THERMAL CARE

Installation & Operation Manual

EQ Series

Portable and Remote Condenser Chillers

1 to 3 Tons

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Foreword

The intent of this manual is to serve as a guide for placing your portable chiller in service and operating and maintaining it properly. Improper installation can lead to poor equipment performance or severe equipment damage. Failure to follow the installation instructions may result in damage not covered by your warranty. It is extremely important that a qualified refrigeration installation contractor perform all installation line sizing and piping. Please supply these instructions to your authorized refrigeration contractor. This manual is for our standard product line with supplements as required to accommodate any special items provided for a specific application. The written information contained in this manual, as well as various drawings, are intended to be general in nature. Unit specific drawings are included with the equipment for troubleshooting and servicing of the unit. Additional copies of drawings are available upon request. We strive to maintain an accurate record of all equipment during the course of its useful life.

Due to the ever-changing nature of applicable codes, ordinances, and other local laws pertaining to the use and operation of this equipment we do not reference them in this manual. There is no substitute for common sense and good operating practices when placing any mechanical equipment into operation. We encourage all personnel to familiarize themselves with this manual's contents. Failure to do so may unnecessarily prolong equipment down time.

The chilling equipment uses chemical refrigerants for heat transfer purposes. This chemical is sealed and tested in a pressurized system containing ASME coded vessels; however, a system failure will release it. Refrigerant gas can cause toxic fumes if exposed to fire. Place these units in a well-ventilated area, especially if open flames are present.

Failure to follow these instructions could result in a hazardous condition. The standard refrigerant used in these units is a hydro fluorocarbon (HFC) trade named R-407c. We strongly recommend a refrigerant management program be implemented which includes a survey of all equipment to document the type and quantity of refrigerant in each machine. In addition, we recommend only licensed and EPA certified service technicians work on our refrigeration circuits. Follow good piping practices and the information in this manual to ensure successful installation and operation of this equipment. We are not responsible for liabilities created by substandard piping methods and installation practices external to the chiller.

We trust your equipment will have a long and useful life. If you should have any questions, please contact our Customer Service Department specifying the serial number and model number of the unit as indicated on the nameplate.

General Data

Table 1 - Air-Cooled Portable Chiller General Data (60 Hz)

Model	Cooling Tons[1]	Set Point Range (°F)	Condenser Air Flow (cfm)	Standard Pump			Unit MCA (amps)[3]	Dimensions (inches)			Weights (Lbs)	
				HP	GPM	PSI		L	W	H	Ship	Oper
EQ3A01	1.0	20 – 65[2]	1,110	¼	2	80	12 @ 230/1/60	28	19	33	255	280
EQ2A02	2.0	20 – 65[2]	1,585	1	5	39	9 @ 460/3/60	40	24	42	420	510
EQ2A03	3.0	20 – 65[2]	2,470	1	7	38	12 @ 460/3/60	40	24	42	430	520

[1]Tons based on 50°F leaving water, 95°F ambient air entering the condenser, R407c refrigerant, and operating at sea level.
[2]Standard set point range is 20°F to 65°F. To extend range to 20°F to 80°F the CPR valve option is required.
[3]MCA is Minimum Circuit Ampacity (for wire sizing). Model EQ3A01 is only available as a 230 volt, single-phase, 60-Hertz unit.

Table 2 - Water-Cooled Portable Chiller General Data (60 Hz)

Model	Cooling Tons[1]	Set Point Range (°F)	Condenser Water Flow (cfm)	Standard Pump			Unit MCA (amps)[3]	Dimensions (inches)			Weights (Lbs)	
				HP	GPM	PSI		L	W	H	Ship	Oper
EQ2W02	2.2	20 – 65[2]	7	1	5	39	8 @ 460/3/60	40	24	37	420	510
EQ2W03	3.3	20 – 65[2]	10	1	8	38	11 @ 460/3/60	40	24	37	430	520

[1]Tons based on 50°F leaving water, 85°F water entering the condenser, and R407c refrigerant.
[2]Standard set point range is 20°F to 65°F. To extend range to 20°F to 80°F the CPR valve option is required.
[3]MCA is Minimum Circuit Ampacity (for wire sizing).

Table 3 - Remote Air-Cooled Condenser Chiller General Data (60 Hz)

Model	Cooling Tons[1]	Set Point Range (°F)	Condenser Air Flow (cfm)	Standard Pump			Unit MCA (amps)[3]	Dimensions (inches)			Weights (Lbs)	
				HP	GPM	PSI		L	W	H	Ship	Oper
EQ2R03	3.0	20 – 65[2]	6,750	1	7	38	11 @ 460/3/60	40	24	37	430	520

[1]Tons based on 50°F leaving water, 95°F ambient air entering the condenser, R407c refrigerant, and operating at sea level.
[2]Standard set point range is 20°F to 65°F. To extend range to 20°F to 80°F the CPR valve option is required.
[3]MCA is Minimum Circuit Ampacity (for wire sizing).

Table 4 - Remote Air-Cooled Condenser General Data (60 Hz)

Model	Chiller Used With	Refrigerant	Condenser Air Flow (cfm)	Connections (inches)		Fan Data		Unit MCA (amps)[1]	Dimensions (inches)			Weights (lbs)	
				Inlet	Outlet	Qty	HP		L	W	H	Ship	Oper
LAVB11210	EQR03	R407c	6,750	1⅛	1⅛	1	½	3	39	46	42	565	600

[1]The remote condenser is only available for use with 230/1/60 main power.

Safety Guidelines

Observe all safety precautions during installation, start-up, and service of this equipment due to the presence of high voltage and refrigerant charge. Only qualified personnel should install, start-up, and service this equipment.

When working on this equipment, observe precautions in literature, and on tags, stickers, and labels located on the equipment. Wear work gloves and safety glasses.

WARNING: This equipment contains hazardous voltages that can cause severe injury or death. Disconnect and lock out incoming power before installing or servicing the equipment.

WARNING: This equipment contains refrigerant under pressure. Accidental release of refrigerant under pressure can cause personal injury and or property damage. Exercise care while working on or around this equipment.

WARNING: Vent all refrigerant relief valves in accordance to ANSI/ASHRAE Standard 15, Safety Code for Mechanical Refrigeration. This equipment should be located within a well-ventilated area. Inhalation of refrigerant can be hazardous to your health and the accumulation of refrigerant within an enclosed space can displace oxygen and cause suffocation.

Pre-Installation

Receiving Inspection

When the unit arrives, verify it is the correct unit by comparing the information that appears on the unit nameplate with that which appears on the order acknowledgement and shipping papers. Inspect the equipment condition for any visible damage and verify all items shown on the bill of lading are present. If damage is evident, properly document it on the delivery receipt and clearly mark any item with damage as "unit damage" and notify the carrier. In addition, make note of the specific damage and notify our Customer Service Department and they will provide assistance in preparation and filing of your claims, including arranging for an estimate and quotation on repairs; however, filing the claim is the responsibility of the receiving party. Do not install damaged equipment without getting the equipment repaired.

Shipping damage is the responsibility of the carrier. To protect against possible loss due to damage incurred during shipping and to expedite payment for damages, it is important to follow proper procedures and keep records. Photographs of damaged equipment are excellent documentation for your records.

Start unpacking the unit, inspect for concealed damages, and take photos of any damages found. Once received, equipment owners have the responsibility to provide reasonable evidence that the damage did not occur after delivery. Photos of the equipment damage while the equipment is still partially packed will help in this regard. Refrigerant lines can be susceptible to damage in transit. Check for broken lines, oil leaks, damaged controls, or any other major component torn loose from its mounting point.

Record any signs of concealed damage and file a shipping damage claim immediately with the shipping company. Most carriers require concealed damages be reported within 15 days of receipt of the equipment. In addition to notifying the carrier, notify our Customer Service Department and they will provide assistance in preparation and filing of your claims, including arranging for an estimate and quotation on repairs; however, filing the claim is the responsibility of the receiving party.

Water-cooled chillers ship with a full refrigerant charge while remote condenser chillers ship with a nitrogen holding charge. Remote air-cooled condensers ship separately with a 350 psi dry nitrogen gas charge. Check the remote condenser for signs of leaks prior to rigging. This will ensure no coil damage has occurred after the unit left the factory. The condenser ships with the legs removed. Mount the legs to the condenser using the provided nuts, bolts, and washers.

Unit Storage

If the chiller is stored prior to installation, it is important to protect it from damage. Blow out any water from the evaporator and water-cooled condenser circuits to protect the unit from damage from freezing. Close any open refrigerant valves. Cover the equipment to keep dirt and debris from accumulating on it. Units charged with refrigerant should not be stored in areas warmer than 145°F.

Installation – Chiller Mechanical

Unit Location

Locate water-cooled and remote air-cooled condenser chillers designed for indoor installation in an area where the temperature is between 40°F and 120°F. Chillers with an integral air-cooled condenser and the optional outdoor-duty construction may be located in an area where the temperature is between -20°F and 110°F. For chillers with a remote air-cooled condenser, locate the remote condenser outside with the chiller unit located inside the building. Allow a minimum of 48 inches of clearance between the remote condenser and any walls or obstructions. For installations with multiple condensers, allow a minimum of 96 inches between condensers placed side-by-side or 48 inches for condensers placed end-to-end. In all cases install the equipment on a rigid surface suitable to support the full operating weight of the unit. Level all equipment to ensure proper operation.

Serviceability was an important factor in the design of our equipment. Do not compromise this feature by locating the chiller in an inaccessible area. When locating the chiller it is important to consider accessibility to the components to allow for proper maintenance and servicing of the unit. In general, allow a minimum of 36 inches of clearance around all sides and above the unit. Avoid locating piping or conduit over the unit. This ensures easy access with an overhead crane or lift to lift out heavier components when they are replaced or serviced.

Proper ventilation is another important consideration when locating the unit. Locate the unit in an area that is well ventilated. In addition, ensure the condenser and evaporator refrigerant pressure relief valves can vent in accordance with all local and national codes.
Chillers with an integral air-cooled condenser require a minimum of 36 inches of clearance at both the condenser air inlet and condenser air discharge. They are not designed to have the condenser air discharge ducted. Improper clearance or poor ventilation will reduce the cooling capacity of the chiller and may cause high refrigerant pressure problems. In order to avoid possible low refrigerant pressure safety trips during start-up, maintain the inlet air temperature above 50°F. If outside air is ducted into an indoor chiller with integral air-cooled condenser there is an option for low ambient heat pressure controls which allow for incoming air temperatures down to 0°F. Cooler temperatures than this require custom modifications.

Rigging

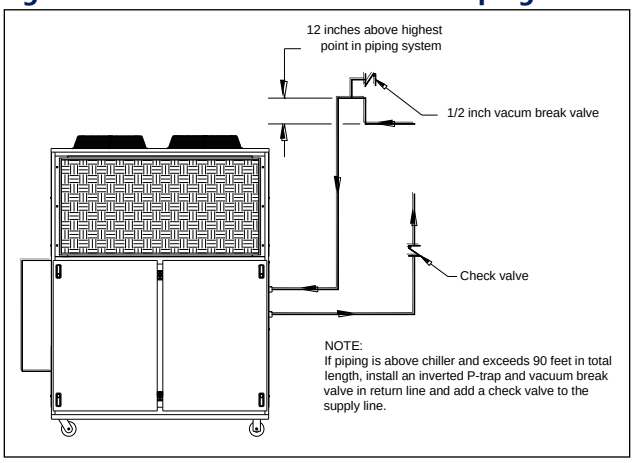
The chiller has a structural steel frame with forklift slots to facilitate easy movement and positioning. Follow proper rigging methods to prevent damage to components. Avoid impact loading caused by sudden jerking when lifting or lowering the chiller. Use pads where abrasive surface contact may occur. Use the frame supporting the unit for positioning it with a crane or a forklift.

