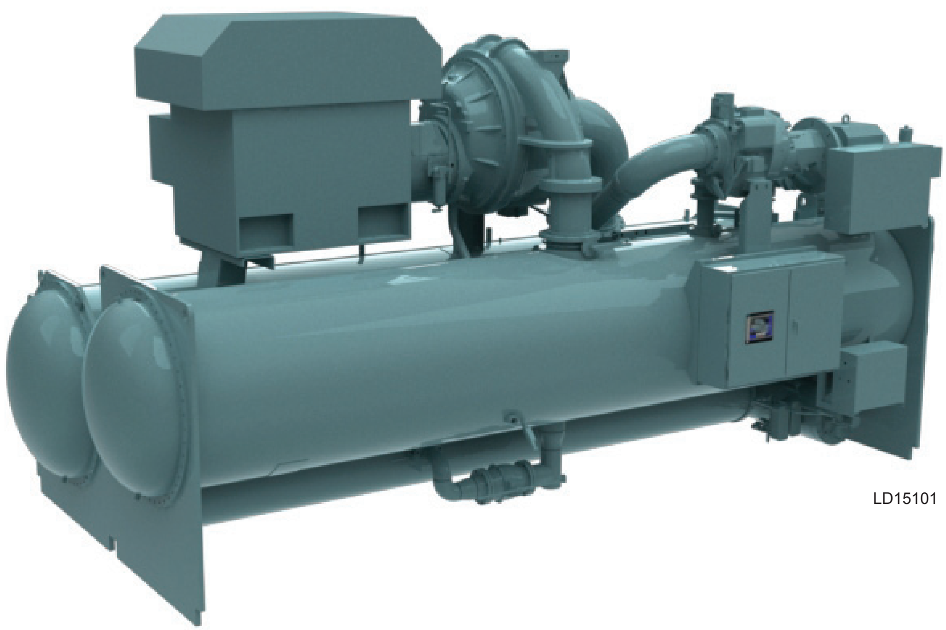
BY JOHNSON CONTROLS	CENTRIFUGAL LIQUID CHILLER WITH ECONOMIZER COMPRESSOR	
OPERATION AND MAINTENANCE	Supersedes: 160.77-O1 (611)	Form 160.77-O1 (1111)

MODEL YKEP
2700 - 3200 TON



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R-134a

Issue Date:
November 15, 2011

IMPORTANT!

READ BEFORE PROCEEDING!

GENERAL SAFETY GUIDELINES

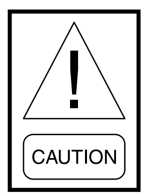
This equipment is a relatively complicated apparatus. During installation, operation maintenance or service, individuals may be exposed to certain components or conditions including, but not limited to: refrigerants, materials under pressure, rotating components, and both high and low voltage. Each of these items has the potential, if misused or handled improperly, to cause bodily injury or death. It is the obligation and responsibility of operating/service personnel to identify and recognize these inherent hazards, protect themselves, and proceed safely in completing their tasks. Failure to comply with any of these requirements could result in serious damage to the equipment and the property in which it is situated, as well as severe personal injury or death to themselves and people at the site.

This document is intended for use by owner-authorized operating/service personnel. It is expected that these individuals possess independent training that will enable them to perform their assigned tasks properly and safely. It is essential that, prior to performing any task on this equipment, this individual shall have read and understood this document and any referenced materials. This individual shall also be familiar with and comply with all applicable governmental standards and regulations pertaining to the task in question.

SAFETY SYMBOLS

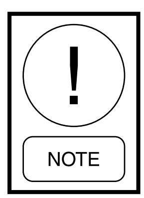
The following symbols are used in this document to alert the reader to specific situations:

Indicates a possible hazardous situation which will result in death or serious injury if proper care is not taken.



Identifies a hazard which could lead to damage to the machine, damage to other equipment and/or environmental pollution if proper care is not taken or instructions and are not followed.

Indicates a potentially hazardous situation which will result in possible injuries or damage to equipment if proper care is not taken.



Highlights additional information useful to the technician in completing the work being performed properly.

External wiring, unless specified as an optional connection in the manufacturer's product line, is not to be connected inside the control panel cabinet. Devices such as relays, switches, transducers and controls and any external wiring must not be installed inside the control panel. All wiring must be in accordance with Johnson Controls' published specifications and must be performed only by a qualified electrician. Johnson Controls will NOT be responsible for damage/problems resulting from improper connections to the controls or application of improper control signals. Failure to follow this warning will void the manufacturer's warranty and cause serious damage to property or personal injury.

CHANGEABILITY OF THIS DOCUMENT

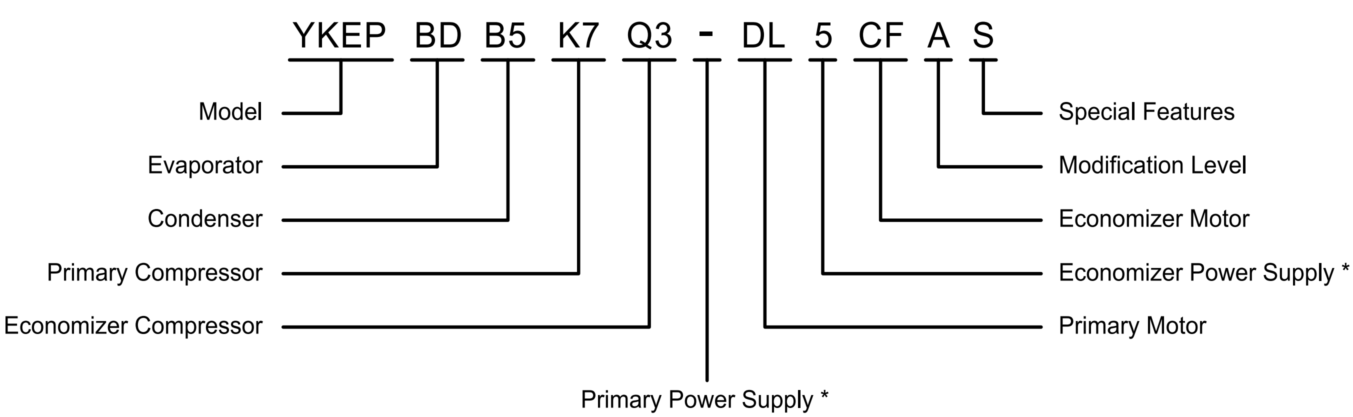
In complying with Johnson Controls' policy for continuous product improvement, the information contained in this document is subject to change without notice. Johnson Controls makes no commitment to update or provide current information automatically to the manual owner. Updated manuals, if applicable, can be obtained by contacting the nearest Johnson Controls Service office.

Operating/service personnel maintain responsibility for the applicability of these documents to the equipment. If there is any question regarding the applicability of these documents, the technician should verify whether the equipment has been modified and if current literature is available from the owner of the equipment prior to performing any work on the chiller.

ASSOCIATED LITERATURE

MANUAL DESCRIPTION	FORM NUMBER
YKEP Installation & Re-assembly	160.77-N1
YKEP Unit Operation & Maintenance	160.77-O1
YKEP Control Center Operation	160.77-O2
YKEP Unit & Control Panel Renewal Parts	160.77-RP1
YKEP Installation Checklist	160.77-CL1
YKEP Startup Checklist	160.77-CL2
YKEP Wiring Diagram - Field Connections	160.77-PW1
YKEP Wiring Diagram - Unit Wiring and Field Control Modification	160.77-PW2
Liquid Cooled Solid State Starter - Operation	160.00-O2
Medium Voltage Variable Speed Drive (2300v - 6600v) - Operation	160.00-O6
Medium Voltage Variable Speed Drive (10,000v - 13,800v) - Operation	160.00-O8
Unit Mounted Medium Voltage Solid State Starter (2300v - 4160v) - Operation	160.00-O7
Long-Term Storage Requirements - General	50.20-NM1
Long-Term Storage Requirements - Field Preparation	50.20-NM5
Long-Term Storage - Periodic Checklist and Logs	50.20-CL5

NOMENCLATURE



* For both Primary and Economizer power supply: "-" = 60Hz and "5" = 50Hz

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SECTION 1 - SYSTEM FUNDAMENTALS

GENERAL

The YORK® YKEP Chiller extends the YORK single-stage centrifugal chiller product range by providing additional capacity and greater efficiency through an economized cycle. This is the only product available that uses a second single-stage compressor to perform half lift in parallel. The advantage of this cycle is greater control flexibility to move the intermediate pressure to maximize efficiency or extend cooling capacity.

COMPONENTS

YKEP chillers are equipped with:

- Single-Stage Flash Economizer
- Primary Compressor: K7 (Model YDHA119)
- Economizer Compressor: Q3 (Model HF416)
- YORK Unit-Mounted Low-Voltage Solid State Starter (LV-SSS) for the economizer compressor motor.

The primary compressor starter, both compressor motors, the evaporator, and the condenser are job-specific.

Figure 1 on Page 7 identifies the major YKEP components, which are described in detail on the following pages.

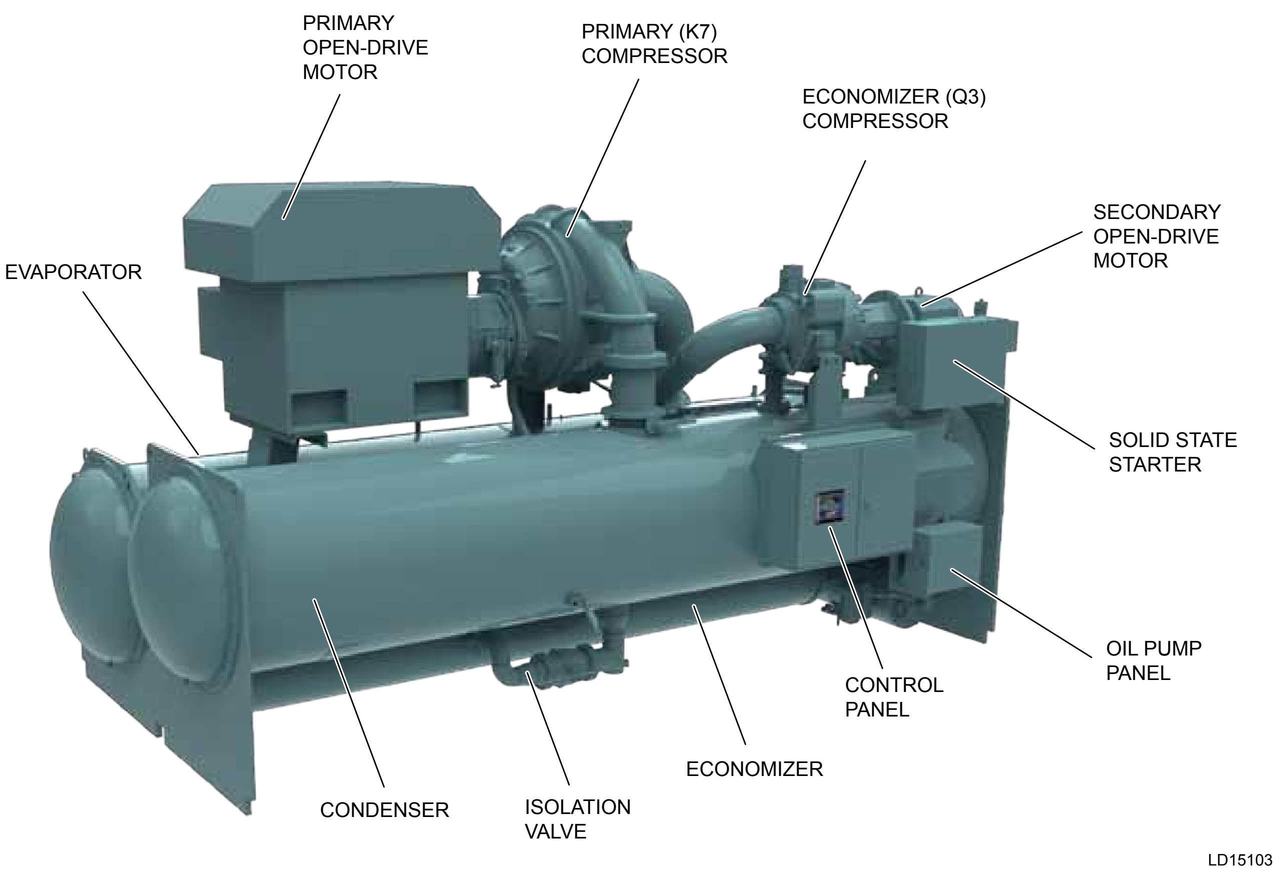

FIGURE 1 - YKEP CHILLER MAJOR COMPONENTS (FRONT VIEW)

