McQuayService
SnyderGeneral

Service Manual

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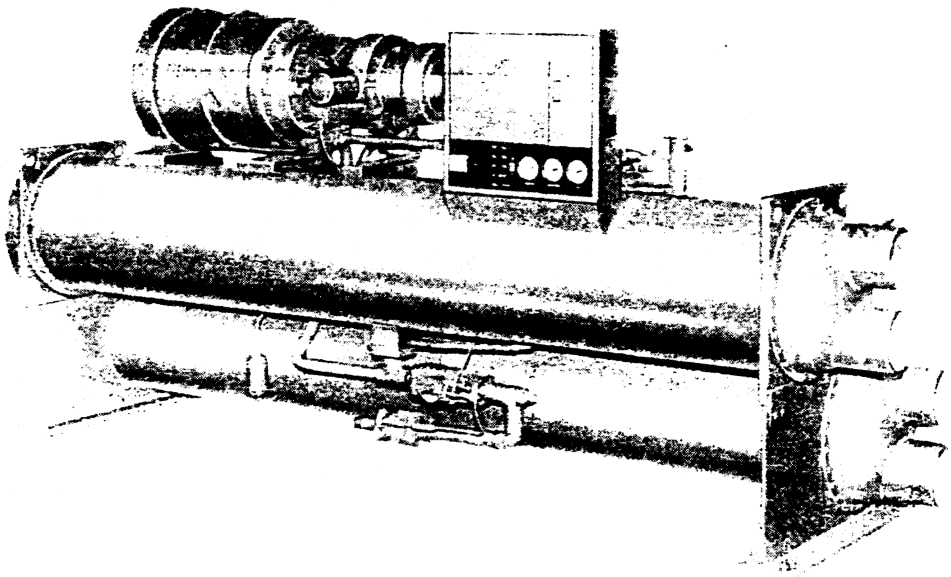
McQuay Centrifugal System Check-out and Start-up Manual



CONTENTS

CAUTION: The following information is intended as a guide for use by persons with a sound basic knowledge of air conditioning equipment, mechancial systems, and electrical wiring and control. Attempts by untrained persons to start, operate and service this equipment can result in personal injury or death, or equipment failure.

The contents of this manual are not intended as a substitute for basic training.

Further, if the unit is equipped with microprocessor controls, solid-state overloads, or starters, ask for and read instructions for operating those devices also. Examples of instructions include:

IM 403 . . . . . MicroTech Control Panel
IM 392 . . . . . IQ-1000

A. GENERAL

The McQuay centrifugal water chiller start-up technician has the responsibility to determine whether or not the unit installation conforms to McQuay specifications for installation. This includes piping, electrical and control installations related to unit. These items must, as a minimum, meet acceptable industry standards. All factory supplied unit controls and valves must be set and, where required, calibrated as specified in Tables 3 and 4. Electrical wiring to the unit must be of adequate size as specified in McQuay wire and fuse sizing information or the National Electrical Code. In addition, conductors between the control power source and the control center must conform to the size indicated in Table 2 for the conductor length required by the installation. All interlock connections between the unit and motor starter, the condenser pump motor starter, and chilled water pump motor starter, flow and/or differential pressure switches and the oil cooler solenoid valve must be made to the unit control panel. The use of an alarm relay or light connection to the panel is at the option of the owner.

It is the responsibility of the McQuay sales representative to verify that all items on the McQuay centrifugal chiller start-up checklist are complete and the system is ready for start-up. If on arrival at the jobsite, the system is not ready and does not conform to the items checked on the start-up checklist, the technician should immediately relay the information to his supervisor and request direction on how to proceed.

B. START-UP ASSISTANCE

The technician must establish contact and meet with the following people and/or their designated representatives:

1. Mechanical contractor
2. Electrical contractor
3. Control contractor
4. McQuay's customer (purchaser that issued purchase order to McQuay for the equipment if it is not the mechanical contractor).

NOTE: The individuals specified in items 1 through 4 above have the responsibility to assist you in the start-up procedure; however, your initial contact has to be McQuay's customer.

C. RESPONSIBILITY OF OTHERS

The various trades associated with the installation have the responsibility to provide the following in accordance with applicable codes and acceptable practices for the trade involved:

1. Correct wire type, size and installation.
2. A power supply adequate for the compressor motor and the unit control panel.
3. All interlock connections to the unit and/or control panel as indicated on the schematic diagram.
4. All towers, pumps, interconnecting piping and fans in proper operating condition and a water system flushed, filled and ready for permanent operation.
5. Chiller, condenser and water cooled oil cooler with pressure rating adequate for the system involved. High rise installations may require vessels rated for water side working pressures above the standard rating of 150 psig.
6. Adequate condenser/cooling tower head pressure control.
7. An adequate load for the system to permit unit checkout and operation. A compressor load of at least 30 percent will be required. Where insufficient load exists on the job, it may be possible to supplement it with the building heating system. If an adequate load is not available, check with your supervisor.
8. A completed and signed McQuay checkoff list.
9. Relief valve piping for the chiller, condenser and oil pump. See installation instructions applicable to unit model being check out.

NOTE: Once the technician is on the job and delays caused by the performance of others are encountered, extra time required may be billable. Contact your supervisor for direction.

D. MAKE AN INITIAL INSPECTION OF THE INSTALLATION

Check the following:

1. CHECK ALL PIPING. Make sure water flows through the chiller(s) and condenser(s) are correct. The production period and size of unit will determine the correct direction of flow for the water chiller vessel. Old style chiller vessel nameplates carried a "TC" prefix on the nameplate in the model number box. These vessels require chilled water IN AT THE TOP and OUT AT THE BOTTOM. Later design model numbers stamped on the nameplate incorporate a twelve (12) digit model number which includes the prefix letter "E". Vessels so identified require water flow IN AT THE BOTTOM and OUT AT THE TOP.

