Installation, Operating and Maintenance Manual	IOMM TSC
	Group: **Chiller**
	Part Number: **736015427**
	Effective: **January 2003**
	Supersedes: **New**

The McQuay *Templifier*™ Water Heater

Single Compressor Centrifugal Models

TSC 063, 079, 087, 100, 126

McQuay® Air Conditioning

Table of Contents

ISO 9002 CERTIFIED

Introduction

General Description

The McQuay Centrifugal Templifier Water Heaters are complete, self-contained, automatically controlled, fluid heating units. Each unit is completely assembled and factory tested before shipment.

Templifier units use refrigerant R-134a to reduce the size and weight of the package and operate at a positive pressure over the entire operation range.

The controls are pre-wired, adjusted and tested. Only normal field connections such as piping, power wiring and flow/pump/control interlocks are required, thereby simplifying installation and increasing reliability. All necessary equipment protection and operating controls are factory installed in the control panel.

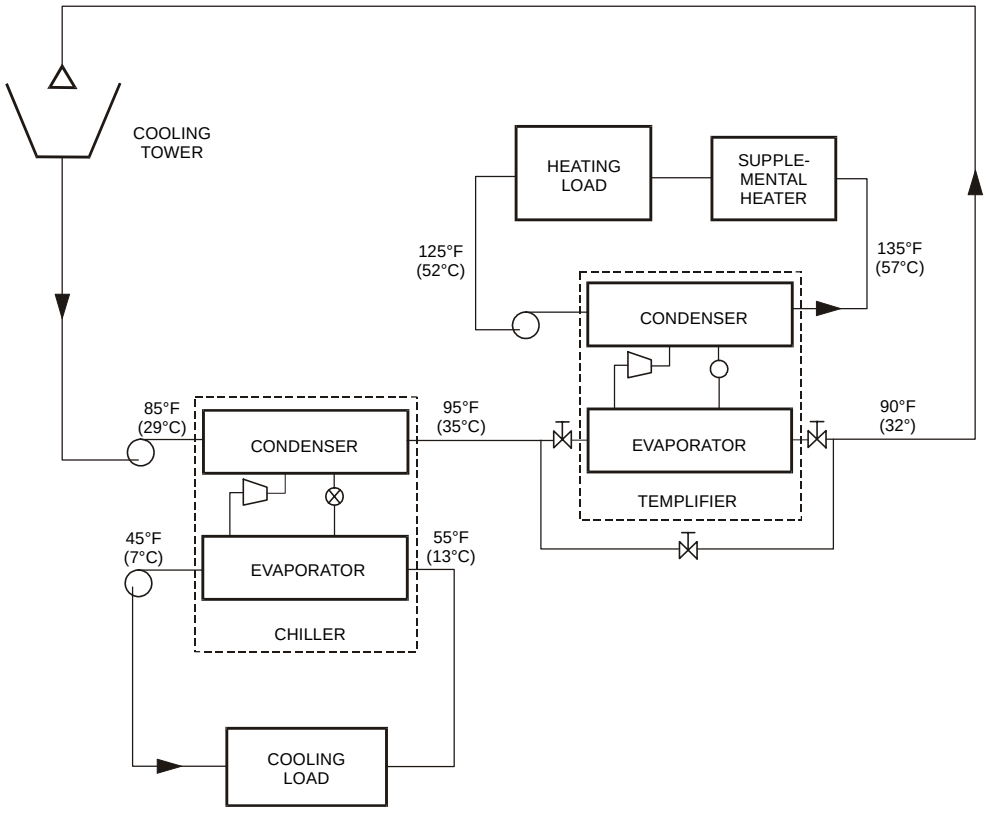
Application

The operation and maintenance procedures presented in this manual apply to the standard TSC family of water heaters.

All McQuay centrifugal Templifier units are factory tested prior to shipment and must be initially started at the job site by a factory-trained McQuay service technician. Failure to follow this startup procedure can adversely affect the equipment warranty.

One very important consideration in the operation of Templifier units is the relationship between the source heat flowing through the evaporator and the heating load being satisfied by the unit condenser. Figure 1 illustrates a Templifier using cooling tower water as the source of heat. The comments following the illustration also apply for other sources of waste heat.

Figure 1, Templifier Flow Diagram



The heat being supplied to the heating load by the Templifier condenser comes from two sources:

1. The heat being absorbed in the evaporator from the waste heat stream (cooling tower water in the diagram).
2. Compressor motor energy that goes into the refrigerant as it is compressed.

If there is insufficient source heat going to the Templifier evaporator, the unit cannot produce sufficient heat in the condenser.

The Templifier capacity is controlled by the hot water temperature leaving the condenser, but the temperature is reset downward as the delta-T decreases to give, in effect, a constant entering water temperature. The leaving hot water temperature decreases with decreasing heat load.

The unit cools the source water to whatever extent is required to meet the heating load at any given time. If there is insufficient source heat available, the Templifier unit will try to pull down the source water temperature (perhaps to unacceptable levels) in an effort to extract the required heat.

This will lower evaporator leaving water temperature and can cause the compressor to pump against a higher refrigerant pressure difference than it was designed for. Centrifugal compressors (as contrasted to reciprocating and screw compressors) are selected for a specific head (pressure difference) for a specific job. If that head is exceeded by a relatively small amount, the compressor can go into an undesirable stall or surge condition.

As a protection against this happening, TSC Templifier units have a special software design (designated as "TFG") that does the following:

1. If the leaving evaporator water temperature drops below a predetermined value, the controller lowers (resets) the leaving hot water setpoint. The unit is basically saying "there is insufficient source heat and I am lowering the hot water temperature. The supplemental heater may have to come on to make up the difference between the heating requirement and the Templifier's limited heat output".
2. If the evaporator leaving water temperature drops further, below the setpoint in #1 above, to another lower setpoint, the controller will shut the unit off.

Insufficient source heat manifested as lower source water temperature (assuming constant flow) can occur in closed loop systems such as cooling tower water or solar collectors, or in open loop systems such as process waste streams or ground water.

Installation

Receiving and Handling

The unit should be inspected immediately after receipt for possible shipping damage.

All McQuay centrifugal Templifier units are shipped FOB factory and all claims for handling and shipping damage are the responsibility of the receiver.

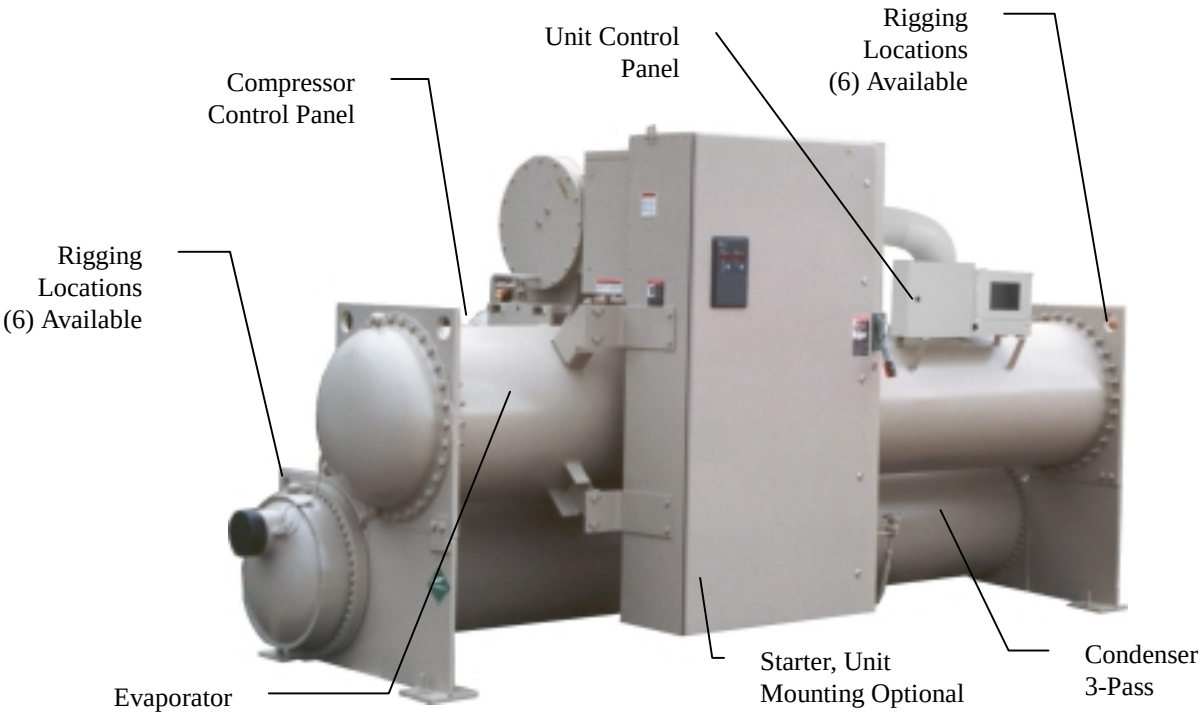
Insulation corners from the unit’s rigging hole locations are shipped loose and should be glued in place after the unit is finally placed. Neoprene vibration pads are also shipped loose. Check to be sure that these items are delivered with the unit.

Leave the shipping skid (if so equipped) in place until the unit is in its final position. This will aid in handling the equipment.

Extreme care should be used when rigging the equipment to prevent damage to the control center or refrigerant piping. See submittal certified dimension sheets for the center of gravity of the unit.

The unit can be lifted by fastening the rigging hooks to the four corners of the unit where the rigging eyes are located (see Figure 2). Use spreader bars between the rigging lines to prevent damage to the control center and motor terminal boxes.

Figure 2, Unit Components



Location and Mounting

Clearance

The unit must be mounted on a level concrete or steel base and have service clearance at one end of the unit for possible removal of evaporator and/or condenser tubes. Tube clearance required is 14 feet (4.3 meters) for units with 12-foot (3.7 meters) long shells, and 11 feet (3.3 meters for units with 9-foot (2.7 meters) long shells. Evaporator and condenser tubes are rolled into the tube sheets to permit replacement. Service clearance on all other sides is 3 feet (1 meter), although the National Electric Code (NEC) may require additional clearances and should be consulted.

Vibration Pads

The shipped loose neoprene vibration pads should be located under the corners of the unit (unless the job specifications state otherwise). They are installed to be flush with the sides and outside edge of the feet. Most TSC units have six mounting feet, although only the outer four are required. Six pads are shipped and the installer can place pads under the middle feet, if desired.

Mounting

Make sure that the floor or structural support is adequate to support the full operating weight of the complete unit.

It will not be necessary to bolt the unit to the mounting slab or framework; but should this be desirable, 1 1/8" (28.5 mm) mounting holes are provided in the unit support at the four corners.

Note: Units are shipped with refrigerant and oil valves closed to isolate these fluids for shipment. Valves must remain closed until start-up by the McQuay technician.

Water Piping

Water Pumps

Note: Avoid the use of 3600/3000 rpm (two-pole motor) pump motors. It is not uncommon for these pumps to operate with objectionable noise and vibration.