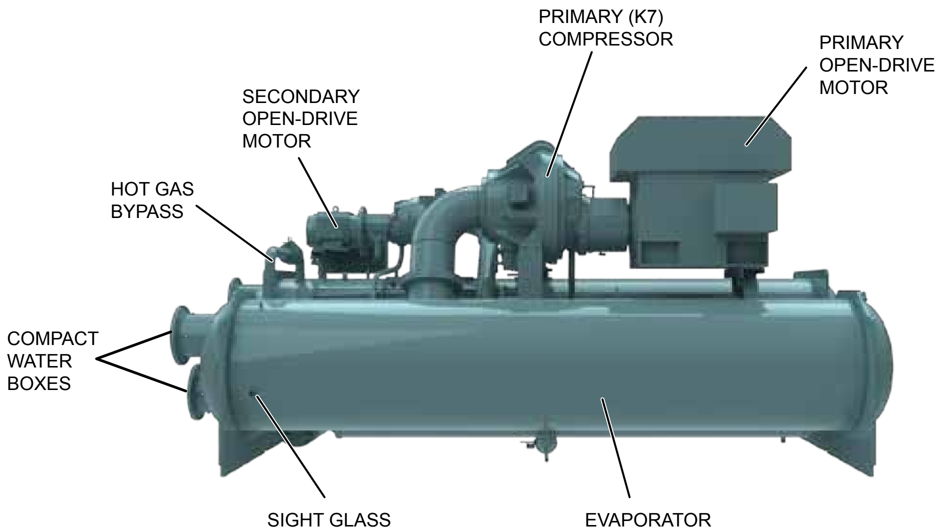

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FIGURE 2 - YKEP CHILLER (REAR VIEW)

Starters

The Economizer compressor motor is always equipped with a YORK Unit-Mounted LV-SSS.

The Primary compressor motor can be equipped with one of two YORK starters, or optionally, supplied by the customer.

Available YORK starters include a Floor-Mounted Medium-Voltage Variable Speed Drive (MV-VSD) (*Figure 3 on Page 8*) and a Unit-Mounted MV-SSS (*Figure 4 on Page 8*).

Customer-supplied starters must be floor-mounted.

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FIGURE 3 - MEDIUM VOLTAGE VSD

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FIGURE 4 - MEDIUM VOLTAGE SSS

Compressors

Two centrifugal compressors are provided, operating partially in parallel and discharging to a common condenser on the chiller. Check valves are supplied on the discharge of the economizer compressor to control refrigerant flow during single compressor operation.

Each of the YKEP's two compressors is a single-stage centrifugal type powered by an open-drive electric motor. The casing is fully accessible with vertical circular joints and fabricated of close-grain cast iron. The complete operating assembly is removable from the compressor and scroll housing.

The rotor assembly consists of a heat-treated alloy steel drive shaft and impeller shaft with a high strength, cast aluminum alloy, fully shrouded impeller. The impeller is designed for balanced thrust and is dynamically balanced and overspeed tested for smooth, vibration free operation.

The insert-type journal and thrust bearings are fabricated of aluminum alloy and are precision bored and axially grooved. The specially engineered, single helical gears with crowned teeth are designed so that more than one tooth is in contact at all times to provide even distribution of compressor load and quiet operation. Gears are integrally assembled in the compressor rotor support and are film lubricated. Each gear is individually mounted in its own journal and thrust bearings to isolate it from impeller and motor forces

Motors

YORK YKEP centrifugal chillers utilize air-cooled motors. This means that refrigerant never comes in contact with the motor.

Starters

Medium Voltage VSD

A variable speed drive is factory-packaged and configured for easy remote mounting. It is designed to vary the compressor motor speed by controlling the frequency and voltage of the electrical power to the motor. The adaptive capacity control logic automatically adjusts motor speed and compressor pre-rotation vane position independently for maximum part load efficiency by analyzing information fed to it by sensors located throughout the chiller. Operational information for the VSD can be found in *MV VSD (2300v - 6600v) - Operation (Form 160.00-O6)*, and *MV VSD (10,000v - 13,800v) - Operation (Form 160.00-O8)*.

Medium Voltage Solid-State Starter

A Solid-State Starter is a unit mounted reduced voltage in-line bypass starter that controls and maintains a constant current flow to the motor during startup. Power and control wiring between the starter and the chiller are factory-installed. Available for 4160V 3-phase 60Hz, 2300V 3-phase 60 Hz or 3300V 3-phase 50 Hz applications, the starter enclosure is NEMA-1, with a hinged access door with lock and key. Electrical lugs for incoming power wiring are not provided. Operational information for the solid state starter can be found in *Unit Mounted Medium Voltage Solid State Starter (2300v - 4160v) - Operation (Form 160.00-O7)*.

Flash Economizer (Intercooler)

The Flash Economizer is a single-stage type, consisting of a horizontal pressure vessel with internally mounted baffles and liquid spray pipe, an externally mounted level transmitter located with a liquid level pipe assembly, and an external control valve mounted in the liquid outlet to the evaporator. Refrigerant from the condenser, after expanding through the condenser subcooler level control valve, enters through the internal spray pipe, where flash gas is removed and channeled through baffles, out the top and on to the economizer compressor suction. The remaining liquid feeds out of the economizer through a liquid level control valve to the evaporator.

Heat Exchangers

Shells

Evaporator and condenser shells are fabricated from rolled carbon steel plates with fusion welded seams or carbon steel pipe. Carbon steel tube sheets, drilled and reamed to accommodate the tubes, are welded to the end of each shell. Intermediate tube supports are fabricated from carbon steel plates, drilled and reamed to eliminate sharp edges, and spaced no more than four feet apart. The refrigerant side of each shell is designed, tested, and stamped in accordance with ASME Boiler and Pressure Vessel Code, Section VIII – Division I, or other pressure vessel codes, as appropriate.

Tubes

Heat exchanger tubes are state-of-the-art, high-efficiency, externally and internally enhanced type to provide optimum performance. Tubes in both the evaporator and condenser are 3/4" (19 mm) O.D. standard or 1" (25.4 mm) copper alloy and utilize the "skip-fin" design, providing a smooth internal and external surface at each intermediate tube support. This provides extra wall thickness (nearly twice as thick) and non work-hardened copper at the support location, extending the life of the heat exchangers. Each tube is roller expanded into the tube sheets providing a leak-proof seal, while still individually replaceable.

Evaporator

The evaporator is a shell and tube, flooded type heat exchanger. A distributor trough provides uniform distribution of refrigerant over the entire shell length to yield optimum heat transfer. A suction baffle or aluminum mesh eliminators are located above the tube bundle to prevent liquid refrigerant carryover into the compressor. A 1 1/2" (38 mm) liquid level sight glass is conveniently located on the side of the shell. The evaporator shell contains a dual refrigerant relief valve arrangement set at 180 psig (12.4 barg); or single-relief valve arrangement, if the chiller is supplied with the optional refrigerant isolation valves. A 1" (25.4 mm) refrigerant charging valve is provided.

Condenser

The condenser is a shell and tube type, with a discharge gas baffle to prevent direct high velocity impingement on the tubes. The baffle is also used to distribute the refrigerant gas flow properly for most efficient heat transfer. An optional cast steel condenser inlet diffuser may be offered in lieu of the baffle, to provide dynamic pressure recovery and enhanced chiller efficiency. An integral subcooler is located at the bottom of the condenser shell providing highly effective liquid refrigerant subcooling to provide the highest cycle efficiency. The condenser contains dual refrigerant relief valves set at 235 psig (16.2 barg).

Water Boxes

The removable water boxes are fabricated of steel. The design working pressure is 150 psig (10.3 barg) and the boxes are tested at 225 psig (15.5 barg). Integral steel water baffles are located and welded within the water box to provide the required pass arrangements. Stub out water nozzle connections with ANSI/AWWA C-606 grooves are welded to the water boxes. These nozzle connections are suitable for ANSI/AWWA C-606 couplings, welding or flanges, and are capped for shipment. Plugged 3/4" (19 mm) drain and vent connections are provided in each water box.

Water Flow Switches

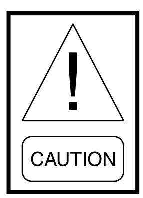
Thermal type water flow switches are factory mounted in the chilled and condenser water nozzles, and are factory wired to the control panel. These solid state flow sensors have a small internal heating-element. They use the cooling effect of the flowing fluid to sense when an adequate flow rate has been established. The sealed sensor probe is 316 stainless steel, which is suited for very high working pressures.

Refrigerant Flow Control

Refrigerant flow to the evaporator is controlled by the YORK variable orifice control system. Liquid refrigerant level is continuously monitored to provide optimum subcooler, condenser, and evaporator performance. The variable orifice electronically adjusts to all real-world operating conditions, providing the most efficient and reliable operation of refrigerant flow control.

Optional Service Isolation Valves

If your chiller is equipped with optional service isolation valves on the discharge and liquid line, these valves must remain open during operation. These valves are used for isolating the refrigerant charge in either the evaporator or condenser to allow service access to the system. A refrigerant pump-out unit will be required to isolate the refrigerant.



Isolation of the refrigerant in this system must be performed by a qualified service technician.

Optional Hot Gas Bypass

The optional hot gas bypass is used to provide greater turndown than otherwise available for load and head conditions. The Control Center will automatically modulate the hot gas valve open and closed as required. Adjustment of the hot gas control valve must only be performed by a qualified service technician.

Control Center

The chiller is controlled by a stand-alone PLC based control center. The chiller control center provides all the necessary controls and control logic to provide automatic start-up, operation, capacity control and safety protection of the chiller.

Control Panel

For operator interface the control panel includes a 10.4” (264.16 mm) color active matrix display with integral keypad. The control panel resides in a factory wired, unit mounted, NEMA 12, gasketed enclosure. The enclosure is fabricated 10 gauge steel and includes full height front access doors. The panel enclosure is painted to match the chiller color on the outside, and gloss white on interior surfaces. All controls are arranged for easy access and internally wired to clearly marked terminal strips or pre-wired PLC interface modules for external wiring connections. Wiring is color-coded black (control), white (neutral), and green (ground), with each wire numerically identified at both ends with heat shrinkable wire markers. Wiring enclosed in shielded cables and pre-wired cables are color coded per the wiring diagram.