   NOTE: Condensers, regardless of when they were produced, will require water flow IN AT THE BOTTOM and OUT AT THE TOP.

2. CHECK THE WATER PIPING SYSTEM (for completeness of the connections). This check will include the tower, all piping specialties, cooling coil connections, chiller and condenser water pumps. On systems where a solenoid valve is opened or closed by the system control in order to regulate water flow to the cooling coil, be sure there is a bypass provided for those periods when flow through the coil is shut off.

3. CHECK THE LOCATION OF FLOW SWITCHES (or differential pressure switches). All flow switches must be installed on the outlet of the vessel a minimum of 6 pipe diameters from any elbow or other pipe fitting. Turbulent flow may occur at these fittings and a flow switch located close to the fitting could cause nuisance tripouts.

   Differential pressure switch connections should be made across the vessel they protect.

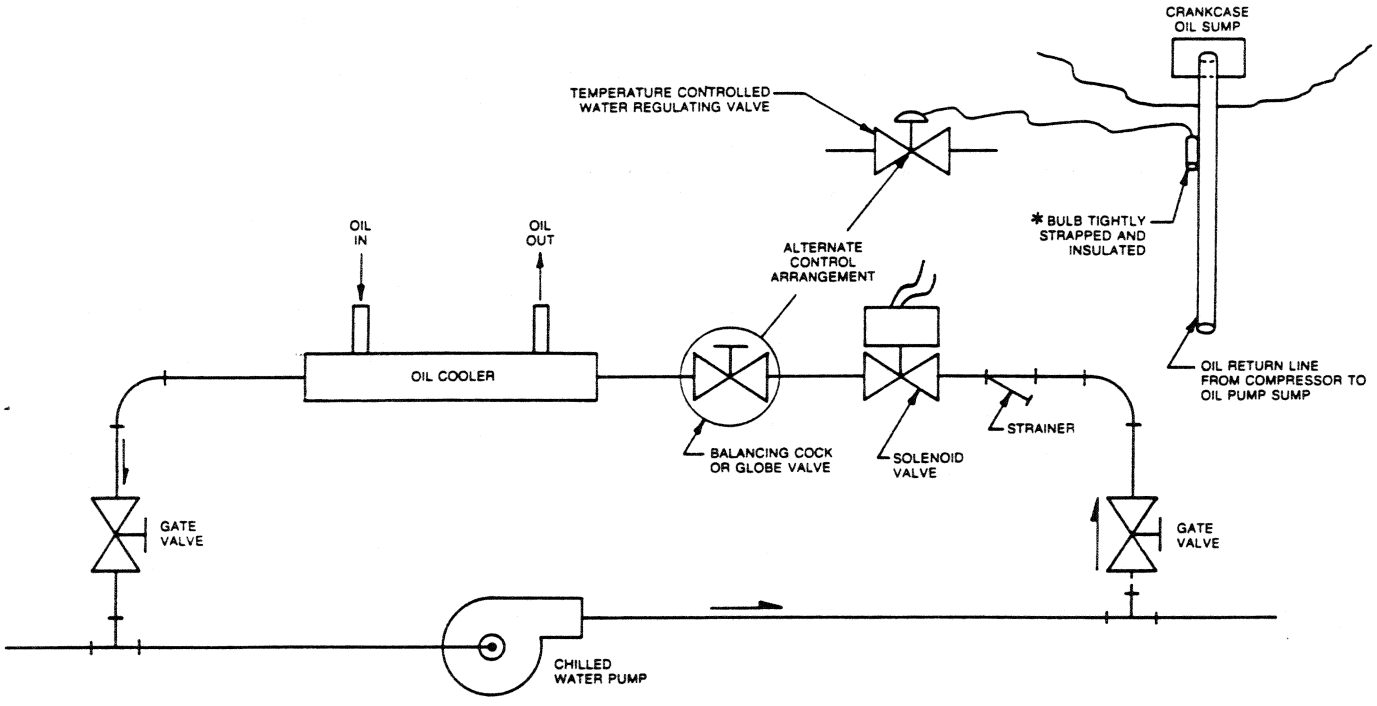
4. CHECK OIL COOLER PIPING. The oil cooler water piping must, as a minmum, include a water strainer, solenoid valve, balancing valve and water and oil flow through the cooler in the proper direction. For proper servicing two shutoff valves should also be included to permit isolating the oil cooler water circuit. If chilled water is being used for oil cooling, THE PREFERRED METHOD IS TO PIPE THE OIL COOLER ACROSS THE CHILLED WATER PUMP, except that piping across the chiller vessel is acceptable if the pressure drop at design water flow across the chiller vessel is equal to or greater than the values shown in Table 1.

Table 1. Minimum pressure drop across the water chiller vessel

COMPRESSOR SIZE	*MINIMUM CHILLER PRESSURE DROP (PSIG)
CE063	5
CE079	5
CE087	5
CE100	6
CE126	9

*The table values for chiller pressure drop are the minimum allowable when the water circuit for the oil cooler is to be piped in parallel with the chiller vessel water circuit. Pressure drops below these values may not provide adequate water flow through the oil cooler.

FIGURE 1. SUGGESTED OIL COOLER WATER PIPING



NOTE: Check that water and oil flows thorugh the chiller are correct.

*The water regulating valve's bulb may also be fastened to the oil line leaving the oil cooler, entering the compressor filter. In either case, the valve should be adjusted to maintain approximately 90°F to 110°F cooled oil temperature.

5. ELECTRICAL CHECKS
   a. Use McQuay wire and fuse sizing information (WS-SVT6). The following must be checked:
      1) Power conductor size entering the disconnect switch.
      2) Conductor sizes between the disconnect switch and starter.

         NOTE: If sizes of conductors do not comply with sizes determined from McQuay wire sizing information (WS-SVT6), do not confront customer. Check with your supervisor for direction.

