I.O.M. #075 11/05

INSTRUCTION MANUAL • INSTALLATION • OPERATION • MAINTENANCE

MW SERIES®
CENTRAL CHILLER

MA SERIES®
CENTRAL CHILLER

TEMPTEK®

TEMPTEK, INC.
525 East Stop 18 Road Greenwood, IN 46142
317-887-0729 fax: 317-881-1277
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MW SERIES® CENTRAL CHILLER

MA SERIES® CENTRAL CHILLER

INSTRUCTION MANUAL
for CHILLING MODULES

MA SERIES
with Air-Cooled Condenser

MW Series
with Water-Cooled Condenser

COVERING

INSTALLATION
OPERATION
MAINTENANCE

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TABLE OF CONTENTS

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1.0 GENERAL

1.1 INTRODUCTION

1.2 SAFETY

1.3 CLEAN AIR ACT

1.4 EFFICIENCY AND LIFE EXPECTANCY

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1.1 INTRODUCTION

A. Immediately inspect the equipment for signs of shipment damage. Look for damage to the shipping crate, enclosure panels and cabinetry. review the refrigerant gauges for pressure. Remove the equipment enclosure panels and look for signs of fluid, compressor oil and / or water. If damage is found, either receive the equipment "damaged" noted on the freight bill of lading or refuse it as "damaged" and have the carrier return the item "free-a-stray". If received as "damaged", you must file a claim with the carrier. The carrier is responsible for any and all shipment damage.

B. It is of the utmost importance to become familiar with both this manual and the equipment operating characteristics. the unit's ability to function properly is greatly affected by the method of installation. Several references are made to important safety issues. The owner is responsible for ensuring proper operator training, equipment maintenance and a safe installation. Read this manual carefully.

C. The Temptek central chiller has an operating range of 20°F to 90°F with the appropriate modifications.

D. Caution: this equipment operates at elevated fluid temperatures along with high water and refrigerant pressures. Only a licensed refrigerant service technician shall service the refrigeration system.

E. If you have any questions, please do not hesitate to contact the Temptek Service Department at 317-887-0729. Prior to contacting the Service Department, obtain the equipment model number, serial number and voltage requirements from the unit's data tag. The data tag is normally located on the side of the electrical cabinet.

1.2 SAFETY

A. Observe all warning and safety palcards applied to the equipment. Failure to comply can result in equipment damage, personal injury or death.

B. It is the owner's responsibility to assure proper installations, training and maintenance.

1.3 CLEAN AIR ACT

A. The refrigerant system utilizes a class 2 substance, HFCF-22 (R22), chlorodifloromethane.

B. Effective July 1, 1992, it is unlawful for any person in the course of maintaining, servicing, repairing or disposing of refrigerant equipment to knowingly vent or otherwise dispose any class 2 substance used as a refrigerant in the manner that permits such substance to enter the atmosphere.

C. De minimis releases associated with good faith attempts to recaptures, reclaim or recycle such substance shall not be subject to the prohibition set forth in the preceding paragraph.

1.4 EFFICIENCY AND LIFE EXPECTANCY

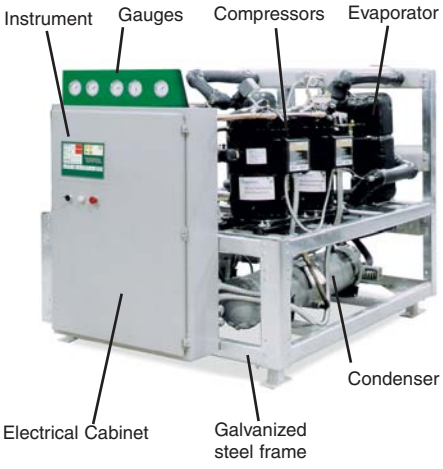
A. Long term efficiency of operation is largely determined by proper maintenance of the mechanical parts of the unit and the water quality.

B. **Temptek** accepts no responsibility for inefficient operation or damage caused by improper installation of the unit or foreign materials in the process fluid.

C. **Temptek** recommends filtering where required to prevent solids from plugging critical parts (pumps, evaporators, condensers, etc).

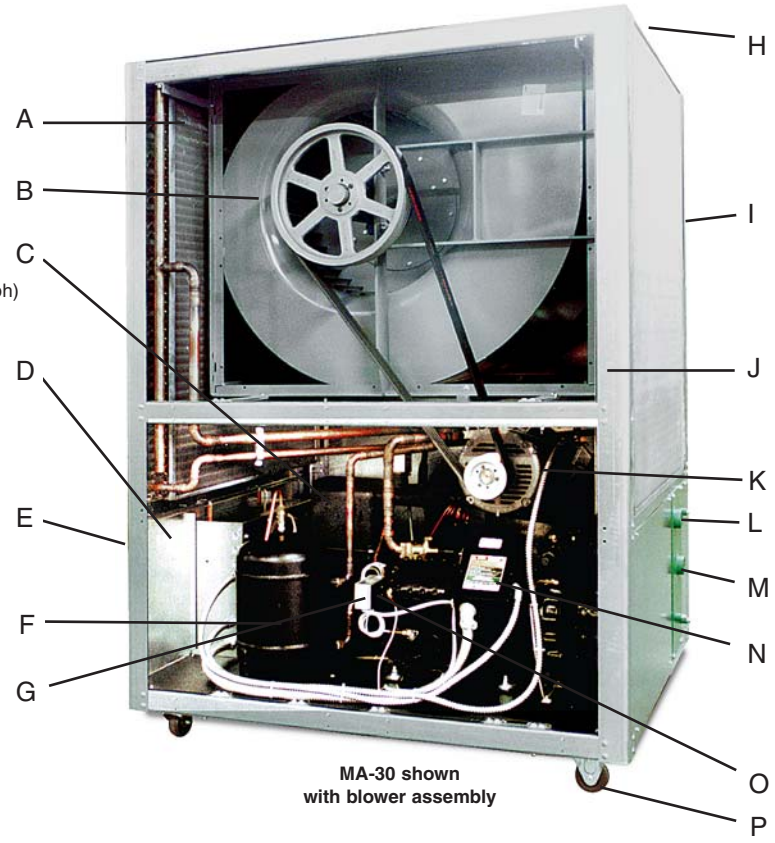
D. **Temptek** highly recommends the services of a competent water treatment specialist be obtained and his recommendations be followed. **Temptek** accepts no responsibility for inefficient operation, or damage caused by foreign materials or failure to use adequate water treatment.

MECHANICAL COMPONENTS
WATER-COOLED MODELS
TO 180 TONS



MECHANICAL COMPONENTS AIR-COOLED MODELS

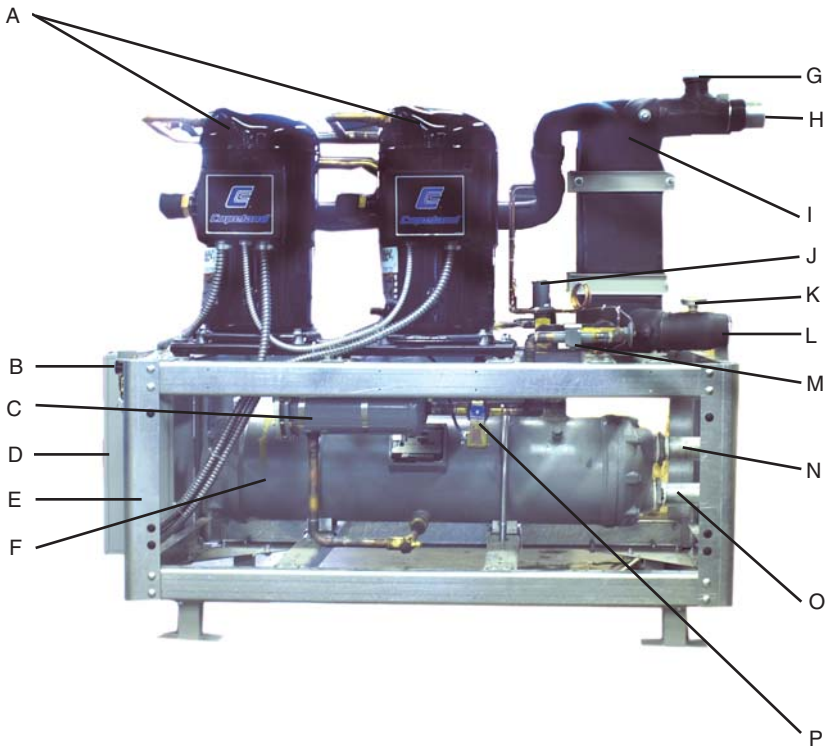
A - Air - Cooled Condenser
B - Centrifugal Blower
C - Evaporator
D - Electrical Cabinet
E - Instrumentation (not visible in photograph)
F - Liquid Receiver
G - Expansion Valve
Liquid Line Solenoid
Refrigerant Sight Glass
Filter-Dryer (not visible in photograph)
H - Air Exhaust
I - Air - Cooled Condenser
J - Galvanized Steel Frame
K - Blower Motor
L - To Process Connection
M - From Process Connection
N - Compressor
O - Oil Pressure Switch
P - Caster



MA-30 shown with blower assembly

MECHANICAL COMPONENTS WATER-COOLED MODELS

A - Compressors
B - Limit Switch
C - Filter - Drier
D - Electrical Cabinet
E - Galvanized Steel Frame
F - Water Cooled Condenser
G - Flow Switch
H - From Process Connection
I - Evaporator
J - Expansion Valve
K - Temperature Gauge
L - To Process Connection
M - Refrigerant Sight Glass
N - Condenser Return
O - Condenser Supply
P - Liquid Line Solenoid Valve



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2.0 INSTALLATION

2.1 GENERAL

A. All process piping materials, such as hose, rigid pipe, valves, and filters or similar, used in the process water piping system must be rated for 150°F minimum temperature and 200 PSIG minimum pressure.

B. All such materials shall have an equal or larger diameter size of its respective process connection.

2.2 WATER PIPING CONNECTIONS

A. Water Supply: certain models may be supplied with an automatic water make-up system.

1. Connect to the plant's water supply source.

2. The normal water supply pressure requirement is 20 PSIG. Refer to the unit's data plate for minimum requirements.

3. Be certain to install a back flow prevention device to prevent contamination of potable water and where local and / or federal regulations require.

B. To Process: connect to the respective water in port at the process (to remote tank).

C. From Process: connect to the respective water out port at the process (from remote tank).

D. Condenser Water In: water-cooled models only, connect tot he facility water supply system, such as tower, city, well and / or lake water.

E. Condenser Water Out: water-cooled models only, connect to the facility water return or drain system such as tower, city, well and / or lake water.

F. All water piping circuits shall be designed to avoid an excessive use of elbows and / or lengths of pipe or hose. If hose is the material of choice, avoid tight twists, curls and kinks.

G. Valves and filters may be installed to facilitate service and / or maintenance. These devices shall maintain the full piping diameter and be open and clean during system operation.

H. All piping shall be installed in accordance with local and federal regulations.

2.3 LOCATION: AIR-COOLED MODELS

A. The condenser is normally selected for outdoor ambient air temperatures from -20°F minimum to 95°F maximum. Ambient conditions outside of the rated temperatures may require an alternate selections for proper operations.

B. The chiller / temperature control system is designed for indoor use and should be located in a clean, dry and well-ventilated environment.

C. Refrigerant piping for remote outdoor condenser models:

1. Only refrigerant grade copper and solder shall be used.

2. The refrigerant line sizes shall be based on equivalent line lengths and acceptable refrigerant pressure drops.

3. A certified refrigerant technician shall evacuate and charge the refrigerant system under loaded conditions.

2.4 LOCATION: WATER-COOLED MODELS

A. The chiller / temperature control system is designed for indoor use and should be located in a clean, dry and well-ventilated environment. Water-cooled condensers require an alternate water source at 85°F maximum temperature for condensing the refrigerant. Tower water is the most common selection. However, city or well water may be utilized. A water regulator valve is supplied to vary flow based on refrigerant discharge pressure.

B. Nominal flow rate requirements are 1.5 GPM / ton @ 65°F or 3 GPM / ton @ 85°F water supply.

C. The pressure differential requirement between the condenser water in and water out connections must be a minimum of 30 PSIG to obtain adequate flow.

2.5 ELECTRICAL

A. The electric power supply requirements are identified on the equipment data plate. Verify that your plant's supply voltage is equal to the equipment rated voltage. Do not connect the equipment to supply voltages not equal to the nameplate rating. Failure to follow these instructions may result with equipment damage, personal injury and / or death. Use of improper voltage will void your warranty.

B. The unit is supplied with a single power entry point via power cord, power distribution block and / or disconnecting means.

C. Select and / or connect the four-wire conductor to the power entry point and / or disconnecting means. The disconnecting means shall be selected according to the equipment's nameplate rating and installed in compliance to local and federal regulations.

D. A control circuit transformer is supplied. The control circuit voltage is 110 volt, 1-phase, 60 cycle.

E. Make certain that all ground and wire connections are properly affixed. check every wire terminal and tighten all loose connections prior to engaging the power supply.

F. Make certain that no moisture and / or standing water or other fluid is present inside the electrical cabinet(s).

3.0 OPERATIONS

3.1 GENERAL

A. Failure to follow the factory required operation procedures may adversely affect the unit's ability to adequately control process temperatures and may create a hazardous operating condition which may result in unit damage, personal injury and / or death.

B. Certain models are equipped with a compressor crankcase heater. While the compressor is idle, the crankcase heater prevents refrigerant vapor from migrating to and condensing in the compressor crankcase. Condensed, liquid, refrigerant can cause catastrophic damage to the compressor.

Systems that include a crankcase heater should have power applied for approximately 12 hours or until the bottom of the compressor is warm to the touch. Power should be applied continuously except during maintenance and service purposes. During maintenance and servicing circumstances, OSHA lockout tag-out rules along with local and federal regulations apply.

3.2 START UP

A. SYSTEM FILL

1. General: this system utilizes a separate chilled water reservoir and plumping system that must be filled, activated and maintained for proper operation.

2. **Temptek r**ecommends the addition of 20% industrial grade inhibited propylene glycol for corrosion and freeze protection. A biocide must be added to the water to prevent organic growth.

B. ELECTRIC MOTOR PHASING

1. To obtain proper rotation, Scroll type compressors require phasing. All models, excluding remote outdoor condenser systems, have their motors factory phased in unison. Therefore, you should only need to check one motor to verify phasing. However, we recommend verifying all motor rotations.

2. Scroll type compressors may be verified by viewing the refrigerant high pressure and low pressure gauges. Normal operating pressures are 190 to 230 PSIG and 68 to 75 PSIG respectively. If pressure gauges are near equal when the compressor is operating, then the rotation is backwards. If phasing is incorrect, disengage power at the power source. Check for 0 voltage on load side of your disconnection means. With the absence of voltage, change

any two legs of the power source. change the phase at your power source. do not change the internal equipment wiring.

3.3 SUGGESTED REMOTE PUMP FLOW ADJUSTMENTS

A. Pump flow must be adjusted based on motor rated amperage at your operating voltage.

B. Excessive flow will cause the motor to operate at high amperage and eventually open the thermal overload safety shutting off the motor. To correct this problem, a throttling valve must be installed in the from process line. With the throttling valve fully closed, slowly open the valve until the correct motor amperage is achieved. Motor amperage rating may be acquired on the motor nameplate.

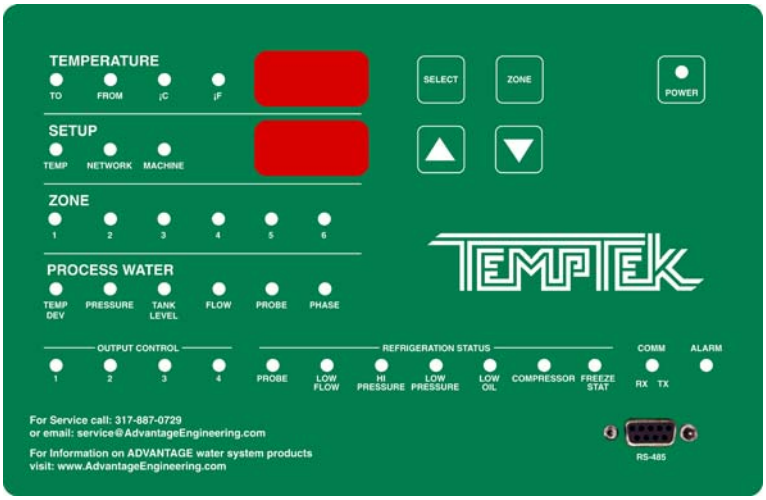
C. Low flow may result in poor temperature control and high temperature rises. To correct this problem, a bypass system must be installed between the to and from process lines. With the bypass valve fully closed, slowly open the valve until the correct motor amperage is achieved. Motor amperage rating may be acquired on the motor nameplate.

3.4 GAUGES (OPTIONAL)

A. **Refrigerant Head Pressure.** 0 - 400 PSIG. Compressor discharge and refrigerant condensing pressure, normally at 190 - 210 PSIG for water condensed models and 210 - 250 for air condensed models.

B. **Refrigerant Low Pressure.** -30 - 160 PSIG. Compressor suction and refrigerant evaporating pressure, normally at 68 - 75 PSIG for 50°F to 55°F fluid temperatures.

C. **Water In Pressure.** 0 - 160 PSIG. Evaporator or process pump supply pressure to chiller.



MZC III
Instrument Control

3.5 CONTROL INSTRUMENT

A. Operator Controls.

1. **Power LED** - indicates the power is applied to the controller board.

2. **Temperature Display Window** - displays the To Process temperature, From Process temperature, Setup text labels and labels for Zone parameters.

3. **Setup Display Window** - displays the Setpoint and Setup parameters that can be modified and Zone parameters that are read only.

4. **Select Button** - when the Select button is pressed and the unit is NOT in a Zone display, the display will cycle forward through all available temperature and setup parameters. The selected setup parameter is indicated in the upper Temperature display window (i.e. “Hi” for High Deviation, “Lo” for Low Deviation) and the parameter value is displayed in the lower Setup display window. Values are changed with the Up Arrow and Down Arrow buttons.

   The available parameters are listed below and are explained in detail in the following paragraphs:

   Temperature / Setup Display Sequence

Temperature Display Window	Setup Display Window
To Temperature	+/- Setpoint
From Temperature	+/- Setpoint
“SP”	+/- Setpoint
“LEA”	+/- lead compressor
“HI”	+/- high temperature deviation limit
“Lo”	+/- low temperature deviation limit
“Pro”	+/- protocol selection (SPI / CAC)
“Adr”	+/- address selection (1-99 / 0-9)
“RAt”	+/- baud rate selection (1200-9600)
“Unt”	+/- temperature units (F / C)

   Note: when the above variables are changed with the Arrow buttons, the instrument must NOT be powered off for 30 seconds. This allows enough time for the variables to be permanently saved in the non-volatile memory.

5. **Zone Button** - depress this button to index through the available refrigerant zone display. When in the Zone mode, the Zone LED's will flash. If the Select button is pressed while a Zone LED is flashing, the Zone parameters will be displayed.

   Zone Parameter Display Sequence

Temperature Display Window	Setup Display Window
"Eix"	EvapIn Temp
"Eox"	EvapOut Temp
"CFx"	Configuration (0-F)
"SPx"	Backup Setpoint (10-90)
"LPx"	Low Pressure Time Delay (10 - 120 seconds)

   Note: "x" represents the displayed zone number. The display will revert back to the Normal Display after approximately 10 seconds.

6. **Up Arrow Button** - depress this push button to increase the parameter displayed in the lower Setup Widow. If this push button is pressed momentarily, the value is incremented by one. If the push button is held down for more than one second, the value will increase slowly at first and then faster after about two seconds.

7. **Down Arrow Button** - depress this push button to decrease the parameter displayed in the lower Setup Window. If this push button is pressed momentarily, the value is decreased by one. If the push button is held down for more than one second, the value will decrease slowly at first and then faster after about two seconds.

   Note: when setting the Low Pressure delay or Backup Setpoint on the Zone boards, press the Up or Down Arrow buttons to keep the display from timing out and reverting back to the default To Process mode.

B. Temperature Section.

1. **To LED** - illuminates when the To Process water temperature is displayed. To is the default setting of the Temperature Display window.

2. **From LED** - illuminates when the From Process water temperature is selected.