The screen details all operations and parameters, using a graphical representation of the chiller and its components. The operator interface is programmed to provide display of all major operating parameters in both graphical and list type screen displays. PID control loop setpoints and Manual/Auto functions are also accomplished by the operator interface. Alarm indicators on the graphic display screen provide annunciation, and an alarm history screen is provided which shows the most recent alarms, with the time and date of occurrence. Trip status screens are provided which show the values of all analog inputs at the time of the last five chiller safety shutdowns. The time and date of the shutdown are also shown. A separate push button is provided on the face of the control panel for Emergency Stop.

Capacity Control System

The major components of a chiller are selected for full load capacities at the highest design head, therefore capacity must be controlled to maintain a constant chilled liquid temperature leaving the evaporator. The YKEP chiller uses a combination of prerotation vanes (PRV) located at the entrance to the compressor impeller, optional hot gas bypass, and variable compressor speed to control capacity.

The position of the vanes is automatically controlled through a lever arm attached to an electric motor located outside the compressor housing.

Compressor speed is controlled to overcome aerodynamic surge and further modulated above the surge limit as part of the capacity control routine.

Compressor Lubrication System

The chiller lubrication system consists of the oil pump, oil filter, oil cooler and all interconnecting oil piping and passages.

The submerged oil pump (oil sump) takes suction from the surrounding oil and discharges it to the oil cooler where heat is rejected. The oil flows from the oil cooler to the oil filter. The oil leaves the filter and flows to the emergency oil reservoir where it is distributed to the compressor bearings. The oil lubricates the compressor rotating components and is returned to the oil sump.

There is an emergency oil reservoir located at the highest point in the lubrication system internally in the compressor. It provides an oil supply to the various bearings and gears in the event of a system shutdown due to power failure. The reservoir allows the oil to be distributed through the passages by gravity flow, thus providing necessary lubrication during compressor coastdown.

Oil Pump

For normal operation, the oil pump should operate at all times during chiller operation.

On shutdown of the system for any reason, the oil pump continues operate for 150 seconds. During this time the system cannot restart.

Oil Heater

During long idle periods, the oil in the compressor oil reservoir tends to absorb refrigerant as it can hold, depending upon the temperature of the oil and the pressure in the reservoir. As the oil temperature is lowered, the amount of refrigerant absorbed will be increased. If the quantity of refrigerant in the oil becomes excessive, violent oil foaming will result as the pressure within the system is lowered on starting. This foaming is caused by refrigerant boiling out of the oil as the pressure is lowered. If this foam reaches the oil pump suction, the bearing oil pressure will fluctuate with possible temporary loss of lubrication, causing the oil pressure safety cutout to actuate and stop the system. The oil heater maintains oil temperature above refrigerant temperature while shutdown to avoid foaming.

YKEP SYSTEM FLOW EXPLANATION

The YORK YKEP chiller operates much the same as the YORK YK Single Stage chiller. The only exception is a small economizer loop to compress partially expanded gas to extend capacity and improve efficiency. Refer to the illustration in *Figure 5 on Page 13* as each step in the flow is described.

Step 1. Evaporator

Liquid refrigerant (R134a) flows into the evaporator and is distributed for contact to a bundle of tubes that carry the chilled liquid for the system. The low pressure liquid refrigerant absorbs heat from the chilled liquid causing the refrigerant to boil. The boiled refrigerant rises to the top of the tube bundle as vapor and passes through a mesh pad that prevents liquid refrigerant droplets from being drawn into the compressor.

Step 2. Primary Compressor

The refrigerant vapor that has passed through the mesh pad is drawn up to the compressor. Centrifugal compression is used to pressurize the refrigerant and generate flow. The high pressure refrigerant vapor is then discharged from the compressor to the condenser.

Step 3. Condenser

The high pressure refrigerant vapor is distributed across a bundle of tubes carrying cooling liquid in the condenser. The high temperature and high pressure refrigerant vapor rejects heat to the cooling liquid that is passing through the tubes. The cooling liquid will reject its heat to the environment in a cooling tower. When the refrigerant vapor gives up its heat to the cooling liquid, it condenses on the outside of the tubes and drips down to the subcooler. The liquid refrigerant passes through the subcooler where it rejects more heat to the cooling liquid as the refrigerant temperature is reduced.

Step 4. Expansion and Economizer

The refrigerant liquid from the condenser is partially expanded to a pressure intermediate to the evaporator and condenser. The partially expanded two phase refrigerant is separated to liquid and vapor streams in the economizer. The liquid stream is expanded a second time to repeat the cycle in the evaporator. The vapor stream is drawn out of the economizer by the economizer compressor. Note that the quality of refrigerant delivered to the evaporator as a result of economizing extends the refrigerating effect of the flow through the evaporator and primary compressor.

Step 5. Economizer Compressor

The economizer compressor draws the refrigerant vapor from the economizer. The efficiency benefit of the cycle is a result of not having to compressor this gas over the full head of the chiller system. As in the primary compressor, centrifugal compression is used to pressurize the refrigerant and develop flow. The high pressure vapor refrigerant is then discharged from the economizer compressor to the condenser.

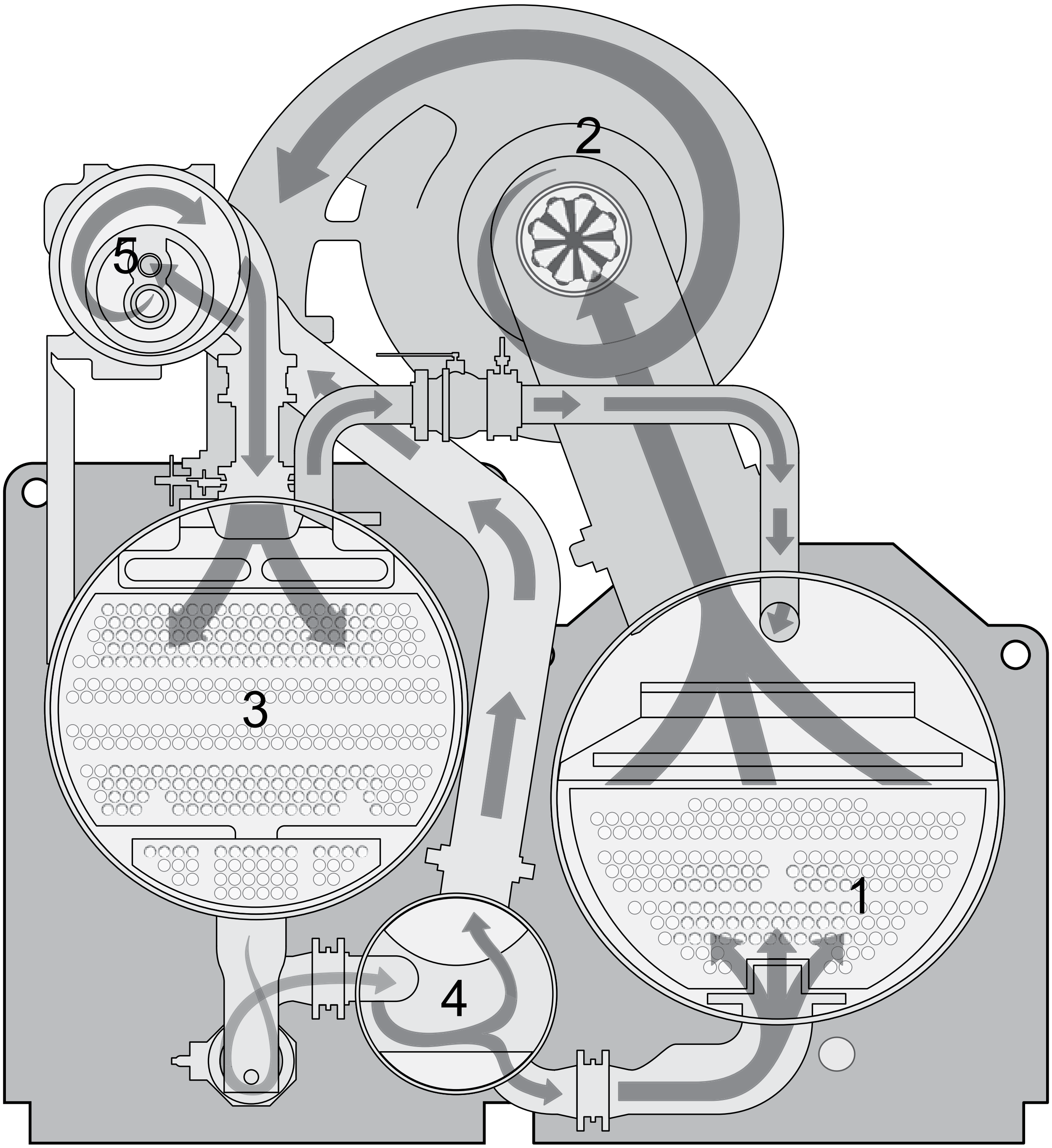


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FIGURE 5 - YKEP SYSTEM FLOW DIAGRAM

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SECTION 2 - SYSTEM OPERATING PROCEDURES

OIL HEATERS

This section along with the *YKEP Startup Checklist (Form 160.77-CL2)* details the process and procedures used to startup and operate the YKEP chiller. If the oil heater is de-energized during a shutdown period, it must be energized for 12 hours prior to starting compressor, or remove all oil and recharge compressor with new oil. (See Oil Charging Procedure on page 21.)

Oil Heater Operation

The oil heater operation is controlled by the YKEP Control Center. The heater is turned on and off to maintain the oil temperature differential to a value 50°F (27.8°C) above the condenser saturation temperature. This target value is maintained by the control panel.

If the target value is greater than 160°F (71°C), the target defaults to 160°F (71°C). If the target value is less than 110°F (43.3°C), it defaults to 110°F (43.3°C).

To prevent overheating of the oil in the event of a control center component failure, the oil heater thermostat (1HTR) is set to open at 180°F (82°C).

Checking the Oil Level in the Oil Reservoir

During operation, the proper oil level should fall into the “Operating Range” identified on the vertical oil level indicator label located on the oil reservoir cover plate.

- If the oil level during operation is in the “Over Full” region of the oil level indicator, oil should be removed from the oil reservoir.
- If the oil level during operation is in the “Low Oil” region of the oil level indicator, oil should be added to the oil reservoir. (See Oil Charging Procedure, page 20.)

CAUTION

Always comply with EPA and Local regulations when removing or disposing of Refrigeration System Oil.

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FIGURE 6 - OIL LIVEL INDICATOR

PRE-STARTING

Prior to starting the chiller, observe the Control Center Refer to the *YKEP Control Panel Operations Manual (Form 160.77-O2)*. Make sure the display reads "SYSTEM READY TO START".

CAUTION

Vent any air from the chiller water boxes prior to starting the water pumps. Failure to do so will result in pass baffle damage.

START-UP

1. If the chilled water pump is manually operated, start the pump. The Control Center will not allow the chiller to start unless chilled liquid flow is established through the unit. If the chilled liquid pump is wired to the Microcomputer Control Center, the pump will automatically start; therefore this step is not necessary.
2. To start the chiller, press the **COMPRESSOR START** button on the control panel. When the start switch is energized, the Control Center is placed in an operating mode and any malfunction will be noted by messages on the graphic display.

   For display messages and information pertaining to the operation of the YKEP Control Center, refer to the *YKEP Control Panel Operations Manual (Form 160.77-O2)*.