      3) Conductor sizes between the starter and compressor motor.
      4) Conductor size supplying the unit control center. The conductor must be sized for a maximum voltage drop of 3 percent; the control center ampacity is 20 amperes at 115 volts. Recommended conductor sizes for various conductor runs are shown in Table 2.

Table 2. Maximum conductor length*

MAXIMUM CONDUCTOR LENGTH (FT.)	WIRE SIZE AWG	MAXIMUM CONDUCTOR LENGTH (FT.)	WIRE SIZE AWG
0 — 50	12	120 — 200	6
50 — 75	10	200 — 275	4
75 — 120	8	275 — 350	3

*Maximum length is distance the conductor will traverse between the control power source and the unit control panel. Wire size is based on a voltage drop not to exceed 3 percent.
Panel terminal connectors will accommodate conductors up to #10 AWG. Larger conductors will require an intermediate junction box.

NOTE: Be sure the wire sizing is correct for the temperature rating and material (copper or aluminum) for the wire being used. The conduit size should also be checked to be sure it is adequate for the number and size conductors being used.

CAUTION: If a discrepancy in the conductor sizing is encountered, DO NOT confront the contractor. Report it to your supervisor for guidance on how the problem should be handled.

   b. CHECK FUSE AND/OR CIRCUIT BREAKER SIZING.
      1) Fuses can be checked from wire and fuse sizing information. See Service Training Manual WS-SVT6.
      2) Circuit breaker maximum settings will vary with the type of breaker and type of starter being used.
         a) Full voltage, Star/Delta, resistor or reactor type starting.
            - Inverse time breaker — 250% of motor full load amperes.
            - Instantaneous trip breaker — 700% of motor full load amperes.
         b) Autotransformer starter.
            - Inverse time breaker — 200% of motor full load amperes.
            - Instantaneous trip breaker — 700% of motor full load amperes.

   c. CHECK THE STARTER.
      1) Tighten all high and low voltage connections.
      2) Remove arc shields over the contacts. Manually verify that contactors operate smoothly and that contacts are in good condition. Where contactors are mechanically interlocked to prevent simultaneous pull-in, check that the interlock is functioning. Be sure the arc shields are in place on the contactor prior to checking the mechanical interlock.
      3) Check that power supply conductors are routed through the ammeter current transformers (if ammeters are supplied).
      4) Remove any debris from the starter.

   d. CHECK AND TIGHTEN ALL ELECTRICAL CONNECTIONS IN THE UNIT CONTROL PANEL, LUBE BOX, AND OIL PUMP. Do not accept the electrician's hookup. Disconnect the compressor motor leads at the starter and check that the motor leads are connected to the right terminals in the starter and marked for connection to the correct terminals on the motor. Ring out and mark each lead. When finished DO NOT RECONNECT THE MOTOR LEADS TO THE STARTER. ALSO, WHERE APPLICABLE, DO NOT PUT DASHPOT FLUID IN THE OVERLOAD RELAYS UNTIL DIRECTED LATER.

Table 3. Safety and operating control settings

COMPONENT IDENTIFICATION	REFRIGERANT TYPE	
	R-12	R-500
High Pressure Cutout Switch (HP) — Manual Reset	See Note 1	See Note 1
Low Pressure Cutout Switch (LP) — Manual Reset	31 psig	39 psig
Low Pressure Override Switch (LPO) — Auto Reset	34 psig	42 psig
High Suction Temperature Thermostat (HST)	125°F	125°F
Oil Pressure Differential Switch (OD) — Adjustable	See Note 2	See Note 2
Oil Pump Time Delay (OTD) — Adjustable	20 — 30 sec.	20 — 30 sec.
Oil Pump Safety Timer (OPT) — Adjustable	60 sec.	60 sec.
Prelube Timer (PLT) — Non-adjustable Preset	20 — 30 sec.	20 — 30 sec.
Vane Close Differential Switch (VC) — Adjustable	55 psig differential	55 psig differential
Load Recycling Thermostat (LRT) — Setting below design leaving chilled water temp.	3 — 5°F	3 — 5°F
Anti-Recycling Time Delay — Non-adjustable Preset	20 min.	20 min.
Transition Protection Relay (TRP) (See Note 3)	1.5 sec.	1.5 sec.
CONTROL MODULE CALIBRATIONS		
Current Limit	Set at motor nameplate rated load amperes	
Temperature	Leaving chilled water as specified °F	
Ramp-up Time	As required by installation	
Gauges	Check and calibrate	

NOTES:
1. High pressure cutout setting is based on saturated discharge pressure shown on the unit shop order data plus (+) 15 psig.
2. Oil pressure setting on the oil pressure differential switch is based on net oil pressure. On all compressor sizes the switch must be set to open at a differential pressure of 50 psig and close at 55 psig.
3. Transition Protection Relay (TRP) — Located in Star/Delta closed transition type starters protect transition resistors if Star to Delta transition is not completed in 1.5 seconds.

E. PREPARE CENTRIFUGAL CHILLER FOR START-UP

1. CALIBRATE AND SET all safety and operating controls(where applicable) as covered in Table 3.

2. LEAK CHECK. If unit pressure gauges show pressure, proceed to leak check the unit. If no leak is found, move to paragraph 3 following. If no pressure is indicated on the gauges, open the valve on the motor cooling line (located on the bottom of the condenser). Pressure should increase on the gauges. If pressure is now not indicated on the gauges, the unit refrigerant charge has been lost. The leak will have to be located and repaired before proceeding to paragraph 3.

   NOTE: If a MicroTech panel is installed on the unit, service gauges must be installed during startup.

3. CLOSE THE DISCONNECT SWITCH SUPPLYING POWER TO THE UNIT CONTROL PANEL. The power will either be supplied by a separate 120 volt fused power circuit or through a 120 volt circuit provided by a step-down transformer located in and wired into the motor starter. With power available to the control panel, the oil heaters in the oil pump sump and gear casing should be energized. **Check that they are.** These heaters must be energized for a **minimum of 24 hours** before attempting to start the compressor.