It is also possible to build up a frequency beat due to the slight difference in the operating rpm of the pump motor and the McQuay compressor motor. McQuay encourages the use of 1750/1460 rpm (four-pole) pump motors whenever possible.

Evaporator and Condenser Water Piping

All evaporators and condensers come standard with groove-type nozzles for Victaulic couplings (also suitable for welding) or optional flange connections. The installing contractor must provide matching connections of the size and type required.

⚠ CAUTION
If welding is to be performed on the mechanical or flange connections, the solid-state temperature sensor and thermostat bulbs must be removed from the wells to prevent damage to those components.
The unit must be properly grounded or severe damage to the MicroTech Controller II can occur.

Water pressure gauge connection taps and gauges must be provided in the field piping at the inlet and outlet connections of both vessels for measuring the water flow pressure drops. The pressure drops and flow rates are specific to the unit and job and can be found in the unit submittal documentation. Refer to the nameplate on the vessel shells for identification.

Evaporator inlet and outlet water connections have been changed over time with design changes in the vessel. Be sure that water inlet and outlet connections match certified drawings and factory-stenciled nozzle markings. The condenser is connected with the coolest water entering at the bottom to maximize subcooling.

The piping must be supported to eliminate any strain on the unit. Piping should also be adequately insulated. Normally, the condenser hot water piping is insulated and the evaporator piping may, or may not, be insulated, depending on its operating temperature range. A cleanable 20-mesh water strainer must be installed at the inlets of both vessels. Sufficient shutoff valves should be installed to permit draining the water from the evaporator or condenser without draining the complete system.

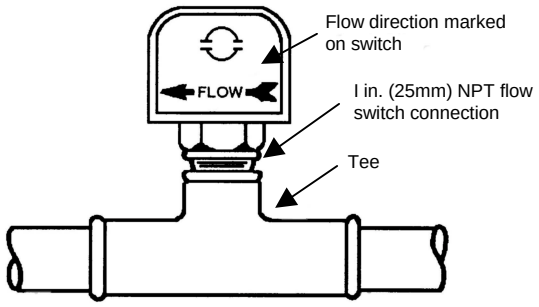
Flow Switches

A flow switch must be mounted in the leaving water line of both vessels to prove adequate water flow before the unit can start. They also serve to shut down the unit in the event that water flow is interrupted.

A flow switch is available from McQuay under Part Number 017503300. It is a "paddle" type switch and adaptable to any pipe size from 1 inch to 8 inches.

Consult the manufacturer's data for the minimum flow rates required to close the switch. Installation should be as shown in Figure 3.

Figure 3, Flow Switch Mounting



Electrical connections in the Unit Control Panel should be made per the field wiring diagram, Figure 8 on page 16. The normally open contacts of the flow switch should be wired between these two terminals. Flow switch contact quality must be suitable for 24 VAC, low current (16ma). Flow switch wiring must be in separate conduit from any high voltage conductors (115V and higher).

⚠ CAUTION

Freeze Notice: The evaporator and condenser are not self-draining; both must be blown out to avoid possible tube failure if sub-freezing temperatures are possible.

The piping should also include thermometers at the inlet and outlet connections and air vents at the high points.

The water heads can be interchanged (end for end) so that the water connections can be made at either end of the unit. If this is done, new head gaskets must be used and the control sensors relocated.

In cases where the water pump noise can be objectionable, vibration isolation sections are recommended at both the inlet and outlet of the pump. In most cases, it will not be necessary to provide vibration eliminator sections in the condenser inlet and outlet water lines.

Physical Data and Weights

Evaporator

The condenser is insulated against heat loss. Optional additional insulation may include the evaporator and non-connection water head, suction piping, compressor inlet, motor housing, and motor coolant suction line.

The insulation used is UL recognized (File # E55475). It is 3/4" thick ABS/PVC flexible foam with a skin. It has a K factor of 0.28 at 75°F. The sheet insulation is fitted and cemented in place forming a vapor barrier, then painted with a resilient epoxy finish that resists cracking.

The insulation complies to appropriate requirements or has been tested in accordance with the following:

ASTM-C-177	ASTM-C-534 Type 2	UL 94-5V
ASTM-D-1056-91-2C1	ASTM E 84	MEA 186-86-M Vol. N
CAN/ULC S102-M88		

Refrigerant-side design pressure is 200 psi (1380 kPa). Standard water-side design pressure is 150 psi (1034 kPa) with higher pressures available as an option.

Table 1, Evaporator Physical Data

Evaporator Code	Refrigerant Charge lb (kg)	Evaporator Water Capacity, gal (L)	Insulation Area Sq Ft (m^2)	Vessel Weight lb (kg)	Number of Relief Valves
E1809	434 (197)	37 (138)	75 (7.0)	2734 (1239)	1
E1812	347 (158)	27 (103)	78 (7.2)	2370 (1075)	1
E2009	561 (254)	34 (164)	82 (7.6)	3026 (1371)	1
E2012	420 (190)	37 9139)	84 (7.8)	2713 (1231)	1
E2209	729 (331)	54 (206)	66 (6.1)	3285 (1488)	1
E2212	500 (227)	45 (170)	90 (8.3)	2877 (1305)	1
E2609	531 (249)	54 (295)	76 (7.1)	2730 (1238)	1
E2612	708 (321)	72 (273)	102 (9.4)	3640 (1651)	1
E3009	676 (307)	67 (252)	86 (8.0)	3582 (1625)	1
E3012	901 (409)	89 (336)	115 (10.6)	4776 (2166)	1
E3609	988 (720)	118 (445)	155 14.4)	5314 (2408)	1
E3612	1317 (597)	152 (574)	129 (11.9)	6427 (2915)	1
E4212	1757 (797)	222 (841)	148 (13.7)	8679 (3937)	1
E4812	2278 (1033)	327 (1237)	169 (15.6)	10943 (4964)	2

Notes:
1. Refrigerant charge is approximate since the actual charge will depend on other variables. Actual charge will be shown on the unit nameplate.
2. Water capacity is based on standard tube configuration and standard dished heads.
3. The evaporator charge includes the maximum condenser charge available with that evaporator and is therefore the maximum charge for a total unit with the evaporator.

Condenser

With positive pressure systems, the pressure variance with temperature is always predictable, and the vessel design and relief protection is based upon pure refrigerant characteristics. HFC-134a requires ASME vessel design, inspection and testing and uses spring-loaded pressure relief valves. When an over-pressure condition occurs, spring-loaded relief valves purge only that amount of refrigerant required to reduce system pressure to a lower level and then close.

Refrigerant-side design pressure is 200 psi (1380 kPa). Standard water side design is 150 psi (1034 kPa).

Pumpdown

To facilitate unit servicing, all McQuay centrifugal Templifier units are designed to permit pumpdown and isolation of the entire refrigerant charge in the unit's condenser.

Table 2, Condenser Physical Data

Condenser Code	Pumpdown Capacity lb (kg)	Water Capacity gal (L)	Vessel Weight lb (kg)	Number of Relief Valves
C1609	468 (213)	33 (125)	1645 (746)	2
C1612	677 (307)	33 (123)	1753 (795)	2
C1809	597 (271)	43 (162)	1887 (856)	2
C1812	845 (384)	44 (166)	2050 (930)	2
C2009	728 (330)	47 (147)	1896 (860)	2
C2012	971 (440)	62 (236)	2528 (1147)	2
C2209	822 (372)	73 (278)	2596 (1169)	2
C2212	1183 (537)	76 (290)	2838 (1287)	2
C2609	1242 (563)	83 (314)	2737 (1245)	2
C2612	1656 (751)	111 (419)	3650 (1660)	2
C3009	1611 (731)	108 (409)	3775 (2537)	2
C3012	2148 (975)	144 (545)	5033 (3383)	2
C3612	2963 (1344)	234 (884)	7095 (3219)	2
C4212	3796 (1722)	344 (1302)	9984 (4529)	2
C4812	4912 (2228)	488 (1848)	12843 (5826)	4

Notes:
1. Condenser pumpdown capacity based on 90% full at 90°F.
2. Water capacity based on standard configuration and standard heads and can be less with lower tube counts.
3. See Relief Valves section on page 11 for additional information.

Compressor

Table 3, Compressor Weights

Compressor Size ⇒	063	079	087	100	126
Weight lb (kg) ⇒	3200 (1440)	3200 (1440)	3200 (1440)	6000 (2700)	6000 (2700)

Oil Coolers

McQuay centrifugal Templifier units have a factory-mounted, brazed-plate, water-cooled oil cooler, temperature controlled water regulating valve and solenoid valve. Cooling water connections are located near the compressor (see Figure 6) and are shown on the specific unit certified drawings.

Field water piping to the inlet and outlet connections must be installed according to good piping practices and should include stop valves to isolate the cooler for servicing. A 1" minimum cleanable filter (40 mesh maximum), and drain valve or plug should also be field installed.

The water supply for the oil cooler must be clean, treated, closed-loop water such as chilled water or from a source such as city water and must be 80°F (27°C) or less. Do not use cooling tower water. If chilled water is used, the oil cooler must be piped across the chilled water pump to provide sufficient pressure. The water flow through the oil cooler will be adjusted by the unit's regulating valve so that the temperature of oil leaving the oil cooler and being supplied to the compressor is between 95°F to 105°F (35°C to 41°C).

Table 4, Oil Cooler Data

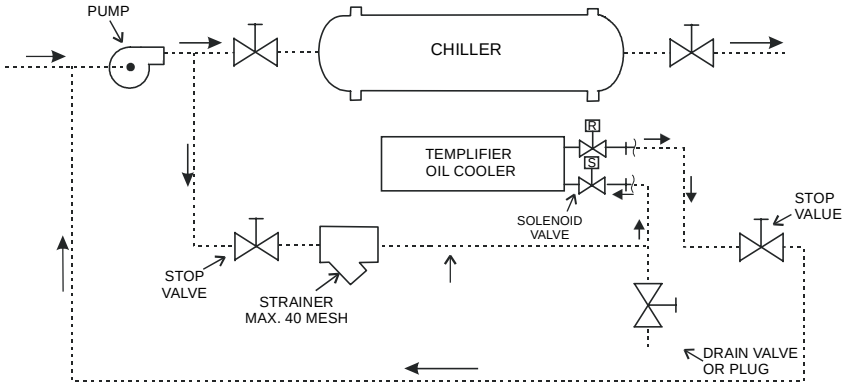
	Hot Side POE Lube	Cold Side Water	Cold Side Water	Cold Side Water	Cold Side Water
TSC 063 - 087					
Flow, gpm	9.9	11.9	2.9	2.0	1.54
Inlet Temperature, °F	118.0	80.0	65.0	55.0	45.0
Outlet Temperature, °F	100.0	87.3	94.5	98.3	101.4
Pressure Drop, psi	-	32.2	2.0	0.9	0.5
TSC 100 - 126					
Flow, gpm	15.8	21.9	5.11	3.5	2.7
Inlet Temperature, °F	120.0	80.0	65.0	55.0	45.0
Outlet Temperature, °F	100.0	87.0	95.0	99.0	102.3
Pressure Drop, psi	-	30.6	1.7	0.8	0.5

Note:
1. Pressure drops include valve on the unit.