NOTE

Any malfunctions which occur during SHUTDOWN are also displayed and recorded.

CHILLER OPERATION

The chiller will vary capacity to maintain the leaving **CHILLED LIQUID TEMPERATURE** setpoint through a specific sequencing of optional hot gas bypass, pre-rotation vanes, and compressor speed.

Throughout capacity control, the compressor speed is maintained above the minimum required for the prevailing head condition, to avoid surge. Otherwise, the device maintaining capacity is controlled by a proportional-integral-derivative (PID) control based on leaving chilled liquid temperature. Pressure and motor current overrides also apply as necessary to maintain operating limits.

CONDENSER WATER TEMPERATURE CONTROL

The YKEP chiller is designed to use less power by taking advantage of lower than design water temperatures that are naturally produced by cooling towers throughout the operating year. Exact control of condenser water, such as a cooling tower bypass, is not necessary for most installations. The minimum entering condenser water temperature for full and part load conditions is specified in the chiller engineering guide.

Where:

$$\text{Min. ECWT} = \text{LCWT} - \text{C RANGE} + 5^{\circ}\text{F} + 12\left(\frac{\%\ \text{Load}}{100}\right)$$

$$\text{Min. ECWT} = \text{LCWT} - \text{C RANGE} + 2.8^{\circ}\text{C} + 6.6\left(\frac{\%\ \text{Load}}{100}\right)$$

ECWT = Entering Condensing Water Temperature
LCWT = Leaving Chilled Water Temperature
C Range = Condensing water temperature range at the given load condition.

At start-up, the entering condenser water temperature may be as much as 25°F (14°C) colder than the standby return chilled water temperature. Cooling tower fan cycling will normally provide adequate control of the entering condenser water temperature on most installations.

OPERATING LOGS

A permanent daily record of system operating conditions (temperatures and pressures) recorded at regular intervals throughout each 24-hour operating period should be kept. Automatic data logging is possible by connecting the optional printer and programming the DATA LOGGER function. An optional status printer is available for this purpose. *Figure 7 on Page 17* shows an example log sheet used for recording data on chiller systems. Log sheets are available in pads of 50 sheets and may be obtained through the nearest YORK/Johnson Controls office; request the *Liquid Chiller Log Sheets (Form 16.44-F7)*.

An accurate record of readings serves as a valuable reference for operating the system. Readings taken when a system is newly installed will establish normal conditions with which to compare later readings.

For example, an increase in condenser approach temperature (condenser temperature minus leaving condenser water temperature) may be an indication of dirty condenser tubes.

OPERATING INSPECTIONS

By following a regular inspection using the display readings of the YKEP Control Center, and maintenance procedure, the operator will ensure smooth operation of the unit. The following list of inspections and procedures should be used as a guide.

Daily

1. Check the YKEP Control Center displays for status and error messages.
2. If either compressor is in operation, check the bearing oil pressure on the SYSTEM screen and then check the oil level in the oil reservoir. The oil level should be within the operating range as marked on the oil indicator. Drain or add oil if necessary.
3. Check the entering and leaving condenser water pressure and temperatures. Condenser water temperatures can be checked on the SYSTEM Screen.
4. Check the entering and leaving chilled liquid temperatures and evaporator pressure on the SYSTEM Screen.
5. Check the condenser saturation temperature (based upon condenser pressure sensed by the condenser transducer) on the SYSTEM Screen.
6. Check the compressor discharge temperature on the SYSTEM Screen. During normal operation discharge temperature should not exceed 220°F (104°C).
7. Check the compressor motor current on the applicable MOTOR Screen.
8. Check for signs of dirty or fouled condenser tubes. The temperature difference between water leaving the condenser and the saturated condensing temperature should not exceed the difference recorded for a new unit by more than 4°F (2.2°C).

Weekly

1. Check the refrigerant charge. Refer to *Checking the Refrigerant Charge During Unit Shutdown* in *SECTION 3 - MAINTENANCE*.

Monthly

1. Leak check the entire chiller.

Quarterly

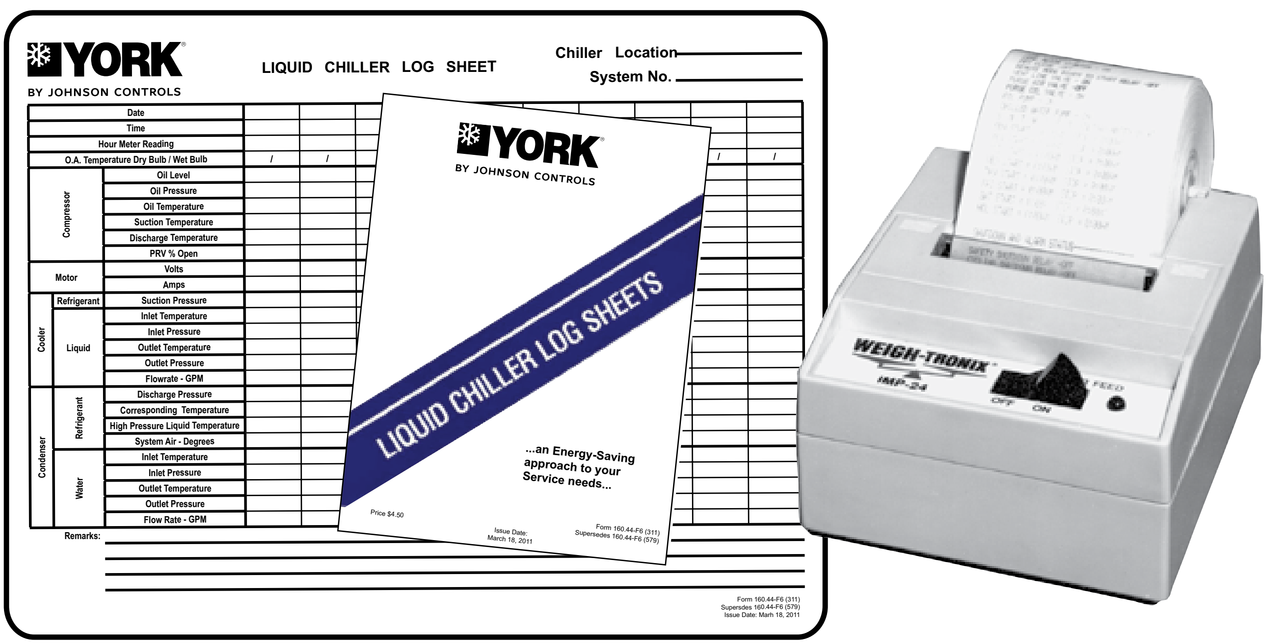
1. Perform chemical analysis of oil.

Semi-Annually (Or More Often As Required)

1. Change and inspect each compressor's oil filter element.
2. Inspect the Oil return system
   a. Change dehydrator
   b. Check nozzle of eductor for foreign particles.
3. Check controls and safety cutouts.

Annually (More Often If Necessary)

1. Drain and replace the oil in the compressor oil sump - refer to Oil Changing Procedure on page 20.
2. Check the Evaporator and Condenser.
   a. Inspect and clean water strainers.
   b. Inspect and clean tubes as required.
   c. Inspect end sheets.
3. Inspect the Compressor Drive Motors (see motor manufacturers maintenance and service instruction supplied with the unit).
   a. Meg motor windings – Refer to *Figure 12 on Page 26* for details.
4. Inspect and service electrical components as necessary.
5. Perform refrigerant analysis.



* **NOTE:** These items can be printed by an electronic printer connected to the Microboard and pressing the PRINT key on the Keypad, or automatically using the Data Logger feature.

FIGURE 7 - LIQUID CHILLER LOG SHEETS

NEED FOR MAINTENANCE OR SERVICE

If the system is malfunctioning in any manner or the unit is stopped by a safety shutdown, refer to the Operation Analysis Chart shown in *SECTION 4 - TROUBLESHOOTING Table 3 on Page 31*. After consulting this chart, if you are unable to make the proper repairs or adjustments to start the compressor or the particular trouble continues to hinder the performance of the unit, please call the nearest Johnson Controls District Office. Failure to report constant troubles could damage the unit and increase the cost of repairs.

STOPPING THE SYSTEM

The YKEP Control Center can be programmed to start and stop automatically (maximum - once each day). For more information on this refer to the YKEP *Control Center Operation Manual (Form 160.77-O2)*.

To stop the chiller, proceed as follows:

1. Push the soft shutdown key on the homescreen of the Control panel. The compressor will stop automatically. Normal stop raises the driveline to stop and should always be used instead of the E-Stop during regular operation.
2. Stop the chilled water pump (if not wired into the Control Center, in which case it will shut off automatically simultaneously with the oil pump).

CAUTION

BRINE APPLICATIONS When the chiller is not running, brine should not be run through the evaporator. However, if there is brine running through the evaporator, there must be flow through the condenser to prevent tubes from freezing.

3. Open the switch to the cooling tower fan motors, if used.

NOTE

In the event of an unusual circumstance requiring immediate stoppage, an emergency stop switch is located on the side of the control panel.

PROLONGED SHUTDOWN

If the chiller is to be shut down for an extended period of time (for example, over the winter season), the following procedure should be followed.

1. Test all system joints for refrigerant leaks with a leak detector. If any leaks are found, they should be repaired before allowing the system to stand for a long period of time.

NOTE

During long idle periods, the tightness of the system should be checked periodically.

2. If freezing temperatures are expected while the system is idle, carefully drain the cooling water from the cooling tower, condenser, condenser pump, and the chilled water system pump and coils.

   Open the drains on the evaporator and condenser liquid heads to assure complete drainage.
3. Drain the VSD cooling system and/or the Solid State Starter cooling loop. If freezing temperatures are expected for periods longer than a few days, the refrigerant should be evacuated to containers to prevent leakage from O-ring joints.
4. Open the main disconnect switches to the compressor motor, condenser water pump, and the chilled water pump. Open the 115 volt circuit to the Control Center.

SECTION 3 - MAINTENANCE

RENEWAL PARTS

For any required Renewal Parts, refer to the *YKEP Unit Renewal Parts Manual (Form 160.77-RP1).*

OIL RETURN SYSTEM

The oil return system continuously maintains the proper oil level in the compressor oil sump (See *Figure 8 on Page 19*).

High pressure condenser gas flows continuously through the eductor inducing the low pressure, oil rich liquid to flow from the evaporator, through the dehydrator to the compressor sump.

Changing The Dehydrator

To change the dehydrator, use the following procedure:

1. Isolate the dehydrator at the stop valves.
2. Remove the dehydrator (refer to *Figure 8 on Page 19*).
3. Assemble the new filter-drier.
4. Open evaporator stop valve and check dehydrator connections for refrigerant leaks.
5. Open all the dehydrator stop valves.