Chilled Water Piping

Proper insulation of chilled water piping is crucial to prevent condensation. The formation of condensation on chiller water piping, the state change of the water from gas to liquid, adds a substantial heat load to the system and becomes an additional burden for the chiller.

The importance of properly sized piping between the chiller and process cannot be overemphasized. See the ASHRAE Handbook or other suitable design guide for proper pipe sizing. In general, run full size piping out to the process and then reduce the pipe size to match the connections on the process equipment. One of the most common causes of unsatisfactory chiller performance is poor piping system design. Avoid long lengths of hoses, quick disconnect fittings, and manifolds wherever possible as they offer high resistance to water flow. When manifolds are required, install them as close to the use point as possible. Provide flow-balancing valves at each machine to assure adequate water distribution in the entire system.

Figure 1 – Recommended Overhead Piping



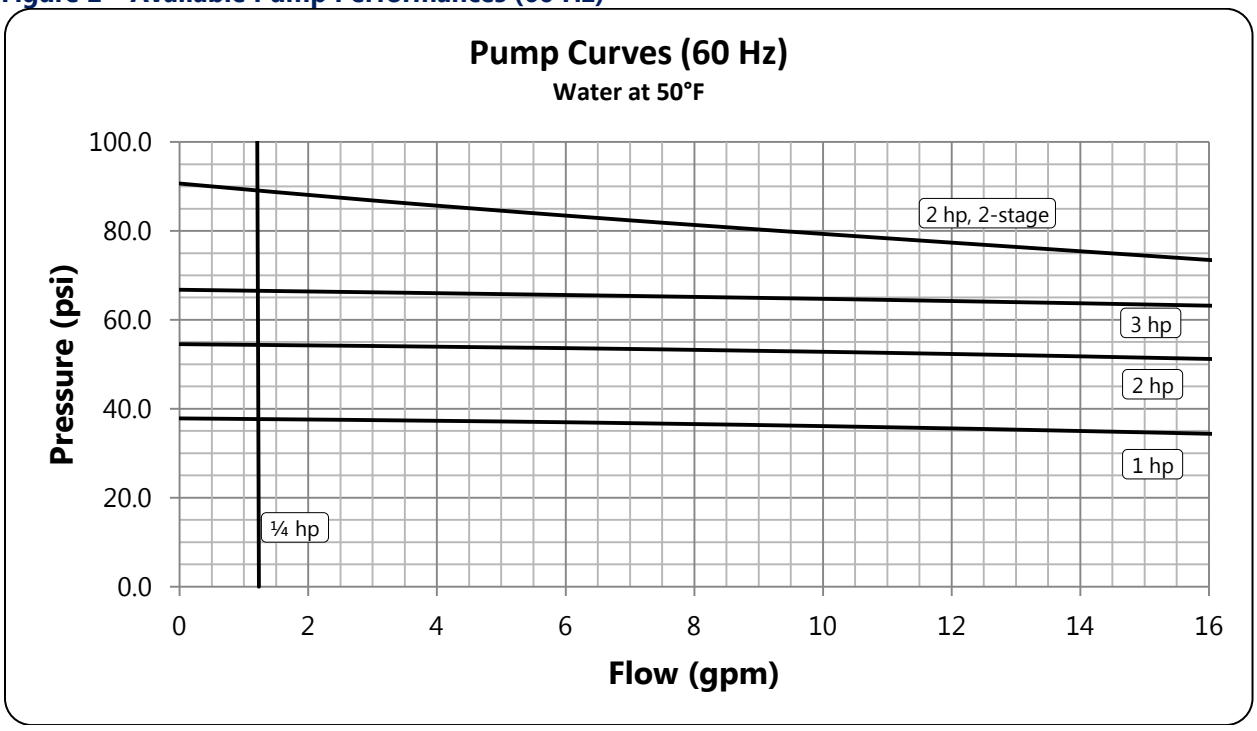
The connection labeled "Chilled Water Supply" delivers fluid to the process and the connection labeled "Chilled Water Return" receives water back from the process. Typically, when piping is overhead with a total run length over 90 feet there should be a valve in the supply line and an inverted P trap with a vacuum break valve installed as shown in Figure 1.

Nominal chilled water flow rates are based on a 10°F rise across the evaporator at 50°F set point and 85°F entering condenser water for water-cooled chillers or 95°F entering air for integral air-cooled or remote air-cooled condenser chillers . Pump curves for typical optional pumps with 60 Hz power are in shown in Figure 2.

Condenser Water Piping

(Water-Cooled Condenser Units Only) The performance of a condenser is dependent on maintaining the proper flow and temperature of water through the heat exchanger. Insufficient water flow or high condenser water supply temperature will result in the reduction of cooling capacity of the chiller. Extreme conditions will eventually result in the chiller shutting down due to high refrigerant pressure. Allowing the condenser to plug up from contaminants in the condenser water stream adversely affects performance. In order to reduce maintenance costs and chiller downtime, a water treatment program is highly recommended for the condenser cooling water. Contact our Customer Service Department for assistance in the proper procedure for cleaning out any plugged condenser.

Figure 2 – Available Pump Performances (60 Hz)



The nominal chiller design is for 85°F condenser cooling water supply. Under normal operation under full load there will be about a 10°F rise through the condenser resulting in 95°F exiting water temperature from the condenser. To ensure proper water flow through the condenser, the condenser water pump should be able to provide at least 25 psi.

Each condenser has a two-way condenser water-regulating valve. Under varying loads and condenser inlet water temperatures the amount of cooling water needed varies. The condenser water-regulating valve controls the amount of water allowed to pass through the condenser in order to maintain proper refrigeration pressures in the circuit.

To prevent damage to the condenser or regulating valve, the condenser water pressure should not exceed 150 psig. The condenser water-regulating valve controls the condenser water flow in order to maintain the pressure set point. The chiller load, condenser-water inlet temperature, and pressure set point determine the actual flow.

Installation – Remote Air-Cooled Condenser

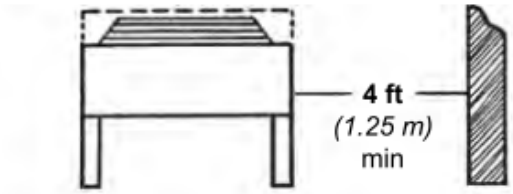
Chillers designed for use with a remote air-cooled condenser are provided with a factory-selected remote condenser. The remote air-cooled condenser ships separately and in most cases will ship from a different location than the chiller so it will most likely be on a separate truck shipment from the chiller.

Location

The remote air-cooled condenser is for outdoor use. A primary concern when designing your unit was serviceability; therefore, the condenser should be located in an accessible area. Install the unit on a firm, level base no closer than their width from walls or other condensers. Avoid locations near exhaust fans, plumbing vents, flues, or chimneys. Fasten the mounting legs at their base to the steel or concrete of the supporting structure. For units mounted on a roof structure, the steel support base holding the condenser should be elevated above the roof and attached to the building.

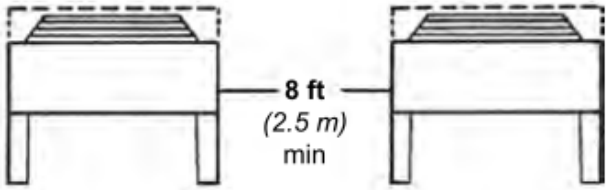
WALLS OR OBSTRUCTIONS

All sides of the unit must be a minimum of **4 feet** *(1.25 m)* away from any wall or obstruction. Overhead obstructions are not permitted. If enclosed by three walls, the condenser must be installed as indicated for units in a pit.



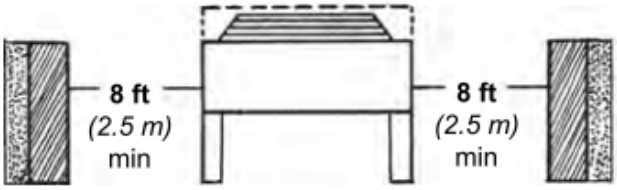
MULTIPLE UNITS

A minimum of **8 feet** *(2.5 m)* is required between multiple units placed side by side. If placed end to end, the minimum distance between units is **4 feet** *(1.25 m)*.



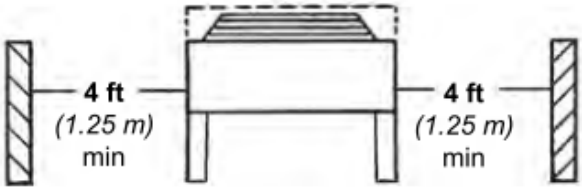
UNITS IN PITS

The top of the condenser must be level with, or above the top of the pit. In addition, a minimum of **8 feet** *(2.5 m)* is required between the unit and the pit walls.



LOUVERS/FENCES

Louvers/fences must have a minimum of 80% free area and **4 feet** *(1.25 m)* minimum clearance between the unit and louvers/fence. Height of louver/fence must not exceed top of unit.



Whenever possible locate the remote condenser away from occupied spaces and above or outside of utility areas, corridors, and auxiliary spaces to reduce the transmission of sound and vibration to occupied spaces. If the refrigerant lines are suspended from the structure of the building, use isolation hangers to prevent the transmission of vibration. Where refrigeration piping passed through a wait it is highly recommended to pack fiberglass and sealing compound around the lines to minimize vibration and retain flexibility in the lines.

Allow a minimum of 48 inches of clearance between the remote condenser and any walls or obstructions. For installations with multiple condensers, allow a minimum of 96 inches between condensers placed side-by-side or 48 inches for condensers placed end-to-end.

Rigging and Assembly

The unit ships on its side with the legs removed to reduce shipping dimensions and provide more protection to the coil from possible damaged caused by impact loading over rough roads and transit conditions.

Interconnecting Refrigerant Piping

The chiller and remote condenser ship with a nitrogen holding charge. Evacuation of this charge is required before charging with refrigerant. The chiller is for use only with the air-cooled condenser provided with the unit. The following section covers the required piping between the chiller and the provided air-cooled condenser.

The discharge and liquid lines leaving the chiller have caps. These line sizes do not necessarily reflect the actual line sizes required for the piping between the chiller and the air-cooled condenser. The installing contractor need only provide the interconnecting piping between the chiller and the air-cooled condenser.

Refrigerant piping size and piping design have a significant effect on system performance and reliability. Refer to the Refrigeration Line Sizing section of this manual to ensure the refrigerant piping and runs are proper. All piping should conform to the applicable local and state codes. Use refrigerant grade copper tubing ASTM B280 only and isolate the refrigeration lines from building structures to prevent transfer of vibration. All copper tubing must have a pressure rating suitable for R-407c: tubing that is ¾" OD or larger must be Type K rigid tubing. ACR annealed tubing coil may be used for sizes ⅝" ODS or smaller.

Do not use a saw to remove end caps. This might allow copper chips to contaminate the system. Use a tube cutter or heat to remove the caps. When sweating copper joints it is important to evacuate all refrigerant present if any and flow dry nitrogen through the system. This prevents the formation of toxic gases, corrosive acids, and the formation of scale within the copper tube. Do not use soft solders. For copper-to-copper joints use a copper-phosphorus braze alloy (BCuP per the American Welding Society) with 5% (BCuP-3) to 15% (BCuP-5) silver content. Only use a high silver content brazing alloy (BAg per AWS) for copper-to-brass or copper-to-steel joints such as a 45% (BAg-5) silver content. Only use oxy-acetylene brazing.