When supplied with city water, the oil piping should discharge through a trap into an open drain to prevent draining the cooler by siphoning. The city water can also be used for cooling tower makeup by discharging it into the tower sump from a point above the highest possible water level.

OIL COOLER CONNECTION SIZE: All TSCs are 1 in. FPT.

Figure 4, Oil Cooler Piping Across Evaporator Water Pump



NOTE: Evaporator water may only be used if it meets the criteria stated above.

Figure 5, Oil Cooler Piping With City Water

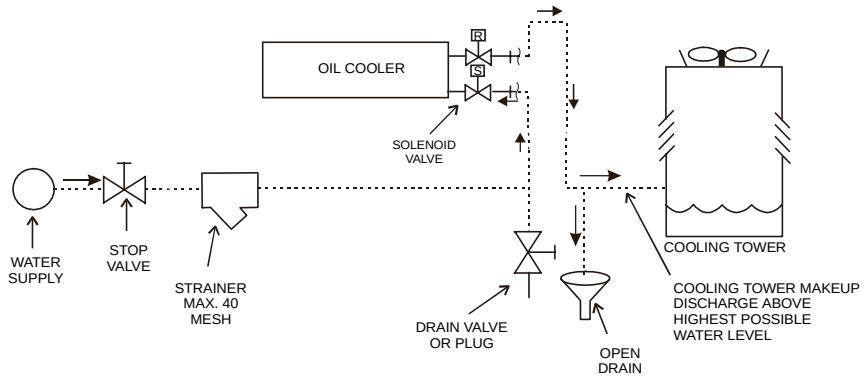
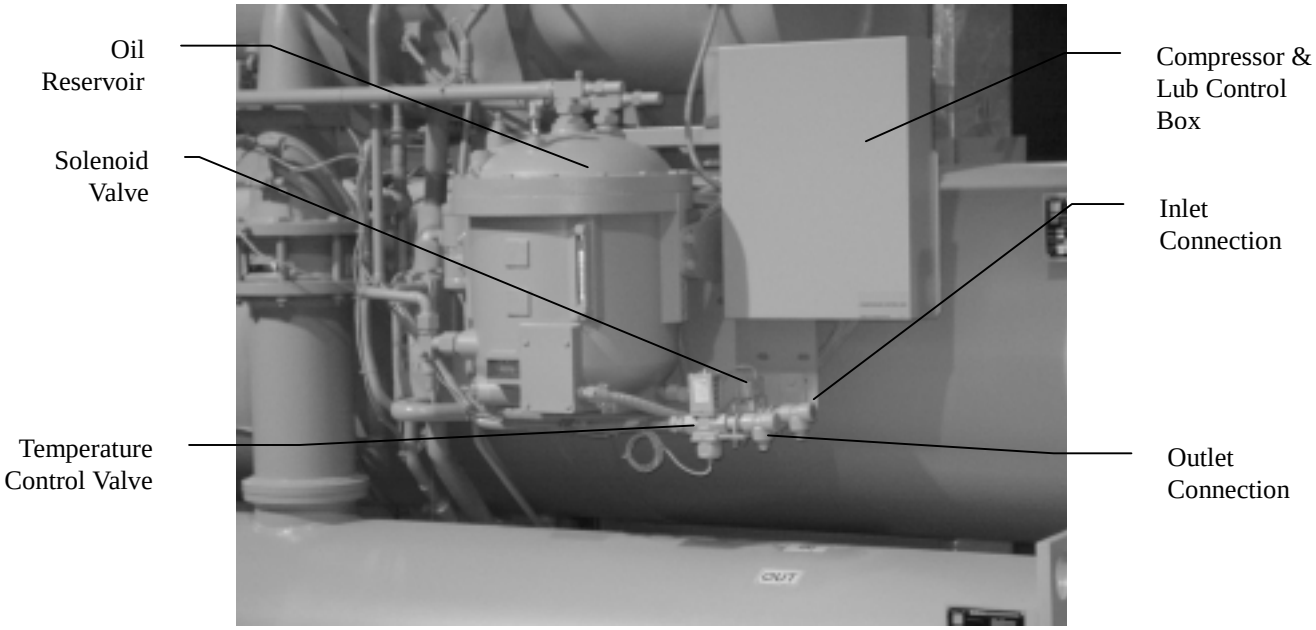


Figure 6, Oil Cooler Connections, TSC Units



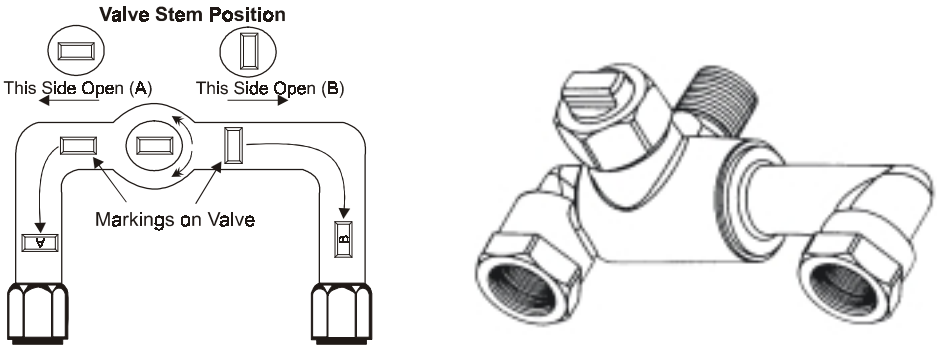
Relief Valves

As a safety precaution and to meet code requirements, each Templifer unit is equipped with pressure relief valves located on the condenser, evaporator, and oil sump vessel for the purpose of relieving excessive refrigerant pressure (caused by equipment malfunction, fire, etc.) to the atmosphere. Codes requires that relief valves must be vented to the outside of a building. Relief piping connections to the relief valves must have flexible connectors.

Note: Remove plastic shipping plugs (if installed) from the inside of the valves prior to making pipe connections. Whenever vent piping is installed, the lines should be run in accordance with local code requirements. Where local codes do not apply, the latest issue of ANSI/ASHRAE Standard 15 code recommendations should be followed.

Condensers have two relief valves as a set with a three-way valve separating the two valves (large condensers will have two such sets). One valve remains active at all times and the second valve acts as a standby.

Figure 7, Condenser 3-Way Valve



The vent line piping to a dual valve set is sized for one relief valve and piped to both valves. On large capacity condenser designs, two separate sets of dual relief valves are used. The vent line must be sized for the total of two valves but piped to all four.

Refrigerant Vent Piping

Relief valve connection sizes are 1-inch FPT and are in the quantity shown in Table 1 and Table 2. Relief valves must be piped to the outside of the building in accordance with ANSI/ASHRAE 15. Twin relief valves mounted on a transfer valve are used on the condenser so that one relief valve can be shut off and removed leaving the other in operation. Only one of the two is in operation at any time. Where four valves are shown in the table, they consist of two valves each mounted on two transfer valves. Only two relief valves of the four are active at any time.

Vent piping is sized for only one valve of the set, since only one can be in operation at a time. In no case would a combination of evaporator and condenser sizes require more refrigerant than the pumpdown capacity of the condenser. Condenser pumpdown capacities are based on the current ANSI/ASHRAE Standard 15 which recommendations of 90% full at 90°F (32°C). To convert values to the older ARI standard, multiply pumpdown capacity by 0.888.

Sizing Vent Piping (ASHRAE Method)

Relief valve pipe sizing is based on the discharge capacity for the given evaporator or condenser and the length of piping to be run. Discharge capacity for HFC-134a vessels is calculated using a complicated equation that accounts for equivalent length of pipe, valve capacity, Moody friction factor, pipe ID, outlet pressure and back pressure. The formula, and tables derived from it, are contained in ASHRAE Standard 15-2001.

McQuay centrifugal Templifier units have the following relief valve settings and discharge capacity:

TSC evaporator and condenser = 200 psi, 75.5 lb of air/min

Since the pressures and valve size are fixed for McQuay Templifier units, the above sizing equation can be reduced to the simple table shown below. The table gives the pipe size required *per valve*. When valves are piped together, the common piping must follow the rules set out in the following paragraph.

Table 5. Relief Valve Piping Sizes

Equivalent length (ft)	3.8	21.1	113.0	313.0	1021.2	4307.6
Pipe Size inch (NPT)	1 1/4	1 1/2	2	2 1/2	3	4
Moody Factor	0.0209	0.0202	0.0190	0.0182	0.0173	0.0163

NOTE: A 1-inch pipe is too small to handle these valves. A pipe increaser must always be installed at the valve outlet.

Common Piping

According to ASHRAE Standard 15, the pipe size can not be less than the relief valve outlet size. The discharge from more than one relief valve can be run into a common header, the area of which can not be less than the sum of the areas of the connected pipes. For further details, refer to ASHRAE Standard 15. The common header can be calculated by the formula:

$$D_{Common} = \left(D_1^2 + D_2^2 .... D_n^2 \right)^{0.5}$$

The above information is a guide only. Consult local codes and/or latest version of ASHRAE Standard 15 for sizing data.

Electrical

Wiring, fuse and wire size must be in accordance with the electrical information located in the submittal data. Refer to electrical data supplied with the unit or McQuay Product Manual PM Templifier.

NOTE: The voltage to these units must be within ±10% of nameplate voltage, and the voltage unbalance between phases must not exceed 3%. Since a 3-1/2% voltage unbalance will cause an approximate 25% increase in motor temperature, it is most important that the unbalance between phases be kept at a minimum.

Power Wiring

WARNING

Qualified and licensed electricians must perform wiring. Shock hazard exists.

Power wiring to compressors must be in the proper phase sequence. Motor rotation is set up for clockwise rotation facing lead end with phase sequence of 1-2-3. Care should be taken that proper phase sequence is carried through the starter to the compressor. With the phase sequence of 1-2-3

and L1 connected to T1 and T6, L2 connected to T2 and T4, and L3 connected to T3 and T5, rotation is proper. See diagram in terminal box cover.

The McQuay start-up technician will check proper phase sequence. Compressors are “bumped” at initial startup and correct rotation is visually confirmed.

NOTE: Connections to terminals must be made with copper lugs and copper wire. Care should be taken when attaching leads to compressor terminals.

NOTE: Do not make final connections to motor terminals until wiring has been checked and approved by the McQuay technician.

CAUTION

Under no circumstances should a compressor be brought up to speed unless proper sequence and rotation have been established.
Serious compressor damage can result if it starts in the wrong direction.

It is the installing contractor's responsibility to insulate the compressor motor terminals when the unit voltage is 600 volts or greater. This is to be done after the McQuay start-up technician has checked for proper phase sequence and motor rotation.