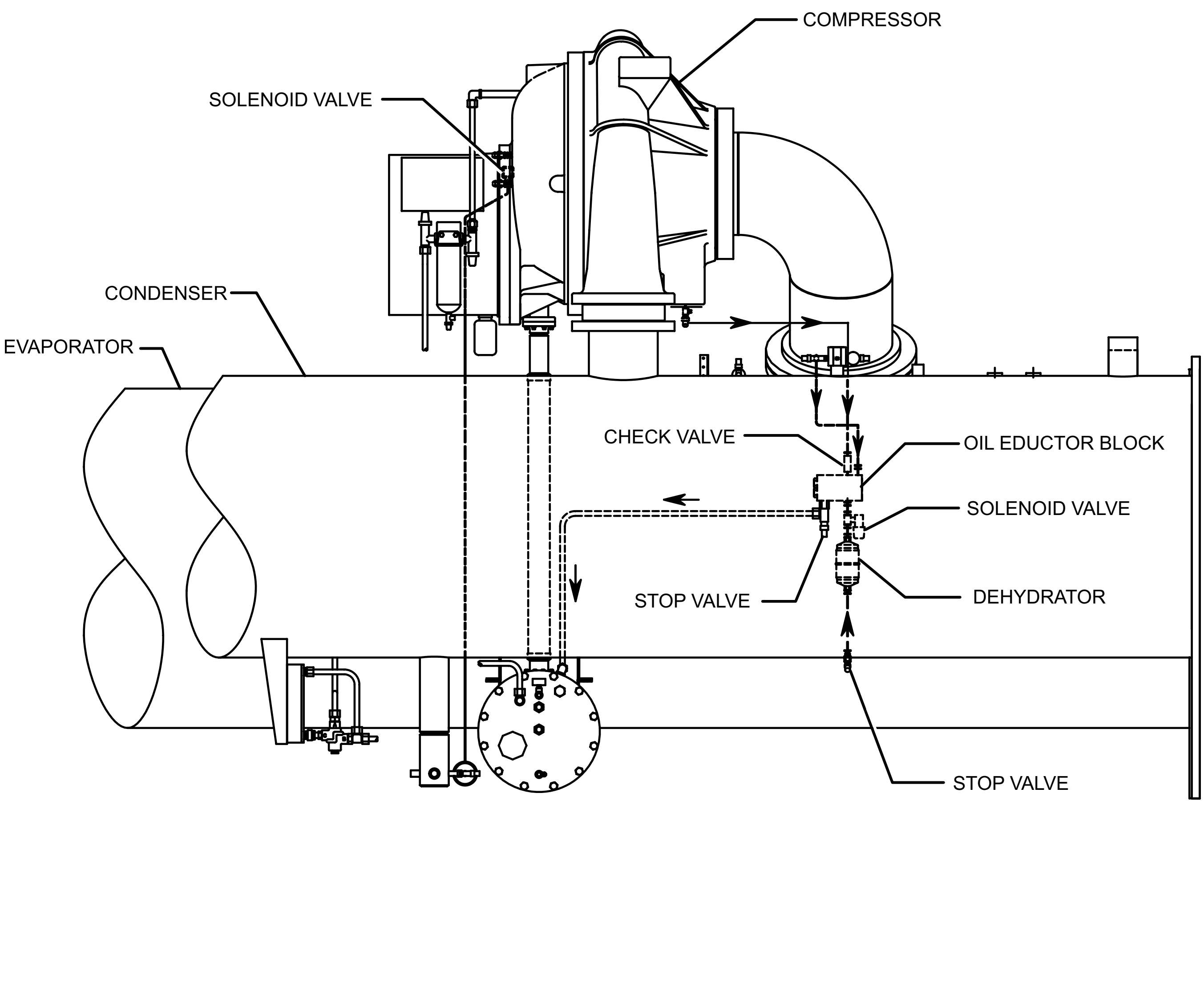


FIGURE 8 - OIL RETURN SYSTEM

Oil Charge

The YKEP oil system uses YORK "K" type oil. The nominal oil charge for the YKEP compressors is 40 gallons.

Always use new YORK refrigeration oil in the centrifugal compressor. Oil absorbs moisture when exposed to the atmosphere, therefore, it should be kept tightly capped until used.

Oil Charging Procedure

During operation the compressor oil level must be maintained in the "Operating Range" identified on the vertical oil level indicator (refer to *Figure 6 on Page 15*). If the oil level falls into the lower oil range, it is necessary to add oil to the compressor oil reservoir. The oil should be charged into the oil reservoir using the YORK Oil Charging Pump (YORK Part No. 070-10654).

Using the following procedures:

1. The unit must be shut down.
2. Immerse the suction connection of the oil charging pump in a clean container of new oil and connect the pump discharge connection to the oil charging valve located on the remote oil reservoir cover plate (see *Figure 8 on Page 19*). Do not tighten the connection at the charging valve until after the air is forced out by pumping a few strokes of the oil pump. This fills the lines with oil and prevents air from being pumped into the system.
3. Open the oil charging valve and pump oil into the system until oil level in the compressor oil reservoir is in the "Over Full" region of the oil level indicator label. Close the charging valve and disconnect the hand oil pump.
4. As soon as oil charging is complete, close the power supply to the starter to energize the oil heater. This will keep the concentration of refrigerant in the oil to a minimum.

When the oil reservoir is initially charged with oil, the oil pump should be started manually to fill the lines, passages, oil cooler and oil filter. This will lower the oil level in the reservoir. It may then be necessary to add oil to bring the level back into the "Operating Range" of the oil level indicator label.

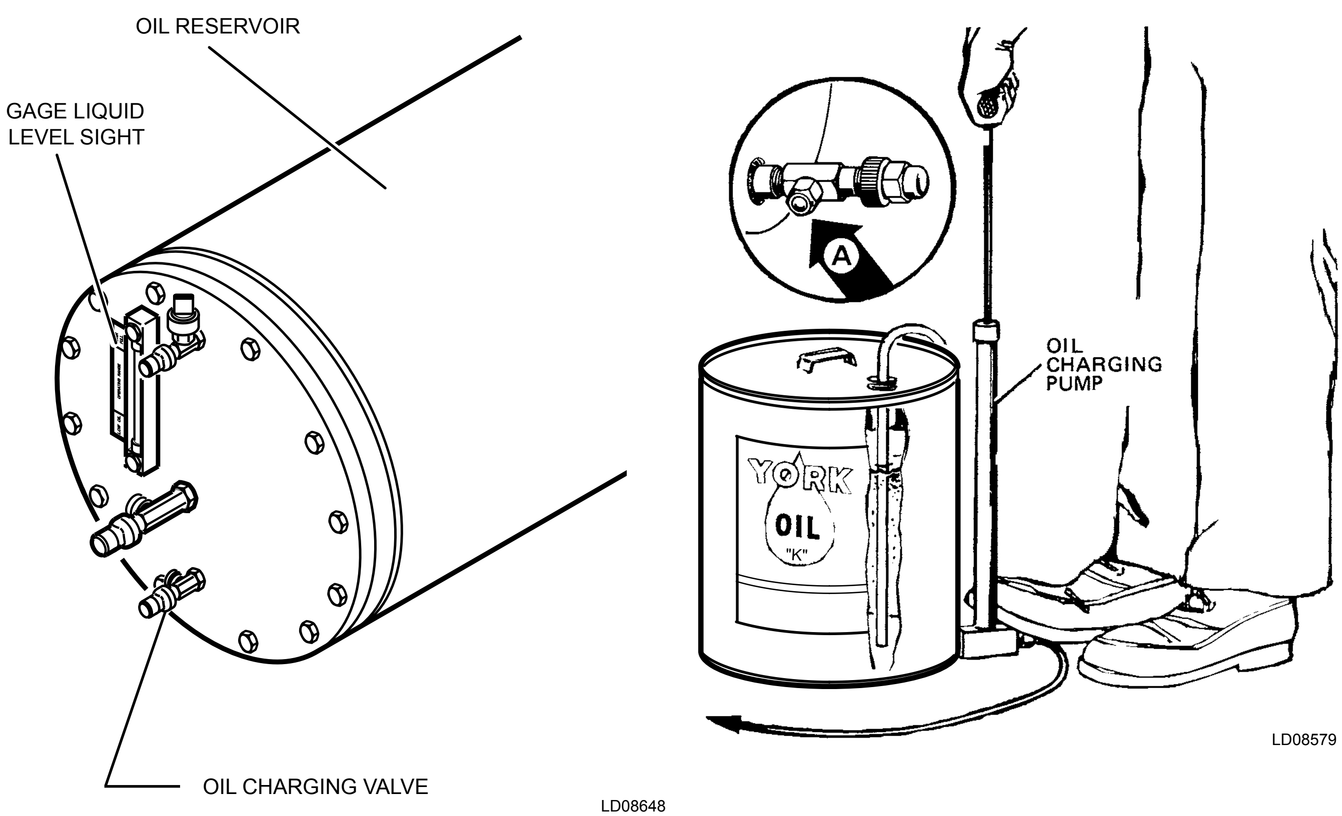


FIGURE 9 - CHARGING OIL RESERVOIR WITH OIL

CHECKING SYSTEM FOR LEAKS

Leak Testing During Operation

The refrigerant side of the system is carefully pressure tested and evacuated at the factory. However, after the system has been charged, the system should be carefully leak tested with a R-134a compatible leak detector to be sure all joints are tight.

If any leaks are found, they must be repaired immediately. Usually, leaks can be stopped by tightening flare nuts or flange bolts; however, for any major repair, the refrigerant charge must be removed. Refer to *Handling Refrigerant For Dismantling And Repairs* in this section.

WARNING

Never perform welding on the chiller unless the refrigerant has been completely evacuated and all other safety measures have been taken.

Testing for Evaporator and Condenser Tube Leaks

Evaporator and condenser tube leaks in R-134a systems may result in refrigerant leaking into the water circuit, or water leaking into the shell depending on the pressure levels. If refrigerant is leaking into the water, it can be detected at the liquid head vents after a period of shutdown. If water is leaking into the refrigerant, system capacity and efficiency will drop off sharply. If a tube is leaking and water has entered the system, the evaporator and condenser should be valved off from the rest of the water circuit and drained immediately to prevent severe rusting and corrosion. The refrigerant system should then be drained and purged with dry nitrogen to prevent rusting and corrosion. If a tube leak is indicated, the exact location of the leak may be determined as follows:

1. Remove the heads and listen at each section of tubes for a hissing sound that would indicate gas leakage. If the probable location of the leaky tubes has been determined, treat that section in the following manner (if the location is not definite, all the tubes will need to be checked).
2. Wash off both tube heads and the ends of all tubes with water.

NOTE

Do not use carbon tetrachloride for this purpose since its fumes give the same flame discoloration that the refrigerant does.

3. With nitrogen or dry air, blow out the tubes to clear them of traces of refrigerant laden moisture from the circulation water.
4. As soon as the tubes are clear, a cork should be driven into each end of the tube.
5. Pressurize the dry system with 50 to 100 PSIG (345 to 690 kPa) of nitrogen. Repeat this with all of the other tubes in the suspected section or, if necessary, with all the tubes in the evaporator or condenser.
6. Allow the evaporator or condenser to remain corked up to 12 to 24 hours before proceeding. Depending upon the amount of leakage, the corks may blow from the end of a tube, indicating the location of the leakage. If not, if will be necessary to make a very thorough test with the leak detector.
7. After the tubes have been corked for 12 to 24 hours, it is recommended that two people, working at both ends of the evaporator, carefully test each tube, – one person removing corks at one end and the other at the opposite end to remove corks and handle the leak detector. Start with the top row of tubes in the section being investigated. Remove the corks at the ends of one tube simultaneously and insert the exploring tube for 5 seconds – this should be long enough to draw into the detector any refrigerant gas that might have leaked through the tube walls. A fan placed at the end of the evaporator opposite the detector will assure that any leakage will travel through the tube to the detector.
8. Mark any leaking tubes for later identification.
9. If any of the tube sheet joints are leaking, the leak should be indicated by the detector. If a tube sheet leak is suspected, its exact location may be found by using a soap solution. A continuous buildup of bubbles around a tube indicates a tube sheet leak.