   Note: the instrument will revert back to the To Process temperature display after 10 seconds if the Select button is used to move from the To Process display.

Note: both the To and From LED's are on when Zone EVAP IN / EVAP OUT temperatures are displayed.

3. °**C LED** - illuminates when the °C (Celsius) temperature display parameter is selected.

4. °**F LED** - illuminates when the °F (Fahrenheit) temperature display parameter is selected. °F is the default setting of the instrument.

C. Setup Section.

1. **Temp LED** - illuminates when the following parameters are selected:

   TO - To Process Temperature
   FROM - From Process temperature
   "SP" - Setpoint Temperature
   "HI" - High temperature deviation limit
   "Lo" - Low temperature deviation limit

   When the instrument is in the TO, FROM or "SP" temperature display, the operator may adjust the setpoint temperature with the Up / Down Arrow buttons.

   "SP" - programs the process Setpoint. This is the target temperature for the process. It can be set to a range of 70 - 48 or 90 - 10 depending on the state of SW-1 referenced in the "Switch Description Section".

   "HI" - programs the process HIGH alarm temperature deviation limit. This is the high temperature setting at which an alarm is activated if the "To Process" temperature reaches it. 1 - 30 units selectable.

   "Lo" - programs the process LOW alarm temperature deviation limit. This is the low temperature setting at which an alarm is activated if the "To Process" temperature decreases to it. 1- 30 units selectable.

2. **Network LED.** The Network LED illuminates when the following parameters are selected.

   "Pro" - protocol selection
   "Adr" - protocol address selection
   "rAt" - protocol baud rate selection

   "Pro" - sets the protocol selection. The protocol is the data format for communications between the unit and the host computer. SPI (standard Society or Plastics Industry) or CAC (standard used on older CMI machines) protocols selectable.

"Adr" - sets the communications address. This is the number assigned to the unit in a network. Selectable from 1 - 99 in SPI protocol and 0 - 9 in CAMAC protocol.
"rAt" - programs the baud rate. The baud rate is the data transfer rate between the unit and the hose computer.1200, 2400, 4800, 9600 units selectable.

3. **Machine LEDs.** The Machine LED illuminates when the following parameters are selected:
"Unt" - temperature unit selection.
"Prb" - from process probe calibration.

"Unt" - sets the temperature / flow display. Select "F" for Fahrenheit temperature display with GPM (gallons per minute) flow display or select "C" for Celsius temperature display with LPM (liters per minute) flow display.

D. Zone Selection.

1. The LED's in the section indicate which Zone is selected for viewing.

2. The status for the selected Zone is displayed in the Output Control and Refrigeration Status sections.

3. the operator can select which zone is displayed by using the Zone button. An **SOLID GREEN** or **FLASHING GREEN** LED indicates the selected zone.

E. Process Water Section. The following LEDs will be illuminated as follows:

SOLID GREEN - the process is ok and working fine.

FLASHING RED - the process is not functioning correctly.

SOLID RED - the process had a fault, but the fault is no longer present.

1. **Temp Dev LED**. Illuminates according to the current state of temperature deviation.

YELLOW - the Setpoint or To Process difference is greater than the programmed Hi / Lo deviation settings.

FLASHING RED - a temperature deviation condition has existed for 90 seconds and the alarm has sounded.

SOLID GREEN - the difference between the Setpoint or To Process difference has returned to acceptable limits before the 90 seconds has elapsed.

2. **Pressure LED.** Illuminates according to the current state of process pressure.

3. **Tank Level LED.** Illuminates according to the current state of reservoir level:

   SOLID GREEN - the reservoir water level is at the proper operating level.

   FLASHING RED - when the reservoir level has dropped below the proper operating level and the automatic water make-up system has activated to restore the water level.
   SOLID RED - the proper reservoir level is reestablished.

5. **Flow LED.** Please note that Flow status is not registered at this time.

6. **Probe LED** - illuminates according to the current state of the process and zone probes.

7. **Phase LED** - illuminates according to the current state of the input from the Phase detector module.

F. **Output control Section.** The following LED's are **SOLID GREEN** when the output is ON and BLANK when the output is off.

1. **Compressor LED** - illuminates when the compressor has cycled on.

2. **Capacity 1 LED** - illuminates when the controller has cycled on the first stage of capacity control, either a hot gas bypass system or a cylinder unloading system, depending on the configuration.

3. **Capacity 2 LED** - illuminates when the controller has cycled on the second stage of capacity control. May not be available, depending on capacity control configuration.

4. **Capacity 3 LED** - illuminates when the controller has cycled on the third stage of capacity control. May not be available, depending on capacity control configuration.

G. **Refrigeration Status Section.** the following LEDs will be illuminated as follows:

SOLID GREEN - the zone process is OK and working fine.

FLASHING RED - the zone process is not functioning correctly.

SOLID RED - the zone process had a fault, but the fault is no longer present.

1. **Probe LED** - indicates the status of the zone “EvapIN” temperature probes.

2. **Low Flow LED** - indicates the status of the zone “Low Flow” switch.

3. **Hi Pressure LED** - indicates the status of the refrigerant “High Pressure” safety switch.

4. **Low Pressure LED** - indicates the status of the refrigerant “Low Pressure” safety switch.

5. **Low Oil LED** - indicates the status of the “Low Oil” pressure safety switch.

6. **Compressor LED** - indicates the status of the zone compressor motor overload relay.

7. **Freezestat LED** - indicates the status of the “Freezestat” safety switch.

H. **Comm Status LED** - the communications display indicates the type of (SPI / CAMAC) exchange between the host computer and the controller.

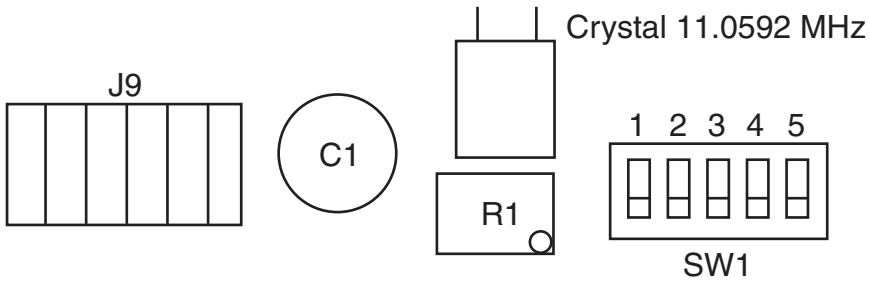
FLASHING GREEN - indicates the controller is sending information to the host computer.

FLASHING YELLOW - indicates the host computer is sending information to the controller.

I. **Alarm Status LED** - when the LED illuminates **SOLID RED**, an unacceptable condition has developed, at which time a 115 volt alarm output is generated for an external (factory or customer installed) alarm beacon or buzzer. Pressing the Select or Zone button can silence the visual and / or audible alarm signal.

J. **Switch Definition Section.**

1. The DIP SWITCH is a 5 position switch located in the lower right side of the MZC III CPU board. The switches are used



to select options for the machine operation. The switches should ONLY be changed when the instrument is in the OFF, no power state.

2. Switch Functions.

SW1-1 : code page for EPROM.
On - code page 0 is active (default).
Off - code page 1 is active.

SW1-2 : Setpoint Range.
On - 70 to 48 (default).
Off - 90 to 10.

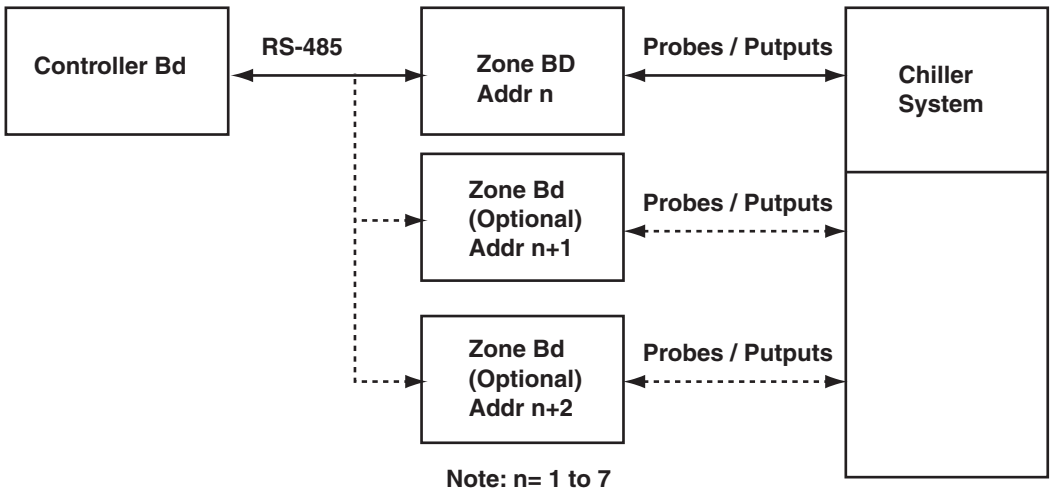
SW1-3 : Extended Configuration.
On - disabled (default).
Off - enabled.

SW1-4 : Not Used.
On - disabled (default).
Off - enabled.

SW1-5 :Not Used.
On - disabled (default).
Off - enabled.

3.8 CONTROL BOARD OPERATION

A. **Introduction.** The Zone Board is used to interface from the Controller Board to the chiller system, compressors, bypass valves and safety switches. Communications with the MZC Controller Board is via an RS-485 network. If communications with the Controller Board fails the Zone Board will switch to a stand-alone mode and maintain control of the system independent of the MZC controller Board based on the value of the alternate Setpoint.



B. User controls.

1. Zone AC Power Switch (toggle switch).

"ON" - applied 110 VAC power to Safety Switches and AC outputs.

"Off" - disconnects 110 VAC power from Safety Switches and AC outputs.

2. Address Switch (rotary switch).

Selects address of Zone Board from 1 to 7. "0" is not used for normal operation. **Note: each Zone Board in the system must be set to a different address.**

3. Configuration Switch (rotary switch).

Selects configuration number from 0 to F.

CONFIGURATION MATRIX CHART

Conf. Setting	OUT 1	OUT 2	OUT 3	OUT 4
0	COMPRESSOR	RESERVED	RESERVED	HGBP
1	COMPRESSOR	UNLOADER	RESERVED	HGBP
2	COMPRESSOR	UNLOADER	UNLOADER	HGBP
3	COMPRESSOR	UNLOADER	RESERVED	RESERVED
4	COMPRESSOR	UNLOADER	UNLOADER	RESERVED
5	COMPRESSOR	COMPRESSOR	RESERVED	HGBP
6	SCREW COMP.	UNLOADER	UNLOADER	UNLOADER
7	SCREW. COMP.	UNLOADER	UNLOADER	UNLOADER
8*	COMPRESSOR	RESERVED	UNLOADER	HGBP
9*	COMPRESSOR	UNLOADER	RESERVED	HGBP
A*	COMPRESSOR	UNLOADER	UNLOADER	HGBP
B*	COMPRESSOR	UNLOADER	RESERVED	RESERVED
C*	COMPRESSOR	UNLOADER	UNLOADER	RESERVED
D*	COMPRESSOR	COMPRESSOR	RESERVED	HGBP
E*	SCREW COMP.	UNLOADER	UNLOADER	UNLOADER
F*	SCREW COMP.	UNLOADER	UNLOADER	UNLOADER

4. Low Pressure Time Delay Potentiometer.

Adjust value of low-pressure time delay from 10 to 120 seconds.

5. Alternate Setpoint Potentiometer.

Adjust value of alternate setpoint from 10 to 90. This setpoint is **ONLY** used when the RS-485 communications with the Controller Board is not working properly.

C. Status Display Section.

1. LED displays that indicate the status of the chiller.

"Power" LED - indicates that 12 VDC power is applied to the Zone Board.

2. Safety / Protection LEDs.

"Oil" - low oil pressure safety switch fault.

"Comp" - compressor motor overload fault.

"HP" - refrigerant high-pressure safety switch fault.

"FREEZE" - freezestat safety switch fault.

"LF" - low water flow switch fault.

"LP" - refrigerant low pressure safety switch fault.

"ZONE" - Zone Board 110 VAC power switch in on.

3. AC Output LEDs.

See configuration matrix chart for descriptions of Output LEDs. The state of these LEDs should correspond with the Output control LEDs on the MZC Controller Board.

"Out 1" - indicates output status of OUT1.

"Out 2" - indicates output status of OUT2.

"Out 3" - indicates output status of OUT3.

"Out 4" - indicates output status of OUT 4.

D. Interface Section.

1. Safety / Protection Connector. Electrical connections to safety switches.

"Oil" - low oil pressure safety switch fault.

"Comp" - compressor motor overload fault.

"HP" - refrigerant high-pressure safety switch fault.

"FREEZE" - freezestat safety switch fault.

"LF" - low water flow switch fault.

"LP" - refrigerant low pressure safety switch fault.

"ZONE" - Zone Board 110 VAC power switch in on.

2. AC Output Connector.

Electrical connections to AC outputs. See configuration matrix chart for description of Outputs.

"OUT 1" - output 1 AC connection.

"OUT 2" - output 2 AC connection.

"OUT 3" - output 3 AC connection.

"OUT 4" - output 4 AC connection.

3. DC Power Supply / Communications Connector.

"PWR" - 12 VDC+

"GND" - 12 VDC GND

"GND" - 12 VDC GND

" + " - RS-485 + TXD / RXD to Controller Board

" - " - RS-485 - TXD / RXD to Controller Board

"GND" - RS-485 GND

4. Evaporator Temperature Probe Input Connector.

"OUT BLK" - evaporator out temperature probe.

"OUT WHT" - evaporator out temperature probe.

"IN BLK" - evaporator in temperature probe.

"OUT WHT" - evaporator in temperature probe.

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4.0 MECHANICAL SYSTEM

4.1 REFRIGERATION SYSTEM

A. Components:

1. **Compressor** - pumps the refrigerant through the system.

2. **Hot Gas Bypass or Cylinder Unloading Solenoid Valve** - reduces the refrigerant system effective cooling capacity to prevent compressor short cycling during low load conditions.

3. **Condenser** - heat exchanger between the refrigerant and condensing media, air or water, location where the refrigerant is changed from a gas to a liquid.

4. **Liquid receiver** - supplied on certain air condensed models only to store the liquid refrigerant leaving the condenser.

5. **Service Valves** - supplied in certain models to allow a certified refrigeration contractor to isolate specific areas.

6. **Filter Dryer** - removes particulate contamination and moisture from the refrigerant.

7. **Liquid Line Solenoid Valve** - prevents liquid refrigerant from migrating to the evaporator during compressor off cycles.

8. **Sight Glass and Moisture Indicator** - provides a visual indication of refrigerant charging and moisture content.

9. **Expansion valve** - regulates refrigerant flow into the evaporator and creates a pressure drop.

10. **Evaporator** - heat exchanger between the refrigerant and chilled water circulating fluid, location where the refrigerant is changed from a liquid to a gas.

B. Safety Devices.

1. **High Pressure** - factory set at 325 PSIG cut out, manual reset required, opens due to high pressures associated with improper refrigerant condensing or high fluid temperature overloading the compressor.

2. **Low Pressure** - factory set to cut out at 58 PSIG and in at 63 PSIG, automatic reset, opens due to low pressures associated with improper refrigerant evaporating temperatures.

3. **Crankcase Heater** - supplied on certain models to prevent refrigerant from mixing with compressor oil during compressor off cycles.

4. **Oil Pressure** - supplied on certain models to protect the compressor from lubrication failure, manual reset.

C. Gauges.

1. **Compressor Discharge (Head) Pressure** - 0 to 400 PSIG, compressor discharge and refrigerant condensing pressure, normally at 190 - 210 PSIG for water condensed models and 210 to 250 PSIG for air condensed models.

2. **Compressor Suction (Low) Pressure** - -30 to 160 PSIG, compressor suction and refrigerant evaporating pressure, normally at 68 to 75 PSIG for 50°F to 55°F fluid temperatures.

D. Typical Cycle.

1. The compressor draws low temperature low pressure gas in through its suction.

2. The gas is compressed and discharged under high pressure and temperature.

3. The gas is pumped into the condenser where it is cooled and changed into a liquid.

4. The liquid is discharged from the condenser through the liquid receiver (certain air condensed models only), filter dryer, liquid line solenoid valve and sight glass / moisture indicator up to the expansion valve under high pressure.

5. The expansion valve regulates the flow of liquid refrigerant into the evaporator and creates an enormous pressure drop.

6. The change in pressure causes the refrigerant to boil into a gas.

7. The physical change of the refrigerant from liquid to gas allows the gas to absorb BTU's (British Thermal Units) or heat from the fluid passing through the opposite side of the evaporator.

8. During low load conditions, a hot gas bypass valve or compressor unloading valve may be activated to reduce effective system capacity and prevent compressor short cycling.

9. Repeat steps 1 through 9.

4.2 TYPICAL CHILLED WATER CIRCUIT

A. Components.

1. **Remote Reservoir** - fluid storage area where air escapes and chemicals and glycol are added.

2. **Remote Process Pump** - recirculates chilled fluid through each cooling point.

3. **Remote Evaporator Pump** - recirculates hot fluid through the refrigerant to water heat exchanger.

4. **Automatic or Manual Low Flow Bypass Valve** - maintains proper chilled water.

5. **Water Make-Up Valve** - automatically fills the remote reservoir with fluid from the facility water supply system.

B. Safety Devices.

1. **Flow Switch** - factory set at approximately 33% of the chiller design flow rate requirements, automatic reset, opens during low flow conditions to prevent evaporator freezing.

2. **Freeze-stat** - factory set at about 40°F, automatic reset, opens during low temperature conditions to prevent evaporator freezing.

3. **Level Switch** - provides low fluid level indication on certain chiller displays.

C. Gauges.

1. **Water In Pressure** - 0 to 160 PSIG.

D. Typical Cycle.

1. The pump draws chilled fluid from the reservoir.

2. The chilled fluid is discharged under pressure to the process.

3. Heated fluid returns from the process to the reservoir.

4. The heated fluid is pumped through the evaporator where BTU's are absorbed by the boiling refrigerant thus reducing the fluid temperature. See typical refrigerant cycle.

5.0 MAINTENANCE

5.1 ROUTINE MAINTENANCE

5.2 REFRIGERANT SYSTEM MAINTENANCE AND SERVICE

5.1 ROUTINE MAINTENANCE

A. A regular scheduled maintenance program will enhance the life expectancy of your system.

1. Lubricate all motors and bearings. Note: certain motors or bearings may be sealed.

2. Tighten all electrical wire terminations.

3. Clean and check all motor starter, contactors and relay contacts.

4. Check all safety switch settings and functions.

5. clean the refrigerant condenser.

6. Back flush and clean the evaporator.

7. Check the glycol-water solutions for proper mix and adjust accordingly.

8. Check the water system for leaks.

9. Check the refrigerant sight glass for bubbles when the compressor is operating at 100%. The bypass and or unloading solenoid valve(s) must be off. Bubbles indicate the system charge is low and that a leak is present. A certified refrigerant technician must find the leak, repair the leak and fully charge the equipment.

10. Check the refrigerant moisture indicator. Green is the normal color. Yellow or chartreuse indicates the presence of moisture. A certified refrigerant contractor must remove the moisture.

5.2 REFRIGERANT SYSTEM MAINTENANCE AND SERVICE

A. Only a certified refrigerant technician is authorized to service and or maintain the refrigeration system.

1. Vacuum check the compressor.

2. Add compressor oil.

3. Add refrigerant.

4. Adjust super heat.

5. replace filter drier or drier core.