CAUTION: The POE oil contained within the compressor is hygroscopic and has the ability to absorb water vapor from the atmosphere. Take necessary steps to prevent an open system from exposure to the atmosphere for extended periods while installing the interconnecting refrigerant tubing.

Refrigeration Piping Design

The system is configurable in any of the arrangements as shown in Figure 3, Figure 4, and Figure 5. The configuration and its associated elevation, along with the total distance between the chiller and the air-cooled condenser are important factors in determining the liquid line and discharge line sizes. This will also affect the field refrigerant charges. Consequently, it is important to adhere to certain physical limitations to ensure the system operates as designed.

General design considerations are:

1. The total distance between the chiller and the air-cooled condenser must not exceed 200 actual feet or 300 equivalent feet. Keep the distance as short as possible.
2. Liquid line risers must not exceed 15 feet in height from the condenser liquid line connection.

3. Discharge line risers cannot exceed an elevation difference greater than 100 actual feet without a minimum of 2% efficiency decrease.

4. To form a proper liquid seal at the condenser, immediately drop at least 15 inches down from the liquid outlet before routing the piping to the chiller. Make the drop leg before any bends or angles connecting to the remainder of the liquid connection piping.

Figure 3 – Condenser Located with No Elevation Difference

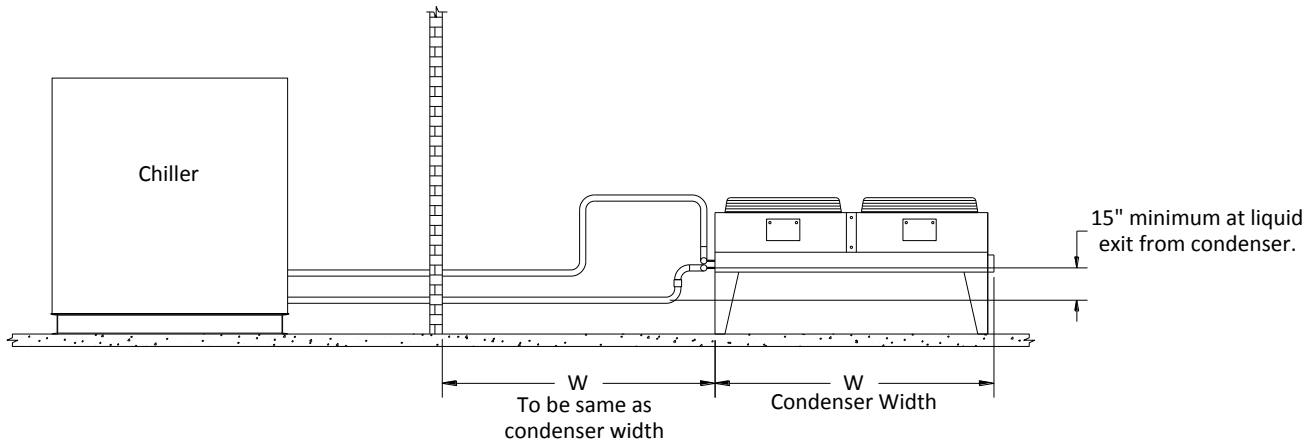


Figure 4 – Condenser Located above Chiller Unit

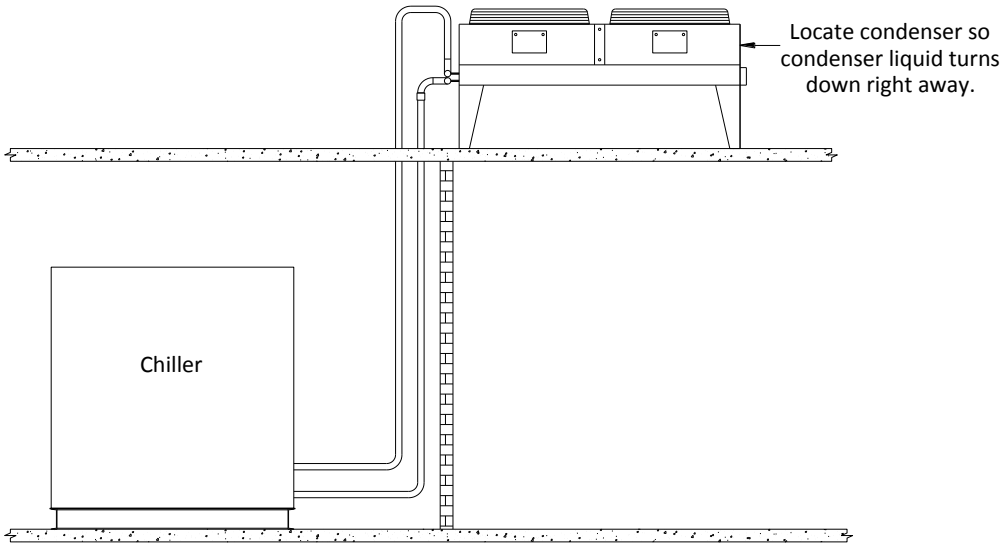
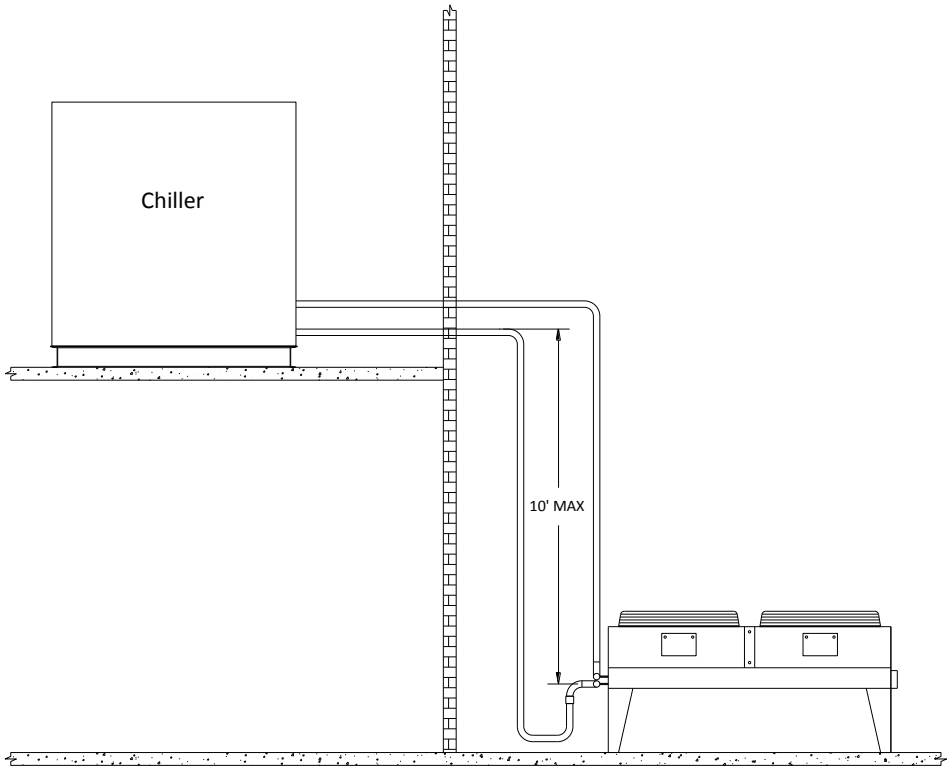


Figure 5 - Condenser Located Below Chiller Unit



Note: Liquid line sizing for each chiller capacity is in Table 6. These line sizes are listed per circuit and apply where leaving water temperature (LWT) is 40°F or higher. For applications where the LWT is below 40°F, size lines using the ASHRAE Refrigeration Handbook or other suitable design guide.

Determining Equivalent Line Length

To determine the appropriate size for field installed liquid and discharge lines, it is first necessary to establish the equivalent length of pipe for each line. The equivalent length is the approximate friction loss from the combined linear run of pipe and the equivalent feet of elbows, valves, and other components in the refrigeration piping. The sum total is the equivalent length of pipe that would have the same pressure loss. See the ASHRAE Refrigeration Handbook for more information.

Follow these steps when calculating line size:

1. Start with an initial approximation of equivalent length by assuming that the equivalent length of pipe is 1.5 times the actual pipe length.
2. Determine approximate line sizes by referring to Table 6 for liquid lines, Table 7 and Table 8 for the discharge lines.
3. Check the line size by calculating the actual equivalent length using the equivalent lengths as shown in Table 5 for all fittings in they systems as well as the actual run of pipe to determine total system equivalent length of pipe in the system.

Note: When calculating the equivalent length, do not include piping of the chiller unit. Only field piping must be considered.

Table 5 – Equivalent Lengths of Fittings

Line Size OD (in)	Equivalent Lengths of Refrigerant Pipe (feet)				
	Elbow 90° Standard	Elbow 90° Long Radius	Elbow 90° Street	Elbow 45° Standard	Elbow 45° Street
½	1.4	0.9	2.3	0.7	1.1
⅝	1.6	1.0	2.5	0.8	1.3
⅞	2.0	1.4	3.2	0.9	1.6

Liquid Line Sizing

The liquid line diameter should be as small as possible while maintaining acceptable pressure drop. This is necessary to minimize refrigerant charge. The total length between the chiller unit and the air-cooled condenser must not exceed 200 actual feet or 300 equivalent feet.

Liquid line risers in the system will require an additional 0.5 psig pressure drop per foot of vertical rise. When it is necessary to have a liquid line riser, make the vertical run immediately after the condenser before any additional restrictions. The liquid line risers must not exceed 15 feet in height from the condenser liquid line connection (see Figure 5). The liquid line does not require pitching. Install a pressure tap valve at the condenser to facilitate measuring pressure for service.

Liquid lines do not typically require insulation. However, if exposing the lines to solar heat gain or temperatures exceeding 110 °F, there is a negative effect on sub-cooling. In these situations, insulate the liquid lines.

Table 6 – Liquid Line Sizes for R407c

3 Ton Circuit (R407c)				
Total Equivalent Length (Ft)	Liquid Line Size (Inch OD)			
	Horizontal or Downflow	Upflow 1 to 5 Feet	Upflow 6 to 10 Feet	Upflow 11 to 15 Feet
25	½	½	½	½
50	½	½	½	½
75	½	½	½	½
100	½	½	½	¾
125	½	½	½	⅝
150	½	½	⅝	⅝
175	½	⅝	⅝	⅝
200	½	⅝	⅝	⅝
225	⅝	⅝	⅝	⅝
250	⅝	⅝	⅝	⅝
275	⅝	⅝	⅝	⅝
300	⅝	⅝	⅝	⅝

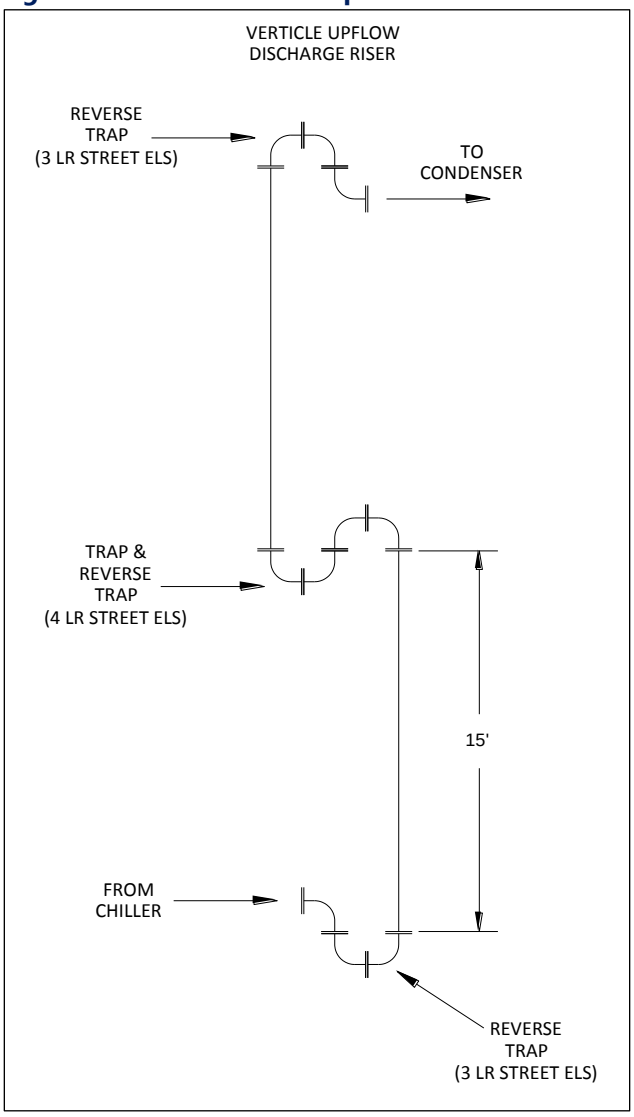
Discharge (Hot Gas) Line Sizing

The discharge line sizes depend on the velocity needed to obtain sufficient oil return. It is very important to minimize line length and restrictions to reduce pressure drop and maximize capacity.