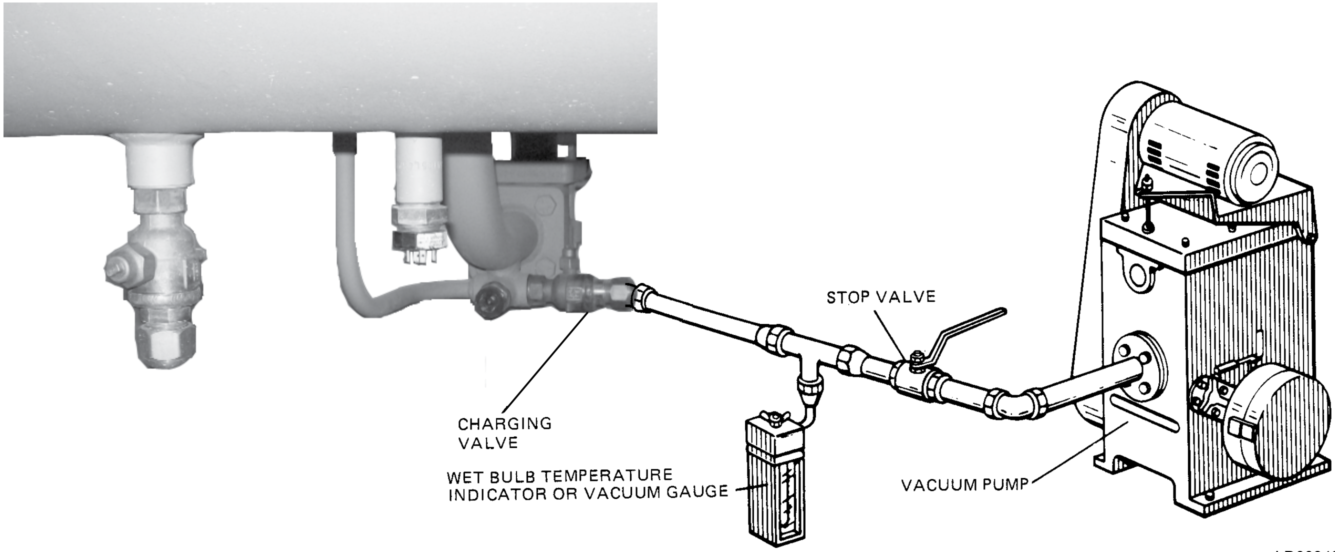


FIGURE 10 - EVACUATION OF CHILLER

CONDUCTING AN R-22 PRESSURE TEST

With the R-134a charge removed and all known leaks repaired, the system should be charged with a small amount of R-22 mixed with dry nitrogen so that a halide torch or electronic leak detector can be used to detect any leaks too small to be found by the soap test.

To test with R-22, proceed as follows:

1. With no pressure in the system, charge R-22 gas into the system through the charging valve to a pressure of 2 PSIG (14 kPa).
2. Build up the system pressure with dry nitrogen to approximately 75 to 100 PSIG (517 to 690 kPa). To be sure that the concentration of refrigerant has reached all parts of the system test for the presence of refrigerant with a leak detector at an appropriate service valve.
3. Test around each joint and factory weld. It is important that this test be thoroughly and carefully done, spending as much time as necessary and using a good leak detector.
4. To check for refrigerant leaks in the evaporator and condenser, open the vents in the evaporator and condenser heads and test for the presence of refrigerant. If no refrigerant is present, the tubes and tube sheets may be considered tight. If refrigerant is detected at the vents, the heads must be removed, the leak located (by means of soap test or leak detector) and repaired.

TABLE 1 - SYSTEM PRESSURES

*GAUGE	ABSOLUTE			BOILING TEMPERATURES OF WATER °F
INCHES OF MERCURY (HG) BELOW ONE STANDARD ATMOSPHERE	PSIA	MILLIMETERS OF MERCURY (HG)	MICRONS	
0"	14.6960	760.00	760,000	212
10.240"	9.6290	500.00	500,000	192
22.050"	3.8650	200.00	200,000	151
25.980"	1.9350	100.00	100,000	124
27.950"	0.9680	50.00	50,000	101
28.940"	0.4810	25.00	25,000	78
29.530"	0.1920	10.00	10,000	52
29.670"	0.1220	6.30	6,300	40
29.720"	0.0990	5.00	5,000	35 ← Water Freezes
29.842"	0.0390	2.00	2,000	15
29.882"	0.0190	1.00	1,000	1
29.901"	0.0100	0.50	500	–11
29.917"	0.0020	0.10	100	–38
29.919"	0.0010	0.05	50	–50
29.9206"	0.0002	0.01	10	–70
29.921"	0	0	0	

*One standard atmosphere = 14.696 PSIA
= 760 mm Hg. absolute pressure at 32°F
= 29.921 inches Hg. absolute at 32°F

NOTES: PSIA = Lbs. per sq. in. gauge pressure
= Pressure above atmosphere
PSIA = Lbs. per sq. in. absolute pressure
= Sum of gauge plus atmospheric pressure

VACUUM TESTING

After the pressure test has been completed, the vacuum test should be conducted as follows:

1. Connect a high capacity vacuum pump, with indicator, to the system charging valve as shown in *Figure 10 on Page 22* and start the pump. Refer to *Vacuum Dehydration* in this section.
2. Be sure all valves to the atmosphere are closed and then open wide all system valves.
3. Operate the vacuum pump in accordance with *Vacuum Dehydration* in this section until a wet bulb temperature of +32°F (0°C) or a pressure of 5 mm Hg is reached. Refer to *Table 1 on Page 23* for corresponding pressure values.
4. To improve evacuation circulate hot water, not to exceed 125°F (51.7ºC) through the evaporator and condenser tubes to thoroughly dehydrate the shells. If a source of hot water is not readily available, a portable water heater should be employed. DO NOT USE STEAM. Another suggested method is to connect a hose between the source of hot water under pressure and the evaporator head drain connection, out the evaporator vent connection, into the condenser head drain

and out the condenser vent. To avoid the possibility of causing leaks, the temperature should be brought up slowly so that the tubes and shell are heated evenly.

5. Close the system charging valve and the stop valve between the vacuum indicator and the vacuum pump. Then disconnect the vacuum pump leaving the vacuum indicator in place.
6. Hold the vacuum pressure obtained in *Step 3* in the system for 8 hours; the slightest rise in pressure indicates a leak or the presence of moisture, or both. If after 24 hours the wet bulb temperature in the vacuum indicator has not risen above 40°F (4.4°C) or a pressure of 6.3 mm Hg, the system may be considered tight.

NOTE

Be sure the vacuum indicator is valved off while holding the system vacuum and be sure to open the valve between the vacuum indicator and the system when checking the vacuum after the 8 hour period.

7. If the vacuum does not hold for 8 hours within the limits specified in *Step 6*, the leak must be found and repaired.

VACUUM DEHYDRATION

To obtain a sufficiently dry system, the following instructions have been assembled to provide an effective method for evacuating and dehydrating a system in the field. Although there are several methods of dehydrating a system, we are recommending the following, as it produces one of the best results, and affords a means of obtaining accurate readings as to the extent of dehydration.

The equipment required to follow this method of dehydration consists of

- a wet bulb indicator or vacuum gauge.
- a chart showing the relation between dew point temperature and pressure in inches of mercury (vacuum), (refer to *Table 1 on Page 23*).
- a vacuum pump capable of pumping a suitable vacuum on the system.

OPERATION

Dehydration of a refrigerant system can be obtained by this method because the water present in the system reacts similar to refrigerant. By pulling down the pressure in the system to a point where its saturation temperature is considerably below that of room temperature, heat will flow from the room through the walls of the system and vaporize the water, allowing a large percentage of it to be removed by the vacuum pump. The length of time necessary for the dehydration of a system is dependent on the size or volume of the system, the capacity and efficiency of the vacuum pump, the room temperature and the quantity of water present in the system. By using a vacuum indicator, the test tube will be evacuated to the same pressure as the system, and the distilled water will be maintained at the same saturation temperature as any free water in the system. This temperature can be observed on the thermometer.

If the system has been pressure tested and found to be tight prior to evacuation, then the saturation temperature recordings should follow a curve similar to the typical saturation curve shown in *Figure 11 on Page 24*.

The temperature of the water in the test tube will drop as the pressure decreases, until the boiling point is reached, at which point the temperature will level off and remain at this level until all of the water in the shell is vaporized. When this final vaporization has taken place, the pressure and temperature will continue to drop until eventually a temperature of 35°F (1.6°C) or a pressure of 5 mm Hg. is reached.

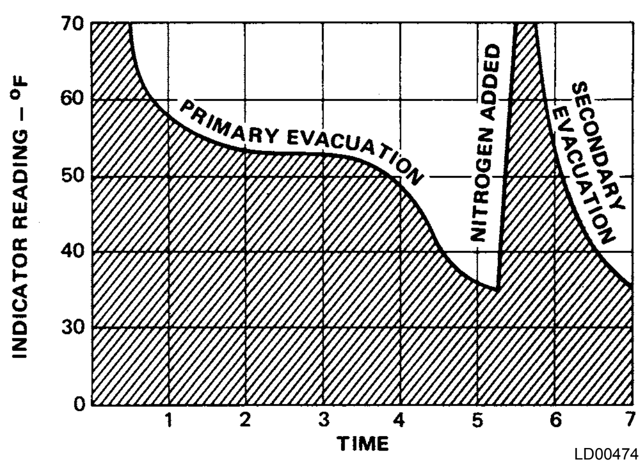


FIGURE 11 - SATURATION CURVE

When this point is reached, practically all of the air has been evacuated from the system, but there is still a small amount of moisture left. In order to provide a medium for carrying this residual moisture to the vacuum pump, nitrogen should be introduced into the system to bring it to atmospheric pressure and the indicator temperature will return to approximately ambient temperature. Close off the system again, and start the second evacuation.

The relatively small amount of moisture left will be carried out through the vacuum pump and the temperature or pressure shown by the indicator should drop uniformly until it reaches a temperature of 35°F (1.6°C) or a pressure of 5 mm Hg.

When the vacuum indicator registers this temperature or pressure, it is a positive sign that the system is evacuated and dehydrated to the recommended limit. If this level cannot be reached, it is evident that there is a leak somewhere in the system. Any leaks must be corrected before the indicator can be pulled down to 35°F (1.6°C) or 5 mm Hg. in the primary evacuation.

During the primary pulldown, carefully watch the wet bulb indicator temperature, and do not let it fall below 35°F (1.6°C). If the temperature is allowed to fall to 32°F (0°C), the water in the test tube will freeze, and the result will be a faulty temperature reading.

REFRIGERANT CHARGING

To avoid the possibility of freezing the liquid within the evaporator tubes when charging an evacuated system, only refrigerant vapor from the top of the drum or cylinder must be admitted to the system pressure. Continue charging vapor only into the system until the system pressure is raised above the point corresponding to the freezing point of the evaporator liquid. For water, the pressure corresponding to the freezing point is 29 PSIG (200 kPa) for R-134a (at sea level).

While charging, every precaution must be taken to prevent moisture laden air from entering the system. Fabricate a suitable charging connection from new copper tubing to fit between the system charging valve and the fitting on the charging drum. This connection should be as short as possible, but long enough to permit sufficient flexibility for changing drums. The charging connection should be purged each time a full container of refrigerant is connected. Changing containers should be done as quickly as possible to minimize the loss of refrigerant.