Following this verification by the McQuay technician, the contractor should apply the following furnished items.

Materials required:

1. Locktite brand safety solvent (12 oz. package available as McQuay part number 350A263H72)
2. 3M Co. Scotchfil brand electrical insulation putty (available in a 60-inch roll as McQuay part number 350A263H81)
3. 3M Co. Scotchkote brand electrical coating (available in a 15 oz. can with brush as McQuay Part Number 350A263H16)
4. Vinyl plastic electrical tape

The above items are also available at most electrical supply outlets.

Application procedure:

1. Disconnect and lock out the power source to the compressor motor.
2. Using the safety solvent, clean the motor terminals, motor barrel adjacent to the terminals, lead lugs and electrical cables within the terminal 4OX to remove all dirt, grime, moisture and oil.
3. Wrap the terminal with Scotchfil putty, filling in all irregularities. The final result should be smooth and cylindrical.
4. Doing one terminal at a time, brush the Scotchkote coating on the motor barrel to a distance of up to 1/2 inch around the terminal, and on the wrapped terminal, the rubber insulation next to the terminal and the lug and cable, for approximately 10". Wrap additional Scotchfil putty insulation over the Scotchkote coating.
5. Tape the entire wrapped length with electrical tape to form a protective jacket.
6. Finally, brush on one more coat of Scotchkote coating to provide an extra moisture barrier.

Control Wiring

The 115-volt control power is supplied from a control transformer in the starter or from a separate power source (meeting the requirements of McQuay Specification R35999901). Either source must be properly fused with 20 amp dual element fuses, or with a circuit breaker selected for motor duty. If the control transformer, or other power source for the control panel, is remote from the unit, conductors must be sized for a maximum voltage drop of 3%. Required circuit ampacity is 20 amps at 115 volts. Conductor size for long runs between the control panel and power source, based upon National Electrical Code limitations for 3% voltage drop, can be determined from the table below.

Control Power Line Sizing

Maximum Length, ft (m)	Wire Size (AWG)	Maximum Length, ft (m)	Wire Size (AWG)
0 (0) to 50 (15.2)	12	120 (36.6) to 200 (61.0)	6
50 (15.2) to 75 (22.9)	10	200 (61.0) to 275 (83.8)	4
75 (22.9) to 120 (36.6)	8	275 (83.8) to 350 (106.7)	3

Notes:

1. Maximum length is the distance a conductor will traverse between the control power source and the unit control panel.
2. Panel terminal connectors will accommodate up to number 10 AWG wire. Larger conductors will require an intermediate junction box.

The disconnect switch should be tagged to prevent current interruption. **The switch is to remain on at all times (except during servicing) in order to keep the oil and compressor casing heaters operative and to prevent refrigerant from diluting the oil.**

The unit Off/On switch, located in the Unit Control Panel, should be turned to the "Off" position any time compressor operation is not desired.

In the event a transformer supplies control voltage, the transformer should be rated at 3 KVA, with an inrush rating of 12 KVA minimum at 80% power factor and 95% secondary voltage. For control wire sizing, refer to N.E.C. Articles 215 and 310. In the absence of complete information to permit calculations, the voltage drop should be physically measured. Again, the disconnect switch should be marked to prevent the control circuit from being de-energized except during panel servicing. Water flow interlock terminals are provided on the control center terminal strip. See field connection diagram in the Electrical Data Section or inside the cover of control panel door for proper connections.

Flow Switches

The purpose of the water flow interlocks is to prevent compressor operation until such time as both the evaporator water and condenser water pumps are running and flow is established through the vessels. If flow or pressure differential switches are not factory-installed and wired as an option, they must be furnished and installed by others before the unit can be started.

System Pumps

Operation of the evaporator water pump and hot water pump can be to 1) cycle the pump with the compressor, 2) operate continuously, or 3) start automatically by a remote source. The pump starter holding coils must be rated at 115 volts, 60 Hz with a maximum 100-volt-amperage rating. If the voltage-amperage rating is exceeded, a control relay is required.

Interlocks

All interlock contacts must be rated for no less than 10 inductive amps. The alarm circuit provided in the control center utilizes 115-volts AC. The alarm used should not draw more than 10 volt-amperes.

Control Panel Switches

Three On/Off switches are located in the upper left corner of the main Unit Control Panel, which is adjacent to the operator interface panel, and have the following function:

- UNIT shuts down the chiller through the normal shutdown cycle of unloading the compressor(s) and provides a post-lube period.
- COMPRESSOR (one switch for each compressor on a unit), executes an immediate shutdown without the normal shutdown cycle.
- CIRCUIT BREAKER disconnects optional external power to system pumps and tower fans.

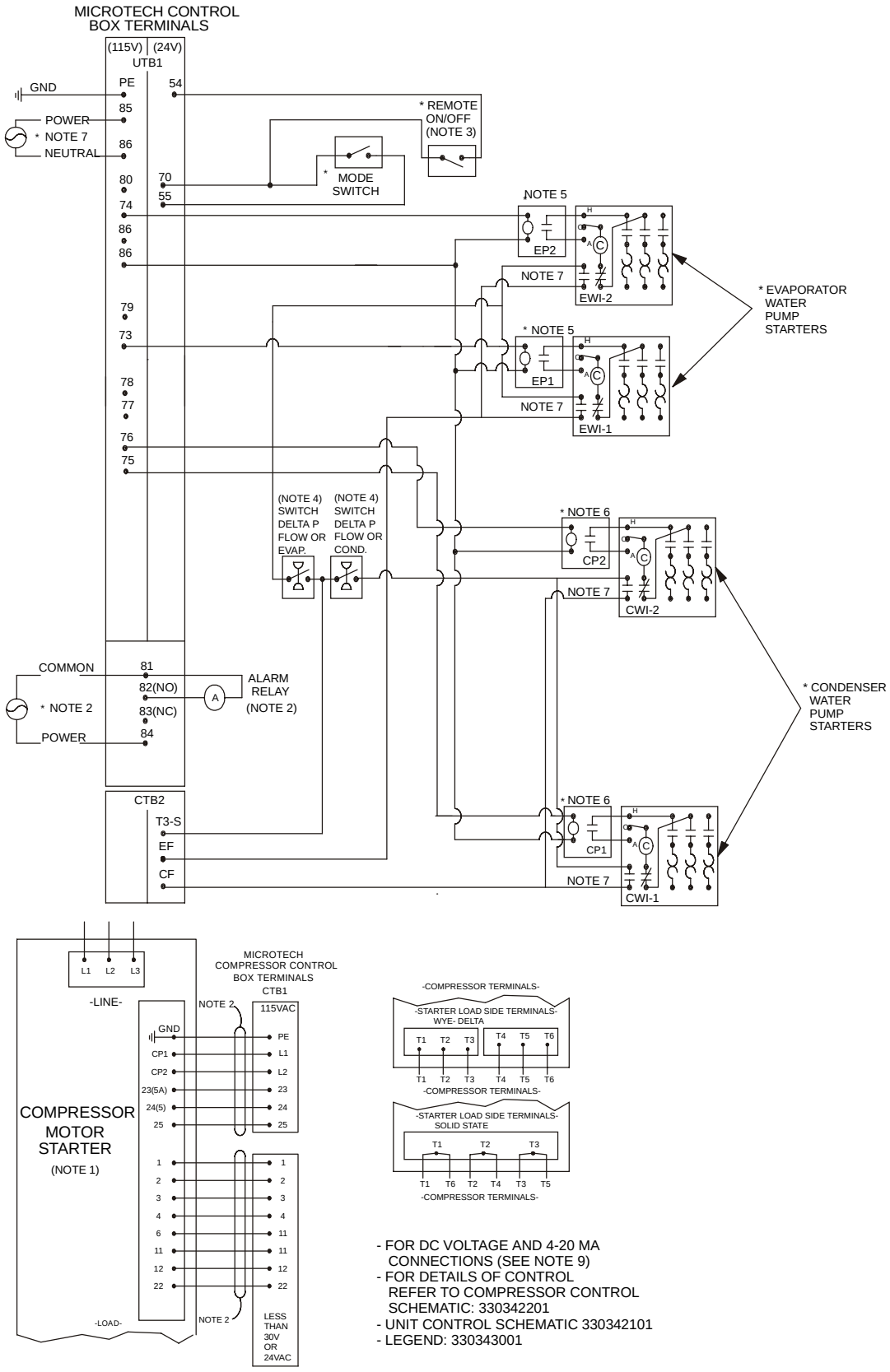
A fourth switch located on the left outside of the Unit Control Panel and labeled EMERGENCY STOP SWITCH stops the compressor immediately. It is wired in series with the COMPRESSOR On/OFF switch.

Surge Capacitors

All units (except those with solid state starters or VFDs) are supplied with standard surge capacitors to protect compressor motors from electrical damage resulting from high voltage spikes.

- For unit-mounted starters, the capacitors are factory-mounted and wired in the starter enclosure.
- For free-standing starters, the capacitors are mounted in the motor terminal box and should be connected to the motor terminals with leads less than 18 inches (460 mm) long when the motor is being wired.

Figure 8, Field Wiring Diagram



Electrical Diagram Notes

1. Compressor motor starters may be factory-mounted and wired or mounted and wired in the field. All line side power conductors must be copper.
2. A customer-furnished 24-volt alarm relay coil can be connected between terminals 81 and 82 of the control panel for normally-open contacts and terminals 81 and 83 for normally-closed contacts. Maximum rating of the alarm relay coil is 25-VA.
3. Remote On/Off enabling control can be accomplished by installing a set of dry contacts between terminals 70 and 54.
4. Evaporator and condenser paddle-type flow switches or pressure differential switches are required and must be wired as shown. Field-supplied pressure differential switches must be installed across the vessel and not the pump.
5. Optional customer-supplied 115VAC, 25-VA maximum coil rated source water pump relay (CHWR 1 and 2) can be wired as shown. This option will cycle the source water pump in response to load.
6. The condenser water pump(s) can be cycled with the unit if desired. A customer supplied 115-VAC 25-VA maximum coil rated condenser water pump relay (CWR 1 and 2) can be wired as shown.
7. Auxiliary 24-VAC rated contacts in both the evaporator water and condenser water pump starters may be wired as shown to provide additional flow protection.
8. DC wiring must be run separately from 115VAC wiring.
9. All wiring to be NEC Class 1.