Upflow hot gas risers need to have a trap at the bottom and reverse trap at the top. In addition, a trap and reverse trap arrangement needs to be spaced every 15 feet in the rise for oil management (see Figure 6).

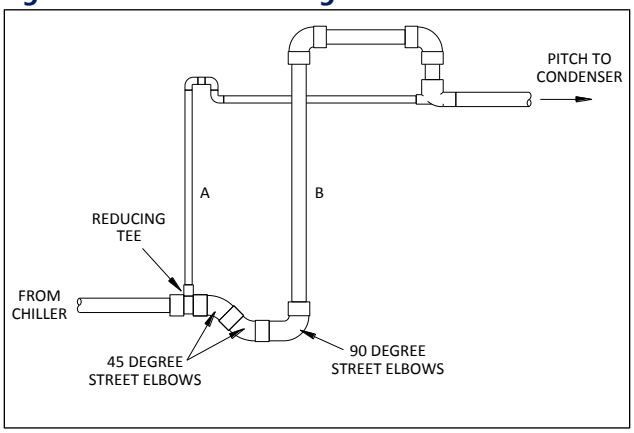
The discharge lines should pitch downward, in the direction of the hot gas flow, at the rate of ½ inch per each 10 foot of horizontal run. If the chiller unit is below the condenser, loop the discharge line to at least 1 inch above the top of the condenser. Install a pressure tap valve at the condenser to facilitate measuring pressure for service. Take careful consideration in the design of the discharge gas riser.

Figure 6 – Vertical Riser Traps



Check the oil level sight glass in the compressor if trapping of oil in the piping is suspected. The chiller is equipped with hot gas bypass capacity control and the gas in the upflow discharge lines may have problems moving the oil against gravity when completely unloaded is a single rise system is used. We recommend a double riser system to ensure proper oil return under low load operation. See Figure 7 and Table 8 for double riser constructions.

Figure 7 - Double Discharge Riser



Note: Discharge line sizing shown in Table 7and Table 8 are listed per circuit and applies where leaving water temperature (LWT) is 40°F or higher. For applications where LWT is below 40°F, size lines using the ASHRAE Refrigeration Handbook or other suitable design guide.

Table 7 - Horizontal or Downflow Discharge Line Sizes for 3-Ton R407c Circuit(inches OD)

Total Equivalent Length (Ft)											
25	**50**	**75**	**100**	**125**	**150**	**175**	**200**	**225**	**250**	**275**	**300**
⅝	⅝	¾	¾	¾	¾	⅞	⅞	⅞	⅞	⅞	⅞

Table 8 - Upflow Discharge Line Sizes for 3-Ton R407c Circuit(inches OD)

Total Equivalent Length (Ft)											
25	**50**	**75**	**100**	**125**	**150**	**175**	**200**	**225**	**250**	**275**	**300**
A-⅜	A-⅜	A-⅜	A-⅜	A-⅜	A-⅜	A-⅜	A-⅜	A-⅜	A-⅜	A-⅜	A-⅜
B-½	B-½	B-⅝	B-⅝	B-⅝	B-⅝	B-¾	B-¾	B-¾	B-¾	B-¾	B-¾

Calculating System Refrigerant and Oil Charge

To determine the approximate charge, assume a combined chiller and remote condenser summer refrigerant charge of 4.6 Lbs of R-407c then refer to Table 9 to determine the charge required for the field-installed piping. The approximate charge is therefore the sum of 4.6 and the value from Table 9.

Table 9 - Field Piping R-407c Refrigerant Charge per 100 Feet of Run (Lbs.)

Line Size OD (inches)	**⅜**	**½**	**⅝**	**¾**	**⅞**
Discharge Line	0.4	0.7	1.1	1.6	2.2
Liquid Line	3.7	6.8	11.0	16.4	22.8

Oil Charge Determination

The chiller is factory charged with the amount of oil required by the chiller only and not the total system. The amount of oil required is dependent upon the amount of refrigerant added to the system for the field-installed piping. Use the following to determine the amount of oil needed for the system.

Pints of Oil = Pounds of refrigerant added to the system / 100

Oil level should be checked after the chiller has run for 15 minutes.

Setting Condenser Fan Controls

The remote condenser has one fan and the fan should be set to turn on a 220 psig and turn off at 180 psig. It is important that these setting be correct in order to maintain proper capacity control and operation of the system.

Installation - Electrical

All wiring must comply with local codes and the National Electric Code. Minimum Circuit Ampacity (MCA) and other unit electrical data are on the unit nameplate. A unit specific electrical schematic ships with the unit. Measure each leg of the main power supply voltage at the main power source. Voltage must be within the voltage utilization range given on the drawings included with the unit. If the measured voltage on any leg is not within the specified range, notify the supplier and correct before operating the unit. Voltage imbalance must not exceed two percent. Excessive voltage imbalance between the phases of a three-phase system can cause motors to overheat and eventually fail. Voltage imbalance is determined using the following calculations:

%Imbalance = (Vavg – Vx) x 100 / Vavg

Vavg = (V1 + V2 + V3) / 3

Vx = phase with greatest difference from Vavg

For example, if the three measured voltages were 442, 460, and 454 volts, the average would be:

(442 + 460 + 454) / 3 = 452

The percentage of imbalance is then:

(452 – 442) x 100 / 452 = 2.2 %

This exceeds the maximum allowable of 2%.

There is a terminal block for main power connection to the main power source. The main power source should be connected to the terminal block through an appropriate disconnect switch. There is a separate lug in the main control panel for grounding the unit. Check the electrical phase sequence at installation and prior to start-up. Operation of the compressor with incorrect electrical phase sequencing will result in mechanical damage to the compressors. Check the phasing with a phase sequence meter prior to applying power. The proper sequence should read "ABC" on the meter. If the meter reads "CBA", open the main power disconnect and switch two line leads on the line power terminal blocks (or the unit mounted disconnect). Do not interchange any load leads that are from the unit contactors or the motor terminals.

WARNING: To prevent equipment damage due to reverse rotation, connect L1-L2-L3 in the A-B-C phase sequence.

CAUTION: The unit requires the main power to remain connected during off-hours to energize the compressor's crankcase heater. Disconnect main power only when servicing the chiller. The crankcase heater should remain on when the compressor is off to ensure liquid refrigerant does not accumulate in the compressor crankcase. Connect main power at least 24 hours prior to initial start-up.

WARNING: Connecting an appropriate power source to the main terminal block energizes the entire electric circuitry of the chiller. A transformer provides 110 VAC control power. Electric power at the main disconnect should be shut off before opening access panels for repair or maintenance. Ground the unit properly in compliance with local and national codes.

Table 10 - EQ Air Cooled Chiller Electrical Specifications

Model	Process Pump (hp)	Rated Voltage	Allowable Power		Compressor Data		Fan	Pump	Control Power	Unit Data	
			Min	Max	RLA[1]	LRA[2]	FLA[3]	FLA[3]	FLA	MCA[4]	MOCP[5]
EQ3A01	None	230/1/60	207	253	5.2	29	1.6	0.0	0.22	8.3	9.9
	¼ hp	230/1/60	207	253	5.2	29	1.6	2.4	0.22	10.7	13.3
EQ2A02	None	230/3/60	207	253	8.6	58	1.6	0.0	0.22	12.6	16.9
	1	230/3/60	207	253	8.6	58	1.6	3.6	0.22	16.2	20.5
	2	230/3/60	207	253	8.6	58	1.6	6.8	0.22	19.4	23.7
	3	230/3/60	207	253	8.6	58	1.6	9.6	0.22	22.2	26.5
	None	460/3/60	414	506	4.6	29	0.8	0.0	0.11	6.7	9.0
	1	460/3/60	414	506	4.6	29	0.8	1.8	0.11	8.5	10.8
	2	460/3/60	414	506	4.6	29	0.8	3.4	0.11	10.1	12.4
	3	460/3/60	414	506	4.6	29	0.8	4.8	0.11	11.5	13.8
EQ2A03	None	230/3/60	207	253	14.3	93	2.9	0.0	0.22	21.0	28.1
	1	230/3/60	207	253	14.3	93	2.9	3.6	0.22	24.6	31.8
	2	230/3/60	207	253	14.3	93	2.9	6.8	0.22	27.8	35.0
	3	230/3/60	207	253	14.3	93	2.9	9.6	0.22	30.6	37.8
	None	460/3/60	414	506	6.4	48	1.5	0.0	0.11	9.6	12.8
	1	460/3/60	414	506	6.4	48	1.5	1.8	0.11	11.4	14.6
	2	460/3/60	414	506	6.4	48	1.5	3.4	0.11	13.0	16.2
	3	460/3/60	414	506	6.4	48	1.5	4.8	0.11	14.4	17.6

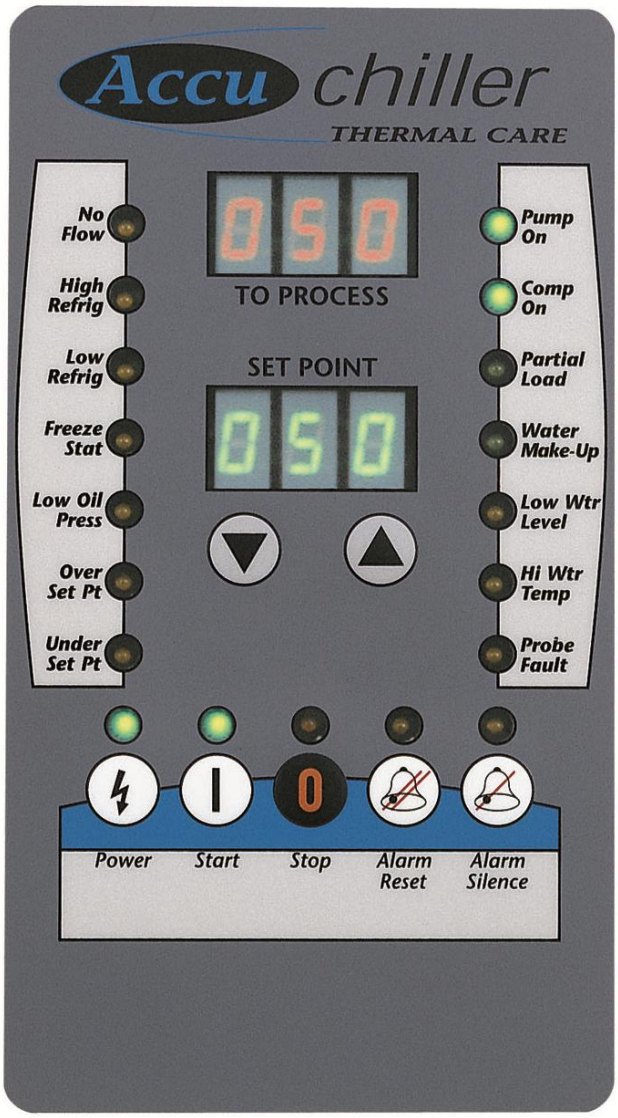
Notes:
1. RLA is Rated Load Amps.
2. LRA is Locked Rotor Amps.
3. FLA is Full Load Amps.
4. MCA is Minimum Circuit Ampacity (for wire sizing) and includes compressor, condenser fans, pump, and control circuit.
5. MOCP is Maximum Overcurrent Protection.