   NOTE: Be sure all oil pump valves are open whenever there is power applied to the unit and also be sure that the power conductors from the starter to the compressor motor are disconnected (see paragraph 4).

4. CHECK PHASE ROTATION in the motor starter with a phase meter. (See Section G, paragraph 2.)
   Disconnect conductors at the compressor motor and ring them out before checking the phase rotation. First check the phase rotation on the leads entering the motor starter. With the conductor leads still disconnected at the motor, dry run the starter and check the phase rotation on the conductors at the compressor motor end.

5. CHECK AND ADJUST FLOWS THROUGH THE EVAPORATOR AND CONDENSER.

   NOTE: The same gauge (preferably calibrated) should be used for all water pressure readings. Gauge pressure readings can be converted as follows:

   Feet of water = Psig × 2.31
   Psig = Feet of water × 0.433

F. MAKE A DRY RUN OF UNIT CONTROLS
Unit With Electric/Mechanical Control Panel

(See separate write-up, number IM 403, for microprocessor panel.)

1. Remove the "TDR" relay furnished in the panel and replace it with another time delay relay, Part Number 350A729H02. The replacement relay should be modified by breaking the relay seal and resetting the timing to 5 or 10 seconds. This will prevent nuisance tripping.

   NOTE: On control panels produced from 1982 until roughly 1986, once the MCR relay is energized, remove the replacement time delay relay to prevent short cycling the compressor motor starter. On later panels, leave the replacement time delay relay (reset to 5 or 10 seconds) in the panel while checking the unit out.

2. Apply power to the compressor motor starter and unit control panel. LEADS FROM THE STARTER TO THE COMPRESSOR MUST STILL BE DISCONNECTED.

   CAUTION: If an autotransformer type of starter is used, disengage the starter from the line so that NO POWER can flow through the autotransformers with the motor disconnected.

3. RESET ALL LOCKOUT RELAYS IN THE CONTROL PANEL.

4. TURN ON THE CHILLED WATER PUMP.

5. TURN THE CONTROL PANEL SWITCH TO THE "ON" POSITION. (All oil pump valves must have been opened prior to energizing the oil heaters and 24 hours have elapsed before the switch is turned to "on.") After one minute has elapsed, the prelube timer (PLT) contacts should close and the condenser water pump should start. With the condenser water pump running, the compressor motor starter should be energized.

6. CHECK OPERATION OF ALL INTERLOCKS. It is now possible to safety check the operation of all interlocks without the compressor operating.
   a. MANUALLY STOP THE CHILLED WATER PUMP. The compressor motor starter should de-energize.
   b. DE-ENERGIZE THE CONDENSER WATER PUMP. The compressor motor starter should de-energize.
   c. STOP THE WATER FLOW TO THE CHILLER. The compressor motor starter should de-energize.
   d. STOP THE WATER FLOW TO THE CONDENSER. The compressor motor starter should de-energize.

7. CHECK THE MOTOR STARTER TRANSITION TIME ON STAR/DELTA TYPE STARTERS. The length of time a starter is held in the Star connection can vary from motor to motor. Sufficient time should be allowed in the Star connection to permit the motor to accelerate to the Star running speed. Generally a time setting of twelve (12) seconds should be adequate before the transition to Delta is made.
   When a closed transition starter is used, the transition protection relay should have a setting of 1.5 seconds; this relay is not adjustable and is factory set. The relay must trip in the 1.5 to 2 second range.

   NOTE: The factory manufactured and mounted starters utilized on the PE050/063 and many PF units utilize a new adjustable timer.

8. CHECK THAT CONTACTS "VD" OPERATE. The "VD" contacts must not close until the compressor is connected across the line with full voltage available to the motor. Allow the starter to make the transition to Delta (Star/Delta type). Watch the R4 relay. If R4 energizes, the "VD" contacts linked to the Delta contactor are closed. This check will also apply to the run contactor on an autotransformer starter. A line starter will not have a delay before R4 is energized.

9. VARIABLE SIGNAL RESISTORS LOCATED IN THE COMPRESSOR MOTOR STARTER. The resistor(s) is located in the compressor starter. The resistor(s) is connected across the secondary of the current transformer and must be adjusted to provide a 5 volt signal across terminals 1 and 2 on the control panel terminal strip when the compressor motor is drawing rated load amperes. (RLA as stamped on the motor nameplate.)

   NOTE:
   a. McQuay built starters are provided with two (2) adjustable signal resistors: one rated at 15 ohms and the other at 100 ohms.

b. Starters supplied by McQuay but manufactured by others (such as Westinghouse or Cutler Hammer) can include only one adjustable signal resistor.
c. The procedure for determining the resistance value for the adjustable signal resistor(s) in the McQuay manufactured starter and starters built by others can differ. The method used to calculate the resistor setting for each is illustrated in Sections 10a, 10b and 10c.

10. Following are sample calculations for determining the correct resistance value to set the variable signal resistor(s).

NOTE: The amperage leaving the secondary of any given current transformer is affected by the location of the transformer (whether it is sensing line or phase current), the number of times the power conductor passes through the transformer and the ratio of the transformer (800/5, 400/5, etc.). For example:

If a motor is drawing 400 line amperes, the current transformer ratio is 800/5 and a conductor carrying 400 line amperes passes once through the transformer, the current leaving the transformer will be

$$\frac{5}{800} \times 400 = 2.5 \text{ amperes}$$

If the conductor passing through the conductor is carrying phase amperes (58% of line amperes), the amperage leaving the transformer will be

$$\frac{5}{800} \times 400 \times .58 = 1.45 \text{ amperes}$$

If the conductor makes more than one pass through the transformer, it will cause an increase in amperes leaving the transformer for either of the above conditions in direct proportion to the number of passes the current carrying conductor passes through the transformer.