Prestart System Checklist

	Yes	No	N/A
Evaporator Water			
Piping complete	☐	☐	☐
Water system filled, vented	☐	☐	☐
Pumps installed, (rotation checked), strainers cleaned	☐	☐	☐
Controls (3-way bypass valves, etc.) operable	☐	☐	☐
Water system operated and the flow balanced to meet unit design requirements	☐	☐	☐
Condenser Water			
Pumps installed, (rotation checked), strainers cleaned	☐	☐	☐
Controls operable	☐	☐	☐
Water system operated and the flow balanced to meet unit requirements	☐	☐	☐
Electrical			
115-volt service completed (if not factory-installed), but not connected to control panel	☐	☐	☐
Power leads connected to starter; load leads run to compressor ready for connection when start-up technician is on hand for start-up	☐	☐	☐
(Do not connect starter or compressor terminals)			
All interlock wiring complete between control panel and complies with specifications	☐	☐	☐
Starter complies with specifications	☐	☐	☐
Wiring complies with National Electrical Code and local codes	☐	☐	☐
(CWR) condenser pump starting relay installed and wired (if used)	☐	☐	☐
Miscellaneous			
Oil cooler water piping complete	☐	☐	☐
Relief valve piping complete	☐	☐	☐
Thermometer wells, thermometers, gauges, control wells, controls, etc., installed	☐	☐	☐
Minimum system load of 80% of machine capacity available for testing and adjusting controls	☐	☐	☐

Note: This checklist must be completed and sent to the local McQuay service location two weeks prior to start-up.

Operation

Operator Responsibilities

It is important that the operator become familiar with the equipment and the system before attempting to operate the Templifier Water Heater.

During the initial startup of the Templifier unit, the McQuay technician will be available to answer any questions and instruct in the proper operating procedures.

It is recommended that the operator maintain an operating log for each individual unit. In addition, a separate maintenance log should be kept of the periodic maintenance and servicing activities.

This McQuay centrifugal Templifier unit represents a substantial investment and deserves the attention and care normally given to keep this equipment in good working order. If the operator encounters abnormal or unusual operating conditions, it is recommended that a McQuay service technician be consulted.

McQuay International conducts training for centrifugal operators at its factory Training Center in Staunton, Virginia, several times a year. These sessions are structured to provide basic classroom instruction and include hands-on operating and troubleshooting exercises. For further information, contact your McQuay representative.

Nomenclature

Each unit is assigned a serial number and style number that are used to describe the unit features and to identify each individual unit. These numbers are stamped on each unit nameplate located on the right side of the Unit Control Panel. All inquiries pertaining to operating and servicing of this unit should include this number.

Each vessel, and the compressor, also has a nameplate to provide certain necessary information to the installer and the operator.

Compressors are designated as model CE. For example, a model CE 063 compressor is used on a model TSC 063 unit. The compressor nameplate identifies the compressor model, style and serial number and includes the electrical characteristics of the compressor motor.

The condenser and evaporator vessels have nameplates stamped with the maximum working pressure of the vessel, the National Board Number, and the vessel style number. Note that the vessel relief valve maximum settings coincides with the maximum refrigerant side vessel working pressure.

MicroTech II™ Control

Figure 9, MicroTech II Control Panel

TSC Templifier units are equipped with the McQuay MicroTech II control system consisting of:

- Operator touchscreen interface panel (shown at the left). It consists of a 10-inch Super VGA color screen and a floppy drive.
- Unit Control Panel containing the MicroTech II unit controller and miscellaneous switches and field connection terminals.
- Compressor Control Panel containing the MicroTech II compressor controller and lube system control components.

NOTE: Detailed information on the operation of the MicroTech II control is contained in the OM CentrifMicro II operating manual.

Building Automation System (BAS) interface (if applicable) utilizing the MicroTech II controller's Protocol Selectability™ feature will be set-up by the McQuay startup service technician.

Capacity Control System

The opening or closing of the compressor inlet vanes controls the quantity of refrigerant that enters the impeller, thereby controlling the compressor capacity. The vane movement is actuated by a piston that moves in response to oil pressure controlled from the SA or SB solenoid valves which, in turn, respond to a load/unload signal from the MicroTech II controller.

Vane Operation

The hydraulic system for the inlet guide vane, capacity control operation consists of a 4-way normally open solenoid valve located on the compressor, close to the suction connection. Oil under pressure from the oil filter is directed by the 4-way valve to either or both sides of the piston, depending on whether the control signal is to load, unload, or hold.

To open the vanes (loading the compressor), solenoid SA is de-energized and solenoid SB is energized, allowing oil flow from port SA to one side of the piston, then drain through port SB.

To close the vanes (unloading the compressor), valve SB is de-energized and valve SA is energized, moving the piston and vanes toward the unload position.

When both solenoid valves SA and SB are de-energized, full and equal oil pressure is directed to both sides of the piston through ports SA and SB and the vanes are held in a stop position. Refer to Figure 12 and Figure 13 for solenoid action. Note that both solenoids cannot be *energized* simultaneously.

Metering Needle Valves

The speed at which the capacity control vanes are opened or closed can be adjusted to suit system operating requirements. Adjustable needle valves in the oil drain lines are used to control the rate of bleed-off and consequently the vane speed. These needle valves are part of the 4-way solenoid valve assembly located on the compressor inlet assembly.

See Vane Speed Adjustment *Figure 10*, on page 21.

The valves are normally factory set so the vanes will move at the speeds shown in Table 6. The speed should be slow enough to prevent over-controlling and hunting.

Vane Speed Adjustment

The left adjusting screw is the SB needle valve for adjusting the vane OPENING speed for loading the compressor. Turn this screw clockwise to decrease the vane opening speed and counterclockwise to increase the opening speed.

The right adjusting screw is the SA needle valve for adjusting the CLOSING speed to unload the compressor. The same adjustment method applies; clockwise to decrease closing, counterclockwise to increase vane closing.

These adjustments are sensitive. Turn the adjusting screws a few degrees at a time.

The vane speed is factory set and varies by compressor size:

The start-up technician may readjust the vane speed at initial start-up to meet job conditions.

Figure 10, Needle Valve Location

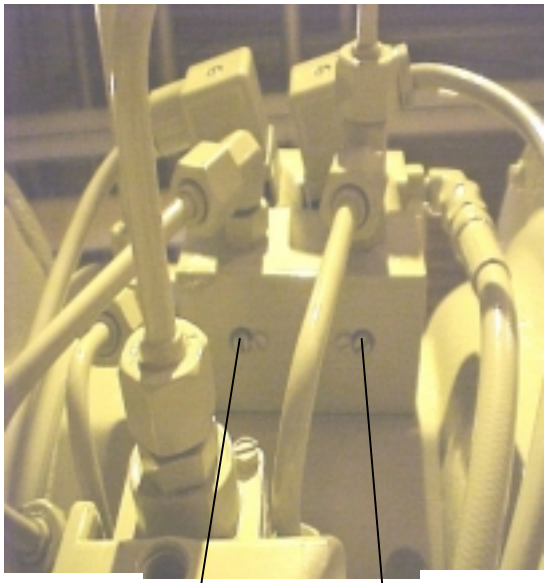


Table 6, Vane Speed, Factory Setting

Compressor Model	Opening Time	Closing Time
CE063 - CE100	3 - 5 min.	1 - 2 min
CE126	5 - 8 min.	1 - 2 min.

Figure 11, Oil Sump and Compressor Controller Panel

NOTE: 4-way solenoid valve and vane close switches are located on the compressor suction inlet. The mechanical high-pressure cutout is located in the discharge line.

Figure 12, Vane Control Solenoid Operation

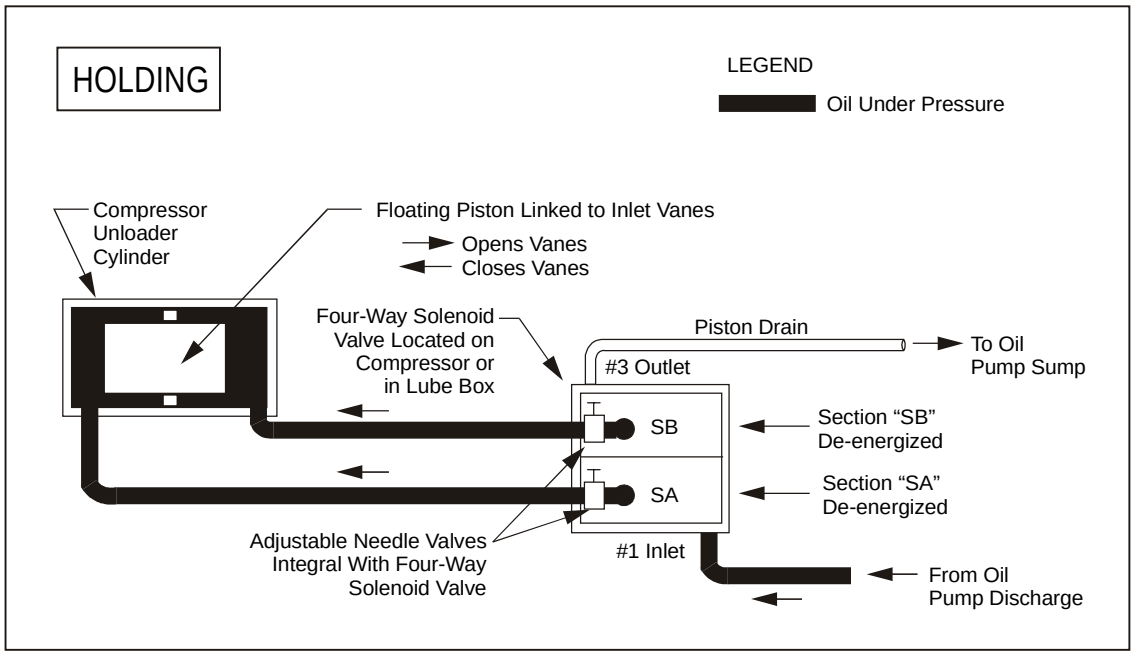
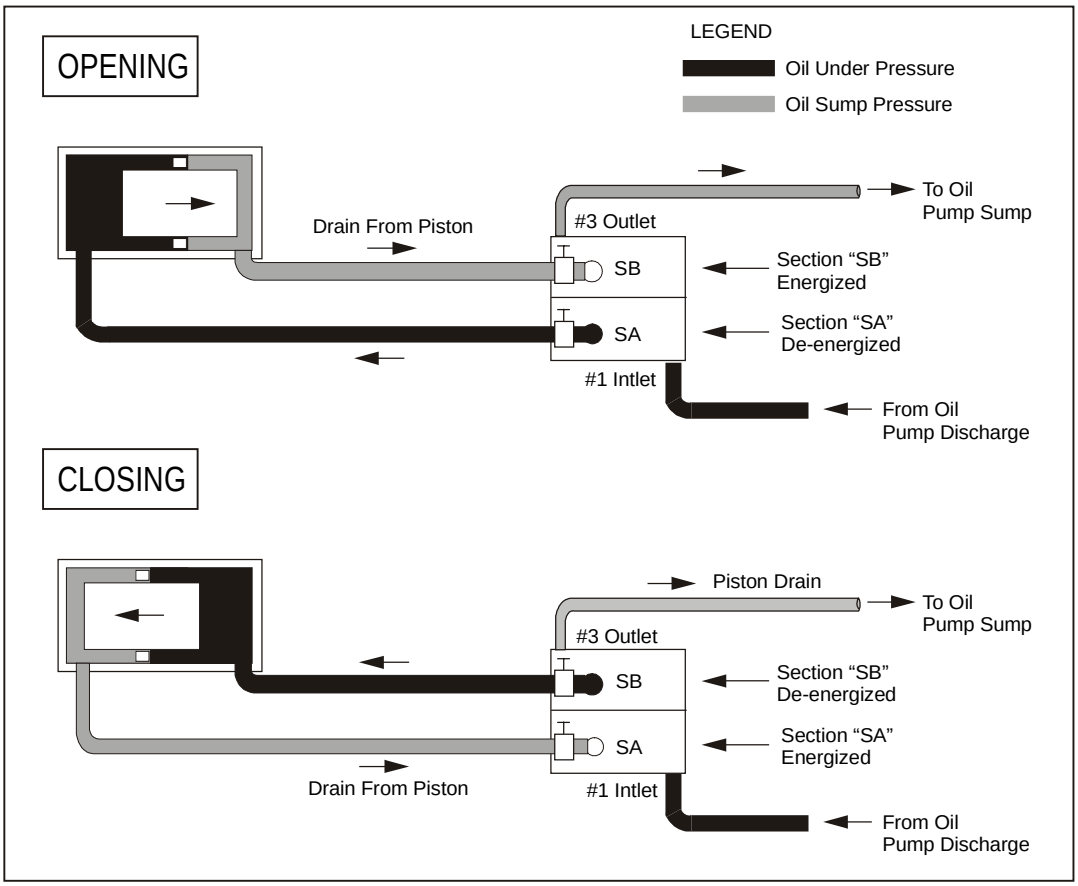