Table 11 - EQ Water Cooled Chiller Electrical Specifications

Model	Process Pump (hp)	Rated Voltage	Allowable Power		Compressor Data		Pump	Control Power	Unit Data	
			Min	Max	RLA[1]	LRA[2]	FLA[3]	FLA	MCA[4]	MOCP[5]
EQ2W02	None	230/3/60	207	253	8.6	58	0.0	0.22	12.6	16.9
	1	230/3/60	207	253	8.6	58	3.6	0.22	16.2	20.5
	2	230/3/60	207	253	8.6	58	6.8	0.22	19.4	23.7
	3	230/3/60	207	253	8.6	58	9.6	0.22	22.2	26.5
	None	460/3/60	414	506	4.6	29	0.0	0.11	6.7	9.0
	1	460/3/60	414	506	4.6	29	1.8	0.11	8.5	10.8
	2	460/3/60	414	506	4.6	29	3.4	0.11	10.1	12.4
	3	460/3/60	414	506	4.6	29	4.8	0.11	11.5	13.8
EQ2W03 & EQR03	None	230/3/60	207	253	14.3	93	0.0	0.22	21.0	28.2
	1	230/3/60	207	253	14.3	93	3.6	0.22	24.6	31.8
	2	230/3/60	207	253	14.3	93	6.8	0.22	27.8	35.0
	3	230/3/60	207	253	14.3	93	9.6	0.22	30.6	37.8
	None	460/3/60	414	506	6.4	48	0.0	0.11	9.6	12.8
	1	460/3/60	414	506	6.4	48	1.8	0.11	11.4	14.6
	2	460/3/60	414	506	6.4	48	3.4	0.11	13.0	16.2
	3	460/3/60	414	506	6.4	48	4.8	0.11	14.4	17.6

Notes:
1. RLA is Rated Load Amps.
2. LRA is Locked Rotor Amps.
3. FLA is Full Load Amps.
4. MCA is Minimum Circuit Ampacity (for wire sizing) and includes compressor, condenser fans, pump, and control circuit.
5. MOCP is Maximum Overcurrent Protection.

Controller Operation



The chiller includes a microprocessor controller to perform all control functions directly from the front panel. When Control Power is applied, the controller initiates a diagnostic test of each indicating light and display segment which momentary lights them sequentially. As part of this initial diagnostic test, the program revision level display in the temperature display for a moment. After the initial diagnostic sequence is completed, the controller is ready for operation.

Power Button

Depressing the Power button will switch the control power on or off. Control power must be initiated before either the Start button or remote on/off contacts can start the chiller.

Start Button

Depressing the Start button will start the pump and enable the compressor. The compressor (and condenser fans or blowers if the chiller is air cooled) will start only if the microprocessor is calling for cooling because the actual To Process temperature is higher than the Set Point temperature.

Note: Once the compressor has cycled off, it will not restart for 2.5 minutes because of an internal anti-cycle time delay.

Stop Button

Depressing the Stop button will shut off the compressor, pump, condenser fans or blowers (if the chiller is air cooled), and clear all fault signals.

Alarm Reset Button

Depressing the Alarm Reset button will reset any fault indicator that has been activated on the control board. This includes any LED indicators or alarm codes. The High Refrigerant Pressure, Low Oil Pressure, and Pump Overload require a mechanical safety to be manually reset before the control board can be reset.

Note: If the condition still exists that originally caused the alarm indication, the alarm may be reactivated as soon as it is reset.

Alarm Silence Button

The Alarm Silence button is only functional if the Alarm Horn option and/or Remote Alarm Contact option has been purchased. If the Alarm Horn option has been purchased, depressing the Alarm Silence button will disable the horn. The horn will not reactivate until the alarm has been reset and a

subsequent alarm has been triggered. If the Remote Alarm contacts option has been purchased, depressing the Alarm Silence button will open the contact that was closed when the alarm occurred. The contact will not close again until the alarm has been reset and a subsequent alarm has been triggered.

Lower Set Point Temperature Button

Each time the Lower Set Point Temperature button is depressed and released the Set Point temperature will decreased by 1°. If the Lower Set Point Temperature button is held down, the Set Point temperature will continue to decrease until the button is released.

Raise Set Point Temperature Button

Each time the Raise Set Point Temperature button is depressed and released the Set Point temperature will increased by 1°. If the Raise Set Point Temperature button is held down, the Set Point temperature will continue to increase until the button is released.

No Flow LED

The No Flow LED will be illuminated if the flow through the chiller is interupted. The pressure or flow switch communicates to the controller the status of coolant flow. When the Start button is depressed, this safety is defeated for a period of 20 seconds in order for the pump to establish flow. The No Flow LED may remain illuminated during this 20 second period. This safety will shut off the pump and the compressor. If the chiller has been shut down by the No Flow safety, the Start button must be depressed in order to restart the pump and reset the 20 second time delay.

High Refrigeration Pressure LED

If the compressor discharge refrigerant pressure exceeds the setting on the high refrigerant pressure safety, the compressor and pump will shut off and the High Refrigerant Pressure LED will be illuminated. Pressing the Alarm Reset button will reset the High Refrigerant Pressure fault, as long as the High Refrigerant Pressure switch located at the discharge of the compressor has been manually reset.

Low Refrigeration Pressure LED

If the compressor suction pressure drops below the setting on the low refrigerant pressure safety, the compressor will shut off, the pump will remain running, and the Low Refrigerant Pressure LED will be illuminated. Pressing the Alarm Reset button will reset the Low Refrigerant Pressure fault, as long as the refrigerant pressure has risen back up above the safety's cutout level.

Freezestat LED

If the coolant temperature being delivered to the process drops below the setting on the Freezestat, the compressor will shut off, the pump will remain running, and the Freezestat LED will be illuminated. The Freezestat should be set 10°F above the freezing point of the glycol solution and 10°F below the minimum operating temperature. The Freezestat is factory set at 38°F. In order to reset the Freezestat fault press the Alarm Reset button on front control interface.

Low Oil Pressure LED

This LED is nonfunctional on standard units and will be activated only if the unit has been modified to include a low oil pressure sensor (typical for semi-hermetic reciprocating compressor units). If the unit has a low oil pressure sensor and the oil pressure in the compressor crankcase drops below the factory set level on the oil pressure switch, the compressor and pump will shut off, and the Low Oil Pressure LED will be illuminated. In order to reset the Low Oil Pressure fault, press the Alarm Reset button after resetting the mechanical pressure switch located inside of the cabinet near the compressor.

Over Set Point LED

The Over Set Point LED will be illuminated if the To Process temperature exceeds the Set Point temperature by more than 5°F. This fault causes only an alarm indication (horn and/or remote contact) and the chiller will continue to operate. Although the Over Set Point LED will turn on immediately whenever the temperature is out of range, the alarm relay is disabled for 30 minutes after start-up or after a change in set point. The alarm will automatically clear when the To Process temperature is no more that 5°F above the Set Point temperature.

Under Set Point LED

The Under Set Point LED will be illuminated if the To Process temperature drops below the Set Point temperature by more than 10°F. This fault will shut off the compressor, but the pump will continue to run. Although the Under Set Point LED will turn on immediately whenever the temperature is out of range, the alarm relay is disabled for 30 minutes after start-up or after a change in set point. Pressing the Alarm Reset button will reset this fault.

Pump On LED

The Pump On LED will be illuminated whenever the pump is running. If the pump is shut off due to a safety, the Pump On LED will turn off. The Start button must be pressed in order to restart the pump.

Compressor On LED

The Compressor On LED will be illuminated whenever the compressor is running. The Compressor On LED will cycle on and off with the compressor. The compressor will not come on unless the pump is already running and the To Process temperature is above the Set Point temperature.

Note: During normal operation, the compressor may cycle on and off. An internal anti-cycle time delay will not allow the compressor to restart for 2.5 minutes after it has cycled off. For air cooled units the fans will cycle off with the compressor.

Part Load LED

The Partial Load LED will be illuminated whenever the microprocessor energizes the hot gas bypass solenoid valve. This valve is cycled in order for the chiller to maintain a constant To Process temperature even when there is only a partial load. The longer that this LED stays on, the more unused excess capacity is available from the chiller. If the Partial Load LED stays off, the chiller is fully loaded by the heat from the process. If the Partial Load LED stays on, the chiller has a very small load on it from the process. If this low load condition persists, the To Process temperature may begin to drop below the Set Point temperature, and when it reaches 7°F below the Set Point temperature, the compressor will cycle off. The compressor will come back on when the To Process temperature rises back up to the Set Point temperature and the anti-cycle 2.5 minute time delay relay has timed out.

Water Make-Up LED

This LED is nonfunctional on standard units and will be active only if the Water Make-Up option has been purchased. When the water level in the reservoir drops below the lower limit of the float switch, the water make-up solenoid valve is opened and the Water Make-Up LED is illuminated. When the water level rises to the upper limit of the float switch, the water make-up solenoid is closed and the Water Make-Up LED turns off. The microprocessor will also close the water make-up solenoid valve if it has been open for 10 minutes. This is done to help prevent further problems if a water leak has developed in the system. If this occurs, the Water Make-Up LED turns off and the Low Water Level LED remains illuminated.

Low Water Level LED

This LED is nonfunctional on standard units and will only be active if the Low Water Level option or the Water Make-Up option has been purchased. When the water level in the reservoir drops below the lower limit of the float switch, the Low Water Level LED is illuminated. When the water level rises to the upper limit of the float switch, the Low Water Level LED will shut off.

High Water Temperature LED

The High Water Temperature LED will be illuminated if the To Process temperature rises more than 10°F above the Set Point temperature. The High Water Temperature LED will turn off when the water temperature is less than 10°F above the Set Point temperature. This fault will not stop operation of the chiller.

Probe Fault LED

The Probe Fault LED will illuminate if the signal from the thermocouple is out of tolerance. This fault will also shut off the compressor and the pump. Pressing the Alarm Reset button will reset this alarm.

Changing Temperature Display Scale

The chiller is able to display temperatures in either °F or °C. To determine which temperature is in use and to change the temperature scale use stop the unit and press the Power button to turn off the controller. Press and hold the Stop Button and then press the Power Button. When the controller illuminates, release both buttons. The To Process display will read "Unt". The Set Point display will show either "F" or "C" depending on the current display units selected. If "F" is displayed the temperature display is in °F mode. If "C" is displayed the temperature display is in °C mode. To change from °F to °C press the Lower Set Point Temperature button. To change from °C to °F press the Raise Set Point Temperature button. After changing to the desired temperature scale the Set Point display show the desired display units. Press and release the Start button to store the new selection into the controller memory then press and release the Power button to exit the function. Press and release the Power button again to restore controller power. The unit is now ready for operation.