If we assume the conductor is carrying phase amperes and the conductor makes three (3) passes through the transformer, the value of current leaving the transformer will increase three times as follows:

$$\frac{5}{800} \times 400 \times .58 \times 3 = 4.35 \text{ amperes}$$

NOTE: The value for one pass above was 1.45 amperes.

$$\text{Three passes} = 3 \times 1.45 = 4.35 \text{ amperes}$$

For calculations 10a, 10b and 10c, assume the following information to be used in the calculations.
- Compressor rated load amperes = 200
- A Star/Delta starter is used with six (6) conductors between the motor and starter.
- The current transformer used has a ratio of 800/5.

a. A SINGLE VARIABLE SIGNAL RESISTOR IS CONNECTED ACROSS THE SECONDARY OF THE CURRENT TRANSFORMER. SEE FIGURE 2.

Solution:

1) Amperes carried in each conductor between the starter and the motor. (Each conductor will be carrying phase amperes.) For six conductors, amperes are calculated as follows:

$$\text{Phase Amperes (6 Conductors)} = 0.58 \times \text{RLA}$$
$$0.58 \times 200 = 116 \text{ amperes}$$

2) Verify the current ratio marked on the current transformer installed in the motor starter. There may be more than one current transformer installed in the starter. The correct current transformer will be the one with a variable resistor(s) connected across its secondary.

3) Calculate the resistance value to which the variable signal resistor will be set based on a voltage to the module of 5 volts.

$$\text{Resistor Setting} = \text{Curr. Trans. Ratio} \times \frac{\text{Volts To Module At Full Load}}{\text{Phase Amperes}}$$

$$= \frac{800}{5} \times \frac{5}{116} = 6.9 \text{ ohms}$$

4) Set the variable resistor to a value of 6.9 ohms.

CAUTION: Be sure the centrifugal unit compressor motor starter disconnect switch is open before making the resistor adjustment. NEVER WORK ON THE CURRENT TRANSFORMER OR RESISTOR CONNECTIONS WHILE THE COMPRESSOR IS RUNNING OR THE DISCONNECT SWITCH IS CLOSED. **AN ENERGIZED CURRENT TRANSFORMER WITH AN OPEN SECONDARY IS AN EXTREMELY DANGEROUS PIECE OF ELECTRICAL EQUIPMENT.**

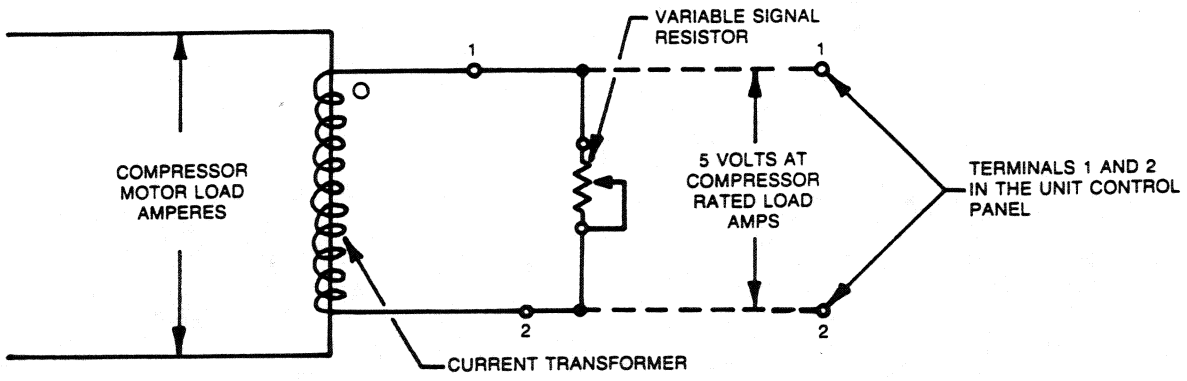
b. STARTER BUILT WITH TWO (2) VARIABLE RESISTORS AND THE UNIT OPERATED WITHOUT LOAD BALANCE. SEE FIGURE 3.

NOTE: Units with wiring as shown in Figure 3 can be adapted to load balance control with another unit or units. See Section C below.

Solution:

1) The resistance value for variable resistor "A" is calculated in the same way as shown in Section 10a above. AGAIN BE SURE THE STARTER

FIGURE 2. SCHEMATIC DIAGRAM FOR STARTERS WITH A SINGLE VARIABLE SIGNAL RESISTOR



DISCONNECT SWITCH IS OPEN BEFORE SETTING RESISTOR "A".

2) If the unit is not going to be operated with one or more units in load balance, adjustment of resistor "B" is not required. DO NOT REMOVE THE SHUNT BETWEEN TERMINALS 2A and 2 IN THE COMPRESSOR STARTER OR THE VOLTAGE SIGNAL TO THE CONTROL MODULE WILL BE INCORRECT.

c. STARTER BUILT WITH TWO VARIABLE RESISTORS WITH UNIT USED IN LOAD BALANCE WITH ONE OR MORE UNITS. SEE FIGURE 4.

NOTES APPLY TO FIGURE 4:

1) If two or more centrifugal units are to be field connected for load balance, be sure the factory installed shunt between terminals 2A and 2 in the starter on each unit is removed.
2) All compressor motor starters involved in a load balance arrangement for two (2) or more centrifugal units must be supplied from the same power system and the current transformers used in the load balance must be connected across the same phase in each starter. It is possible to have two different power transformers each connected differently (i.e., "Wye" or "Delta"). If this occurs, the load balance system will not function as it should.

d. CALCULATING RESISTOR VALUES FOR SCHEMATIC SHOWN IN FIGURE 4.

1) The resistance value for variable resistor "A" is calculated in the same way as shown in Section 10a above. AGAIN, BE SURE THE STARTER DISCONNECT SWITCH IS OPEN BEFORE ATTEMPTING TO ADJUST VARIABLE RESISTOR "A".