6. Repairing or replacing refrigerant components like the solenoid valves and compressor valve plates.

6.0 RELATED FYI DOCUMENTS

6.1 TYPICAL REFRIGERANT CYCLE AND COMPONENTS
6.2 WATER ASSIST UNITS
6.3 MAINTAINING PROPER WATER FLOW IN CHILLERS
6.4 OPERATION OF THE HOST GAS BP-PASS ON REFRIGERANT ZONES
6.5 PRECAUTIONS WHEN OPERATING CHILLERS BELOW 48°F
6.6 LOW AMBIENT CONTROLS FOR AIR-COOLED CHILLERS
6.7 WATER REGULATOR VALVES ON WATER-COOLED CHILLERS
6.8 CHILLER CAPACITY AND DERATE CHART
6.9 SELECTION CRITERIA FOR WATER OR AIR-COOLED CONDENSERS
6.10 OPERATION OF CYLINDER UNLOADING
6.11 PROPER CLEANING PROCEDURE FOR BRAZED PLATE EVAPORATORS
6.12 REFRIGERANT SAFETY SWITCHES ON CHILLERS
6.13 SERVICING WATER-COOLED CONDENSERS
6.14 PHASING OF SCROLL COMPRESSORS
6.15 REFRIGERANT LINE PIPE SIZING FOR REMOTE CONDENSERS
6.16 TYPICAL WATER-COOLED CHILLER MODULE SCHEMATIC - MW SERIES
6.17 TYPICAL AIR-COOLED CHILLER MODULE SCHEMATIC - MA SERIES
6.18 TYPICAL PIPING FOR REMOTE AIR-COOLED CONDENSER WITH DUAL SPILT SYSTEMS
6.19 TYPICAL REFRIGERANT PIPING FOR OUTDOOR CONDENSERS
6.20 LARKIN AIR-COOLED CONDENSER DIMENSIONS
6.21 SPECIFIC HEAT AND DENSITY FOR COMMON MATERIALS
6.22 FREEZING POINTS FOR WATER / PROPYLENE GLYCOL SOLUTIONS
6.23 PROPER USE OF INHIBITED PROPYLENE GLYCOL
6.24 LARKIN AIR-COOLED CONDENSER MODEL RC
6.25 TEMPERATURE - PRESSURE CHART FOR HCFC-22 REFRIGERANT
6.26 COPELAND SCROLL COMPRESSORS
6.27 USEFUL ENGINEERING FORMULAS
6.28 WATER DISTRIBUTION PIPE SIZING
6.29 PIPE SIZING - GPM AND PRESSURE LOSS
6.30 RELUBRICATION INTERVALS (MOTORS WITH GREASERT FITTINGS)

6.1 REFRIGERANT CYCLE AND KEY COMPONENTS

A. **Temptek** chillers employ a refrigeration circuit to chill water. Below is a description of the typical refrigeration circuit. Refer to the chart below for a diagram of the refrigerant flow.

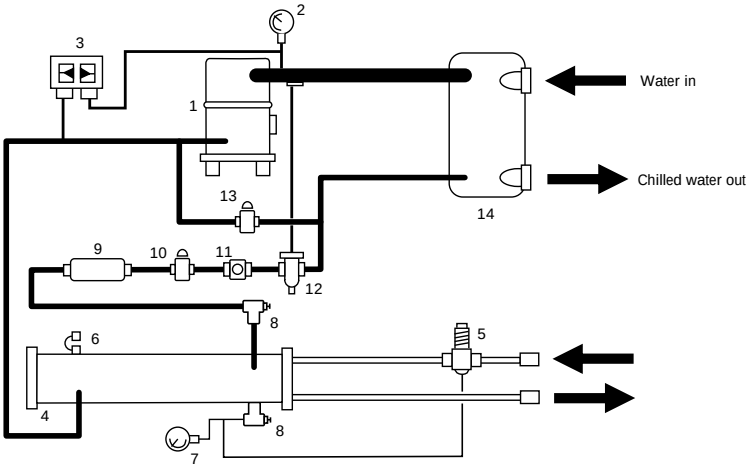
1. The Compressor (1) draws low pressure - low temperature gas from the Evaporator (14) through the suction (low pressure) side of the refrigerant circuit. Inside the Compressor, the gas is compressed, thus increasing its temperature and pressure. The Compressor discharges (pumps) the compressed gas through the refrigerant circuit.

2. The gas flows through the Condenser (4). Heat (BTU's) from the gas is released into the condensing media (air or water). As the heat is removed, the temperature of the gas is reduced and the gas condenses into a liquid. The pressure of the liquid refrigerant remains the same.

3. The liquid refrigerant flows from the Condenser through the Filter Drier (9), Liquid Line solenoid valve (10), the refrigerant Sight Glass (11), and into the Expansion valve (12) and Evaporator.

4. The Expansion valve creates a pressure drop in the refrigeration circuit. This pressure drop causes the refrigerant liquid to evaporate into a gas inside the Evaporator. The Evaporator is the a heat exchanger in the circuit that allows the refrigerant to absorb heat from the water. As heat is absorbed, the refrigerant changes state from liquid form to vapor.

5. The low temperature and low pressure refrigerant vapor is drawn out of the evaporator to the compressor to complete the cycle. The cycle is continuous while the compressor is operating.



Liquid Line Solenoid Valve: installed between condenser and expansion valve in the liquid line. Valve closes when compressor stops to prevent liquid refrigerant migration to the low pressure side of the system.

Refrigeration Service Valves: installed at key locations within the refrigeration circuit. Used by qualified refrigeration service personnel to isolate refrigerant charge into condenser to perform service to the filter drier, liquid line solenoid, expansion valve, high pressure gauge and water regulator valve. Extremely valuable when used to recover and dispose of the the existing refrigerant charge.

Refrigerant Pressure Relief Valve: installed in the condenser on water cooled units and the liquid receiver on air cooled units. Set to relieve pressure at 400 psi. Loss of condensing medium will cause condensing pressures to exceed ratings making this device vital. A safety pressure switch will stop the compressor at 325 psi if working properly. This valve also contains a fusible link in case the chiller would ever be exposed to fire. The lead fuse would melt allowing valve to open to protect personnel

Refrigerant Sight Glass: installed in the liquid line. User may check for appropriate charge by the absence of froth or foam when compressor is operating 100%. Sight glass also contains a moisture indicator by a green dot in the center of the sight glass. A color other than green indicates moisture and service required.

Condenser Water Regulator Valve: standard on all MX model chillers. Installed on the condenser water inlet, serves to modulate water flow based on refrigerant condensing pressure. Ideal condensing pressure is 210 psi. The valve will shut off all water flow when compressor is off.

Expansion Valve: vital to the refrigeration process. Installed immediately before the evaporator. Purpose is to control refrigerant flow to the evaporator based on refrigerant temperature leaving the evaporator. The high pressure liquid refrigerant enters the valve and flows through an orifice which drops the refrigerant pressure by 150 psi so the refrigerant liquid can evaporate in the Evaporator.

Hot Gas By-Pass Solenoid Valve: installed between the compressor discharge line and the evaporator inlet. When water reaches set temperature, the controller signals the valve to open which allows a portion of the hot gas discharging from compressor to enter evaporator. This reduces chiller capacity by approximately 50% and prevents compressor short cycling.

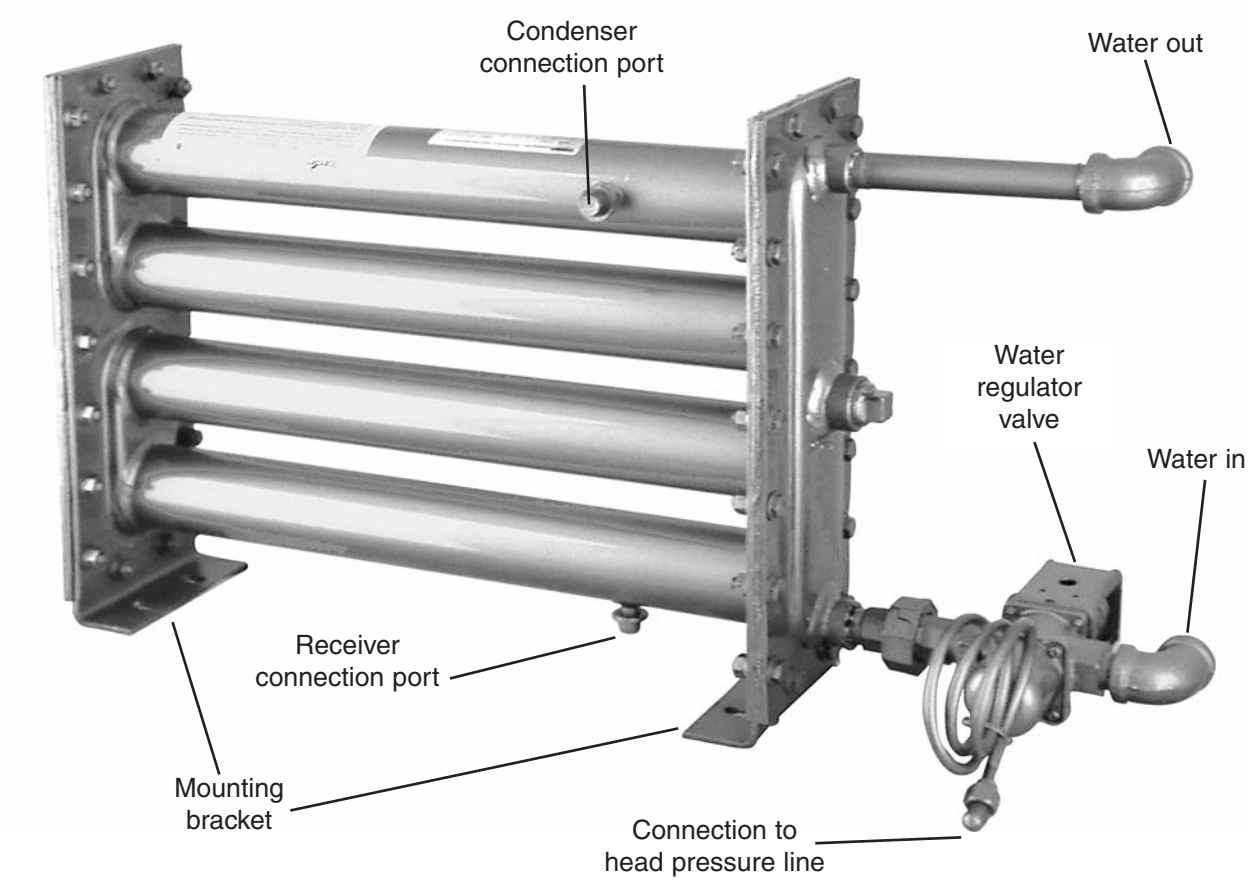
Filter Drier: installed in liquid line to strain and hold solid contaminants circulating with the refrigerant. The unit contains desiccant which absorbs moisture from the refrigerant system which otherwise would be extremely detrimental to the refrigeration components.

6.2 WATER ASSIST UNITS

A. Water assist modules are used only on air condensed water chillers to "assist" in the refrigerant condensing function during periods of ambient temperatures exceeding 95°F or 100°F. Temptek chillers have been carefully engineered to provide condensing conditions better than competitive makes. But, all air cooled chillers begin to fail both mechanically and in capacity during prolonged ambient conditions exceeding 100°F.

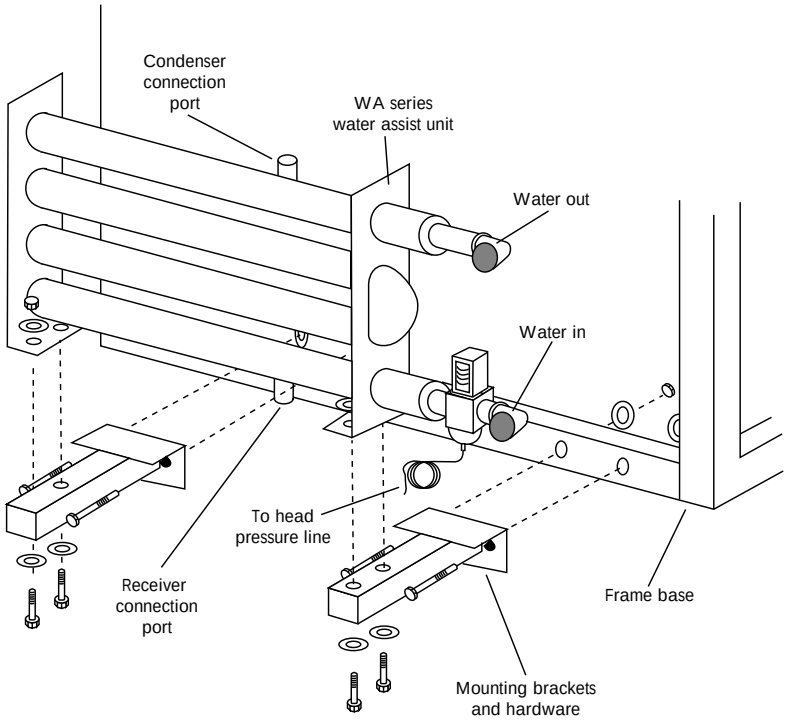
B. The Temptek water assist module is a small water cooled refrigerant condenser with automatic provisions for utilizing available plant water supplies to condense a portion of the refrigerant charge automatically. The modules' pressure actuated water regulating valve senses the chiller head pressure (which rises as ambient temperatures rise). At head pressure exceeding 260 psi, the automatic valve modulates open to provide added condensing, maintaining rated chiller performance. Maintaining full productivity and increasing chiller mechanical longevity create rapid pay-backs in the investment in an Temptek water assist unit. **An installation diagram is on the reverse of this page.**

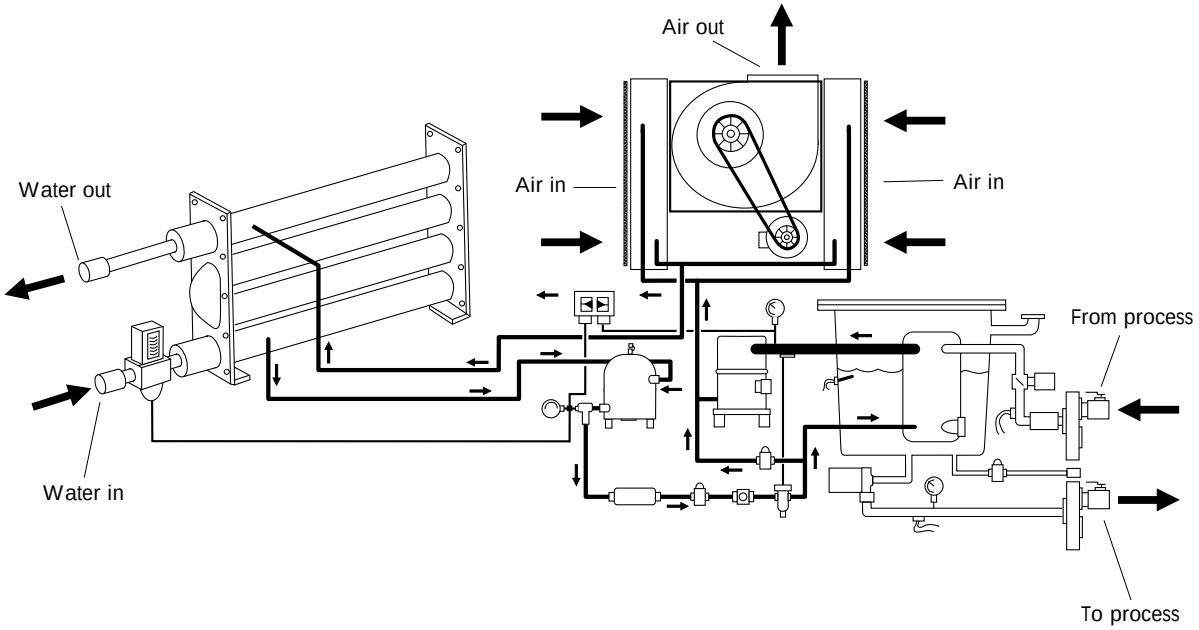
C. Typically, there are between five and twenty "high ambient" manufacturing days, depending upon geographical location, or location of the chiller in the owner's plant environment. Many plants suffer from reduced production on high ambient days. A water assist unit can solve this problem!



TYPICAL RETROFIT WATER ASSIST UNIT INSTALLATION

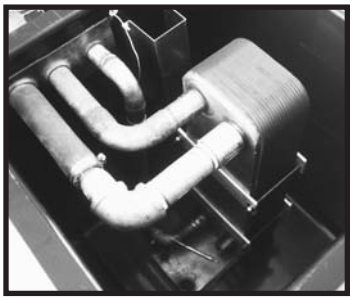
NOTE: WA SERIES WATER ASSIST UNITS SHOULD BE INSTALLED BY A QUALIFIED REFRIGERATION SERVICE PERSON.





6.3 MAINTAINING PROPER WATER FLOW IN CHILLERS

A. The evaporators in most liquid chillers are flow sensitive, that is, the efficiency of operation is directly related to the flow of liquid. Efficiency is obtained at approximately 2.4 GPM per ton of rated capacity. Low liquid flow can reduce efficiency and in some cases allow ice to form in the evaporator which can damage the evaporator.

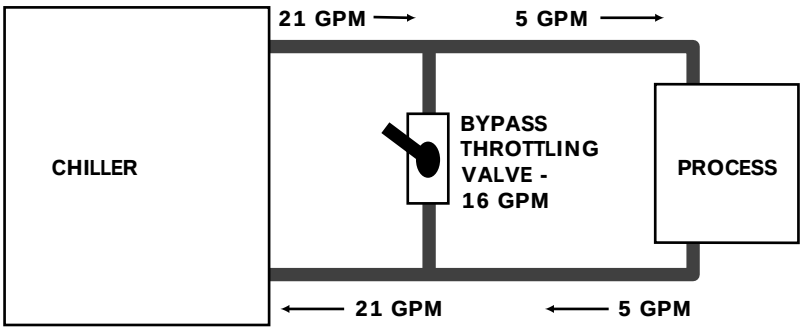


The evaporator is the heat exchanger where in the refrigeration circuit that allows the liquid refrigerant to absorb heat from the water. As the heat is absorbed, the liquid refrigerant changes state from liquid to vapor, and the water is chilled.

B. On some systems, to assure proper flow, a low flow safety switch in installed to stop the refrigeration system if the liquid flow falls to approximately 33% of full flow. This is a paddle type flow switch which is mounted directly in the water stream.

The flow switch extends a “paddle” into the liquid stream. Sufficient flow from the pump will force the paddle forward, which closes the switch’s internal contacts. This consents the control circuit to the microprocessor, and the refrigeration system is allowed to operate. Without sufficient flow, the flow switch will not consent the circuit, and the refrigeration system cannot operate.

C. A one pump system is designed so that all process flow must pass through the evaporator. If the process flow is less than 33% of full flow at anytime the unit will be stopped by the low flow safety switch. To allow operation under this it will be necessary to install a flow bypass system in the process lines (see diagram below). This will allow a portion of the process flow to bypass the process and return directly to the chillers which keeps the total flow above the cutoff point.



6.4 OPERATION OF THE HOT GAS BY-PASS ON REFRIGERANT ZONES

A. The ideal chiller application would have a constant load, with the chiller perfectly matched to achieve 100% operation. Since this is not possible, Temptek recommends chillers be sized to have at least 50% heat load presented at all times (single zone units).

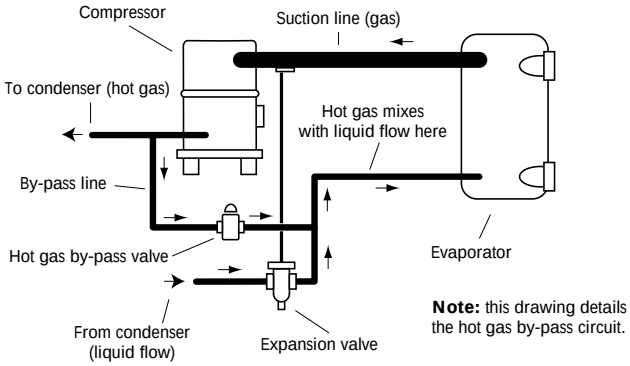
B. It is not practical to cycle the compressor on and off to control temperature. This reduces compressor life. Each time the compressor starts, the inrush current (while the motor is coming up to speed) is very high. If electricity rates are based on peak demand, this can also increase operating costs. To assure the compressor operates as much as possible, Temptek uses a hot gas by-pass system. Based on system load, the control instrument will activate a solenoid valve to control the flow of hot gas into the evaporator, based on load and water temperature.

C. During normal operation, 100% of the hot gas passes through the condenser, where heat is removed. It then passes through the expansion valve into the evaporator, where the evaporating refrigerant liquid absorbs heat from the water.

D. During 50% operation, the solenoid valve open and allows a portion of the hot gas to pass directly into the evaporator inlet. The expansion valve reacts to the hot gas and adjusts to maintain proper superheat for compressor protection. Operation in the 50% mode for extended periods of time is not detrimental to compressor life, and is actually preferred, rather that cycling the compressor on and off.

E. During operation with a load more than 50% but less that 100%, the control instrument will activate the 50% approximately 1° below the setpoint and deactivate it approximately 1° above the setpoint.

