Step Compressors -

This state is entered when a fully loaded circuit, that has more than one step, has encountered either a dangerously high discharge pressure or discharge temperature. One step of cooling capacity will be turned off. The circuit will remain in this state for a minimum of five minutes before returning to the LOADED state if the dangerous condition has been corrected.

Infinite Step Compressors -

When capacity is being held due to a high discharge condition, once the discharge goes to normal operating condition the circuit will return to its appropriate state.

16. HI DIS TMP HLD (I M R)

Refer to setpoints numbers 87, HI DISCH TMP; 88, HI DISCH UNLD; and 84, HI DISCH RELD.

This state is entered when a fully loaded circuit, that has more than one step, has encountered a dangerously high discharge temperature. One step of cooling capacity will be turned off. The circuit will remain in this state for a minimum of five minutes before returning to the LOADED state if the dangerous condition has been corrected.

17. LO SUCT UNLOAD SCREEN ONLY (C H O P S)

Refer to setpoints numbers 77, LOW SUCTION; 78, LO SUCT UNLD; and 79, LO SUCT RELD.

Infinite step compressors only: The capacity is being unloaded due to a low suction pressure. The compressor will stay in this state until the suction pressure has is above the critical value. The system will then move to the LO SUCT HOLD State.

18. LO SUCT HOLD (all software releases)

Refer to setpoints numbers 77, LOW SUCTION; 78, LO SUCT UNLD; and 79, LO SUCT RELD.

Fixed Step Compressors -

This state is entered when a fully loaded circuit, that has more than one step, has encountered a dangerously low suction pressure. One step of cooling capacity will be turned off. The circuit will remain in this state for a minimum of five minutes before returning to the LOADED state if the dangerous condition has been corrected.

Infinite Step Compressors -

When capacity is being held due to a low suction pressure condition, once the suction pressure returns to a normal operating condition the circuit will return to its appropriate state.

19. LO TMP UNLOAD SCREEN ONLY (C H O P S)

The circuits leaving liquid temperature has caused the system to unload. When the leaving liquid temperature gets to within 1.5 degrees F of the Freeze setpoint, the unload occurs before we hit the freeze protect safety.

20. LO TMP HOLD (C M O R S P)

Reload from the LO TMP UNL occurs when we are 3.0 degrees F above the freeze setpoint. Until we reach this point the system will remain in the LO TMP HOLD State.

21. HI AMP HOLD (I M R)

Not used with infinite step compressors. This state is entered when a fully loaded circuit, that has more than one step, has encountered a dangerously high AMP draw. Refer to setpoints numbers 65 through 72 for FLA per circuit and 75 HI AMPS %. In this state, one step of cooling capacity will be turned off. The circuit will remain in this state for a minimum of five minutes before returning to the LOADED State if the dangerous condition has been corrected.

Note: Following the state names are indicators as to which MCS-B Chiller V8 software versions support the state:

C = CHL C software, Centrifugal Compressors
H = CHL H software, Open Drive Screw w/Heat Reclaim system.
I = CHL I software, Ice Making Machine system
M = CHL M software, Mitsubishi Screw Compressor system
O = CHL O software, Open Drive Screw Compressor.
P = CHL P software, Semi-Hermetic Screws Compressors w/Voltage Control
R = CHL R software, Recip & Scrolls (fixed steps) Compressors
S = CHL S software, Semi-Hermetic Screw Compressors

1. MCS-B LINC V4 Sequence of Operation

1.1. General Information

The LINC V4 MCS-B unit control has been designed to provide easy to understand user interface via the on board key pad and LCD display or via the PC-COMM program running on a Window based PC. The status/control state of the unit, of the pumps and stages of cooling or heating is displayed. The control states are defined in defined in this manual.

Setpoints can be changed in a live unit with the proper authorization. This provides the user with flexibility to change parameters during the commissioning or during the running of a live unit. The setpoints are defined in defined in this manual.

The system will support up to five loops and control each loop independently. Each loop will have its own:

- Pumps or fans can be selected and the loop states name will be changed to match the selection,
- Run/stop switch, run override (occupancy) indicator,
- Individual schedule options can be selected,
- Up to four pumps with one variable speed with its control sensor,
- Up to sixteen stages of cooling with one variable speed,
- Up to sixteen stages of heating with one variable speed,
- Up to sixteen stages of ice making are available,
- Either cooling or ice making can be selected plus the heating stages,
- The controlling sensor for the stages of heating and cooling-ice making can be different sensors or the same,
- Each pump will have its own sensor to indicate a pump failure.

1.2. System Overview

Unless there is a problem with the MCS-B I/O network or the unit's emergency stop indicator is on, the unit will be in the UNIT-NORMAL RUN, in this state each loop will be controlled independently. If the unit state is not normal, no control of the individual loops will be executed.

The individual loops will be controlled based upon the various options that have been selected.

1.3. Schedule Options

The loop control logic has been designed to provide maximum flexibility in the scheduling of each individual loop. The following options are available:

1. DoW SCH/ON, this option will first check the day of week schedule for the loop as specified in the PC-Config program. If this option is set to:




- ON ALL DAY, the schedule will be true for that day;
- OFF ALL DAY, the schedule will be false for that day;
- DoW SCH/ON, the associate setpoints for this loop (setpoints 15, 37, 54, 81 or 103 for beginning of the first schedule and setpoints 16, 38, 60, 82 or 104 for the duration of the first schedule and setpoints 17, 39, 61, 83 or 105 for beginning of the second schedule and setpoints 18, 40, 62, 84 or 106 for the duration of the second schedule) will be tested to determine if the schedule is true or not. Note a schedule can extend into the next day.

2. PEAK/OFF, this option will look only at the Peak Hour Flags that have been set in the PC-Config program. If the time is one of the peak hours the schedule will be false and the Loop State will be LOOP STOP PEAK. If the current time is with in ten minutes of the first peak hour, the schedule will be false and the Loop State will be LOOP PRE PEAK. If the current time is with in the first ten

RECORD DRAWINGS

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