Table 12 - Microprocessor Control Fault Logic

Fault	Alarm Indication	Compressor Shutdown	Pump Shut Off	Alarm Reset Required[1]	Manual Reset Required[2]	Remote Alarm Activated[3]
No Flow	LED	Yes	Yes	No	No	Yes
High Refrigerant Pressure	LED	Yes	Yes	Yes	Yes	Yes
Low Refrigerant Pressure	LED	Yes	No	Yes	No	Yes
Freezestat	LED	Yes	No	Yes	No	Yes
Low Oil Pressure	LED	Yes	Yes	Yes	Yes	Yes
Over Set Point	LED	No	No	No	No	Yes
Under Set Point	LED	Yes	No	Yes	No	Yes
Low Water Level	LED	No	No	No	No	No
High Water Temperature	LED	No	No	No	No	No
Probe Fault	LED	Yes	Yes	Yes	No	Yes
Low Power	Pr OFF	Yes	Yes	Yes	No	Yes
Pump Overload	Err 126	Yes	Yes	Yes	Yes	Yes
Compressor Overload	Err 127	Yes	Yes	Yes	No	Yes
High Temperature Safety	Err 128	Yes	Yes	Yes	No	Yes

[1] Alarm Reset button or Stop button on control panel must be pressed.
[2] Safety control must be manually reset before the controller can be reset.
[3] Activates the alarm horn (if included) and closes the alarm contact (if included).

Diagnostic Error Codes

Several different error codes may be displayed on the digital readouts labeled To Process and Set Point. Most of the possible error codes indicate some type of failure in the microprocessor controller. Table 13 shows a list of the error codes. If there are any error codes other than the one listed below, try to reset the unit by shutting the power off and then turning it back on. If this does not work, make a note of the error code and contact our Customer Service Department for further assistance.

Table 13 - Diagnostic Error Codes

Error Code	Description	Cause/Corrective Action
Pr Off	Brown Out Indication	Indicates the chiller is running and main power is discontinued or drops more than 10% below the normal operating voltage, the unit will shut down and the Pr OFF fault will be indicated on the digital displays. Pressing the Power button will clear this fault condition.
101	EEPROM Failure	Controller requires servicing. Contact Manufacturer for repair or replacement.
102	A/D Converter Failure	Controller requires servicing. Contact Manufacturer for repair or replacement.
103	Controller serial bus failure	Controller requires servicing. Contact Manufacturer for repair or replacement.
105	CJC Error	Controller requires servicing. Contact Manufacturer for repair or replacement.
109	Unused memory byte changed	Controller requires servicing. Contact Manufacturer for repair or replacement.
110	Device or communication configuration change or invalid	Controller requires servicing. Contact Manufacturer for repair or replacement.
111	Fixed parameter associated with range invalid	Controller requires servicing. Contact Manufacturer for repair or replacement.
112	Setpoint out of temperature range	Controller requires servicing. Contact Manufacturer for repair or replacement.
113	RAM hardware failure	Controller requires servicing. Contact Manufacturer for repair or replacement.
114	Invalid device configuration	Controller requires servicing. Contact Manufacturer for repair or replacement.
117	Invalid program counter	Controller requires servicing. Contact Manufacturer for repair or replacement.
118	Infinite software loop detect	Controller requires servicing. Contact Manufacturer for repair or replacement.
119	Data direction register failure	Controller requires servicing. Contact Manufacturer for repair or replacement.
120	Communication data register failure	Controller requires servicing. Contact Manufacturer for repair or replacement.
121	Timer data register failure	Controller requires servicing. Contact Manufacturer for repair or replacement.
122	Hardware watchdog data register failure	Controller requires servicing. Contact Manufacturer for repair or replacement.
123	Option data register failure	Controller requires servicing. Contact Manufacturer for repair or replacement.
125	Jumper for temperature controller missing	Indicates the jumper is loose or missing on the control circuit board.
126	Pump overload on chiller	Indicates the pump overload has tripped. In order to reset this fault; press the Alarm Reset button after resetting the pump overload inside the electrical enclosure.

Table 13 – Diagnostic Error Codes (continued)

Error Code	Description	Cause/Corrective Action
127	Compressor overload on chiller	Indicates the internal compressor motor winding thermostat or the external compressor motor overload has tripped. This fault also shuts off the pump. The internal compressor motor winding thermostat automatically resets when the temperature drops back into the normal operating range. The external compressor motor overload must be manually reset. The compressor motor overload is located inside the electrical enclosure. Once the internal compressor motor winding thermostat resets and/or the external compressor overload are reset, press the Alarm Reset button to reset the fault.
128	Chiller high temperature safety	Indicates the chiller has been shut off due to the high temperature safety. This safety shuts off both the pump and compressor. This safety is triggered if the To Process temperature rises more than 10°F above the maximum operating temperature noted on the chiller nameplate. The To Process temperature must be over the limit for three minutes before this safety will be triggered, and the fault is defeated for a period of thirty minutes from the time the Start button is pressed or the Set Point temperature is changed. Pressing the Alarm Reset button will reset this fault.
129	Input Contact Chatter	

SPI Communications Option

Several members of SPI: The Plastics Industry Trade Association joined together to define a communications standard to various pieces of plastic processing equipment to communicate. They chose to adopt the Serial Peripheral Interface bus (SPI bus) which coincidently has the same abbreviation as the trade association. To allow our unit to operate as a slave unit is a plastic processing system using this protocol, we offer an option that includes an expansion module for the control board and a RS-485 communication port on the unit. The communication hardware firmware is SPI 3.01 standard compliant.

Units ordered with this option will have this feature activated at the factory. If for some reason this feature is deactivated the DIP switch setting may need to be adjusted.

When the SPI option is purchased, there is a second set of DIP switches included on the back of the main control panel. This set of DIP switches is labeled "COMM". All DIP switch adjustments that follow are to be made on the COMM set. Do not adjust any DIP switches on the CONFIG set.

Note: All DIP switch changes must be made with power disconnected.

In order to activate the SPI protocol, DIP switch #8 must be set to the "On" position. To deactivate the SPI communication, set DIP switch #8 to the "Off" position.

If more than one piece of equipment is going to be on the same communications network, the base address will have to be changed so that each unit has a unique address. This is done by changing one or more of the DIP switches to the "Off" position. The base address is 32 decimal. Changing these switches causes the following address change.

Table 14 - SPI Baud Rate Adjustment

BAUD Rate	DIP Switch #6	DIP Switch #7
1200	ON	ON
2400	OFF	ON
4800	ON	OFF
9600	OFF	OFF

DIP Switch 1 OFF adds one to base address
DIP Switch 2 OFF adds two to base address
DIP Switch 3 OFF adds four to base address
DIP Switch 4 OFF adds eight to base address
DIP Switch 5 OFF adds sixteen to base address

The BAUD rate can be adjusted to the appropriate setting by using the information found in Table 14.

Table 15 - SPI Parameters

Command	Poll	Select	Description
Echo	20 20	20 21	This is the controller integrity command used to accept and retain data and provide it in response to a poll inquiry. This is an open 4 byte ASCII format with ASCII units.
Version	20 22		This is the controller version command used to provide a version number following format: AABB, where AA = SPI assigned version level, BB = vendor assigned version level. This is in an open 4 byte ASCII format with ASCII units.
Setpoint Process Temperature	20 30	20 31	This is the temperature which the process supply is to be maintained. This is a numeric format in °F.
Alarm, High Temperature Deviation	20 32	20 33	This is the valve in conjunction with the process setpoint that determines the high alarm temperature. This value must always be positive. This is a numeric format in °F.
Alarm, Low Temperature Deviation	20 34	20 35	This is the value in conjunction with the process setpoint that determines the low alarm temperature. This value must always be positive. This is a numeric format in °F.
Status, Process	20 40		This is the process status in a 16 bit format as follows: 0 = Controlling 1 = An alarm is present 2 = An alarm affecting the process has occurred (high temperature deviation or low temperature deviation) 3 = An alarm affecting the machine has occurred (probe fault or pump fault) 4 = The controller has exceeded its over setpoint deviation 5 = The controller has exceeded its below setpoint deviation
Status, Machine 1	20 42		This is the machine status in a 16 bit format as follows: 0 = Controlling 1 = An alarm is present 2 = An alarm affecting the process has occurred (high temperature deviation or low temperature deviation) 3 = An alarm affecting the machine operation has occurred (probe fault or pump fault) 4 = The controller has exceeded its over setpoint deviation 5 = The controller has exceeded its below setpoint deviation
Status, Machine 2	20 44		This is the machine status in a 16 bit format as follows: 0 = Controlling 1 = An alarm is present 2 = An alarm affecting the process has occurred (high temperature deviation or low temperature deviation) 3 = A sensor error has been detected 4 = An alarm affecting the machine operation has occurred
Mode, Machine	20 48	20 40	This is the machine mode in two 8-bit bytes. When polling 20 48 bit 0 indicated the machine is off 20 40 bit 0 commands the unit to be turned on or off (on when high or off when low) 20 40 bit 1 is used to recognized the alarm condition
Temperature, To Process (Supply)	20 70		Returns the process supply temperature. This is a numeric format in °F.
Temperature, To Process (Return)	20 72		Returns the process return temperature. This is a numeric format in °F.

Return Temperature Display Option

This option allows the To Process digital display to indicate To Process or Return Water Temperatures. To view the Return Water Temperature, hold down the Lower Set Point Temperature and Raise Set Point Temperature buttons simultaneously. Once the buttons are released, the display will return to the To Process temperature.

Remote On/Off Contacts Option

This option allows the unit to be turned on and off via a remote contact closure. Two terminals are provided in the control panel to be wired to a remote contact closure device. Switching the contacts from open to closed simulates pressing the Start button on the control panel. Switching the contacts from closed to open simulates pressing the Stop button. Please note that the Remote On/Off contacts are nonfunctional until the Power button has been depressed and the control circuit has been energized. This option also includes a remote/local toggle switch that allows the operator to disable the remote contacts for safety purposes while the unit is being serviced. ***Note: Do not introduce any external voltage to these contacts as this will result in damage to the microprocessor, which will not be covered by the warranty.***

Remote Alarm Contacts Option

This option includes a set of dry (no voltage induced by chiller), normally open contacts that will close when there is an alarm condition. Refer to Table 12 to determine which faults will trigger the Remote Alarm contacts. The contacts will reopen by clearing the fault or by pressing the Alarm Silence button.

Alarm Horn Option

This option includes an alarm horn that will be activated by certain faults. Refer to Table 12Table 12 to determine which faults will trigger the Alarm Horn. The Alarm Horn will be silenced by clearing the fault or by pressing the Alarm Silence button. If this option is selected in conjunction with the remote control panel, the Alarm Horn will be mounted on the chiller and not the remote control panel.

Remote Hand-Held Control Option

This option removes the display and control buttons from the chiller and places them in a small hand-held enclosure. Included with this option is a 50 foot cable to connect the controller and the chiller. All control functions are available to the operator at the location of the remote panel and no control functions are available at the location of the chiller.

Safety Guidelines

Observe all safety precautions during installation, start-up, and service of this equipment due to the presence of high voltage and refrigerant charge. Only qualified personnel should install, start-up, and service this equipment.