The weight of the refrigerant charged should be recorded after initial charging. Refrigerant may be furnished in cylinders containing either 30, 50, 125, 1,025 or 1750 lbs. (13.6, 22.6, 56.6, 464 or 794 kg) of refrigerant.

The refrigerant charge is specified for each chiller model in *Table 2 on Page 25*. Charge the correct amount of refrigerant and note the level in the evaporator sight glass.

Proper refrigerant charge trimming is accomplished while running at design full load. Ensure condenser and economizer level settings cover the condenser subcooler and maintain economizer liquid seal. Then trim charge for design evaporator approach (leaving chilled liquid temperature minus refrigerant temperature) and compressor discharge superheat.

TABLE 2 - REFRIGERANT CHARGE

<table>
<tr><th>COMPRESSOR</th><th>CONDENSER</th><th>EVAPORATOR</th><th>ESTIMATE REFRIGERANT CHARGE LBS (KGS) 1</th></tr>
<tr><td rowspan="6">K7 (YDHA119) and Q3 (HF416)</td><td rowspan="6">BB, BC, BD, B5, B6, B7, B8</td><td>BB</td><td>8300 (3765)</td></tr>
<tr><td>BC</td><td>7800 (3538)</td></tr>
<tr><td>BD</td><td>7320 (3320)</td></tr>
<tr><td>B6</td><td>8080 (3665)</td></tr>
<tr><td>B7</td><td>7800 (3538)</td></tr>
<tr><td>B8</td><td>7520 (3411)</td></tr>
</table>

1 Refrigerant charge quantity and weights will vary based on tube count.
* Refer to product drawings for detailed weight information.

HANDLING REFRIGERANT FOR DISMANTLING AND REPAIRS

If it becomes necessary to open any part of the refrigerant system for repairs, it will be necessary to remove the charge before opening any part of the unit. If the chiller is equipped with optional valves, the refrigerant can be isolated in either the condenser or the evaporator / compressor while making any necessary repairs.

MEGGING THE MOTOR

While the compressor motor leads are lifted at the lugs in the drive, meg the motor as follows:

1. Using a megohm meter (megger), meg between phases and each phase to ground (refer to *Figure 12 on Page 26*). These readings can be interpreted using the graph shown in *Figure 13 on Page 27*.
2. If readings fall below the shaded area, remove external leads from motor and repeat the test.

CAUTION

The motor is to be megged with the starter at ambient temperature after 24 hours of idle standby with no water flow through the unit.

The unit must be at positive pressure (no vacuum) during the megging procedure.

CONDENSERS AND EVAPORATORS

Maintenance of condenser and evaporator shells is important to provide trouble free operation of the chiller. The water side of the tubes in the shell must be kept clean and free from scale. Proper maintenance such as tube cleaning, and testing for leaks, is covered on the following pages.

Chemical Water Treatment

The mineral content of the water circulated through evaporators and condensers varies with almost every source of supply. Water containing excess amounts of minerals may corrode the tubes or deposit heat resistant scale in them. Reliable water treatment companies are available in most larger cities to supply a water treating process which will greatly reduce the corrosive and scale forming properties of almost any type of water.

As a preventive measure against scale and corrosion, and to prolong the life of evaporator and condenser tubes, a chemical analysis of the water should be made preferably before the system is installed. A reliable water treatment company can be consulted to determine whether water treatment is necessary, and if so, to furnish the proper treatment for the particular water condition.

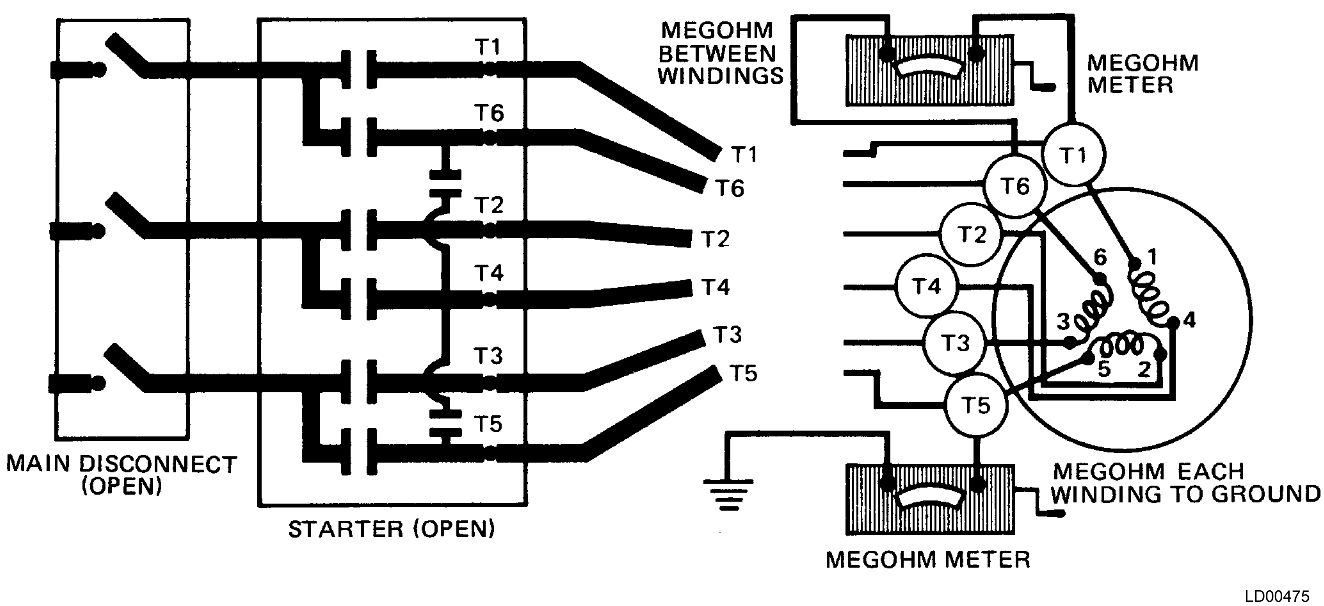


FIGURE 12 - MEGGING MOTOR WINDINGS

Minimum Insulation Resistance vs. Temperature (per IEEE Std 43) Hermetic Motors

1. Megger readings should be taken after Megger voltage has been applied one minute.
2. If insulation resistance lies to the right of the applicable curve the motor is acceptable for use.
3. If insulation resistance lies to the left of the applicable curve, the motor should not be run. The motor should be heated to 250° F in an effort to remove moisture and obtain an acceptable reading at room ambient temperature. This can be done either by baking in a forced hot air oven or, if proper voltage is available, apply 5 - 10% of rated voltage to motor windings.
4. Any gradual or abrupt decrease in Megger readings over an extended period of time is an indication of deterioration of insulation and/or moisture absorption or oil/dirt contamination.
5. Megger readings of individual phase coils of 200 - 600V motors should be made with coils not under test being grounded.
6. Motor is to be megged with the starter at ambient temperature after 24 hours of idle standby with no water flow thru unit. Unit must be at positive pressure (no vacuum) during the megging procedure.

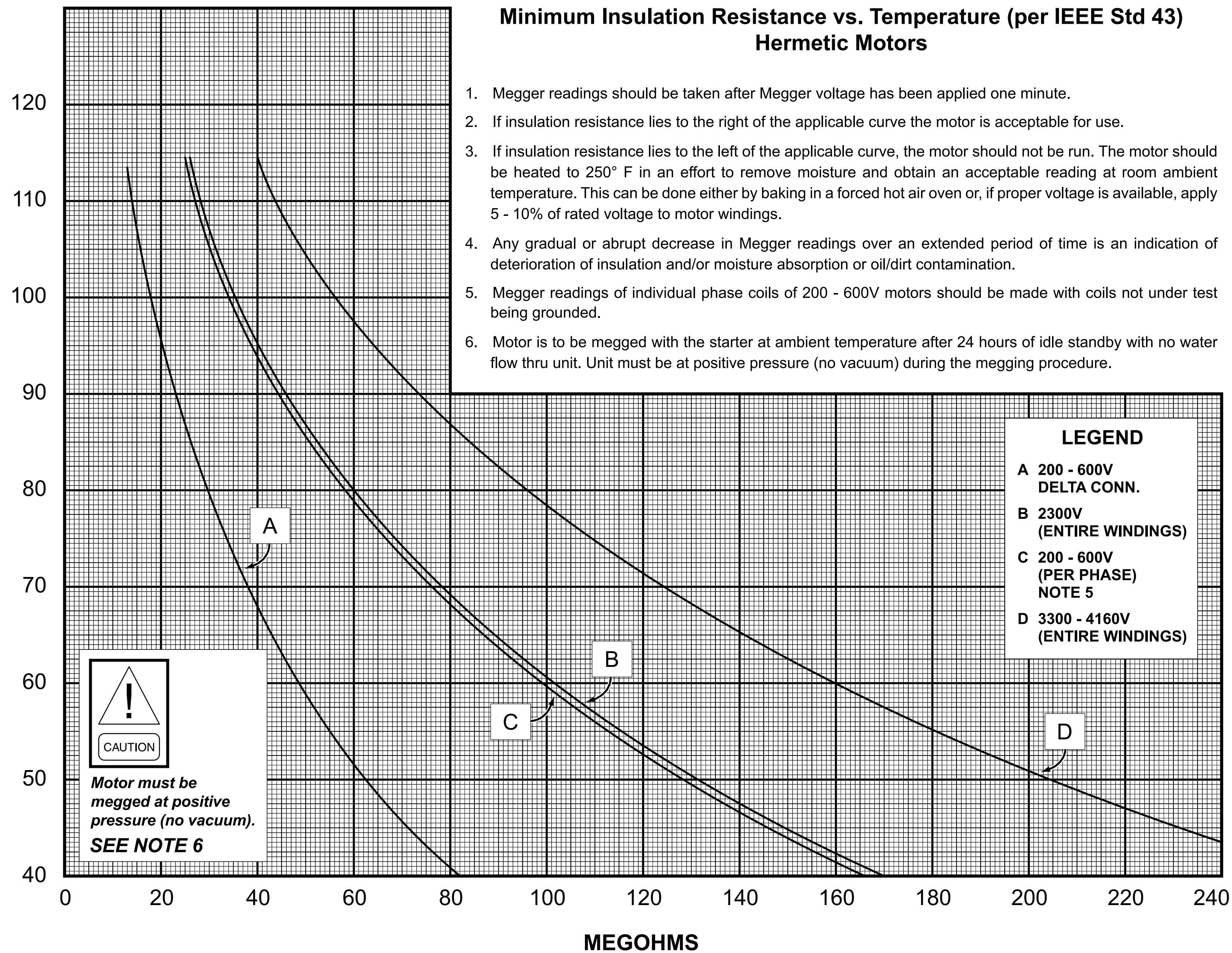


FIGURE 13 - MOTOR STARTER TEMPERATURE AND INSULATION RESISTANCES

Cleaning Evaporator and Condenser Tubes

Evaporator

It is difficult to determine by any particular test whether possible lack of performance of the water evaporator is due to fouled tubes alone or due to a combination of other issues. Trouble which may be due to fouled tubes is indicated when, over a period of time, the cooling capacity decreases and the approach (temperature difference between water leaving the evaporator and the refrigerant temperature in the evaporator) increases. A gradual drop-off in cooling capacity can also be caused by a gradual leak of refrigerant from the system or by a combination of fouled tubes and shortage of refrigerant charge.