2) The resistance value for setting resistor "B" is calculated at six times the value of the resistance setting of resistor "A".

Resistance "B" = 6 × Resistor "A" Setting
From Section 10a above:
Resistor "A" Setting = 6.9 ohms
Resistance "B" = 6 × 6.9 = 41.4 ohms

e. Units manufactured to "UL" requirements will include a 2 ohm resistor across terminals 1 and 2 in the unit control center (as illustrated schematically in Figure 5). The unit control module like non-"UL" units will still require a 5 volt signal for proper operation.

Before the unit can be put in operation, resistor R will have to be adjusted to a value that, when combined with the fixed 2 ohm resistor and with the compressor motor drawing nameplate rated load amperes, will result in a 5 volt signal across terminals 1 and 2 in

FIGURE 3. SCHEMATIC DIAGRAM FOR STARTERS WITH TWO VARIABLE SIGNAL RESISTORS & NO LOAD BALANCE

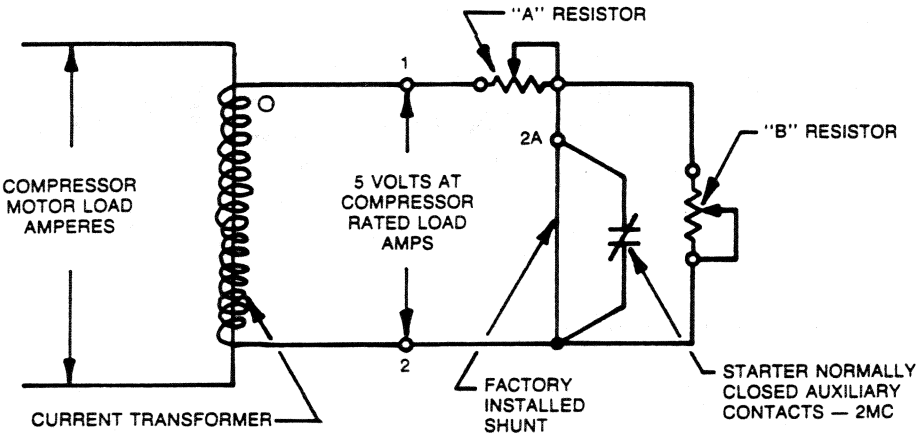
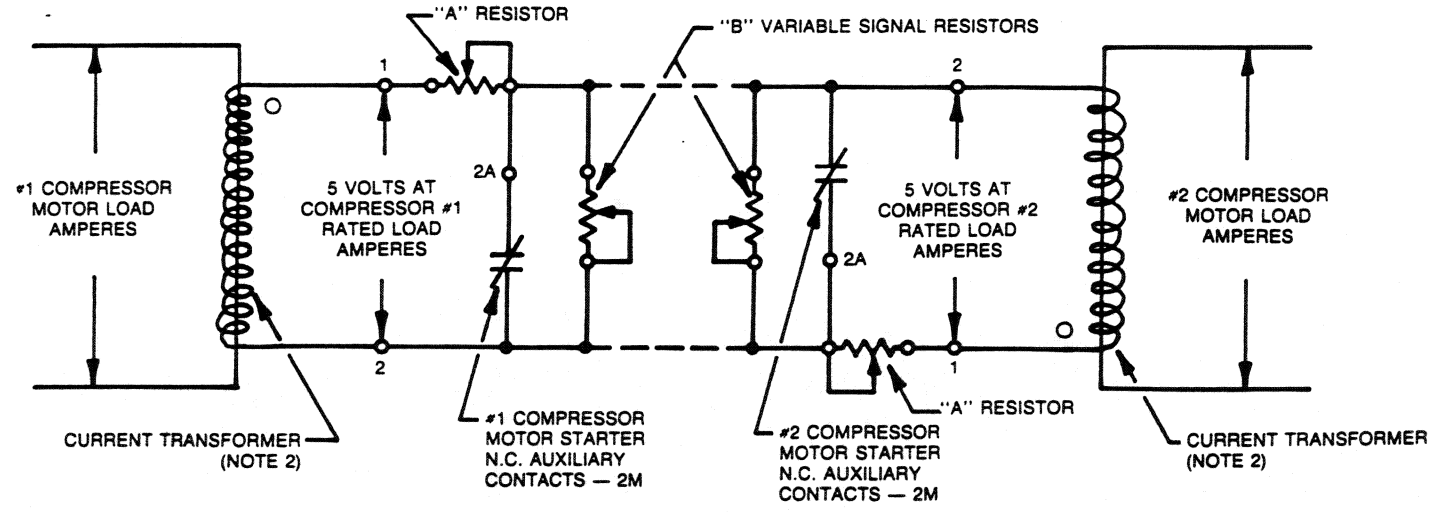


FIGURE 4. SUGGESTED SCHEMATIC FOR STARTERS WITH TWO VARIABLE SIGNAL RESISTORS IN EACH STARTER & CONNECTED FOR LOAD BALANCE



the compressor motor starter. Calculations required to determine the resistance setting follow.

1) Calculate the equivalent resistance "R_E" for resistor R_A and its parallel fixed 2 ohm resistor.

$$R_E = \frac{\text{Volts}}{I}$$

Where Volts = 5

I_S = Output amperes of the current transformer when compressor motor is drawing nameplate rated load amps.

R_E = Equivalent resistance of R_A and a fixed 2 ohm resistor R_C operating in parallel.

Assume: 1. Current transformer ratio = 400/5
2. Rated Load Amperes = 300
3. Current transformer is installed in a Star/Delta starter and is sensing phase amperes from a conductor making one pass through the transformer.

Current from the current transformer = I_S

$$I_S = \frac{5}{400} \times 300 \times .58 = 2.175 \text{ amperes}$$

NOTE: Generally, if I_S results in amperes less than 2.5, the power conductor will have to pass two or more times through the current transformer. A second pass through the transformer will increase the amperage calculated above by a factor of two (2).