When working on this equipment, observe precautions in literature, and on tags, stickers, and labels located on the equipment. Wear work gloves and safety glasses.

WARNING: This equipment contains hazardous voltages that can cause severe injury or death. Disconnect and lock out incoming power before installing or servicing the equipment.

WARNING: This equipment contains refrigerant under pressure. Accidental release of refrigerant under pressure can cause personal injury and or property damage. Exercise care while working on or around this equipment.

WARNING: Vent all refrigerant relief valves in accordance to ANSI/ASHRAE Standard 15, Safety Code for Mechanical Refrigeration. This equipment should be located within a well-ventilated area. Inhalation of refrigerant can be hazardous to your health and the accumulation of refrigerant within an enclosed space can displace oxygen and cause suffocation.

Start-Up

Every unit is factory set to deliver chilled water in accordance with the standard operating specifications for that particular chiller. Due to variables involved with different applications and different installations, minor adjustments may be required during the initial start-up to ensure proper operation.

We strongly recommend the following start-up procedure be performed by a qualified experienced refrigeration technician and must be followed in sequence. If trouble is encountered the fault can usually be traced to one of the control or safety devices. This outline serves as a checklist for the

initial start-up and for subsequent start-ups if the chiller is out of service for a prolonged time.

Connect Main Power

Connect main power properly ensuring it matches the voltage shown on the nameplate of the unit. Check the electrical phase sequence prior to start-up. Operation of the compressor with incorrect electrical phase sequencing will result in mechanical damage to the compressors. Check the phasing with a phase sequence meter prior to applying power. The proper sequence should read "ABC" on the meter. If the meter reads "CBA", open the main power disconnect and switch two line leads on the line power terminal blocks (or the unit mounted disconnect). All components requiring electric power are in-phase at the factory. Do not interchange any load leads that are from the unit contactors or the motor terminals. After making proper power connection and grounding, turn the main power on.

WARNING: To prevent equipment damage due to reverse rotation, connect L1-L2-L3 in the A-B-C phase sequence.

CAUTION: The unit requires the main power to remain connected during off-hours to energize the compressor's crankcase heater. Disconnect main power only when servicing the chiller. The crankcase heater should remain on when the compressor is off to ensure liquid refrigerant does not accumulate in the compressor crankcase.

WARNING: Connecting an appropriate power source to the main terminal block energizes the entire electric circuitry of the chiller. A transformer provides 120 VAC control power. Electric power at the main disconnect should be shut off before opening access panels for repair or maintenance. Ground the unit properly in compliance with local and national codes.

Fill Coolant Circuit

Check to make sure all process chilled-water piping connections are secure. Open the chiller cabinet and fill the coolant reservoir with the proper water or water/glycol solution following the guidelines of the system fill water chemistry as shown below and in Table 16Table 16. When using a glycol solution only use glycol with a corrosion inhibitor. See Table 17 for recommended glycol solutions.

System Fill Water Chemistry Requirements

Water is a unique molecule whose properties make it ideal for heat transfer applications. It is safe: non-flammable and non-poisonous. It is easy to handle, widely available and inexpensive in most industrialized areas. It is capable of absorbing more heat per unit mass than almost any other material.

Water also has properties that need to be within limits to avoid unwanted side effects. Water is a "universal solvent" because it can dissolve many solid substances to some extent and absorb gasses. As a result, water can cause the corrosion of metals used in a cooling system. Often water is in an open system (exposed to air) that concentrates the ions as water evaporates as in a cooling tower. As the concentration exceeds the solubility of some minerals, scale forms. The life giving properties of water can also encourage biological growth that can foul heat transfer surfaces.

Sometimes the source of the water can be the cause of some of the problems. Anyone living in an area with extremely hard water that has caused scale build up can attest to that. Source waters available for make-up use have an almost unlimited chemistry variation.

To avoid the unwanted side effects associated with water cooling, proper chemical treatment and preventive maintenance is required for continuous plant productivity.

Unwanted Side Effects of Improper Water Quality

- Corrosion
- Scale
- Fouling
- Biological Contamination

Cooling Water Chemistry Properties

- Electrical Conductivity
- pH
- Alkalinity
- Total Hardness
- Dissolved gases

Some of the water chemistry properties can combine to cause the unwanted side effects. Some of the levels are temperature dependant (i.e. dissolved gases).

Our chiller construction minimizes the potential for corrosion by using stainless steel brazed plate heat exchangers. The stainless steel resists corrosion but is not immune to it. These, as all heat exchangers, are susceptible to fouling that may coat the heat transfer surfaces. Coating of these surfaces reduces the heat transfer surface, increases the fluid velocities and pressure drops through the heat exchanger. All of these effects reduce the heat transfer and affect the productivity of the plant. This is just as true with shell and tube heat exchangers.

Chilled cooling water systems, at their simplest, have two main heat exchangers: one that absorbs the heat from the process and the evaporator of the chiller that removes the heat from the system. The chiller is only part of the entire cooling system. The system requires proper design following sound engineering practice and satisfying local and industry standards. Improperly designed or installed systems may cause unsatisfactory operation and/or system failure.

The complex nature of water chemistry requires a specialist to evaluate and implement appropriate sensing, measurement and treatment needed for satisfactory performance and life. The recommendations of the specialist may include filtration, monitoring, treatment and control devices. With the ever-changing regulations on water usage and treatment chemicals, the information is always up to date when a specialist in the industry is involved. Table 16 shows the list of water characteristics and quality limitations.

Table 16 – Fill Water Chemistry Requirements

Water Characeristic	Quality Limitation
Alkalinity (HCO_3^-)	70-300 ppm
Aluminum (Al)	Less than 0.2 ppm
Ammonium (NH_3)	Less than 2 ppm
Chlorides (Cl^-)	Less than 300 ppm
Electrical Conductivity	10-500µS/cm
Free (aggressive) Carbon Dioxide (CO_2)†	Less than 5 ppm
Free Chlorine(Cl_2)	Less than 1 PPM
HCO_3^-/SO_4^{2-}	Greater than 1.0
Hydrogen Sulfide (H_2S)*	Less than 0.05 ppm
Iron (Fe)	Less than 0.2 ppm
Manganese (Mn)	Less than 0.1 ppm
Nitrate (NO_3)	Less than 100 ppm
pH	7.5-9.0
Sulfate (SO_4^{2-})	Less than 70 ppm
Total Hardness (dH)k	4.0-8.5

* Sulfides in the water quickly oxidize when exposed to air, requiring that no agitation occur when taking a water sample. Unless tested immediately at the site, the sample will require stabilization with a few drops of one Molar zinc acetate solution, allowing accurate sulfide determination up to 24 hours after sampling. A low pH and high alkalinity cause system problems, even when both values are within the range shown. The term pH refers to the acidity, basicity, or neutrality of the water supply. Below 7.0, water is considered to be acidic. Neutral water contains a pH of 7.0.

† Dissolved carbon dioxide calculation is from the pH and total alkalinity values shown below or measured on the site using a test kit.

Dissolved Carbon Dioxide, PPM = TA x $2^{[(6.3-pH)/0.3]}$

where TA = Total Alkalinity, PPM as $CaCO_3$

Table 17 - Recommended Ethylene Glycol Solutions

Chilled Water Temperature	Percent Glycol By Volume
50°F (10°C)	Not required
45°F (7.2°C)	5 %
40°F (4.4°C)	10 %
35°F (1.7°C)	15 %
30°F (-1.1°C)	20 %
25°F (-3.9°C)	25 %
20°F (-6.7°C)	30 %

Note: When your application requires the use of glycol, use industrial grade glycol specifically designed for heat transfer systems and equipment. Never use glycol designed for automotive applications. Automotive glycols typically have additives engineered to benefit the materials and conditions found in an automotive engine; however, these additives can gel and foul heat exchange surfaces and result in loss of performance or even failure of the chiller. In addition these additives can react with the materials of the pump shaft seals resulting in leaks or premature pump failures.

Check Condenser

There are three possible types of condenser present in the chiller: Integral air-cooled, water-cooled, and remote air-cooled. It is important to verify the chiller will have adequate condenser cooling for proper chiller operation.

Intergral Air-Cooled Condenser Check

Make sure the chiller is properly installed as described in the mechanical installation section of this manual. Check to make sure the chiller condenser is clear of obstructions and has at least 36 inches of open air on the air inlet and outlets for proper airflow.

Water-Cooled Condenser Check

Check the condenser water lines to make sure all connections are secure. Make sure sufficient condenser water flow and pressure are available, the condenser water supply is turned on, and all shut-off valves are opened.

Remote Air-Cooled Condenser Check

Check the refrigerant lines to make sure all connections are secure and that a proper evacuation of the chiller, the field piping, and the remote condenser has occured. Verify the refrigeration piping has been installed as descibed in the installation section of this manual. Check the remote condenser main power and control wiring to ensure all connections are secure.

Check Refrigerant Valves

During shipment or installation it is possibe valves where closed. Verify that all refrigerant valves are open.

Verify Freezestat Setting

Make sure the Freezestat is set appropriately for the operating conditions of the chiller. The Freezestat setting is in a password protected menu of the chiller controller. Refer to the Controller Operation Section for instruction on how to access this menu, It should be set at 10°F below the minimum chilled water temperature setting that the chiller will be operating. Reference Table 17 to be sure the coolant solution has sufficient freeze protection (glycol) to handle at least 5°F below the Freezestat setting. All chillers are shipped from the factory with the Freezestat set at 38°F. This is done to protect against a possible freeze-up if no glycol has been added to the coolant. Once the proper glycol solution has been added, the Freezestat can be adjusted to the appropriate setting.

> ***Note: The manufacturer's warranty does not cover the evaporator from freezing. It is vital that the Freezestat is set properly.***

Turn On Control Power

Turn on the control power by turning the control power switch to "On". The panel displays should now be illuminated. Due to extreme ambient temperatures that the unit may be exposed to during shipment, the High Refrigerant Pressure switch may have tripped. If this is the case, disconnect the main power and reset the High Refrigerant Pressure by depressing the manual reset button located on the switch. Reconnect the main power and turn the control power on by pressing the Power button. Clear the alarm condition by pressing the Alarm Reset button.

Establish Coolant Flow

Standard units are provided with an internal pump that can be energized by pressing the Start button. If the unit has been customized and does not have an

internal pump, the external pump should be energized to establish flow through the chiller.

Note: The compressor will not start as long as the flow switch is open. A positive flow must be established through the evaporator before the compressor can operate.

Set water flow using a discharge throttling valve or flow control valve (by others). The valve should be the same size as the To Process connection of the chiller. Standard chillers are designed for approximately 2.4 gpm/ton of nominal capacity. A significant increase in flow beyond this in a standard chiller may result in excessive pressure loss and negatively impact chiller efficiency and in extreme cases may cause premature wear or damage of internal components.

Intial Unit Operation

Entering the desired leaving fuid temperature on the control panel. Unless otherwise specified, the chiller is factory set to deliver coolant at 50°F. Adjust to the desired operating temperature. The chiller should now be controlling to the selected temperature. Please note that if there is insufficient load the compressor may cycle on and off causing swings in temperature.

WARNING: Under no circumstance should the High Refrigerant Pressure or the Low Compressor Pressure switch be deactivated. Failure to heed this warning can cause serious compressor damage, severe personal injury or death.