F. Hot gas valves are found on Temptek chillers of 2 tons and greater. Generally, the hot gas by-pass valve is maintenance free, but if service is necessary, it should only be performed by a qualified refrigerant technician since it is located on the high pressure circuit.



6.5 PRECAUTIONS WHEN OPERATING CHILLERS BELOW 48°F

A. A chiller typically operates with a setpoint of 50°F or higher. However, if setpoints between 20° - 48°F are required, special precautions must be taken to prevent freezing and possible damage. Attention must be given to freeze protection, water supply and safety adjustments.

B. **FREEZE PROTECTION.** It is understood that untreated water freezes at 32°F. Therefore, an inhibited propylene glycol and water solution must be used in lieu of ordinary water. Prescribed amounts are listed in figure A.

C. On initial installation of the unit, the water/glycol solution should be premixed, then added to the reservoir. After the pump has been started, water lines filled and air purged, it may be necessary to add more water/glycol solution to maintain the recommended reservoir level. **Note:** a hygrometer should be used on a regular basis to determine the mixture strength according to freezepoint. The freezepoint temperature should be 25° below the lowest required setpoint. Water will evaporate from the mixture, and if you continue to add a premixed solution eventually you will have too much glycol. It is necessary to add water or glycol to maintain proper freezepoint temperature.

D. **PLEASE NOTE THAT A CHILLER IS NOT DESIGNED TO ACCOMMODATE AUTOMOTIVE TYPE ANTI-FREEZE.** This is due to the fact that automotive type anti-freeze contains silicates that adhere to heat transfer surfaces of the system preventing maximum heat transfer. Also, improper portions of inhibited propylene glycol to water inhibits effective heat transfer. Consult the chiller's operating manual for specific details.

E. **WATER SUPPLY.** The automatic water supply (if equipped) restores the reservoir water level as needed. However, if untreated water is added to an water/glycol solution, dilution will occur decreasing the freeze protecting ability of the solution. Therefore, the water supply source must be disconnected and the connection capped. The operator must monitor the water/glycol level and manually make-up to maintain proper reservoir level.

F. **SAFETY ADJUSTMENTS.** To ensure safe and efficient operations at lower setpoints, adjustments of the freezestat and low pressurestat factory settings are required. Figure B lists the appropriate settings.

G. The freezestat serves as the mainline defense against freezing in that it shuts down the chiller if the coolant temperature ever decreases to its setting. For mechanical freezestats, adjustments are made by removing the cover and rotating the selector dial with a screwdriver. Electronic freezestats are adjusted through the setup parameters via the instrument control panel (consult the operating manual for details).

H. The low pressurestat serves to protect the compressor from unsafe suction pressures. Suction pressures decrease with lower operating setpoints. To prevent short cycling of the compressor, the low pressurestat must be adjusted to accommodate the lower setpoint. Adjustments to the low pressurestat are made by rotating the adjusting screws on top of the control and observing the movement of the pointers in the control window until the prescribed setting is determined.

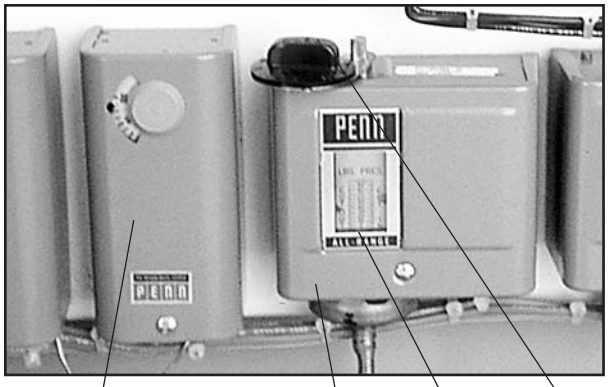
I. **PRECAUTIONS.** At any setpoint, the possibility of freezing exists and it is the operator's responsibility to take necessary action to prevent freezing at all times.

OPERATING TEMPERATURE	ANTI-FREEZE MIXTURE PROPYLENE GLYCOL	WATER
40°F	20%	80%
35°F	25%	75%
30°F	30%	70%
25°F	35%	65%
20°F	40%	60%

FIGURE A

OPERATING TEMPERATURE	LOW CUT IN	LOW CUT OUT	FREEZESTAT SETTING
48°F	63#	58#	38°F
40°F	50#	35#	30°F
35°F	45#	30#	25°F
30°F	40#	25#	20°F
25°F	35#	20#	15°F
20°F	30#	15#	10°F

FIGURE B



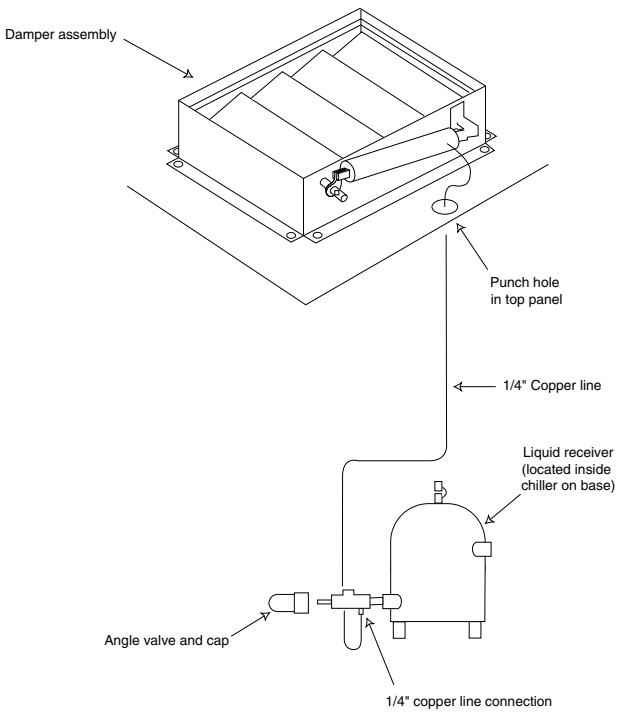
6.6 LOW AMBIENT CONTROLS FOR AIR-COOLED CHILLERS

A. Standard air cooled chillers are designed to operate with condenser intake air between 60° and 95°F. To operate with condenser intake air below 60°F requires some modifications. They are:

B. **First**, a crankcase heater must be fitted to the compressor (standard on all chillers 5 tons and up). This heater activates when the compressor cycles off, and keeps the compressor's crankcase warm while waiting for the next cycle. This prevents freon from condensing inside the crankcase. If freon did condense inside the crankcase, it could be drawn into the cylinders on start up and cause extensive damage to the compressor.

C. **Second**, the low pressurestat circuit must be equipped with a bypass timer. Freon has a direct pressure temperature relationship. At low ambients, the freon pressure could be below the cut-out setting of the safety switch which prevents the compressor from starting even though it has sufficient freon. The bypass timer, set at approximately 90 seconds, allows the compressor to start and achieve normal operating pressures, but still allows the low pressurestat to stop the compressor during operation if a problem arises.

Low pressurestat



Damper assembly

D. Third, the amount of condensing required will vary from 0 to 100% depending on the compressor staging and ambient temperatures. Centrifugal blower units may be equipped with a pressure modulating discharge damper to regulate the amount of condensing during operation (by regulating the air flow across the condenser). Multiple fan units may use pressure activated cycle switches to stage the condensing as needed. Variable speed motor controllers may also be used alone or in conjunction with fan staging.

E. These devices will help protect the chiller from costly damage, and provides consistent operation under variable ambient conditions.

6.7 WATER REGULATOR VALVES WATER-COOLED CHILLERS

A. To achieve maximum condensing efficiency, refrigerant head pressure of 210 psi must be maintained. Changes in condensing load and condenser water supply temperature can adversely affect head pressure in water cooled chillers.

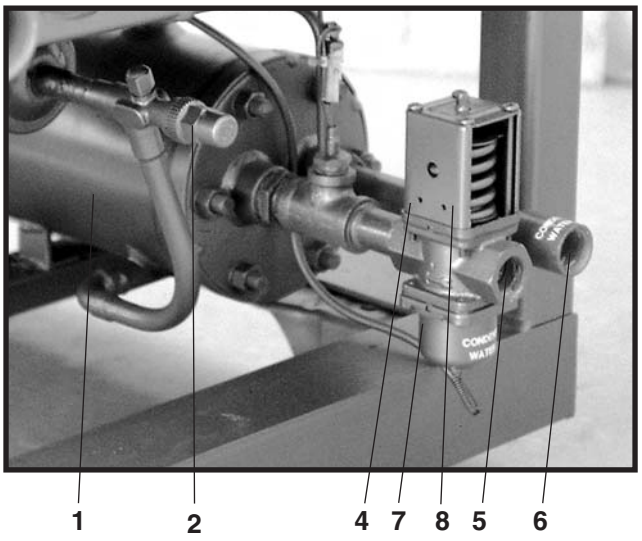
B. When condenser water supply temperature will be less than 70°F, a water regulator valve must be added. This valve is installed on the water inlet to the condenser. It will modulate water flow to control head pressure at 210 psi.

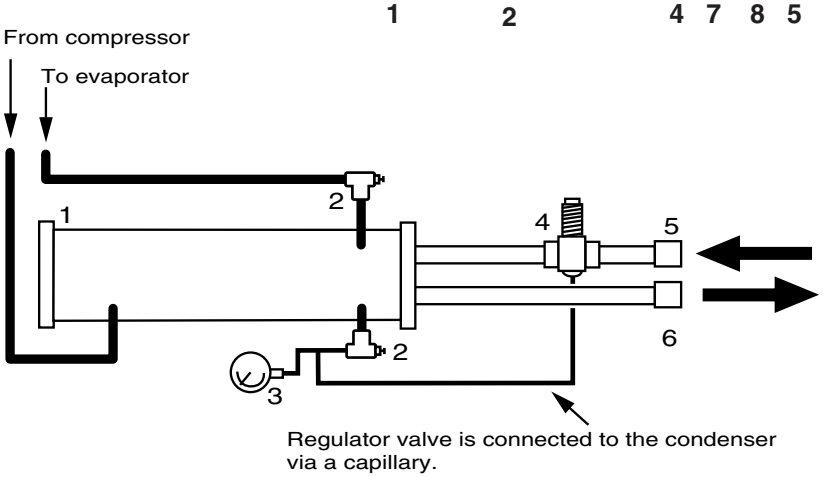
C. The regulator is a cast iron body with a set of freon bellows mounted on the bottom and a modulating spring on top. Internal components are the diaphragm, which covers the water orifice, and the plunger which connects the bellows and diaphragm.

D. **Note:** the bellows is connected to the high pressure side of the refrigerant system. Therefore, it should only be serviced by a certified refrigeration technician.

1 Water cooled condenser
2 Service valve
3 Head pressure gauge
4 Water regulator valve
5 Condensing water in connection
6 Condensing water out connection
7 Bellows assembly
8 Spring assembly

This list applies to the photo and drawing.





6.8 CHILLER CAPACITY AND DERATE CHART

A. Standard chiller rating is at 50°F. For all other temperature settings, output tonnage is altered as follows:

B. If operation of the chiller at less than 48°F is required, an inhibited propylene glycol solution is required.

C. Consult factory for chiller operation below 20°F.

D. Ambient conditions affect air cooled chiller operation and capacity. Standard rating is at 95°F entering air temperature. For ambient air conditions greater than 95°F, chiller derating will occur. For ambients of 95-105°F, select the next larger capacity chiller. For ambients over 105°F, consult factory.

OUTPUT TEMPERATURE °F	FULL AVAILABLE % CAPACITY
60	105%
50	100%
45	90%
40	80%
35	70%
30	60%
25	50%
20	40%
15	30% *
10	22% *
5	15% *
0	9% *
-5	5% *

* These ranges require special options.

6.9 SELECTION CRITERIA FOR WATER OR AIR-COOLED CONDENSERS

A. In water chillers, latent heat is introduced to the refrigerant system when refrigerant gas is compressed to a high pressure. But, before the refrigerant gas can evaporate in an effort to chill water, it must change state from a gas to a liquid. This occurs inside a condenser, which is an heat exchanger with higher temperature gas on one side and lower temperature condensing medium, either air or water, on the other.

B. The temperature differential inside the condenser allows latent heat in the gas to pass to the lower temperature medium. With the heat removed, the gas will condenser into a liquid state.The latent heat becomes sensible heat in the condensing medium and therefore, its temperature will increase. Recovery of the sensible heat is possible only in air cooled condensers.

C. There are two type of condensers to choose from: water cooled or air cooled. Water cooled condensers use plant water supplies with a tube and shell heat exchanger. Air cooled condensers use motor driven fans or centrifugal blowers to move air through the condenser. The processor must select the condenser best suited for his operation. Selection criteria are listed here and the advantage/disadvantage of each.

E. **Select Water-Cooled:**

1. Adequate water supply available from tower or well sources.
2. Water supply is of good quality.
3. Heat recovery is not practical or unimportant.
4. Plant ambient temperatures consistently exceed 95°F.
5. Ambient air is polluted with large dust and dirt particles.

Consider:

1. Offer lower capital investment.
2. Operates more efficiently on hot summer days.
3. Easier to operate.
4. Does not offer summer ventilation.

F. **Select Air-Cooled:**

1. Adequate water supply not available from tower or well sources.
2. Water supply is not of good quality.
3. Heat recovery is practical and important.
4. Plant ambient temperature will not consistently exceed 95°F.
5. Ambient air is not polluted with large dust and dirt particles.

Consider:

1. Somewhat more costly to purchase and operate.
2. Gives less cooling on hot summer days.
3. Consumes more electricity.
4. Offers summer ventilation and winter supplement heating.

6.10 OPERATION OF CYLINDER UNLOADING

A. Some applications do not always require 100% chilling capacity at all times. Therefore, Temptek offers the option of CYLINDER UNLOADING on semi-hermetic compressors to reduce capacity when needed.

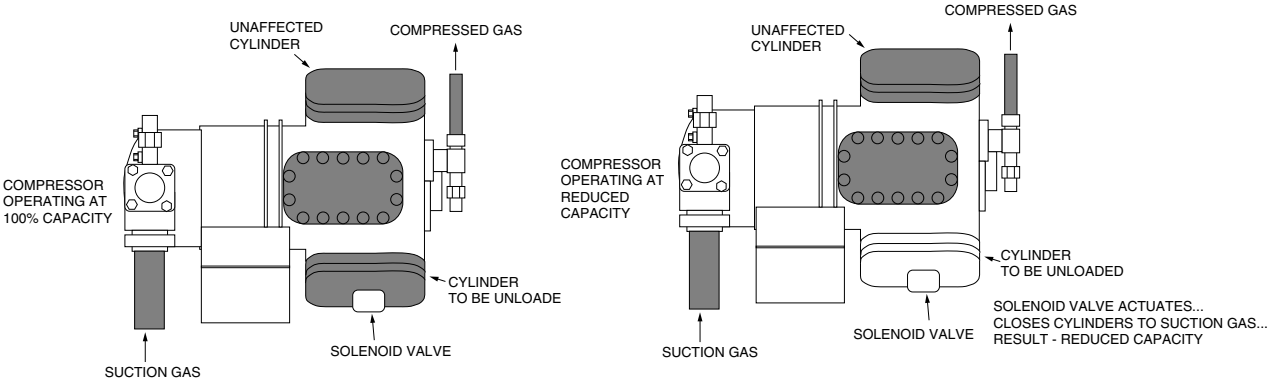
B. Refrigerant compressors work most efficiently under 100% constant load. During normal operation, 100% of refrigerant gas passes through the compressor. The compressor increases gas pressure via compression. The compressed gas is pumped to the condenser where heat is removed and the gas condenses into a liquid state. The liquid refrigerant passes through the liquid line to the expansion valve. The expansion valve creates a pressure drop and the liquid refrigerant “boils off” (evaporates) inside the brazed plate evaporator and absorbs heat from the process water.

C. As the process water is chilled to the setpoint temperature, capacity (the chiller’s ability to chill water) must be reduced or the chiller will continue to decrease water temperature. Yet, cycling the compressor on and off to maintain full capacity is inefficient and greatly decreases useful compressor life. To keep the compressor at full operation, the compressor can be “unloaded”. Once unloaded, the compressor capacity is reduced.

E. Four cylinder compressors may be unloaded on one head (50%). Six cylinder compressors may be unloaded on two heads (66%).

F. The cylinder unloading kit (factory installed or field retrofitted) places a solenoid valve on a special cylinder head. When actuated by the controller, the solenoid valve closes 2 cylinders to suction line gas. The remaining cylinders continue to operate. The compressor is now operating at reduced capacity.

G. Temptek offers cylinder unloading kits for 7.5 to 30 ton chillers with 4 cylinder semi-hermetic compressors. Temptek offers a second unloading kit for 6 cylinder semi-hermetic compressors, from 25 to 30 tons.



6.11 PROPER CLEANING PROCEDURE FOR BRAZED PLATE EVAPORATORS

A. The brazed plate evaporator is made of stamped stainless steel plates, furnace brazed together with copper based joints. The complex geometry of the flow passages promotes turbulent flow which gives high efficiency and reduces fouling by mineral deposits. Large solids (plastic pellets, chunks of mineral deposits etc...) will collect at the water inlet port or the evaporator and restrict flow through some of the passages. If this possibility exists we recommend filters or strainers be added to the from process line. If the evaporator becomes fouled there are a couple of methods for cleaning.

B. Remove the piping to the water in port at the evaporator, if there are solids at the inlet remove them. Then backflush to removed any solids that may be trapped between the plates (see backflush procedure below). If there are mineral deposits adhered to the plates, the evaporator must be backflushed with a mild acid solution: 5% phosphoric, or 5% oxalic acid is recommended. After cleaning, rinse with clear water before returning to service.

BACKFLUSHING PROCEDURE

1. Turn off all power to the machine. For chillers with a reservoir tank (as in picture), drain tank to below evaporator outlet. For chillers without a reservoir tank, drain total unit.

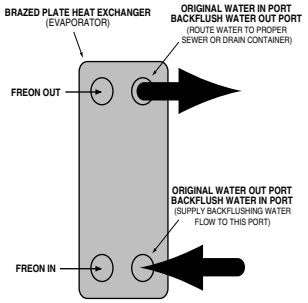
2. Connect a water supply hose to the evaporator water outlet. If acid cleaning, connect the discharge hose from the acid pump to the evaporator outlet port.

3. Connect a hose to the evaporator water supply port and to an appropriate containment vessel. If acid cleaning, connect the evaporator water inlet port to an acid solution reservoir tank. Dispose of all backflush water according to local codes.

4. Your water supply source should have at least 20psi available. If acid cleaning, follow the instructions supplied with the acid solution carefully.

5. Reinstall all water lines to original factory orientation. Restart the unit and check for proper operation.

Please note... this procedure is not normal maintenance... maintaining proper water quality and filtration will MINIMIZE THE NEED TO BACKFLUSH THE EVAPORATOR.



6.12 REFRIGERANT SAFETY SWITCHES ON CHILLERS

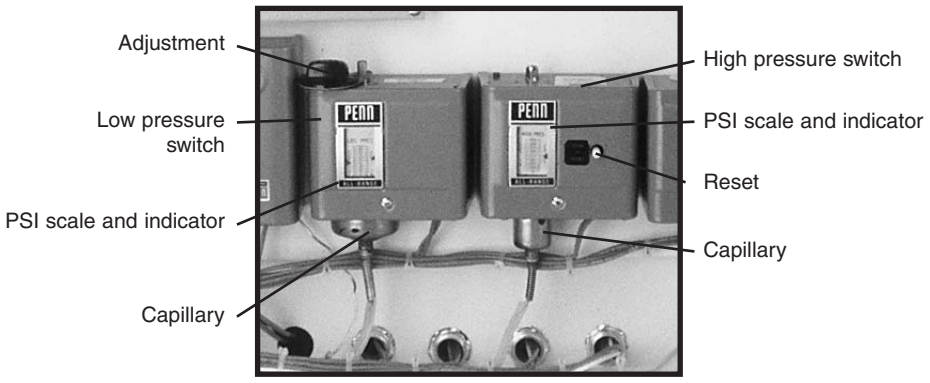
A. All Temptek chillers use high pressure and low pressure safety switches on the refrigerant circuit. The safeties prevent circuit damage due to out-of-spec operating pressure. Depending on the model of the Temptek chiller, separate high and low switches could be used or high and low switches in a common housing.