Figure 13, Vane Control Solenoid Operation, Continued



Lubrication System

The lubrication system provides lubrication and heat removal for compressor bearings and internal parts. In addition, the system provides lubricant under pressure to hydraulically operate the unloading piston for positioning the inlet guide vanes for capacity control.

Only the recommended lubricant, as shown in Table 7, can be used for proper operation of the hydraulic system and bearing lubrication system. Each unit is factory charged with the correct amount of the recommended lubricant. Under normal operation, no additional lubricant is needed. Lubricant should be visible in the oil sump sight glass at all times.

The compressors have an lubricant pump located in the lubricant reservoir. The reservoir includes the pump and motor, heater and lubricant/refrigerant vapor separator system. lubricant is pumped from the lubricant sump, through the external water-cooled lubricant cooler and then to the lubricant filter located inside the compressor housing.

The lubricant cooler maintains the proper oil temperature under normal operating conditions. The coolant flow control valve should maintain 95°F to 105°F (35°C to 41°C) lubricant temperature entering the compressor. A spring-loaded piston in the compressor accomplishes lubrication protection for coast down in the event of a power failure. When the lubricant pump is started, the piston is forced back by the lubricant pressure, compressing the spring and filling the piston cavity with lubricant. When the pump stops, the spring pressure on the piston forces the lubricant out to the bearings.

In models CE100 and CE126, the compressor coast down lubrication is supplied from gravity-feed oil reservoir.

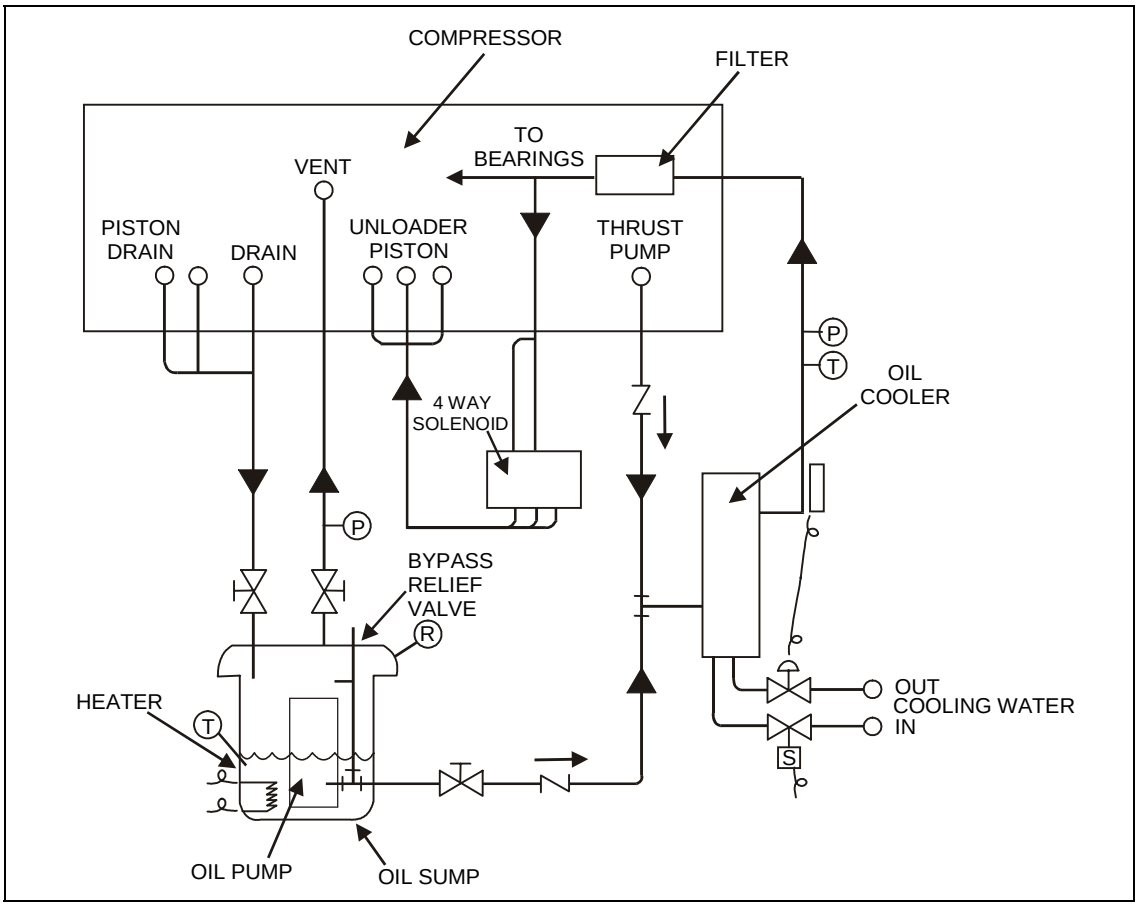
A typical flow diagram is shown in Figure 14.

Table 7, Approved Polyolester Lubricants For R-134a Units

Compressor Models	CE063 - 126
Lubricant Designation	Mobil Artic EAL 46; ICI Emkarate RL32H
McQuay Part Number 55 Gal. Drum 5 Gal. Drum 1 Gal. Can	 735030432 735030433 735030435
Compressor Oil Label	070200106

NOTE: Approved lubricant from two suppliers can be mixed.

Figure 14, Typical Lubricant Flow Diagram



NOTES:
1. Connections are not necessarily in the correct relative location.
2. P = pressure sensor, T = temperature sensor, S = solenoid valve, R = relief valve

Hot Gas Bypass

Templifier units are usually equipped with a hot gas bypass system to feed discharge gas directly into the evaporator at low system loads.

Light load conditions are signaled by measurement of a set percentage of RLA amps by the MicroTech II controller. When the RLA drops to the setpoint, the hot gas bypass solenoid is energized making hot gas bypass available for use. This introduction of hot gas provides a stable refrigerant flow and keeps the unit from short cycling under light load conditions.

The factory setpoint for bringing on hot gas bypass is 40% of RLA.

Pressure/Temperature Chart

HFC-134a Temperature Pressure Chart							
°F	PSIG	°F	PSIG	°F	PSIG	°F	PSIG
6	9.7	46	41.1	86	97.0	126	187.3
8	10.8	48	43.2	88	100.6	128	192.9
10	12.0	50	45.4	90	104.3	130	198.7
12	13.2	52	47.7	92	108.1	132	204.5
14	14.4	54	50.0	94	112.0	134	210.5
16	15.7	56	52.4	96	115.9	136	216.6
18	17.1	58	54.9	98	120.0	138	222.8
20	18.4	60	57.4	100	124.1	140	229.2
22	19.9	62	60.0	102	128.4	142	235.6
24	21.3	64	62.7	104	132.7	144	242.2
26	22.9	66	65.4	106	137.2	146	249.0
28	24.5	68	68.2	108	141.7	148	255.8
30	26.1	70	71.1	110	146.3	150	262.8
32	27.8	72	74.0	112	151.1	152	270.0
34	29.5	74	77.1	114	155.9	154	277.3
36	31.3	76	80.2	116	160.9	156	284.7
38	33.1	78	83.4	118	166.0	158	292.2
40	35.0	80	86.7	120	171.1	160	299.9
42	37.0	82	90.0	122	176.4	162	307.8
44	39.0	84	93.5	124	181.8	164	315.8

Routine Maintenance

Lubrication (See Caution)

After the system is once placed into operation, no other additional oil is required, except in the event that repair work becomes necessary to the oil pump, or unless a large amount of oil is lost from the system due to a leak.

If oil must be added with the system under pressure, use a hand pump with its discharge line connected to the back seat port of the valve in the lub drain from the compressor to the sump See Figure 11 on page 21. The POE oils used with R-134a are hygoscopic and care must be exercised to avoid exposure to moisture (air).

The condition of compressor oil can be an indication of the general condition of the refrigerant circuit and compressor wear. An annual oil check by a qualified laboratory is essential for maintaining a high level of maintenance. It is useful to have an oil analysis at initial start-up to provide a benchmark from which to compare future tests. The local McQuay service office can recommend suitable facilities for performing these tests.

The following table gives the upper limits for metals and moisture in the polyolester lubricants required by McQuay chillers.

Table 8, Metal and Moisture Limits

Element	Upper Limit (PPM)	Action
Aluminum	50	1
Copper	100	1
Iron	100	1
Moisture	400	2
Silica	50	1
Total Acid Number (TAN)	0.19	3

Key to Action

1) Re-sample after 500 hours of unit operation.
   a) If content increases less than 10%, change oil and oil filter and re-sample at normal interval (usually one year).
   b) If content increases between 11% and 24%, change oil and oil filter and re-sample after an additional 500 hours of operation.
   c) If content increases more than 25%, inspect compressor for cause.
2) Re-sample after 500 hours of unit operation.
   a) If content increases less than 10%, change filter-drier and re-sample at normal interval (usually one year).
   b) If content increases between 11% and 24%, change filter-drier and re-sample after an additional 500 hours of operation.
   c) If content increases more than 25%, monitor for a water leak.
3) If TAN is less than 0.10, system is safe as far as acid is concerned.
   a) For TAN between 0.10 and 0.19, re-sample after 1000 hours of operation.
   b) For TAN above 0.19, change oil, oil filter, and filter-drier and resample at normal interval

Changing Oil Filters

McQuay Templifier units are at positive pressure under normal standby and operating conditions and do not leak contaminated moist air into the refrigerant circuit. This eliminates the need for annual oil changes. An annual laboratory oil check is recommended to check overall compressor and system condition.