Operate the system for approximately 30 minutes. Check the liquid line sight glass. The refrigerant flow past the sight glass should be clear. Bubbles in the refrigerant indicate either low refrigerant charge or excessive pressure drop in the liquid line. A shortage of refrigerant is indicated if operating pressures are low and subcooling is low. Normal subcooling ranges are from 10°F to 20°F. If subcooling is not within this range, check the superheat and adjust if required. The superheat should be approximately 10°F. Since the unit is factory charged, adding or removing refrigerant charge should not be necessary. If the operating pressures, sight glass, superheat, and subcooling readings indicate a refrigerant shortage, charge refrigerant as required. With the unit running, add refrigerant vapor by connecting the charging line to the suction service valve and charging through the backseat port until operating conditions become normal.

CAUTION: A clear sight glass alone does not mean that the system is properly charged. Also check system superheat, subcooling, and unit operating pressures. If both suction and discharge pressures are low but subcooling is normal, a problem other than refrigerant shortage exists. Do not add refrigerant, as this may result in overcharging the circuit.

Once proper flow and temperature are achieved, press the Stop button. The unit is now ready to be placed into service.

Preventive Maintenance

Once your portable chiller has been placed into service, the following maintenance procedures should be adhered to as closely as possible. The importance of a properly established preventive maintenance program cannot be overemphasized. Taking the time to follow these simple procedures will result in substantially reduced downtime, reduced repair costs, and an extended useful lifetime for the chiller. Any monetary costs of implementing these procedures will almost always more than pay for it.

To make this as simple as possible, a checklist should be prepared which lists the recommended service operations and the times at which they are to be performed. At the end of this section we have included a checklist that can be used for this purpose. Notice that there are locations for voltage readings, amperages, etc. so that they can be monitored over time. With this information, maintenance personnel may be able to correct a potential problem before it causes any downtime. For best results, these readings should be taken with a full heat load from process, preferably with similar operating conditions each time. The following is a list of suggested periodic maintenance.

Once a Week

1. (Air-Cooled Units Only) Check the surface of the air-cooled condenser coil for dirt and debris. To clean, rinse thoroughly with water. Mild detergent can be used to remove smoke and or grease stains.
2. Check to make sure that the To Process temperature is maintained reasonably close to

the Set Point temperature. If the temperature stays more than 5°F away from the set point, there may be a problem with the chiller. If this is the case, refer to the Troubleshooting Chart or contact the Customer Service Department.

3. Check the pump discharge pressure on the gauge on the back panel of the chiller. Investigate further if the pressure starts to stray away from the normal operating pressure.

4. Check the coolant level in the reservoir. Replenish if necessary making sure to take proper precautions to maintain the appropriate glycol concentration.

5. Check coolant circulation pump for leaks in the seal area. Replace pump seal if necessary.

6. Check refrigerant sight glass for air bubbles or moisture indication. If the sight glass indicates that there is a refrigeration problem, have the unit serviced as soon as possible.

Once a Month

7. With the main disconnect shut off and locked out, check the condition of electrical connections at all contactors, starters and controls. Check for loose or frayed wires.

8. Check the incoming voltage to make sure it is within 10% of the design voltage for the chiller.

9. Check the amp draws to each leg of the compressor (fans or blowers on air-cooled units) and pump to confirm that they are drawing the proper current.

Every Three Months

10. Units are equipped with a Y-strainer between the return connection and the evaporator inlet. The strainer basket should be removed and cleaned if necessary. This may be required more often if contaminants can easily get into the process water.

11. Have a qualified refrigeration technician inspect the operation of the entire unit to ensure that everything is operating properly. Have condenser cleaned out if necessary.

Preventive Maintenance Checklist

Model # _____

Serial # _____

Maintenance Activity	Week Number												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Date													
Clean Condenser Coil and Inlet Filter (air cooled units)													
Temperature Control													
Pump Discharge Pressure													
Coolant Level													
Glycol Concentration													
Pump Seal													
Refrigerant Sight Glass													
Electrical Connections													
Incoming Voltage													
Compressor L1 Amps													
Compressor L2 Amps													
Compressor L3 Amps													
Pump L1 Amps													
Pump L2 Amps													
Pump L3 Amps													
Fan L1 Amps													
Fan L2 Amps													
Fan L3 Amps													
Clean Y-Strainer													
Refrigerant Circuit Check													
Refrigerant Suction Pressure													
Refrigerant Discharge Pressure													
Refrigerant Superheat													

Troubleshooting

Problem	Possible Cause	Remedy
Compressor will not start	Compressor overload	Check supply voltage, start components (single phase), and wiring
	Run capacitor (single phase units only)	Measure capacitance and replace if faulty
	Start capacitor (single phase units only)	Measure capacitance and replace if faulty
	Start relay (single phase units only)	Check for contiuity between 2,5 and 1,2. Replace if no continuity
	Compressor contactor	Replace if faulty
	Microprocessor control board	Replace if faulty
	Compressor failure	Contact Customer Service Department for assistance
Pump will not start	Pump overload	Check supply voltage, wiring, overload set point (external overload)
	Pump contactor	Replace if faulty
	Microprocessor control board	Replace if faulty
	Pump motor failure	Check motor windings and replace if faulty
Low refrigerant pressure	Low refrigerant charge	Contact refrigeration service technician
	Refrigerant leak	Contact refrigeration service technician
	Low refrigeration pressure sensor	Check for proper range, replace if faulty
	Microprocessor control board	Replace if faulty
High refrigerant pressure	Dirty air filters (air cooled units only)	Clean filters
	Air flow obstruction (air cooled units only)	Make sure chiller is installed in accordance with recommendations in this manual
	High ambient air temperature (air cooled units only)	Ambient temperature must be reduced below 105°F (40.5°C)
	Condenser fan motor (air cooled units only)	Check start compents and motor windings for failure and replace if faulty
	Condenser fan cycling control (air cooled units only)	Confirm proper operation, replace if faulty
	Plugged condenser (water cooled units only)	Clean out tubes
	Insufficient condenser water flow (water cooled units only)	Make sure chiller is installed in accordance with the recommendations of this manual
	High condenser water temperature (water cooled units only)	Condenser water temperature must be reduced below 90°F (38°C)
	Condenser water regulating valve	Check setting, replace if faulty
	Refrigerant circuit overcharged	Contact refrigeration service technician
	High refrigerant pressure sensor	Replace if faulty
	Microprocessor control board	Replace if faulty

Troubleshooting (continued)

Problem	Possible Cause	Remedy
Freezestat	Low flow through evaporator	Adjust flow to proper level
	Freezestat control module	Check for proper setting, replace if faulty
	Microprocessor control board	Replace if faulty
	Freezestat sensor	Replace if faulty
Low pump discharge pressure	Pump running backwards (three-phase pumps only)	Switch two legs of the incoming power
	Pump pressure gauge	Replace if faulty
	Pump failure	Replace if faulty
	Excessive flow	Reduce flow
High pump discharge pressure	Closed valves in process piping	Open valves
	Obstruction in piping or process	Remove obstruction
	Clogged Y-strainer	Clean strainer
	Pressure gauge	Replace if faulty
Erratic temperature control	Low coolant flow through evaporator	Adjust flow to proper level
	Intermittent overloading of chiller capacity	Check to make sure chiller is properly sized for process load
	Hot gas bypass valve	Contact refrigeration service technician
	Microprocessor control board	Replace if faulty
	Thermocouple	Replace if faulty
Insufficient cooling (temperature continues to rise above set point)	Process load too high	Check to make sure chiller is properly sized for process load
	Coolant flow through evaporator too high or too low	Adjust flow to proper level
	Insufficient condenser cooling	See “High Refrigerant Pressure”
	Hot gas bypass valve stuck open	Contact refrigeration service technician
	Refrigeration circuit problem	Contact refrigeration service technician
	Microprocessor control board	Replace if faulty
	Thermocouple	Replace if faulty

Drawings

We have prepared a custom set of drawings for your unit and placed them inside the control panel prior to shipment. Please refer to these drawings when troubleshooting, servicing, and installing the unit. If you cannot find these drawings or wish to have additional copies, please contact our Customer Service Department and reference the serial number of your unit.

Warranty

Thermal Care warrants its equipment to be free from defects in material and workmanship when used under recommended operating conditions.

Thermal Care's obligation is limited to repair (i.e. rewind a motor) or replacement (not adjustment or maintenance), F.O.B. the factory of any parts supplied by Thermal Care within a period as shown below from the date of shipment to the original purchaser.

Model	**Parts**	**Labor**[1]
SQ, LQ, NQ	18 months	12 months
EQ	12 months	12 months
EQR, LQR, SQR, NQR(remote condensers)	12 months	12 months[2]
TCW, TSW, MXW,	12 months	12 months
TCR, TSR, MXR (remote condensers)	12 months	12 months[2]
Optional Compressor Warranty	5 years	
Chilled Water Systems	See note[3]	12 months[4]
FT or FC Tower Systems	See note[3]	12 months[4]
FT Cooling Tower	12 months (10 years - shell)	
FC Cooling Tower	5 years (10 years - shell)	
RA, RB, RQ	(See Warranty Sheet - Form 1-415.7 or 1-416.2)	
All other products	12 months	

[1]Continental U.S.A., Canada, and Puerto Rico only.
[2]Refrigerant and any labor associated with its evacuation or replacement are not covered for remote condenser systems.
[3]See individual product listing for parts warranty coverage.
[4]The labor warranty covers all equipment purchased at the same time consisting of a minimum of at least one pumping system and one cooling tower and/or chiller.

This warranty does not cover the cost of labor during overtime hours (after normal working hours or during weekends and holidays). Any cost differential for overtime labor will be the responsibility of the customer. Thermal Care is not responsible for any sales, use, excise or other applicable taxes associated with the replacement of parts under this warranty. This warranty will be voided when, in Thermal Care's opinion, the equipment and/or system has been subject to misuse, negligence or operation in excess of recommended limits, including freezing, or has been altered, and/or repaired without express factory authorization. If equipment is installed in hostile environments, unless such conditions were specified at the time of purchase; or the serial number has been removed or defaced, this warranty shall not apply. All labor warranty coverage provided by the Seller is based on normal ground mounted equipment with proper clearance and equipment access. The Buyer is responsible for any additional costs associated with special rigging or access platforms required to perform the warranty work and/or any additional labor cost associated with delays caused by the Buyer which prevent the Seller's service technician from performing their repair work in a proper timely manner. This warranty is not transferable.

Under no circumstances shall Thermal Care be liable for loss of prospective or speculative profits, or special, indirect, incidental or consequential damages.

Thermal Care must authorize all warranty service prior to work being performed and have a Thermal Care purchase order issued. All defective parts become the property of Thermal Care and must be returned as advised by Thermal Care.

Thermal Care neither assumes, nor authorizes any person to assume for it, any liability not expressed in this warranty. There is an implied warranty of merchantability and of fitness for that particular purpose; all other implied warranties, and any liability not based upon contract are hereby disclaimed and excluded by this warranty. This warranty is part of the standard conditions and terms of sale of Thermal Care.

THERMAL CARE
7720 N. Lehigh Avenue
Niles, Illinois 60714-3491
Phone: (847) 966-2260
(888) 828-7387
Fax: (847) 966-9358

Email: info@thermalcare.com
www.thermalcare.com
Customer Service
Phone: (847) 966-2636
Fax: (847) 966-2906

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Notes

Notes

Thermal Care, Inc.
7720 North Lehigh Ave.
Niles, IL 60714-3491
www.thermalcare.com

New Equipment Sales
Phone (847) 966-2260
Fax (847) 966-9358
info@thermalcare.com

Customer Service
Phone (847) 966-2636
Fax (847) 966-2906
service@thermalcare.com

Parts
Phone (847) 966-8560
Fax (847) 966-6065
tcparts@thermalcare.com

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