B. The refrigerant safety switches are wired into the 115 volt control circuit of the compressor. Both high and low switches are normally closed. However, if either switch detects a pressure outside its prescribe parameter, the switch will open the control circuit and the compressor will stop.

C. The HIGH pressure switch is mounted on the discharge side of the compressor. Optimal refrigerant high pressure in Temptek chillers is 210 PSI. High pressure safeties will cut-out at 325 PSI. There is no allowable field adjustment of the high pressure safety. If the chiller defaults on the high pressure safety, the cause must be isolated and corrected.

D. The LOW PRESSURE switch is mounted on the suction side of the compressor. Low pressure fluctuates with process water temperature. Field adjustments of the low pressure safety are allowed when setpoints below 48°F are required.

E. The high and low pressure safeties are connected to the refrigerant circuit, which is pressurized at all times. Only a qualified refrigeration technician should service the high and low safeties.



Low and high pressure safeties in separate housings

6.13 SERVICING WATER-COOLED CONDENSERS

A. Water removes heat from metal surfaces about 15 times more rapidly than air. Therefore, water cooled condensers are much smaller than air cooled condensers. A common problem with water cooled condensers, however, is formation of deposits from water on the tubing walls. These scale deposits act as an insulating layer, causing lack of proper heat transfer for condensing of refrigerant. This causes high refrigerant discharge pressures and loss of refrigeration capacity.

B. When condenser tubes have hard lime or iron scale, they may be cleaned with an acid solution (the procedure is as sketched in figure 1). Caution: always wear goggles and rubber gloves when using an acid solution. The pump must be designed for acid solutions (see figure 2). Use of plastic pipe or tubing is recommended. Warm solutions will work best, but do not heat above a warm temperature.

C. Mix warm water and acid according to container instructions (usually 10 parts water to one part acid). Circulate acid mixture through condenser for 15-30 minutes. Remember acid is corrosive so do not circulate longer than 1 hour. A 'tee' fitting could be installed in the inlet and outlet of the condenser water circuit for future condenser cleaning.

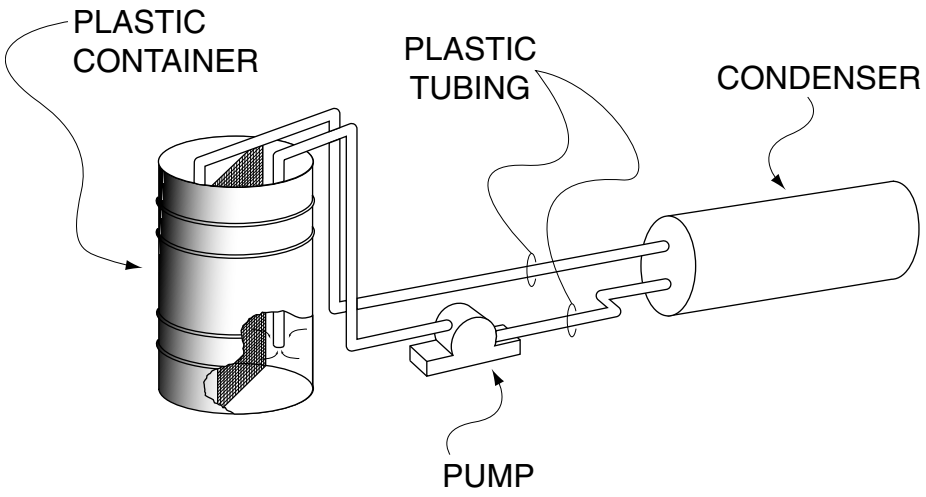


FIGURE 1

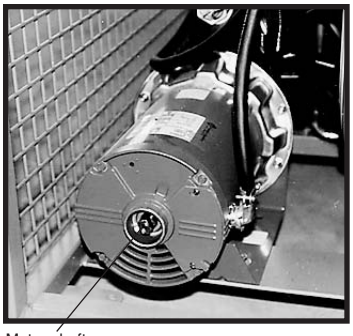
6.14 PHASING OF SCROLL COMPRESSORS

A. Many Temptek chillers use Scroll (rotary) compressors because they are more efficient, durable and reliable than traditional reciprocating compressors. Scroll compressors are liquid tolerant, have low torque variation and contain fewer moving parts.

Scroll Compressor

B. It is important to understand that unlike reciprocating compressors, scroll compressors are phase sensitive. They must be rotating in the correct direction to be effective. The following guidelines should help ensure that installation and start-up remain as trouble free as possible.

C. Portable chillers that have one or more internal coolant pumps, the compressor(s) will be set in phase with the pump(s) during the factory testing process. The phase status must be checked by observing the pump motor shaft on the end of the pump and comparing its rotation to the directional arrow on the motor. Correct rotation is clockwise when the motor is in view as in the picture to the left. Changing the phase should only be done at the main power entry. To do so, lock out the power at the main disconnect and switch any 2 power wires at the disconnect.



Motor shaft

View of motor shaft on typical chiller pump

D. WATER CONDENSED CENTRAL CHILLERS WITH PUMP STATION... on all water-cooled central chillers that have internal coolant pumps, the compressor(s) will be set in phase with the pump(s) during the factory testing process. At start-up, the phase status must be checked by observing the pump motor shaft of either pump. Correct rotation is a clockwise direction when the motor shaft is viewed from the rear of the motor (see above picture). Correct rotation is confirmed by the directional arrow on the motor. The

phase needs to be changed if the pump is rotating backwards, evidenced when the motor shaft is rotating in a counter-clockwise direction. Changing the phase should only be done at the main power entry. To do so, lock out the power at the main disconnect and switch any 2 power wires at the disconnect.

E. MA AND MW CENTRAL CHILLER MODULES... chilled water modules have no internal coolant pumps. So even though they are run tested at the factory, the phase sequence will be lost when power is disconnected for shipment. To facilitate recreating the proper phase sequence, a small black phase detector with a single red LED is installed on the electrical sub panel. In the field, a glowing red light indicates that the unit is properly phased. If the red LED is not on, the phase is incorrect must be altered. To do so, lock out the disconnect and switch any two power wires at the disconnect.

F. ALL CHILLERS WITH OUTDOOR REMOTE CONDENSERS... since these units are not charged with refrigerant, they cannot be fully run tested and phased at the factory. These units must be phased entirely in the field. If the unit has an integral pump, first check the pump for proper rotation and if necessary, change it at the power entry. After that is done, or if the unit has no coolant pump, wait for the compressor to come on. When it does, observe the refrigerant gauges. If the compressor is rotating in the proper direction, the gauge readings will diverge, meaning that the head pressure will increase and the suction pressure decrease. If the pressures stay about the same and the compressor emits a rattling of noise, shut the unit down and change the phase for that individual compressor either at the contactor or at the compressor itself. In the case of multiple compressors, each one must be checked independently.

If you have questions concerning the phasing of scroll compressors, please call the Temptek service department at 317-887-0729.

6.15 REFRIGERANT LINE PIPE SIZING FOR REMOTE CONDENSERS

A. LIQUID LINES

1. Assume an equivalent feet of pipe. Usually estimate the run and multiply by 1.5 to account for elbows, etc.

2. Using estimated equivalent feet from Step 1, enter chart A and pick line size required. Pick the closest next larger size when your point falls between two line sizes.

3. Using the line size selected above, calculate the actual equivalent feet using table 1.

4. Compare actual equivalent feet with estimated equivalent feet. If actual is less than or equal to estimated, your selection is good. If actual is more than estimated, enter chart A to be sure it is still a good selection. Reselect if necessary.

B. HOT GAS LINES

1. Assume an equivalent feet of pipe. Usually estimate the run and multiply by 1.5 to account for elbows, etc.

2. Using estimated equivalent feet from Step 1, enter chart B and pick line size required. Pick the closest next larger size when your point falls between two line sizes.

3. Using the line size selected above, calculate the actual equivalent feet using table 1.

4. Compare actual equivalent feet with estimated equivalent feet. If actual is less than or equal to estimated, your selection is good. If actual is more than estimated, enter chart B to be sure it is still a good selection. Reselect if necessary.

FITTING LOSSES IN EQUIVALENT FEET OF PIPE Screwed, Welded, Flanged, Flared, and Brazed Connections

	SMOOTH BEND ELBOWS						SMOOTH BEND TEES			
NOMINAL PIPE OR TUBE SIZE (in.)	90° Std	90° Long Radius	90°Street	45°Std	45°Street	180°Std	Flow thru Branch	Straight-thru Flow		
								No Reduction	Reduced 1/4	Reduced 1/2
3/8	1.4	0.9	2.3	0.7	1.1	2.3	2.7	0.9	1.2	1.4
1/2	1.6	1.0	2.5	0.8	1.3	2.5	3.0	1.0	1.4	1.6
3/4	2.0	1.4	3.2	0.9	1.6	3.2	4.0	1.4	1.9	2.0
1	2.6	1.7	4.1	1.3	2.1	4.1	5.0	1.7	2.3	2.6
1-1/4	3.3	2.3	5.6	1.7	3.0	5.6	7.0	2.3	3.1	3.3
1/1/2	4.0	2.6	6.3	2.1	3.4	6.3	8.0	2.6	3.7	4.0
2	5.0	3.3	8.2	2.6	4.5	8.2	10	3.3	4.7	5.0
2-1/2	6.0	4.1	10	3.2	5.2	10	12	4.1	5.6	6.0
3	7.5	5.0	12	4.0	6.4	12	15	5.0	7.0	7.5

CHART A

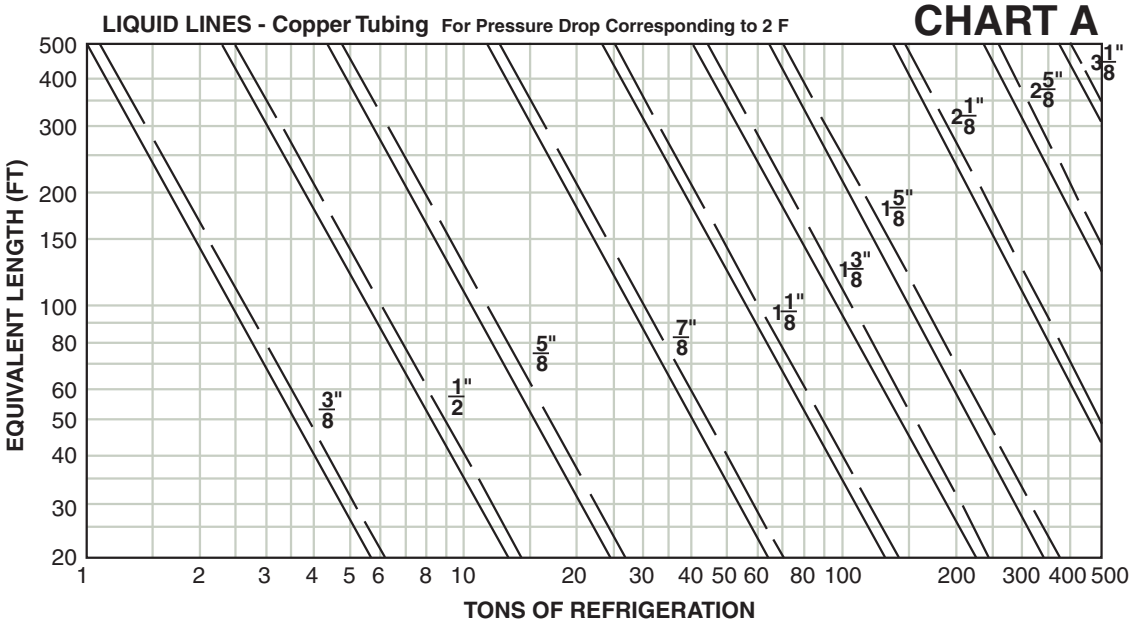


CHART B

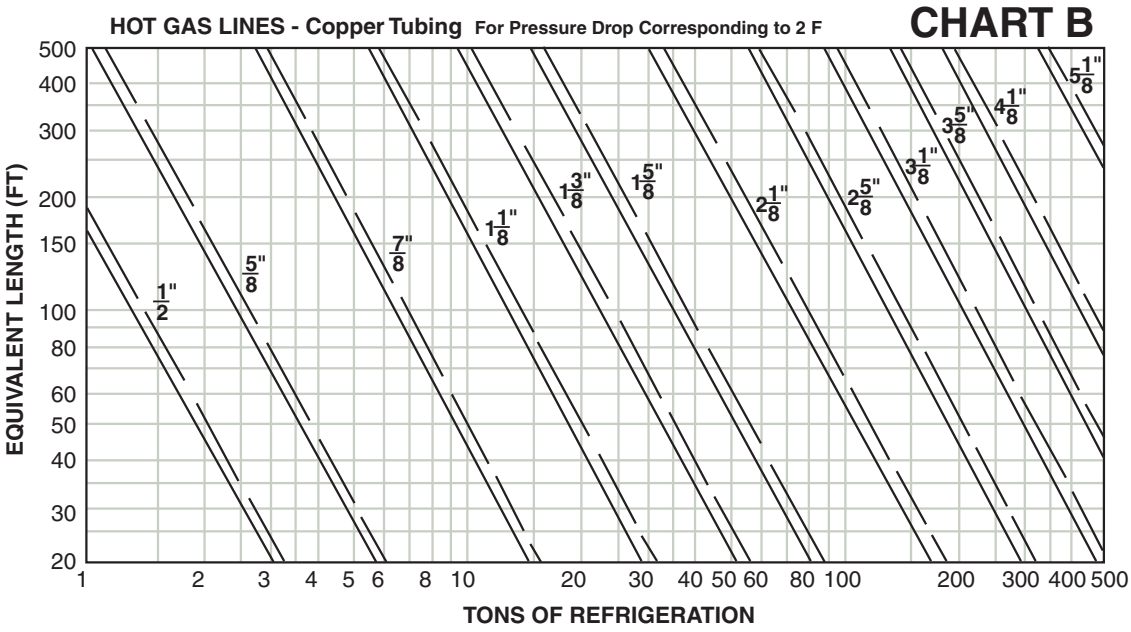
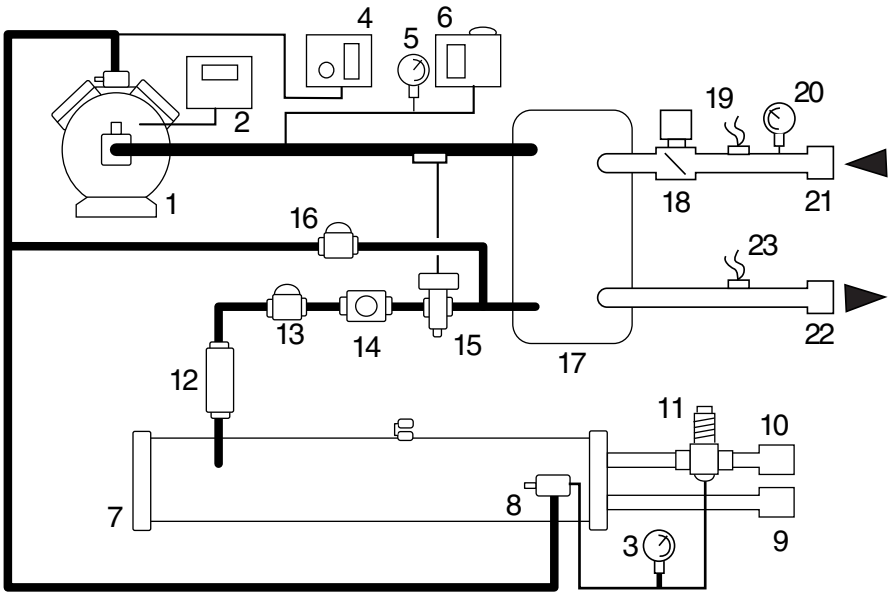


TABLE 1

6.16 TYPICAL WATER-COOLED CHILLER MODULE SCHEMATIC - MW SERIES

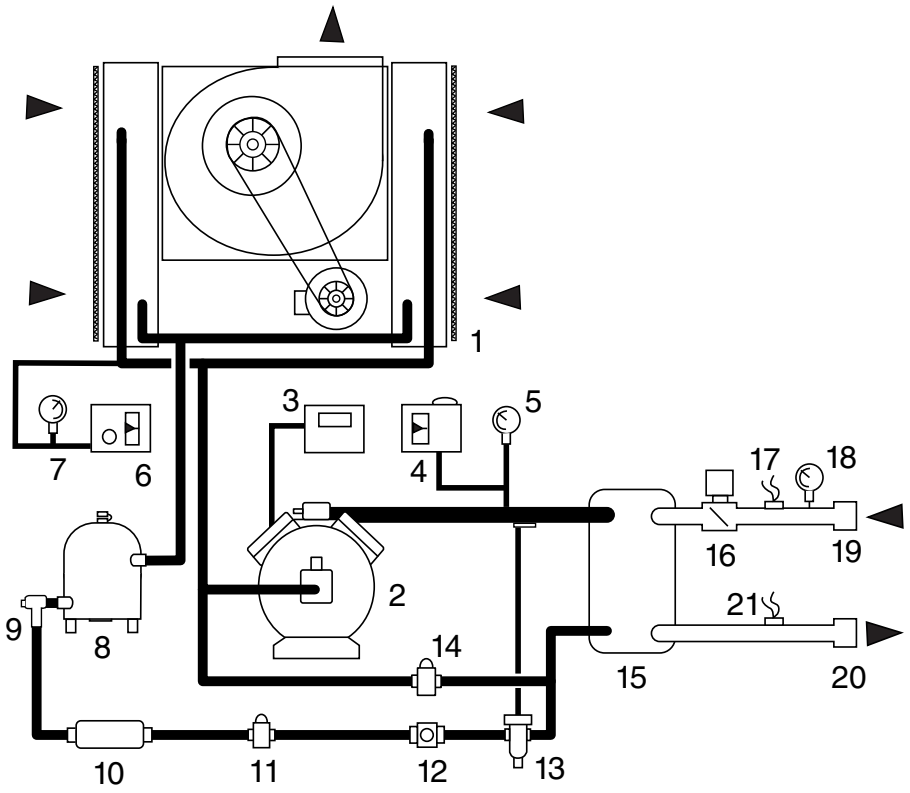


1 Semi-hermetic compressor (above 10 tons)
2 Oil pressure safety switch
3 Refrigerant high pressure gauge
4 Refrigerant high pressure safety
5 Refrigerant low pressure gauge
6 Refrigerant low pressure safety
7 Water cooled condenser
8 Service valve
9 Condenser water out connection
10 Condenser water in connection
11 Water regulator valve
12 Filter-drier
13 Liquid line solenoid valve
14 Refrigerant sight glass
15 Expansion valve
16 Hot gas by-pass valve
17 Brazed plate evaporator
18 Low flow safety switch
19 From process temperature sensor
20 From process pressure gauge
21 From process connection
22 To process connection
23 To process temperature sensor

COMMENTS

1. These components are all housed in a common frame.
2. This unit requires an external pump for the water flow.
3. This unit is generally used as an add-on to an existing TITAN water-cooled unit or in conjunction with a separate pump tank.