The oil filter in each of these compressors can be changed by simply isolating the filter cavity. Close the oil discharge line service valve at the oil pump (at the filter on CE100 and CE126). Remove the filter cover. Some foaming can occur, but the internal check valve should limit leakage from the compressor interior. Remove the filter, replace with a new element and replace the filter cover using a new gasket. Reopen the valve in the pump discharge line and purge air from the oil filter cavity.

When the compressor is operated again, the oil level should be checked to determine if oil needs to be added to maintain the proper operating level.

CAUTION

Improper servicing of the lubrication system, including the addition of excessive or incorrect oil, substitute quality oil filter, or mishandling of the equipment under pressure can damage the compressor. Only authorized and trained service personnel should attempt this service. For qualified assistance, contact your local McQuay service location.

Filter-driers

The filter-drier is located in the motor cooling refrigerant feed line. New filter-driers have been developed for use in compressors utilizing POE lubricants. These filter-driers are balanced to remove moisture and acids to help system reliability.

Use ALCO® "UK" series or Sporlan® "CW/RCW" series driers. ALCO "W48" series or Sporlan "HH" series can be used once or twice for system cleanup, followed by installation of "UK" or "CW/RCW" filter-driers.

Do not leave the "HH" or "W48" cleanup driers permanently installed in the system. Prolonged use could strip important additives out of the oil and/or they can break down.

Refrigerant Cycle

Maintenance of the refrigerant cycle should include maintaining a log of the operating conditions and checking that the unit has the proper oil and refrigerant charge. (See the maintenance schedule and the appropriate operating log at the end of this manual).

At every inspection, the oil, suction and discharge pressures should be noted and recorded, as well as condenser and evaporator water temperatures. These values can be read from the operator interface panel or downloaded from the MicroTech II History Log via a floppy drive located in the panel (see OM CentrifMicro II).

Subcooling/Superheat

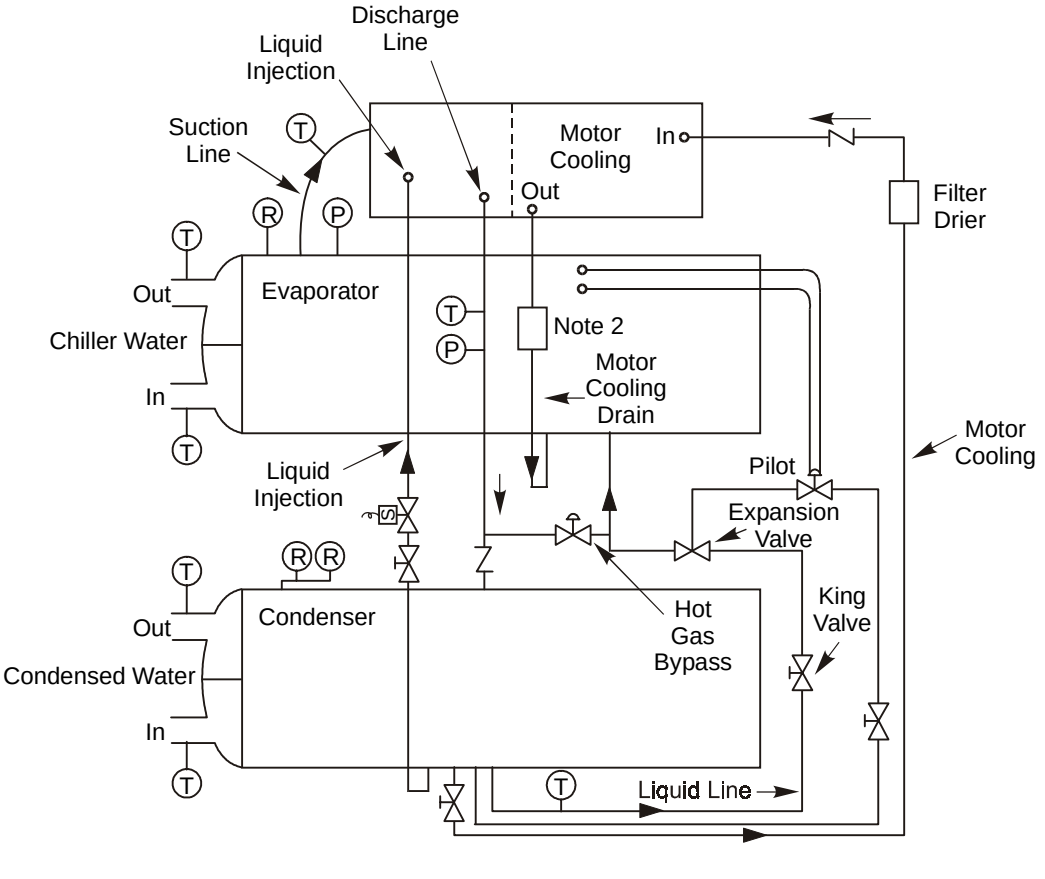
The suction line temperature at the compressor should be taken at least once a month. Subtracting the saturated temperature equivalent of the suction pressure will give the superheat. Although the interface screen gives this information, it is worthwhile double-checking it periodically. Extreme changes in subcooling and/or superheat over a period of time will indicate losses of refrigerant or possible deterioration of the expansion valves. Proper superheat setting is 0 to 1 degree F (0.5 degree C) at full load. Such a small temperature difference can be hard to measure accurately. Another method is to measure the compressor discharge superheat, the difference between the actual discharge temperature and the saturated discharge temperature. The discharge superheat should be between 14 and 16 degrees F (8 to 9 degrees C) at full load with R-134a refrigerant. The liquid injection should be deactivated (by closing the liquid injection line ball valve or removing the leads to the injection line solenoid valve) when taking the discharge temperature. The superheat will increase linearly to 55 degrees F (30 degrees C) at 10% load. The MicroTech II control can display all superheat and subcooling temperatures.

Subcooling is the difference between the condenser saturated temperature and the refrigerant liquid temperature, both measured at the condenser outlet. For a 10-degree F design condenser water range, the subcooling should be 10-degrees F at full load, decreasing proportionally with load to zero degrees. Another simple measurement is the entering condenser water temperature and the leaving refrigerant liquid temperature. This difference should be about two degrees F at full load, decreasing to one degree F at 50 % load and less.

Approach Temperature

Approach temperature is the difference between the temperature of the fluid leaving a heat exchanger and the saturated temperature of the refrigerant in the vessel. It is a good indication of the performance of an evaporator or condenser. McQuay's high efficiency heat exchangers have approach temperatures as low as 0.5 degrees F, ranging up to 2 or 3 degrees F. These small temperature differences are hard to measure accurately, but as a rule-of-thumb, approach temperatures in excess of 4 to 5 degrees F could indicate a problem such as plugged tubes or excessive tube fouling. If this condition occurs, it would be prudent to remove a water head and examine the condition of the vessel. This is especially true if an increase in pressure drop is also observed.

Figure 8. Typical Refrigerant Flow Diagram



N

NOTES:
1. Connections not necessarily in correct relative location.
2. Secondary filter-drier used to choke off refrigerant flow in the event of a motor burnout.
3. HGBP, hot gas bypass valve is standard on Templifier units.
4. T = temperature sensor, P = pressure sensor, R = relief valve

Electrical System

Maintenance of the electrical system involves the general requirement of keeping contacts clean and connections tight and checking on specific items as follows:

1. The compressor current draw should be checked and compared to nameplate RLA value. Normally the actual current will be lower since the nameplate rating represents full load operation. Also check all pump and fan motor amperages and compare with nameplate ratings.
2. Inspection should verify that the oil heaters are operative. The heaters are insert cartridge type and can be checked by ammeter reading. They should be energized whenever power is available to the control circuit, when the oil temperature sensor calls for heat, and when the compressor is inoperative. When the compressor runs, the heaters are de-energized. The Digital Output screen and second View screen on the interface panel both indicate when the heaters are energized.
3. At least once a quarter, all equipment protection controls except compressor overloads should be made to operate and their operating points checked. A control can shift its operating point as it ages and this must be detected so the controls can be adjusted or replaced. Pump interlocks and flow switches should be checked to be sure they interrupt the control circuit when tripped.

4. The contactors in the motor starter should be inspected and cleaned quarterly. Tighten all terminal connections.
5. The compressor motor resistance to ground should be checked and logged semi-annually. This log will track insulation deterioration. A reading of 50 megohms or less indicates a possible insulation defect or moisture and should be further checked.

> ⚠ **CAUTION**
> **Never megger a motor while in a vacuum. Severe motor damage can result.**

6. The centrifugal compressor must rotate in the direction indicated by the arrow near the rotation sight glass on the rear motor cover plate. If the operator has any reason to suspect that the power system connections may have been altered (phases reversed), the compressor should be jogged to check rotation. For assistance, call the McQuay service location.

Cleaning and Preserving

A common cause of service calls and equipment malfunction is dirt. This can be prevented with normal maintenance. Remove and clean strainers in the source water system, oil cooler line and condenser water system at every inspection.

Seasonal Servicing

Prior to shutdown periods and before starting up again, the following service procedures should be completed.

Annual Shutdown

Where the Templifier Water heater may be subject to freezing temperatures when not operating, the evaporator, condenser and Templifier water piping should be drained of all water. Dry air blown through the vessels will aid in forcing all water out. Removal of condenser heads is also recommended. The condenser and evaporator are not self-draining. Water permitted to remain in the piping and vessels can rupture these parts if subjected to freezing temperature.

Forced circulation of antifreeze through the water circuits is one way of avoiding freeze up.

1. Take measures to prevent the shutoff valve in the water supply line from being accidentally turned on.
2. If a cooling tower is used as a heat source, and if the water pump will be exposed to freezing temperatures, be sure to remove the pump drain plug and leave it out so any water that accumulates will drain away.
3. Open the compressor disconnect switch and remove the Fusetrons. If the transformer is used for control voltage, the disconnect must remain on to provide power to the oil and casing heaters. Set the UNIT On/Off switch to the Off position.
4. Check for corrosion and clean and paint rusted surfaces.
5. Clean and flush the water tower for all units using a water tower. Make sure tower “blowdown” or bleed-off is operating. Set up and use a good maintenance program to prevent “liming up” of both tower and evaporator. It should be recognized that atmospheric air contains many contaminants that increase the need for proper water treatment. The use of untreated water can result in corrosion, erosion, sliming, scaling or algae formation. It is recommended that the service of a reliable water treatment company be used. McQuay International assumes no responsibility for the results of untreated or improperly treated water.
6. If open circuit water is used in either vessel, remove the heads at least once a year to inspect the tubes, and clean if required.

> **NOTE: It is of utmost importance that all local, national, and international regulations concerning the handling and emission of refrigerants are observed.**

Annual Startup

A dangerous condition can exist if power is applied to a faulty compressor motor starter that has been burned out. This condition can exist without the knowledge of the person starting the equipment.