$I_S = 2.175 \times 2 = 4.35$ amperes

Equivalent Resistance = R_E

$$R_E = \frac{\text{Volts}}{I} = \frac{5}{4.35} = 1.15 \text{ ohms}$$

Once the equivalent resistance is determined, the resistance value for R_A can be calculated using the formula shown below.

R_C = 2 ohm resistor located in control panel.

$$R_A = \frac{R_E \times R_C}{R_C - R_E}$$

$$= \frac{1.15 \times 2}{2 - 1.15} = \frac{2.30}{0.85} = 2.71 \text{ ohms}$$

The value of 2.71 ohms can be checked by calculating the total amperes flowing in the 5 volt circuit. The value of these amperes is equal to I_S.

$$I_C \text{ (2 ohm)} = \frac{\text{Volts}}{\text{Resistance}} = \frac{5}{2} = 2.5 \text{ amperes}$$

$$I_A \text{ } (R_A) = \frac{5}{2.71} = 1.85 \text{ amperes}$$

TOTAL: 4.35 amps = I_S

After the value of R_A has been verified, the variable resistor can be set prior to starting the unit.

NOTE: IF A UNIT MANUFACTURED TO "UL" REQUIREMENTS MUST BE CONNECTED FOR LOAD BALANCE, CONTACT YOUR SUPERVISOR.

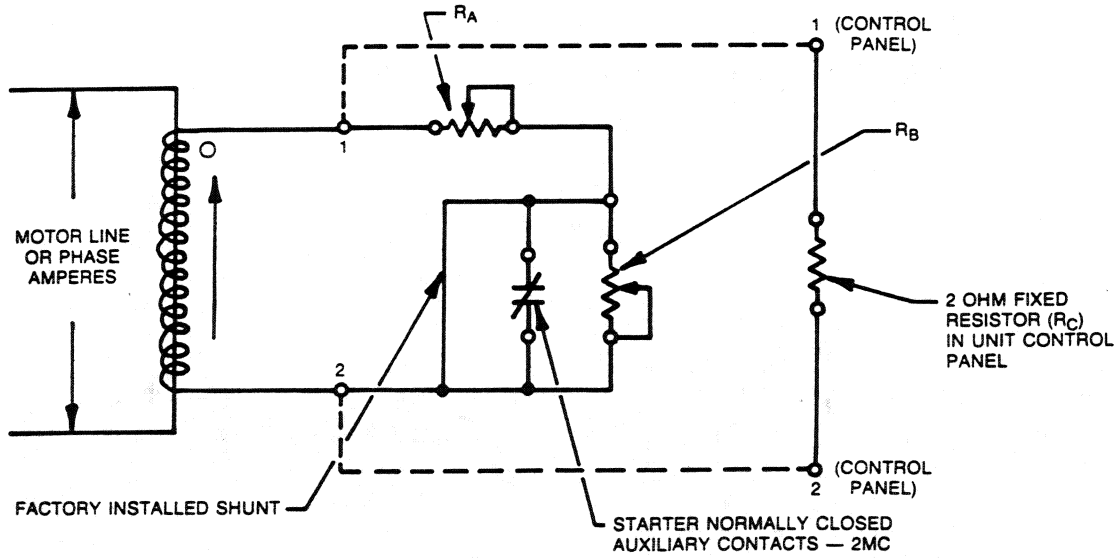
11. CHECK OUT THE OIL PUMP. Verify that the oil pressure is 105 to 110 psig of net pump oil pressure. If it is not, adjust the relief valve to provide this pressure.

    NOTE: Oil pumps on the CE050 and CE126 are exceptions.

    a. CE050 — Oil return from the mist eliminator is better when the pump net oil pressure is at least 150 to 170 psig above suction pressure (net oil pressure).
    b. CE126 — Oil pressure developed will be determined by measuring the oil pump running amperes. Set the oil pump relief valve to maintain approximately 14 running amperes.

12. RECONNECT THE COMPRESSOR MOTOR CONDUCTORS TO THE LOAD SIDE OF THE STARTER.

FIGURE 5. SCHEMATIC DIAGRAM FOR STARTERS WITH TWO VARIABLE SIGNAL RESISTORS AND NO LOAD BALANCE CONNECTED IN PARALLEL WITH FIXED 2 OHM RESISTOR (LOCATED IN THE UNIT CONTROL PANEL)



G. PREPARE THE UNIT TO RUN

1. Open and/or backseat all valves listed in Table 4.

Table 4. Service valve positions

SERVICE VALVE IDENTIFICATION	VALVE POSITION
Condenser Liquid Line Service Valve	Open or Backseat
Motor Liquid Line Service Valve	Open or Backseat
Pilot Expansion Valve Service Valve	Open
Main Expansion Valve Stem Position	See Notes 1 & 2
Oil Cooler Service Valve	Open
Oil Filter Service Valve	Open
Oil Pump Service Valves:	
Oil Return	One (1) Turn Off Backseat
Suction Scavenger	Open or Backseat
Oil Discharge	Open or Backseat
Suction Line Service Valve	Open
Motor Suction Return Service Valve	Open

NOTES:
1. Alco Valves — For automatic operation, turn the valve stem full counterclockwise to the stop.
2. McQuay Self-manufactured Valves — For automatic operation, turn the valve stem full clockwise to the stop.

2. CHECK MOTOR ROTATION. Using a phase sequence meter, verify that the phase sequence is correct (1-2-3, a-b-c, or red-white-blue, depending on the meter used). Jog the compressor and visually check the motor rotation. When looking through the sightglass on the motor cover, the rotation should be clockwise. If the motor rotation is not in the right direction, make the necessary correction. The Allen Bradley overload relays (when supplied) can be utilized to jog the compressor motor. One or more of the relays with no fluid in the dashpots should trip instantly when the system calls for compressor operation and the motor should be jogged sufficiently to permit a check of rotation.