6.17 TYPICAL AIR-COOLED CHILLER MODULE SCHEMATIC - MA SERIES

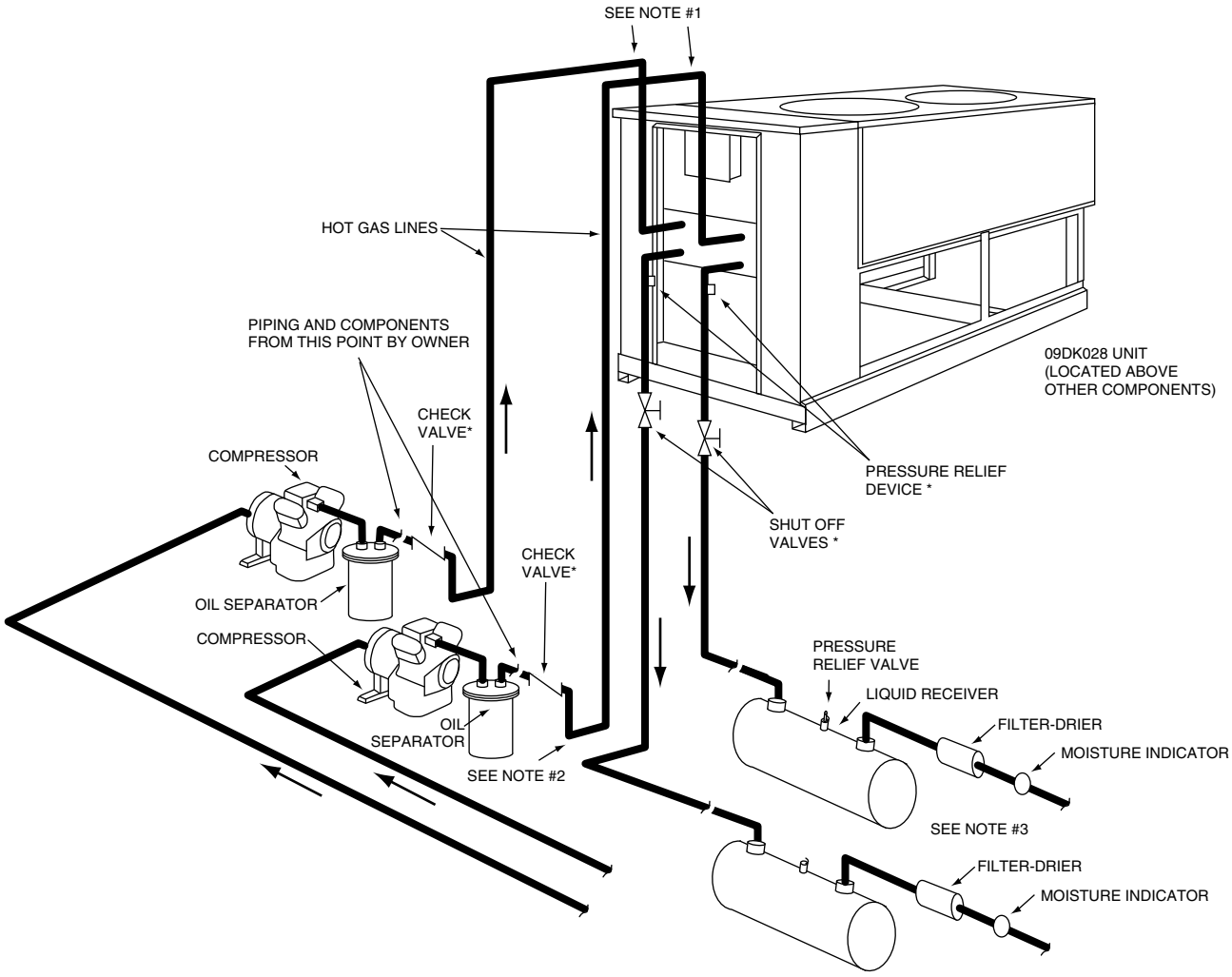


1 Centrifugal blower
2 Semi-hermetic compressor (above 10 tons)
3 Oil pressure safety
4 Refrigerant low pressure safety
5 Refrigerant low pressure gauge
6 Refrigerant high pressure safety
7 Refrigerant high pressure gauge
8 Liquid receiver
9 Service valve
10 Filter-drier
11 Liquid line solenoid valve
12 Refrigerant sight glass
13 Expansion valve
14 Hot-gas by-pass valve
15 Brazed plate evaporator
16 Low flow safety switch
17 From process temperature sensor
18 From process coolant pressure gauge
19 From process connection
20 To process connection
21 To process sensor

COMMENTS

1. These components are all housed in a common frame.
2. This unit requires an external pump for the water flow.
3. This unit is generally used as an add-on to an existing TITAN air-cooled unit or in conjunction with a separate pump tank.

6.18 TYPICAL PIPING FOR REMOTE AIR-COOLED CONDENSER WITH DUAL SPLIT SYSTEMS

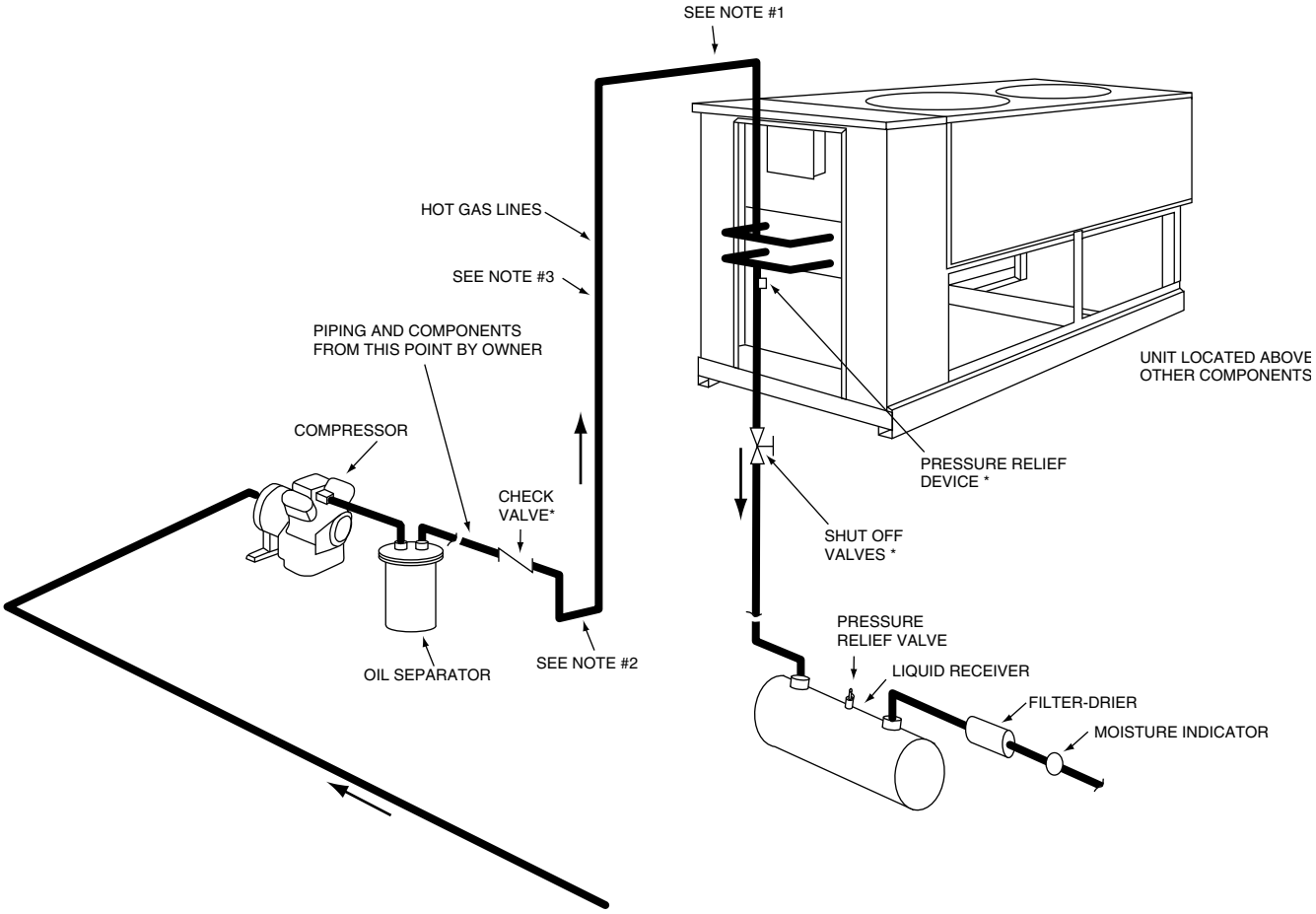


*Items are field supplied

Notes:

1. Hot gas lines should rise above refrigerant level in condenser circuit.
2. Trap should be installed on hot gas lines to prevent condenser oil and refrigerant vapor migration from accumulating on compressor heads during off cycle.
3. Refer to Carrier System Design Manual, part 3 for proper piping sizes and design.
4. For piping lengths greater than 50 ft. provide support to liquid and gas lines near the connections to the coil.

6.19 TYPICAL REFRIGERANT PIPING FOR OUTDOOR CONDENSERS



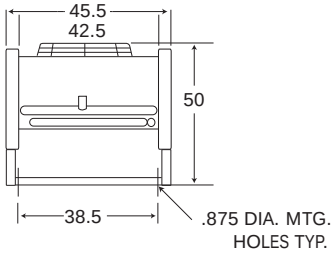
*Items are field supplied

Notes:

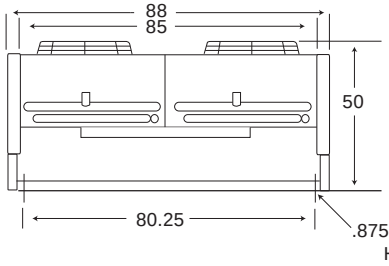
1. Hot gas lines should rise above refrigerant level in condenser circuit.
2. Trap should be installed on hot gas lines to prevent condenser oil and refrigerant vapor migration from accumulating on compressor heads during off cycle.
3. For piping lengths greater than 50 ft. provide support to liquid and gas lines near the connections to the coil.

6.20 LARKIN AIR-COOLED CONDENSER DIMENSIONS

End Views

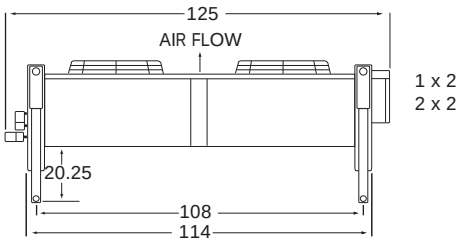


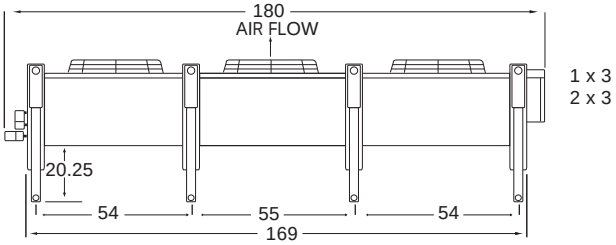
Single Row of Fans

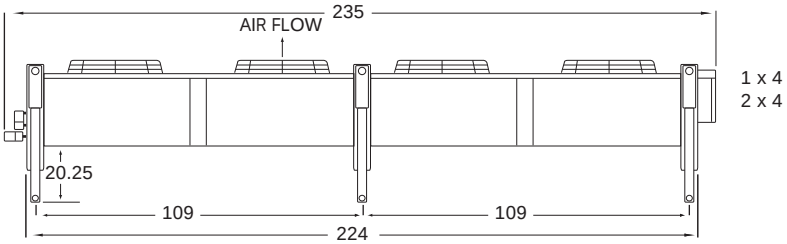


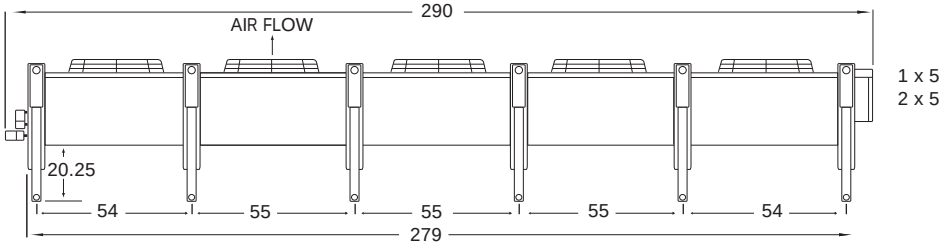
Double Row of Fans

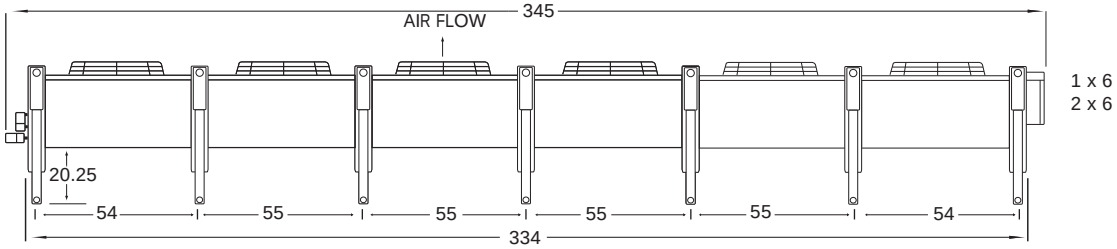
Side Views











6.21 SPECIFIC HEAT AND DENSITY FOR COMMON MATERIALS

MATERIAL	SPECIFIC HEAT	#/CUBIC FOOT
ETHYLENE GLYCOL / H_2O - 25/75 - 35/65 - 45/55	 .92 .86 .79	
ALUMINUM	.24	159.7
IRON	.12	449.2
STEEL	.12	486.7
GLASS	.20	163.0
RUBBER	.45	58.0
PLASTIC, NOI	.65	
GRAPHITE	.20	130.0
PAPER	.45	58.8
WOOD	.52	45.0 (average)
ACETATE	.3 - .5	81.2
DELRIN	.35	88.1
NYLON	.40	69.1
PHENOLIC	.40	79.5
POLYETHYLENE	.55	60.5
POLYSTYRENE	.32	65.7
TEFLON	.25	135.0
VINYL	.3 - .5	79.5
ISOCYANATE	.8 - .9	
POLYOL	.8 - .9	

6.22 FREEZING POINTS FOR WATER / PROPYLENE GLYCOL SOLUTIONS

FREEZING POINTS FOR WATER/PROPYLENE GLYCOL SOLUTIONS

PERCENTAGE OF GLYCOL*	WATER	FREEZE POINT °F	°C
0	100	32	0
10	90	25	-3.9
20	80	10	-12.2
30	70	0	-17.8
40	60	-10	-23.3
50	50	-30	-34.4
60	40	-60	-51.4

*PROPLYLENE GLYCOL

NOTES:

It is not recommended that ordinary automotive anti-freeze by used in **Temptek** chillers. A good industrial grade inhibited propylene glycol us suggested.

Chiller warranty is not applicable to freeze-up damage. It is the users' obligation to utilize the correct antifreeze procedures.

Chiller capacity is derated the greater the percent propylene glycol mixture. See specific heat value of mixtures - FYI #7-A-108.

Chillers are rated at stated tonnage at 50°F, clear water. See derating chart - FYI #3-A-105.

6.23 PROPER USE OF INHIBITED PROPYLENE GLYCOL

A. The use of a water-glycol mixture is needed when the operator desires a process temperature below 48°F. Freeze protection is required so ice crystals do not form and cause severe damage to both the water and refrigeration system.

B. Choosing the proper glycol:

For getting the most efficiency from your system, a propylene glycol such as “DowFrost” is a must. DowFrost contains special corrosion inhibitors for low system maintenance and better transfer capabilities than normal glycols. It also has a much longer fluid life up, to 20 years in some cases.

C. Use of plain glycol:

Even through they do lower the freeze point, plain glycols are even more corrosive than water. The corrosion rate of plain ethylene glycol on iron, for example, is more than 2.5 times faster than plain water. On steel, it is 4.5 times faster.

D. Automotive based antifreeze:

Should never be used! Automotive antifreeze contains silicate based inhibitors, which are compatible with automotive components. In an industrial application, the silicates will leach out and form a gel-like substance on the heat transfer surfaces and reduce cooling efficiency of the system. These silicates have shown to significantly reduce the lifetime of pump seals.

E. Maintenance responsibility:

A hygrometer should be used on a regular basis to determine the mixture strength according to freezepoint. The freezepoint temperature should be 25°F below the lowest required setpoint (see chart). Water will evaporate from the mixture, and if you continue to add a premixed solution, eventually you will have too much glycol. It is necessary to add water or glycol to maintain proper freezepoint temperature. The device pictured is by far the most accurate and easy to use for maintaining and checking for proper glycol levels.

FREEZING POINTS FOR WATER/PROPYLENE GLYCOL SOLUTIONS

PERCENTAGE OF GLYCOL*	WATER	FREEZE POINT ¡F	¡C
0	100	32	-6.7
20	80	20	-9.4
25	75	15	-12.2
30	70	10	-16.1
35	65	3	-20.6
45	55	-15	-26.7
50	50	-20	-33.3

*PROPLYLENE GLYCOL

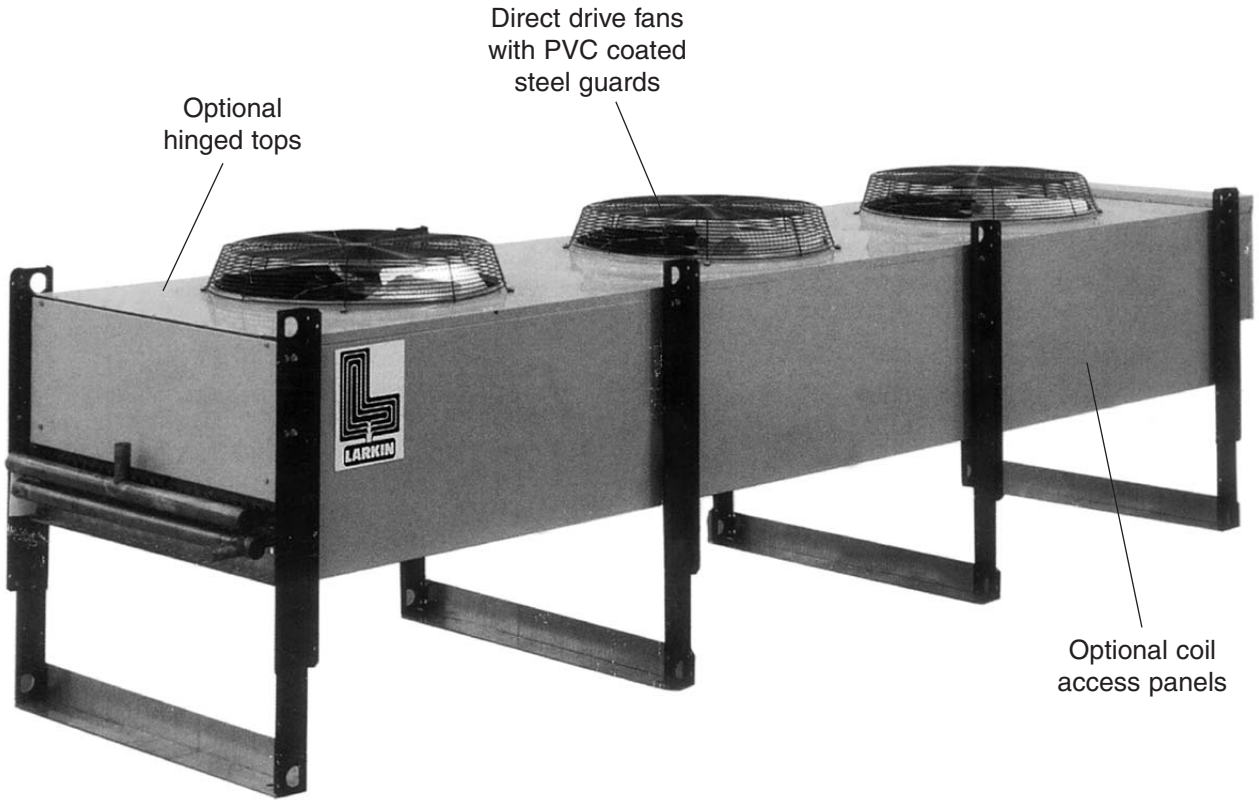
NOTE: GLYCOL FREEZE POINT MUST BE 10¡F BELOW LOWEST SETPOINT

6.24 LARKIN AIR-COOLED CONDENSER MODEL RC

A. Temptek supplies Larkin or Carrier air cooled condensers for use in remote condenser applications. The following information applies to Larkin condensers only.