This is a good time to check all the motor winding resistance to ground. Semi-annual checking and recording of this resistance will provide a record of any deterioration of the winding insulation. All new units have well over 100 megohms resistance between any motor terminal and ground.

Whenever great discrepancies in readings occur or uniform readings of less than 50 megohms are obtained, the motor cover should be removed for inspection of the winding prior to starting the unit. Uniform readings of less than 5 megohms indicate motor failure is imminent and the motor should be replaced or repaired. Repairing the motor before a failure occurs can save a great deal of time and labor expended in the cleanup of a system after motor burnout.

1. The control circuit should be energized at all times *except* during service work. If the control circuit has been off and oil is cool, energize the oil heaters and allow 24 hours for them to heat the oil and separate refrigerant from the oil before starting.
2. Check and tighten all electrical connections.
3. Replace the drain plug in the cooling tower pump if it was removed at shutdown the previous season.
4. Install Fusetrons in main disconnect switch (if removed).
5. Reconnect water lines and turn on supply water. Flush out vessels and check for leaks.

Repair of System

Pressure Relief Valve Replacement

Current condenser designs use two relief valves (1 set), separated by a three-way shutoff valve. Very large condensers can have two sets. The 3-way valve allows either relief valve to be shut off, but at no time can both together be shut off. In the event one of the relief valves in the two-valve set is leaking, these procedures should be followed:

1. If the valve closest to the valve stem is leaking, back seat the three-way valve all the way, closing the port to the leaking pressure relief valve.
2. Remove and replace the faulty relief valve. The three-way shutoff valve should remain either fully back seated or fully forward for normal operation.
3. If the relief valve farthest from the valve stem is leaking, front seat the three-way valve and replace the relief valve as stated above.

Evaporators have a single relief valve (some large vessels may have two singles). Three-way valves are not used since the evaporator can be pumped down into the condenser vessel before the evaporator relief valve is removed.

Pumping Down

If it becomes necessary to pump the system down, extreme care should be used to avoid freezing the evaporator. Make sure that full water flow is maintained through the evaporator and condenser while pumping down. To pump the system down, close all liquid line valves, and with water flowing, start the compressor. Set the MicroTech II panel to the manual load. The vanes must be open while pumping down to avoid a surge or other damaging condition.

Pump the unit down until the MicroTech II control cuts out at approximately 20 psig. It is possible that the unit might experience a mild surge condition prior to cutout. If this should occur, immediately shut off the compressor. Use a portable condensing unit to complete the pump down, condense the refrigerant, and pump it into the condenser or pumpout vessel using approved procedures.

Pressure Testing

No pressure testing is necessary unless some damage was incurred during shipment. Damage can be determined by visual inspection of the exterior piping, checking that no breakage occurred or fittings loosened. Service gauges should show a positive pressure. If no pressure is evident on the gauges, a leak may have occurred discharging the entire refrigerant charge. In this case, the unit should be leak tested to determine the location of the leak.

Leak Testing

If the entire refrigerant charge is lost, the unit should be checked for leaks prior to charging the complete system. This can be done by charging enough refrigerant into the system to build the pressure up to approximately 10 psig (69 kPa) and adding sufficient dry nitrogen to bring the pressure up to a maximum of 125 psig (860 kPa), and then leak test with an electronic leak detector. Halide leak detectors do not function with R-134a. Water flow through the vessels should be maintained anytime refrigerant is added or removed from the system.

DANGER

Do not use oxygen or a mixture of R-134a and air to build up pressure as a serious explosion can result.

A pressure regulating valve should always be used on the drum used to build up the system pressure. Also, do not exceed the test pressure given above. When the test pressure is reached, disconnect the gas cylinder.

If any leaks are found in welded or brazed joints, or it is necessary to replace a gasket, relieve the test pressure in the system before proceeding. Brazing is required for copper joints.

After making any necessary repair, the system should be evacuated as described in the following section.

Evacuation

After it has been determined that there are no refrigerant leaks, the system should be evacuated using a vacuum pump with a capacity that will reduce the vacuum to **at least 1000 microns of mercury**.

A mercury manometer, electronic or other type of micron gauge, should be connected at the farthest point from the vacuum pump. For readings below 1000 microns, an electronic or other micron gauge should be used.

The triple evacuation method is recommended and is particularly helpful if the vacuum pump is unable to obtain the desired 1 millimeter of vacuum. The system is first evacuated to approximately 29 inches of mercury. Dry nitrogen is then added to the system to bring the pressure up to zero pounds.

Then the system is once again evacuated to approximately 29 inches of mercury. This is repeated three times. The first pulldown will remove about 90% of the noncondensables, the second about 90% of that remaining from the first pulldown, and after the third, only 0.1% noncondensables will remain.

Charging the System

TSC Templifier units are leak tested at the factory and shipped with the correct charge of refrigerant as indicated on the unit nameplate. In the event the refrigerant charge was lost due to shipping damage, the system should be charged as follows, after first repairing the leaks and evacuating the system.

a. Connect the refrigerant drum to the gauge port on the liquid line shutoff valve and purge the charging line between the refrigerant cylinder and the valve. Then open the valve to the mid-position.

b. Turn on both the source water pump and hot water pump and allow water to circulate through the condenser and the evaporator. (It will be necessary to manually close the condenser pump starter if it is controlled by the Templifer microprocessor.)

c. If the system is under a vacuum, stand the refrigerant drum with the connection up and open the drum. Break the vacuum with refrigerant gas and charge to a saturated pressure above freezing.

d. With a system gas pressure higher than the equivalent of a freezing temperature, invert the charging cylinder and elevate the drum above the condenser. With the drum in this position, valves open, and water pumps operating, liquid refrigerant will flow into the condenser. Approximately 75% of the total requirement estimated for the unit can be charged in this manner.

e. After 75% of the required charge has entered the condenser, reconnect the refrigerant drum and charging line to the service valve on the bottom of the evaporator. Again purge the connecting line, stand the drum with the connection up, and place the service valve in the open position.

IMPORTANT: At this point, the charging procedure should be interrupted and prestart checks made before attempting to complete refrigerant charge. The compressor must not be started at this time. (Preliminary check must first be completed.)

Maintenance Schedule

	Monthly	Quarterly	Semi-Annually	Annually	As Required By Performance
I. Compressor					
A. Performance Evaluation (Log & Analysis) *	O				
B. Motor					
• Meg. Windings (Note 2)			X		
• Ampere Balance (within 10%)		X			
• Terminal Check (tight connections, porcelain clean)				X	
• Motor Cooling (check temperature)		X			
C. Lubrication System					
• Oil Lines Temperatures	O				
• Water Coolant Temperature	O				
• Oil Cooler Strainer (water)				O	
• Oil Cooler Solenoid Operation		X			
• Oil Analysis				X	
• Oil Appearance (clear color, quantity)	O				
• Oil Filter Change					X
• Oil change if indicated by oil analysis					X
D. Vane Operation					
• Compressor Loads:					
Operate Manual Switch		X			
Record Motor Amps		X			
• Compressor Unloads:					
Operate manual Switch		X			
Record Motor Amps		X			
• Vanes Will Hold (place manual switch in "hold")					
Observe Water Temp and Record Amps		X			
E. Internal Compressor Check					X
II. Controls					
A. Operating Controls					
• Check Settings and Operation			X		
• Check Vane Control Setting and Operation			X		
• Verify Motor Load Limit Control			X		
• Verify Load Balance Operation			X		
• Check Oil Pump Contactor			X		
B. Protective Controls					
• Test Operation of:					
Alarm Relay		X			
Pump Interlocks		X			
Hot and Cold Oil Temperature Cutouts		X			
Guardistor and Surgeguard Relays		X			
High and Low Pressure Cutouts		X			
High Suction Temperature Cutout		X			
High Discharge Temperature Cutout		X			
Low Pressure Override Switch		X			
Oil Pump Pressure Differential Cutout		X			
Oil Pump Safety Timer		X			
Oil Pump Time Delay		X			
Vane Closed Switch		X			

See Notes at the end of the table on the following page

Maintenance Schedule, Cont.

	Monthly	Quarterly	Semi-Annually	Annually	As Required By Performance
III. Condenser					
A. Performance Evaluation	O				
B. Test Water Quality		X			
C. Clean Condenser Tubes (as required)				X	
D. Eddycurrent Test - Tube Wall Thickness					X
E. Seasonal Protection					X
IV. Evaporator					
A. Performance Evaluation (log conditions and analysis	O				
B. Test Water Quality		X			
C. Clean Evaporator Tubes (as required)					X
D. Eddycurrent Test - Tube Wall thickness (as required)					X
E. Seasonal Protection					X
V. Expansion Valves					
A. Performance Evaluation (superheat control)		X			
VI. Compressor - Templifier Unit					
A. Performance Evaluation	O				
B. Leak Test:					
• Compressor Fittings and Terminal		X			
• Piping Fittings		X			
• Oil Pump Joints and Fittings		X			
• Vessel Relief Valves		X			
C. Vibration Isolation Test		X			
D. General Appearance:					
• Paint				X	
• Insulation				X	
VII. Starter(s)					
A. Examine Contactors (hardware and operation)		X			
B. Verify Overload Setting and Trip		X			
C. Test Electrical Connections		X			
VIII. Optional Controls					
A. Hot Gas Bypass (verify operation)		X			
B. Liquid Injections Controls (verify operation)		X			

NOTES:

1. Key: O = Performed by in-house personnel, X = Performed by McQuay Service personnel
2. Some compressors use power factor correction capacitors and all have a surge capacitor (excepting units with solid state starters and VFDs). In all cases, capacitors must be disconnected from the circuit to obtain a useful Megger reading. Failure to do so will produce a low reading. In handling electrical components, only fully qualified technicians should attempt service.

   Do not Hi-Pot test the compressor motor in the field. The Hi-Pot test is a destructive test and has a high probability of causing premature motor failure. There are other tests such as the Megger test and the Polarization Index that are non-destructive and are recommended instead.

Service Programs

It is important that an air conditioning system receive adequate maintenance if the full equipment life and efficiency are to be realized.

Maintenance should be an ongoing program after the system is initially started. A full inspection should be made after 3 to 4 weeks of normal operation on a new installation and on a regular basis thereafter.

McQuay offers a variety of maintenance services through the local McQuay service office and can tailor these services to suit the needs of the building owner. Most popular among these services is the McQuay Comprehensive Maintenance Contract.

For further information concerning the many services available, contact your local McQuay service office.

Operator Schools

Training courses for Centrifugal Maintenance and Operation are held through the year at the McQuay Training Center in Staunton, Virginia. The school duration is three and one-half days and includes instruction on basic refrigeration, MicroTech controls, enhancing Templifier efficiency and reliability, MicroTech Ii control troubleshooting, system components, and other related subjects. Further information can be found on www.mcquay.com or call McQuay at 540-248-0711 and ask for the Training Department.