   NOTE: If the starter is supplied with a Westinghouse or McQuay IQ-1000 electronic module in place of conventional overload relays, see the start-up and check out information in IM 392.

3. CHECKING MOTOR STARTER OVERLOAD RELAYS. Two types of motor starter overload relays are utilized in the centrifugal compressor motor starter.
   a. Allen Bradley Bulletin 810, "magnetic type."
   b. Westinghouse fast trip, "thermal type."

   Regardless of the type overload used, verify the setting of the overload relay. See overload tester operating instruction leaflet PE-I 229 for information on how the relays are set.

   The Allen Bradley 810 relays trip amperes should be checked without fluid in the dashpots. Once you are satisfied they are properly set, fluid can be added to the dashpots. When adding fluid, be sure it is the correct fluid for the application. Pour about one half inch (½") of fluid into the dashpot with the plunger removed. Insert the plunger and depress it to the bottom of the dashpot. Add additional fluid until the pegs attached to the plunger are just covered. (See Service Bulletin, Number SB1164 for additional information on Allen Bradley dashpots and the effect of different fluids.)

   Replace all of the dashpots and reset the overload switches. It is not unusual when an overload relay trips to find that all overloads did not trip. A minor variation in settings between relays and a variation in phase currents can cause one overload relay to trip before the others.

   The Westinghouse thermal type is set by turning the knob on top of the relay to the trip setting. Be sure the pointer and setting are secured by tightening the screw. This overload relay must hold in at 105 percent of rated load amperes and must trip at 125 percent.

   NOTE: Either type of overload must be set at 105 percent of rated load amperes. The Westinghouse thermal type must hold at 105% and trip at 125% of rated load amperes. The Allen Bradley magnetic type must hold at 100% and trip at 105% of rated load amperes.

H. UNIT IS READY TO RUN

Close all disconnects related to the compressor motor and control center power supplies. Make sure the condenser and chiller water systems are full. Check that the chilled water pump is running and the condenser water pump is capable of operating. Also make sure the tower fans and air handling unit(s) are operating or are capable of doing so. Turn the control center manual switch to ON. After the compressor has started, check motor amperages, pressure gauges and thermometers to verify that the unit is operating as it should.

I. CHECK SUPER HEAT & SUBCOOLING SETTINGS

Check settings only at full load:
1. Superheat: 2 to 3°F
2. Subcooling: 10°F (approximate at full load; varies slightly with components selection)

J. CALIBRATE CURRENT LIMIT & TEMPERATURE SECTIONS OF CONTROL MODULE & SET RAMP-UP

NOTE: When calibrating the current limit, use the leg with the highest amperage draw to measure the amperage. If the load is not sufficient for a full load calibration, a temporary calibration can be made at a lower load value (not less than 30%). Assume the unit can be loaded to about 50% of full load; calibrate the current limit to this value. After the module has been calibrated at this lower value, remove the knob and set and secure it at the 55% point on the scale. This will prevent the unit from operating above 100%, as the building load increased. This could prevent nuisance trip outs until the system load is great enough to be re-calibrated for full load at a later time.

K. ADJUST WATER FLOW TO THE OIL COOLER

Water flow to the oil cooler must be adjusted to maintain oil temperatures leaving the oil cooler between 90°F and 110°F.

L. OPERATE THE UNIT

Operate the unit at rated load amperes and verify that a 5 volt signal is supplied between terminals 1 and 2 on the terminal strip in the unit control center.

M. INSTRUCT AUTHORIZED OPERATING PERSONNEL

Instruct personnel in the operation of the centrifugal water chilling unit.

1. Be sure they have a copy of the shop order data for the unit.

   NOTE: If while starting up a centrifugal unit the customer requests you set the controls to something other than design leaving conditions shown on the shop order, first allow the unit to settle out and run at design conditions.

   Note on the start-up sheet that the unit was checked at design conditions and then the controls were adjusted to the customer's requested setting. This will prevent misunderstandings at a later date.

2. Instruct them on the importance of proper maintenance of the cooling tower, pumps, strainers, tower water treatment, etc.
3. Instruct them on how to check the oil system, oil temperatures to the bearings, oil level and color, etc.
4. Instruct them on the function of the compressor, evaporator, condenser and expansion valve.
5. Provide them with a folder on the factory operator's school.

N. COMPLETE START-UP SHEETS

These sheets must be completed in detail.

1. Do not omit or delete any information required on the form.
2. Be sure to note any discrepancies found in the system piping, piping components, controls, and any unit damage. Note any questionable operating data such as low water flows, condenser pump cycling, etc.
3. Repairs to the unit as a result of a factory defect(s) will require a separate service order which must be filled out at the time the repair is made.
4. Any items that do not conform to McQuay application and/or operation requirements should be indicated in the "Remarks" section of the form.
5. Acceptance — Have the installing contractor and/or his representative sign for the acceptance of the equipment.

O. REFERENCE INFORMATION

The following publications supplement the data contained in this bulletin. This information is available on request.

1. Wire Sizing Information ..... Publication No. WS-SVT6
2. MicroTech Control Panel ..... Publication No. IM 403
3. Westinghouse IQ-1000 Panel ..... Publication No. IM 392
4. Instructions for Insulating Compressor Terminals ..... Publication No. CE-I-228

P. COMPRESSOR MOTOR TERMINALS

On centrifugal compressor motors installed in locations where equipment rooms are subjected to high humidity, and on all installations employing 2300, 3300, or 4160 volt power, insulation over the motor terminals to prevent leakage of voltage to ground and premature failure is recommended.

Installation of the insulation is the reponsibility of the contractor, following verification of proper wire size and tightness of the electrical connections.

A recommended procedure is covered in McQuay Service Bulletin No. 14-8727-I and will be furnished on request.

NOTES

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