B. FEATURES

- Pre-mounted and wired low ambient controls
- Patented floating tube design
- Aluminum housing
- Control circuit transformer
- High efficiency 1140 RPM fan motors
- Copper tube - aluminum fin construction



6.25 TEMPERATURE - PRESSURE CHART FOR HCFC-22 REFRIGERANT

TEMPERATURE - PRESSURE CHART

PRESSURE-POUNDS PER SQUARE INCH FOR HCFC-22 REFRIGERANT

TEMPERATURE °F	PRESSURE PSI	TEMPERATURE °F	PRESSURE PSI	TEMPERATURE °F	PRESSURE PSI
-40	0.5	15	37.7	44	74.5
-35	2.6	16	38.7	45	76.0
-30	4.9	17	39.8	46	77.6
-25	7.4	18	40.9	47	79.2
-20	10.1	19	41.9	48	80.8
-18	11.3	20	43.0	49	82.4
-16	12.5	21	44.1	50	84.0
-14	13.8	22	45.3	55	92.6
-12	15.1	23	46.4	60	101.6
-10	16.5	24	47.6	65	111.2
-8	17.9	25	48.8	70	121.4
-6	19.3	26	49.9	75	132.2
-4	20.8	27	51.2	80	142.6
-2	22.4	28	52.4	85	155.7
0	24.0	29	53.6	90	168.4
1	24.8	30	54.9	95	181.8
2	25.6	31	56.2	100	195.9
3	26.5	32	57.5	105	210.8
4	27.3	33	58.8	110	226.4
5	28.2	34	60.1	115	242.7
6	29.1	35	61.5	120	259.9
7	30.0	36	62.8	125	277.9
8	30.9	37	64.2	130	296.8
9	31.8	38	65.6	135	316.6
10	32.8	39	67.1	140	337.3
11	33.7	40	68.5	145	358.9
12	34.7	41	70.0	150	381.5
13	35.7	42	71.5	155	405.1
14	36.7	43	73.0		

6.26 COPELAND SCROLL COMPRESSORS

A. Copeland Scroll compressors are used on most Temptek portable and central chillers, from 3 to 90 tons, air and water cooled.


Scroll compressor

B. Copeland Scroll compressors have several benefits over other types of compressors. Scroll Compressors...

1. Have only three moving parts. Fewer moving parts mean increased reliability. By comparison, piston compressors have up to nine moving parts per cylinder. Benefit: fewer maintenance calls.

2. Do not use complex internal suction and discharge valves. Because of this, scroll compressors are more tolerant to liquid refrigerant and debris. Benefit: durability.

3. Are more efficient over their entire operating range, thanks to less cycling and 100% volumetric efficiency. Benefit: higher efficiency.

4. Are compact in overall size, are light weight, and are simple in design. Benefit: easy service and maintenance.

5. Operate at a lower sound and vibration levels. Benefit: quiet operation.

Scroll Compressor Cycle:

1. Refrigerant enters outer opening as one scroll orbits the other.

2. The open passage is sealed as refrigerant is drawn into the compression chamber.

3. As one scroll continues orbiting, the refrigerant is compressed into an increasingly smaller, crescent-shaped pocket.

4. By the time the refrigerant reaches a central port in the stationary scroll, it has achieved maximum (discharge) pressure.

5. During actual operation, all passages are in various stages of compression at all times, resulting in near-continuous intake and discharge for optimum performance.

6.27 USEFUL ENGINEERING FORMULAS

1 Ton = 12,000 BTU/Hr.
BTU = Mat'l weight in lbs. x specific heat of material x temperature difference
1 BTU = .293 watts
1 Watt = 3.42 BTU
1 KW = 1000 watt = 3,420 BTU's
BTU/Hr. = GPM x 500 x ∅T = CFM x 1.08 x ∅T (air)

$$\text{Tons} = \frac{\text{(Water) GPM x 8.34 x 60 x temp. diff. x sp. ht.}}{12{,}000} = \frac{\text{(Water) GPM x } \varnothing T}{24}$$

1 Gal./Water = 8.34 lbs. = 231 cu. in. = .1337 cu. ft. = 3.785 liters = 4 quarts
1 Lb./Water = .1198 gallons
1 Cu. Ft./Water = 7.481 gallons = 62.37 lbs.
1 Liter = .2642 gallons
1 HP = 2545 BTU/Hr. = 745.7 watts

$$\text{HP} = \frac{\text{PSI x GPM}}{1199} = \frac{\text{Ft. Hd. x GPM x Sp. Gr.}}{2772} = 42.442 \text{ BTU/Min.} = 2546.5 \text{ BTU/Hr.}$$

$$\text{PSI} = .4331 \text{ x Ft. Hd.} = \frac{\text{Ft. Hd.}}{2.3}$$

1 Foot Head = .4332 PSI
Feet of Head = PSI x 2.3
Watts = Amps x volts (1Ø) or amps x volts x 1.73 (3Ø)

$$\text{Volts} = \frac{\text{Watts}}{\text{Amps}} = \sqrt{\text{Watts x Ohms}} = \text{ohms x amps}$$

$$\text{KVA (3Ø)} = \frac{\text{Amps x volts x 1.73}}{1000} \quad \text{(omit 1.73 for 1Ø)}$$

$$\text{CFM} = \frac{\text{KW x 300}}{\text{temp diff.}} = \frac{\text{tons x 10530}}{\text{temp. diff.}} \qquad \text{KW} = \frac{\text{CFM x temp. diff.}}{3000}$$

°F = (9/5 x °C) + 32
°C = 5/9 (°F - 32)
Volume of Cylinder = pi x r^2 x L
Circumference of Circle = Diameter x 3.1416
Diameter = Circumference x .3183
Area of Circle = pi x r^2 = D^2 x .7854
1 Gram = .0353 oz.
1 Gallon = 3.79 liters
1 Foot = 30.48 cm
454 Gm = 1 lb.
1 Oz. = 28.35 grams
1 Kilogram-calorie = BTUH x .252
1 Millimeter = inches x 25.4
1 Kilogram = Lbs. x .454
1 Sq. Cm. = .155 sq. in.
1 Sq. In = 6.452 sq. cm.

6.28 WATER DISTRIBUTION PIPE SIZING

DISCHARGE		PRESSURE DROP PER 100 FEET AND VELOCITY IN SCHEDULE 40 PIPE FOR WATER AT 60°F															
		Velocity	Pressure Drop	Velocity	Pressure Drop	Velocity	Pressure Drop	Velocity	Pressure Drop	Velocity	Pressure Drop	Velocity	Pressure Drop	Velocity	Pressure Drop	Velocity	Pressure Drop
Gallons per Minute	Cubic Feet per Second	Feet per Second	LBS per Sq. In.	Feet per Second	LBS per Sq. In.	Feet per Second	LBS per Sq. In.	Feet per Second	LBS per Sq. In.	Feet per Second	LBS per Sq. In.	Feet per Second	LBS per Sq. In.	Feet per Second	LBS per Sq. In.	Feet per Second	LBS per Sq. In.
		1/8"		1/4"		3/8"		1/2"									
.2	0.000446	1.13	1.86	0.616	0.359												
.3	0.000668	1.69	4.22	0.924	0.903	0.504	0.159	0.317	0.061	3/4"							
.4	0.000891	2.26	6.98	1.23	1.61	0.672	0.345	0.422	0.086								
.5	0.00111	2.82	10.5	1.54	2.39	0.840	0.539	0.528	0.167	0.301	0.033						
.6	0.00134	3.39	14.7	1.85	3.29	1.01	0.751	0.633	0.240	0.361	0.041						
.8	0.00178	4.52	25.0	2.46	5.44	1.34	1.25	0.844	0.408	0.481	0.102	1"		1 1/4"		1 1/2"	
1	0.00223	5.65	37.2	3.08	8.28	1.68	1.85	1.06	0.600	0.602	0.155	0.371	0.048				
2	0.00446	11.29	134.4	6.16	30.1	3.36	6.58	2.11	2.10	1.20	0.526	0.743	0.164	0.429	0.044		
3	0.00668			9.25	64.1	5.04	13.9	3.17	4.33	1.81	1.09	1.114	0.336	0.644	0.090	0.473	0.043
4	0.00891			12.33	111.2	6.72	23.9	4.22	7.42	2.41	1.83	1.49	0.565	0.858	0.150	0.630	0.071
5	0.01114	2"				8.40	36.7	5.28	11.2	3.01	2.75	1.86	0.835	1.073	0.223	0.788	0.104
6	0.01337	0.574	0.044	2 1/2"		10.08	51.9	6.33	15.8	3.61	3.84	2.23	1.17	1.29	0.309	0.946	0.145
8	0.01782	0.765	0.073			13.44	91.1	8.45	27.7	4.81	6.60	2.97	1.99	1.72	0.518	1.26	0.241
10	0.02228	0.956	0.108	0.670	0.046			10.56	42.4	6.02	9.99	3.71	2.99	2.15	0.774	1.58	0.361
15	0.03342	1.43	0.224	1.01	0.094	3"				9.03	21.6	5.57	6.36	3.22	1.63	2.37	0.755
20	0.04456	1.91	0.375	1.34	0.158	0.868	0.056	3 1/2"		12.03	37.8	7.43	10.9	4.29	2.78	3.16	1.28
25	0.05570	2.39	0.561	1.68	0.234	1.09	0.083	0.812	0.041	4"		9.28	16.7	5.37	4.22	3.94	1.93
30	0.06684	2.87	0.786	2.01	0.327	1.30	0.114	0.974	0.056			11.14	23.8	6.44	5.92	4.73	2.72
35	0.07798	3.35	1.05	2.35	0.436	1.52	0.151	1.14	0.704	0.882	0.041	12.99	32.2	7.51	7.90	5.52	3.64
40	0.08912	3.83	1.35	2.68	0.556	1.74	0.192	1.30	0.095	1.01	0.052	14.85	41.5	8.59	10.24	6.30	4.65
45	0.1003	4.30	1.67	3.02	0.668	1.95	0.239	1.46	0.117	1.13	0.064			9.67	12.80	7.09	5.85
50	0.1114	4.78	2.03	3.35	0.839	2.17	0.288	1.62	0.142	1.26	0.076	5"		10.74	15.66	7.88	7.15
60	0.1337	5.74	2.87	4.02	1.18	2.60	0.406	1.95	0.204	1.51	0.107			12.89	22.2	9.47	10.21
70	0.1560	6.70	3.84	4.69	1.59	3.04	0.540	2.27	0.261	1.76	0.143	1.12	0.047			11.05	13.71
80	0.1782	7.65	4.97	5.36	2.03	3.47	0.687	2.60	0.334	2.02	0.180	1.28	0.060			12.62	17.59
90	0.2005	8.60	6.20	6.03	2.53	3.91	0.861	2.92	0.416	2.27	0.224	1.44	0.074	6"		14.20	22.0
100	0.2228	9.56	7.59	6.70	3.09	4.34	1.05	3.25	0.509	2.52	0.272	1.60	0.090	1.11	0.036	15.78	26.9
125	0.2785	11.97	11.76	8.38	4.71	5.43	1.61	4.06	0.769	3.15	0.415	2.01	0.135	1.39	0.055	19.72	41.4
150	0.3342	14.36	16.70	10.05	6.69	6.51	2.24	4.87	1.08	3.78	0.580	2.41	0.190	1.67	0.077		
175	0.3899	16.75	22.3	11.73	8.97	7.60	3.00	5.68	1.44	4.41	0.774	2.81	0.253	1.94	0.102		
200	0.4456	19.14	28.8	13.42	11.68	8.68	3.87	6.49	1.85	5.04	0.985	3.21	0.323	2.22	0.130	8"	
225	0.5013			15.09	14.63	9.77	4.83	7.30	2.32	5.67	1.23	3.61	0.401	2.50	0.162	1.44	0.043
250	0.557					10.85	5.93	8.12	2.84	6.30	1.46	4.01	0.495	2.78	0.195	1.60	0.051
275	0.6127					11.94	7.14	8.93	3.40	6.93	1.79	4.41	0.583	3.05	0.234	1.76	0.061
300	0.6684					13.00	8.36	9.74	4.02	7.56	2.11	4.81	0.683	3.33	0.275	1.92	0.072
325	0.7241					14.12	9.89	10.53	4.09	8.19	2.47	5.21	0.797	3.61	0.320	2.08	0.083
350	0.7798							11.36	5.41	8.82	2.84	5.62	0.919	3.89	0.367	2.24	0.095
375	0.8355							12.17	6.18	9.45	3.25	6.02	1.05	4.16	0.416	2.40	0.108
400	0.8912							12.98	7.03	10.08	3.68	6.42	1.19	4.44	0.471	2.56	0.121
425	0.9469							13.80	7.89	10.71	4.12	6.82	1.33	4.72	0.529	2.73	0.136
450	1.003	10"						14.61	8.80	11.34	4.60	7.22	1.48	5.00	0.590	2.89	0.151
475	1.059	1.93	0.054							11.97	5.12	7.62	1.64	5.27	0.653	3.04	0.166
500	1.114	2.03	0.059							12.60	5.65	8.02	1.81	5.55	0.720	3.21	0.182
550	1.225	2.24	0.071							13.85	6.79	8.82	2.17	6.11	0.861	3.53	0.219
600	1.337	2.44	0.083	12"						15.12	8.04	9.63	2.55	6.66	1.02	3.85	0.258
650	1.448	2.64	0.097									10.43	2.98	7.22	1.18	4.17	0.301
700	1.560	2.85	0.112	2.01	0.047							11.23	3.43	7.78	1.35	4.49	0.343
750	1.671	3.05	0.127	2.15	0.054	14"						12.03	3.92	8.33	1.55	4.81	0.392
800	1.782	3.25	0.143	2.29	0.061							12.83	4.43	8.88	1.75	5.13	0.443
850	1.894	3.46	0.160	2.44	0.068	2.02	0.042					13.64	5.00	9.44	1.96	5.45	0.497
900	2.005	3.66	0.179	2.58	0.075	2.13	0.047					14.44	5.58	9.99	2.18	5.77	0.554
950	2.117	3.86	0.198	2.72	0.083	2.25	0.052					15.24	6.21	10.55	2.42	6.09	0.613
1000	2.228	4.07	0.218	2.87	0.091	2.37	0.057	16"				16.04	6.84	11.10	2.68	6.41	0.675
1100	2.451	4.48	0.260	3.15	0.110	2.61	0.068					17.65	8.23	12.22	3.22	7.05	0.807
1200	2.674	4.88	0.306	3.44	0.128	2.85	0.080	2.18	0.042					13.33	3.81	7.70	0.948
1300	2.896	5.29	0.355	3.73	0.150	3.08	0.093	2.36	0.048					14.43	4.45	8.33	1.11
1400	3.119	5.70	0.409	4.01	0.171	3.32	0.107	2.54	0.055					15.55	5.13	8.98	1.28
1500	3.342	6.10	0.466	4.30	0.195	3.56	0.122	2.72	0.063	18"				16.66	5.85	9.62	1.46
1600	3.565	6.51	0.527	4.59	0.219	3.79	0.138	2.90	0.071					17.77	6.61	10.26	1.65
1800	4.010	7.32	0.663	5.16	0.276	4.27	0.172	3.27	0.088	2.58	0.050			19.99	8.37	11.54	2.08
2000	4.456	8.14	0.808	5.73	0.339	4.74	0.209	3.63	0.107	2.87	0.060			22.21	10.3	12.82	2.55
2500	5.570	10.17	1.24	7.17	0.515	5.93	0.321	4.54	0.163	3.59	0.091	20"				16.03	3.94
3000	6.684	12.20	1.76	8.60	0.731	7.11	0.451	5.45	0.232	4.30	0.129	3.46	0.075	24"		19.24	5.59
3500	7.798	14.24	2.38	10.03	0.982	8.30	0.607	6.35	0.312	5.02	0.173	4.04	0.101			22.44	7.56
4000	8.912	16.27	3.08	11.47	1.27	9.48	0.787	7.26	0.401	5.74	0.222	4.62	0.129	3.19	0.052	25.65	9.80
4500	10.03	18.31	3.87	12.90	1.60	10.67	0.990	8.17	0.503	6.46	0.280	5.20	0.162	3.59	0.065	28.87	12.2
5000	11.14	20.35	4.71	14.33	1.95	11.85	1.28	9.08	0.617	7.17	0.340	5.77	0.199	3.99	0.079		
6000	13.37	24.41	6.74	17.20	2.77	14.23	1.71	10.89	0.877	8.61	0.483	6.93	0.280	4.79	0.111		
7000	15.60	28.49	9.11	20.07	3.74	16.60	2.31	12.71	1.18	10.04	0.652	8.08	0.376	5.59	0.150		
8000	17.82			22.93	4.84	18.96	2.99	14.52	1.51	11.47	0.839	9.23	0.488	6.38	0.192		
9000	20.05			25.79	6.09	21.34	3.76	16.34	1.90	12.91	1.05	10.39	0.608	7.18	0.242		
10000	22.28			28.66	7.46	23.71	4.61	18.15	2.34	14.34	1.28	11.54	0.739	7.98	0.294		
12000	26.74			34.40	10.70	28.45	6.59	21.79	3.33	17.21	1.83	13.85	1.06	9.58	0.416		
14000	31.19					33.19	8.89	25.42	4.49	20.08	2.45	16.16	1.43	11.17	0.562		
16000	35.65							29.05	5.83	22.95	3.18	18.47	1.85	12.77	0.723		
18000	40.10							32.68	7.31	25.82	4.03	20.77	2.32	14.36	0.907		
20000	44.56							36.31	9.03	28.69	4.93	23.08	2.86	15.96	1.12		

6.29 PIPE SIZING - GPM AND PRESSURE LOSS

5' - 7' FEET PER SECOND VELOCITY

PIPE SIZE	5' - 7' FPS GPM Range	PSI Pressure Loss per 100'
1/2"	5 - 7	11 - 15
3/4"	8 - 11	6 - 9
1"	12 - 20	6 - 11
1 1/4"	20 - 30	2.7 - 6
1 1/2"	30 - 50	2.7 - 7
2"	55 - 80	2.5 - 5
2 1/2"	80 - 100	2 - 3
3"	110 - 175	1.6 - 3
4"	200 - 300	.9 - 2.1
6"	450 - 650	.6 - 1.18

EQUIVALENT LOSSES

90° elbow	20'
45° elbow	12'
Branch tee	15'
Gate valve (open)	15'
Ball valve (open)	25'
Quick disconnect (open)	35'
Hose barb	10'

6.30 RELUBRICATION INTERVALS (MOTORS WITH GREASERT FITTINGS

A. New motors having been in storage for over a year should be relubricated by the procedure noted below. The following relubrication intervals are suggested as a guide for long operating life.

B. LUBRICANT:

Baldor motors are pre-greased normally with Shell Oil company's "Dollum R". Several equivalent greases which are compatible with the Baldor furnished grease are Chevron Oil's "SRI No.2" and Texaco Inc. "Premium RD".

C. PROCEDURE:

Overgreasing bearings can cause premature bearing failure. If motor is equipped with Alemite fitting, clean tip of fitting and apply grease gun. Use 1 to 2 full strokes on motors in NEMA 215 frame and smaller. Use 2 to 3 strikes on NEMA 254 thru NEMA 365 frame. Use 3 to 4 strokes on NEMA 404 frames and larger. On motors having drain plugs, remove grease drain plug and operate motor for 20 minutes before replacing drain plug.

D. CAUTION

Keep grease clean. Lubricate at standstill. Remove and replace drain plugs at standstill. Do not mix petroleum grease and silicone grease in motor bearings.

	SUGGESTED RELUBE INTERVAL		
HOURS OF SERVICE PER YEAR	**NEMA FRAME SIZE**		
	42 TO 215T	**254 TO 326T**	**364 TO 447T**
5000 HRS	5 yrs	3 yrs	1 yr
Continuous Normal Application	2 yrs	1 yr	9 months
Seasonal Service	1 yr.	1 yr.	1 yr.
Motor is idle for 6 months or more	(beginning of season)	(beginning of season)	(beginning of season)
Continuous high ambients dirty or moist locations high vibration, or where shaft end is hot (pumps - fans)	6 months	6 months	6 months

7.0 AIR-COOLED REMOTE CONDENSER

7.1 INTRODUCTION

A. If you have purchased a chiller with model number that is similar to CF-XXA-RC (where XX is the nominal capacity of your chiller in tons) your chiller is equipped with a remote outdoor condenser. This document is a supplement to your primary manual. This document covers the differences related to the remote condenser option purchased. This document replaces section 2.4 of IOM Manual #056 7/99.

B. The chiller unit component of the system is generally installed inside protected from the elements (generic unit shown).

C. The remote condenser is generally installed outside using the guidelines illustrated in sections 2 - 4.

7.2 UNIT LOCATION

NOTE: Installation and maintenance to be performed only by qualified personnel who are familiar with local codes and regulations, and experience with this type of equipment.

CAUTION:

Sharp edges and coil surfaces are a potential injury hazard. Avoid contact with them.

A. Units are designed for outdoor application and may be mounted on a roof or concrete slab (ground level installation).

B. **Roof mounted units** should be installed level on steel channels or an I-beam frame to support the weight of the unit.

C. **Concrete slabs** used for unit mounting should be installed level and be properly supported to prevent settling. A one-piece concrete slab with footings extending below the frost line is recommended.

D. The condenser should be located no closer than four feet from any wall or other obstruction to provide sufficient clearance for air entrance.

E. Do not attach ductwork to the coil inlet or fan outlet.

F. Care should be taken to avoid air recirculation conditions that can be caused by sight screenings, walls, etc. Also keep unit fan discharge away from any building air intakes.

WARNING:

This equipment may contain a substance which harms the public health and environment by destroying ozone in the upper atmosphere. Venting of certain refrigerants to the atmosphere may be illegal in your location. Refrigerant recovery devices should be used when installing or servicing this product. Consult your local codes for requirements in your location.

G. Units should be installed away from occupied spaces and above or outside of utility areas, corridors and auxiliary space to reduce the transmission of sound and vibration to occupied spaces.

H. The refrigerant piping should be flexible enough to prevent the transmission of noise and vibration from the unit into the building. If

the refrigerant lines are to be suspended from the structure of the building, isolation hangers should be used to prevent the transmission of vibration. Where piping passes through a wall, it is advisable to pack fiberglass and sealing compound around the lines to minimize vibration and retain flexibility in the lines.

I. The unit needs to be secured in its final location. Holes are provided in the base runner for this purpose.

WARNING:

There may be more than one source of electrical current in this unit. Do not service before disconnecting all power supplies.

7.3 SPACE AND LOCATION REQUIREMENTS

A. The most important consideration which must be taken into account when deciding upon the location of air cooled equipment is the provision for a supply of ambient air to the condenser, and removal of heated air from the condenser area. Where this essential requirement is not adhered to, it will result in higher head pressures, which cause poor operation and possible eventual failure of equipment.

B. Units must not be located in the vicinity of steam, hot air or fume exhausts.

C. Another consideration which must be taken in that the unit should be mounted away from noise sensitive spaces and must have adequate support to avoid vibration and noise transmission into the building.

D. Units should be mounted over corridors, utility areas, rest rooms and other auxiliary areas where high levels of sound are not an important factor.

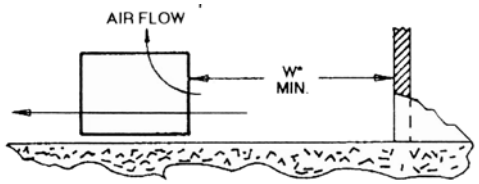
E. Sound and structural consultants should be retained for recommendations.

F. Different methods of installation:

1. **Walls or Obstructions:** the unit should be located so that air may circulate freely and not be recirculated. For proper air flow and access all sides of the unit should be a minimum of the width of the unit “W” away from any wall or obstruction (see diagram). It is preferred that this distance be increased whenever possible. Care should be taken to see that ample room is left for maintenance work through access doors and panels. Overhead obstructions are not permitted. When the unit is in an area where it is enclosed

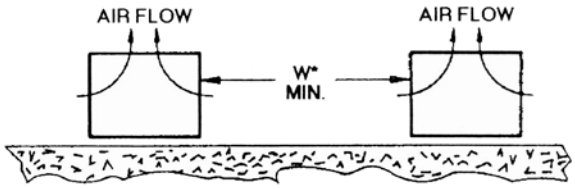
by three walls, the unit must be installed as indicated for “Units In Pits”.

2. **Multiple Units:** for units placed side by side, the minimum



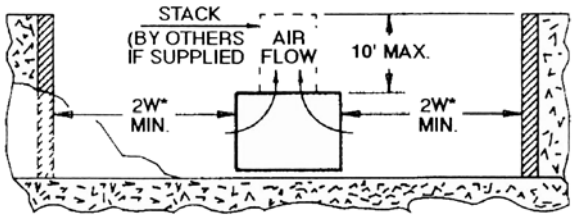
distance between units is the width of the largest unit. If units are placed end to end, the minimum distance between units if four feet.

3. **Units in Pits:** the top of the unit should be level with the

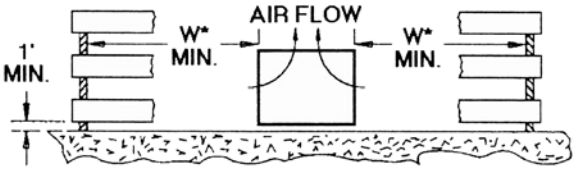


top of the pit, and side distance increased to “2W”. If the top of the unit is not level with the top of the pit, discharge cones or stacks must be used to raise discharge air to the top of the pit. This is a minimum requirement.

4. Fences must have 50% free area, with one-foot undercut, a



“W” minimum clearance, and must not exceed the top of the unit. If these requirements are not met, unit must be installed as indicated for “Units In Pits”.



7.4 RIGGING AND MOVING UNITS

A. The exact method of handling and setting the unit depends on available equipment, size of unit, final location, and other variables. It is up to the judgement of the riggers and movers to determine the specific method of handling each unit.

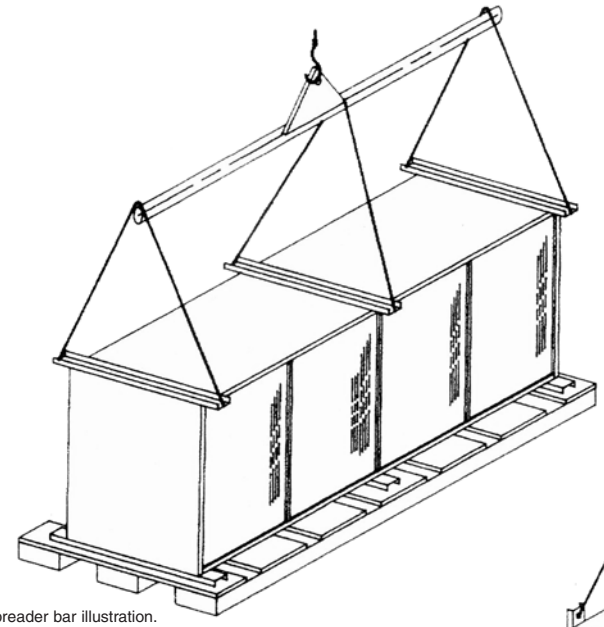
B. All units are shipped on heavy skids and enclosed in open crating. Generally, it is advisable to bring the unit as close to its final location as possible before removing crating.

C. Units are provided with lifting ears near the four corners. Under no circumstances should the coil headers or return bends be used for moving these units.

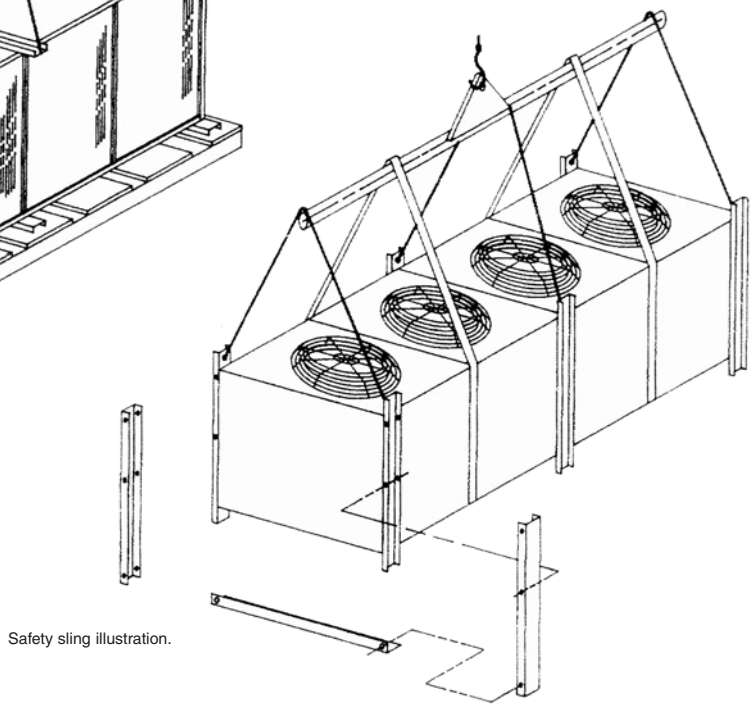
D. NOTE FOR ALL MODELS:

1. Spreader bars must be use (contractor supplied).

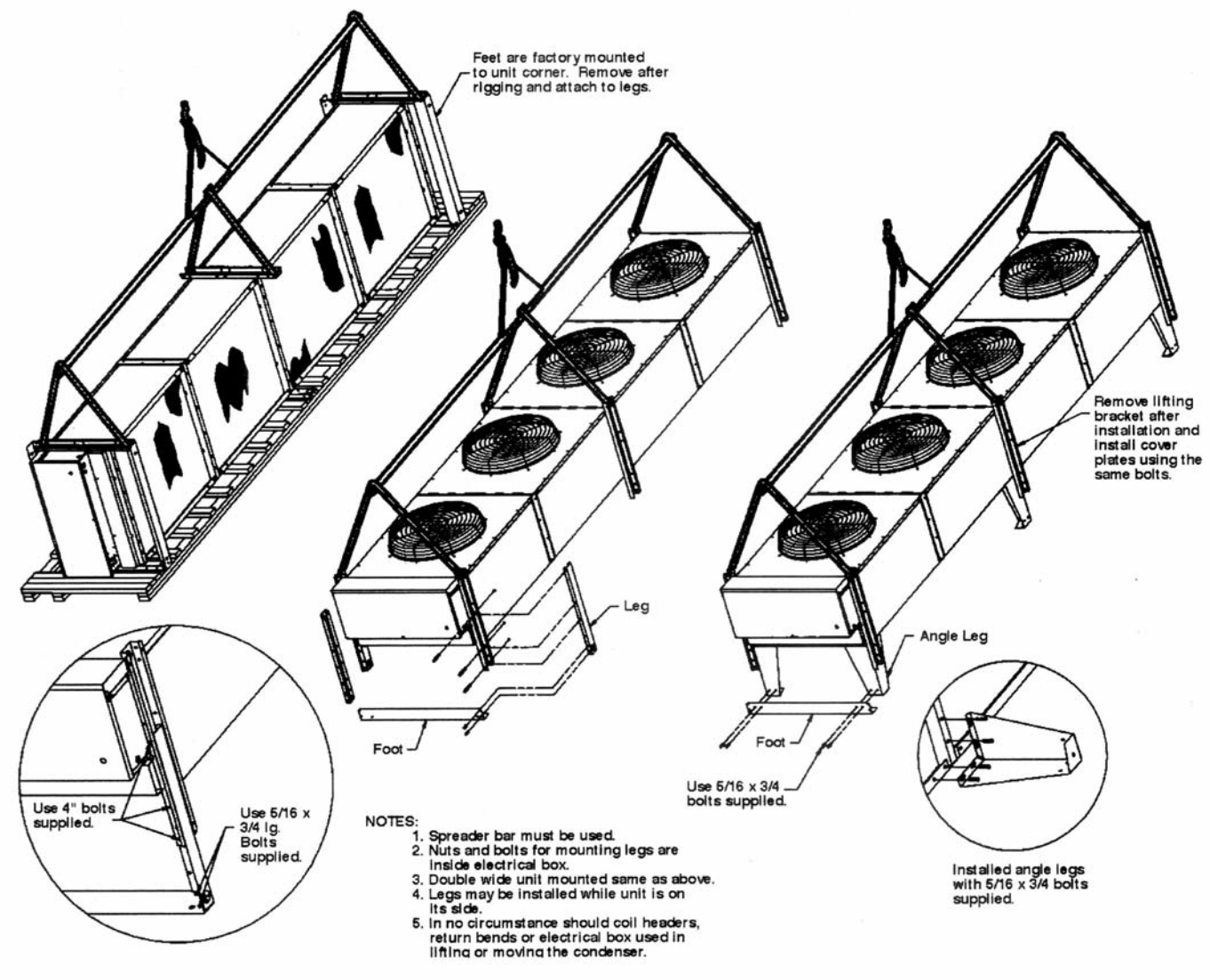
2. Safety sling should be used when making lift.



Spreader bar illustration.



Safety sling illustration.



7.5 INSTALLATION OF REFRIGERANT PIPING / SYSTEM CHARGING

A. Install piping according to standard accepted refrigeration practice. The following recommendations should be adhered to:

1. Use only refrigeration grade copper tubing.

2. Soft solder joints are not acceptable.

3. Put dry nitrogen through lines while brazing.

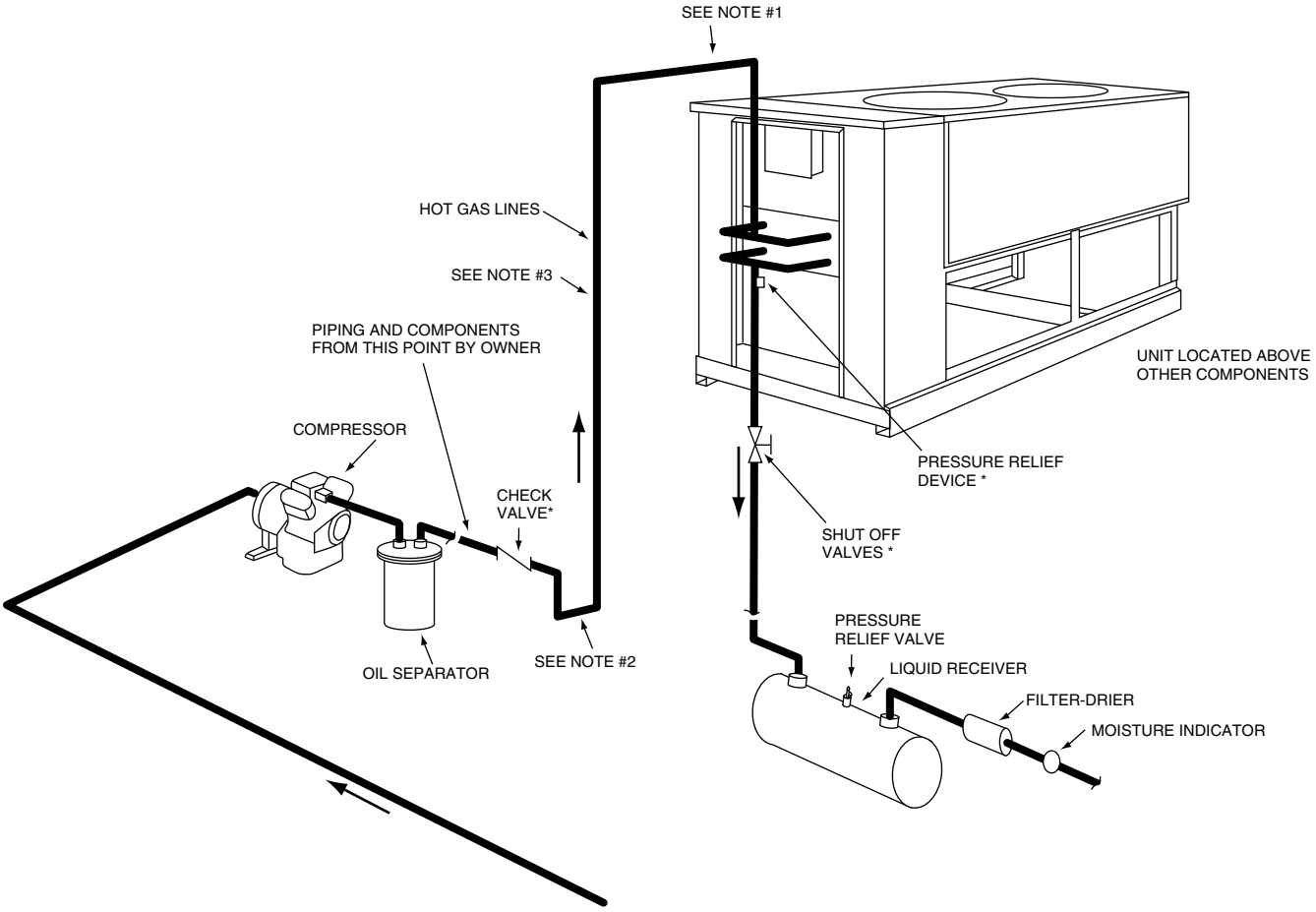
4. Do not leave dehydrated piping or components open to the atmosphere any longer than absolutely necessary.

B. Notes: (see diagram below)

1. Hot gas lines should rise above refrigerant level in condenser circuit.

2. Trap should be installed on hot gas lines to prevent condenser oil and refrigerant vapor migration from accumulating on compressor heads during off cycle.

3. Provide support to liquid and gas lines.



C. A qualified installation technician based on job specific installation parameters should determine the refrigerant piping size. The following table provides some approximate sizing guide lines that must be checked based on the specific requirements. It may be necessary to adapt the piping size to the condenser connections in the field.

Line Size Type L Copper OD	Tons Carried in Discharge Line with HCFC-22 with 80 Equivalent Feet of Piping	Tons Carried in Drain Liquid Line with HCFC-22 with 80 Equivalent Feet of Piping
1/2"	.85	5.0
5/8"	2.5	10.0
7/8"	7.0	25.0
1 1/8"	14.0	50.0
1 3/8"	25.0	90.0
1 5/8"	35.0	150.0
2 1/8"	70.0	250.0

D. The chiller unit component has been shipped with a holding charge of nitrogen. Once connected to the condenser with the proper piping, the complete system should be charged with nitrogen and checked for leaks. When no leaks exist the nitrogen should be released and the system must be evacuated to 50 microns with a vacuum pump

The system must be charged with HCFC liquid on the high side of the system. The system should be charged until the sight glass is clear and no bubbles can be seen while operating at 100% capacity. The approximate charge for the chiller system is shown below. The exact charge will be dependent on each specific job based on installation and piping.

Model	Approximate System (HCFC-22, lbs)
IK-2A-RC	12
IK-3A-RC	18
IK-4A-RC	24
MK-5A-RC	30
MK-7.5A-RC	48
MK-10A-RC	60
MK-15A-RC	90
MK-20A-RC	120
MK-25A-RC	150
MK-30A-RC	180
MK-35A-RC	210
MK-40A-RC	240

7.6 ELECTRICAL WIRING

A. The electrical installation should be in accordance with the National Electrical Code, local codes and regulations. Proper overcurrent protection should be provided for the fan motors. Wiring diagrams shown are only basic and do not show fuses, disconnect switches, etc., which must be provided in the field.

B. All standard motors have internal inherent overload protectors. Therefore, contactors can be used instead of starters requiring thermal protectors, eliminating the problem of furnishing the proper heating elements.

C. All air-cooled condensers are furnished with either single phase or three phase fan motors which are identified by the unit data plate.

D. Electrical leads from each motor terminate at the unit junction box. Field connections must be made from these leads through a contactor, fuse and disconnect in accordance with local, state and national codes.

E. Three phase motors must be connected to three phase power of voltage to agree with motor and unit data plate.

F. The motors are wired into a common junction box. Where fan cycling is furnished and factory installed, the motors are completely wired through the control and to the contactors. The motors must be checked for proper rotation. Be sure to check that motor voltage and control connection agree with electric services furnished.

G. There is no inter-connecting wiring between the chiller unit and remote condenser.

WARNING:

There may be more than one source of electrical current in this unit. Do not service before disconnecting all power supplies.

7.7 GENERAL MAINTENANCE

A. Air-cooled condensing units require a minimum of maintenance. The unit coil will require a periodic cleaning and this can be accomplished by a brush, vacuum cleaner, pressurized air stream or a commercially available coil cleaning foam.

B. All of the condenser fan motors have sealed ball bearings. The only acceptable service to these bearings is replacement.

7.8 CLEANING INSTRUCTIONS

A. The finned surface of this unit should be cleaned approximately every six months; more frequent cleaning may be required if extreme conditions cause clogging or fouling of air passages through the finned surface.

B. Calgon Corporation's CalClean (or equal) should be acceptable for cleaning this unit. CalClean should be applied liberally to entering air and leaving air surfaces of the finned area in accordance with the label directions.

CAUTION:

Under no circumstances should this unit be cleaned with an acid-based cleaner.

7.9 START-UP : ROTATION

A. Check for proper fan rotation. Air is drawn through the coil on all units. Be sure the fans turn freely.

B. Rotation of the motors and blades should be in a "CW" direction looking at the unit from the blade side. On three phase units, it may be necessary to reverse two of the three power leads to the unit.

WARNING:

The manifold assembly is not designed to support field piping. Any damages to the condenser due to excessive weight, pressure or vibration will not be covered by our standard warranty.

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