Condenser

In a condenser, trouble due to fouled tubes is usually indicated by a steady rise in head pressure, over a period of time, accompanied by a steady rise in condensing temperature, and noisy operation. These symptoms rarely may also be due to improper evacuation before charging refrigerant during system breach.

Tube Fouling

Fouling of the tubes can be due to deposits of two types as follows:

1. Rust or sludge – which finds its way into the tubes and accumulates there. This material usually does not build up on the inner tube surfaces as scale, but does interfere with the heat transfer. Rust or sludge can generally be removed from the tubes by a thorough brushing process.
2. Scale – due to mineral deposits. These deposits, even though very thin and scarcely detectable upon physical inspection, are highly resistant to heat transfer. They can be removed most effectively by circulating an acid solution through the tubes.

Tube Cleaning Procedures

Brush Cleaning of Tubes

If the tube fouling consists of dirt and sludge, it can usually be removed by means of the brushing process. Drain the water sides of the circuit to be cleaned (cooling water or chilled water) remove the heads and thoroughly clean each tube with a soft bristle bronze or nylon brush. DO NOT USE A STEEL BRISTLE BRUSH. A steel brush may damage the tubes.

Improved results can be obtained by admitting water into the tube during the cleaning process. This can be done by mounting the brush on a suitable length of 1/8" pipe with a few small holes at the brush end and connecting the other end by means of a hose to the water supply.

Acid Cleaning of Tubes

Tubes that are fouled with a hard scale deposit, may require acid cleaning. The tubes should always be brush cleaned before acid cleaning. If the relatively loose foreign material is removed before the acid cleaning, the acid solution will have less material to dissolve and flush from the tubes resulting in a better cleaning job.

WARNING

Acid cleaning should only be performed by an expert. Please consult your local water treatment representative for assistance in removing scale buildup and preventative maintenance programs to eliminate future problems.

Commercial Acid Cleaning

In many major cities, commercial organizations now offer a specialized service of acid cleaning evaporators and condensers. If acid cleaning is required, Johnson Controls recommends the use of this type of organization. The Dow Industries Service Division of the Dow Chemical Company, Tulsa, Oklahoma, with branches in principal cities is one of the most reliable of these companies.

COMPRESSORS

Maintenance for the compressor assembly consists of the following checks:

- checking the operation of the oil return system and changing the dehydrator
- checking and changing the oil
- checking and changing the oil filters
- checking the operation of the oil heater
- checking the operation of the oil pump
- observing the operation of the compressor.

Internal wearing of compressor parts could be caused by improper lubrication, brought about by restricted oil lines, passages, or dirty oil filters. If the unit is shutting down on High Oil Temperature (HOT) or Low Oil Pressure (LOP), change the oil filter element. Examine the oil filter element for the presence of aluminum particles. Aluminum gas seal rings can contact the impeller and account for some aluminum particles accumulating in the oil filter, especially during the initial start up and first several months of operation. However, if aluminum particles continue to accumulate and the same conditions continue to stop the unit operation after a new filter is installed, notify the nearest Johnson Controls office to request a Johnson Controls Service Technician.

ELECTRICAL CONTROLS

For information covering the YKEP Control Center operation, refer to the *YKEP Control Center Operations Manual (Form 160.77-O2)*.Preventative Maintenance

It is the responsibility of the owner to provide the necessary daily, monthly and yearly maintenance requirements of the system.

NOTE

If a unit failure occurs due to improper maintenance during the warranty period; Johnson Controls will not be liable for costs incurred to return the system to satisfactory operation.

In any operating system it is most important to provide a planned maintenance and inspection of functioning parts to keep the unit operating at its peak efficiency. Therefore, the following maintenance should be performed as prescribed in *Table 3 on Page 31*.

COMPRESSOR MOTORS

1. Check mounting screws and piping joint nuts frequently to insure tightness.
2. Meg motor windings annually to check for deterioration of windings.

LEAK TESTING

The unit should be leak tested monthly. Any leaks found must be repaired immediately.

EVAPORATOR AND CONDENSER

The major portion of maintenance on the condenser and evaporator will deal with maintaining the water side of the condenser and evaporator in a clean condition.

The use of untreated water in cooling towers, closed water systems, etc. frequently results in one or more of the following:

- Scale Formation.
- Corrosion or Rusting.
- Slime and Algae Formation.

Therefore, proper water treatment is essential to provide for longer and more economical life of the equipment. The following recommendations should be followed in determining the condition of the water side of the condenser and evaporator tubes.

1. The condenser tubes should be cleaned annually or earlier if conditions warrant. If the temperature difference between the water off the condenser and the condenser liquid refrigerant temperature is more than 4°F (2°C) greater than the difference recorded on a new unit, it is a good indication that the condenser tubes require cleaning. Refer to *Cleaning Evaporator and Condenser Tubes on Page 28* in this section for condenser tube cleaning instructions.
2. The evaporator tubes under normal circumstances will not require cleaning. If the temperature difference between the refrigerant and the chilled water increases slowly over the operating season, it is an indication that the evaporator tubes may be fouling or that there may be a water bypass in the water box requiring gasket replacement or refrigerant may have leaked from the chiller.

OIL RETURN SYSTEM

1. Change the dehydrator in the oil return system semi-annually or earlier if the oil return system fails to operate.
2. When the dehydrator is changed, use care that any foreign particles that may obstruct the eductor orifices are removed.

ELECTRICAL CONTROLS

1. All electrical controls should be inspected for obvious malfunctions.
2. It is important that the factory control settings (operation and safety) not be changed. If the settings are changed without Johnson Controls approval, the warranty may be voided.

YORK BY JOHNSON CONTROLS

MAINTENANCE REQUIREMENTS FOR YORK YKEP CHILLERS

PROCEDURE	DAILY	WEEKLY	MONTHLY	YEARLY	OTHER
Record operating conditions (on applicable Log Form)	X				
Check oil levels	X				
Check refrigerant levels		X			
Check oil return system operation			X		
Check operation of motor starter			X		
Check sump heater and thermostat operation			X		
Check three-phase voltage and current balance			X		
Verify proper setting of safety controls[1]			X		
Verify condenser and evaporator water flows			X		
Leak check and repair leaks as needed[1]			X		
Check and tighten all electrical connections				X	
Megohm motor windings				X	
Replace oil filter and oil return filter/driers				X	
Clean or backflush heat exchanger (VSD, SSS Applications)				X	
Replace starter coolant (VSD, SSS Applications)				X	
Replace or clean starter air filters if applicable				X[2]	
Perform oil analysis on compressor lube oil[1]				X	
Perform refrigeration analysis[1]				X	
Perform vibration analysis				X	
Clean tubes				X[2]	
Perform Eddy current testing and inspect tubes					2 - 5 Years
Lubricate motor	Refer to motor manufacturer's recommendations				

For operating and maintenance requirements listed above, refer to appropriate service literature, or contact your local Johnson Controls Service Office. A record of all procedures being successfully carried out (as well as operating logs) must be maintained on file by the equipment owner should proof of adequate maintenance be required at a later date for warrenty validation purposes.

[1] This procedure must be performed at the specified time interval by an Industry Certified Technician who has been trained and qualified to work on this type of YORK equipment.

[2] More frequent service may be required depending on local operating conditions.

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SECTION 4 - TROUBLESHOOTING

If the system is malfunctioning in any manner, refer to the Operation Analywsis Chart shown in *Table 4*. After consulting these references, if you are unable to make the proper repairs or adjustments to start the compressor or the particular trouble continues to hinder the performance of the unit, please call the nearest Johnson Controls District Office. Failure to report constant troubles could damage the unit and increase the cost of repairs. If the system shuts down on a safety fault, refer to the control panel operating manual Form 160.77-O2 or contact JCI Service.

TABLE 3 - OPERATION ANALYSIS CHART

SYMPTOM	RESULTS	POSSIBLE CAUSE	REMEDY
Abnormally High Discharge Pressure	Temperature difference between condensing temperature and water off condenser higher than normal.	Air in condenser.	
		Condenser tubes dirty or scaled	Clean condenser tubes. Check water conditioning.
	High discharge pressure.	High condenser water temperature.	Reduce condenser water inlet temperature. (Check cooling tower and water circulation.)
	Temperature difference between condenser water on and water off higher than normal, with normal evaporator pressure.	Insufficient condensing water flow.	Increase the quantity of water through the condenser to proper value.
Abnormally Low Suction Pressure	Temperature difference between leaving chilled water and refrigerant in evaporator greater than normal with high discharge temperature.	Insufficient charge of refrigerant.	Check for leaks and charge refrigerant into system.
		Variable orifice problem.	Remove obstruction.
	Temperature difference between leaving chilled water and refrigerant in the evaporator greater than normal with normal discharge temperature.	Evaporator tubes dirty or restricted.	Clean evaporator tubes.
	Temperature of chilled water too low with low motor amperes.	Insufficient load for system capacity.	Check prerotation vane motor operation and setting of controls.
High Evaporator Pressure	High chilled water temperature.	Prerotation vanes fail to open.	Check the prerotation vane motor positioning circuit.
		System overload.	Be sure the vanes are wide open (without overloading the motor) until the load decreases.
No Oil Pressure When System Start Button Pushed	Low oil pressure displayed on control center; compressor will not start.	Oil pump running in wrong direction.	Check rotation of oil pump (Electrical Connections).
		Oil pump not running.	Troubleshoot electrical problem with oil pump VSD.
Unusually High Oil Pressure Develops When Oil Pump Runs	Unusually high oil pressure is displayed when the oil pressure display key is pressed when the oil pump is running.	High oil pressure. Transducer defective.	Replace low or high oil pressure transducer.

TABLE 3 - OPERATION ANALYSIS CHART (CONT'D)

Oil Pump Vibrates Or Is Noisy	Oil pump vibrates or is extremely noisy with some oil pressure when pressing OIL PRESSURE display key. NOTE: ***When oil pump is run without an oil supply it will vibrate and become extremely noisy.***	Oil not reaching pump suction inlet in sufficient quantity.	Check oil level.
		Worn or failed oil pump.	Repair/Replace oil pump.
Reduced Oil Pump Capacity	Oil pump pumping capacity.	Excessive end clearance pump. Other worn pump parts.	Inspect and replace worn parts.
		Partially blocked oil supply inlet.	Check oil inlet for blockage.
Symptom: Oil Pressure Gradually Decreases (Noted by Observation of Daily Log Sheets)	When oil pump VSD frequency increases to 55 + hz to maintain target oil pressure.	Oil filter is dirty.	Change oil filter.
Symptom: Oil Return System Ceases To Return An Oil/Refrigerant Sample	Oil refrigerant return not functioning.	Filter-drier in oil return system dirty.	Replace old filter-drier with new.
		Jet or orifice of oil return jet clogged.	Remove jet, inspect for dirt. Remove dirt using solvent and replace.
Symptom: Oil Pump Fails To Deliver Oil Pressure	No oil pressure registers when pressing OIL PRESSURE display key when oil pump runs.	Faulty oil pressure transducer. Faulty wiring/connectors.	Replace oil pressure transducer.

SI METRIC CONVERSION

The following factors can be used to convert from English to the most common SI Metric values.

TABLE 4 - ANALOG INPUT RANGES (LOW PRESSURE CHILLERS)

MEASUREMENT	MULTIPLY ENGLISH UNIT	BY FACTOR	TO OBTAIN METRIC UNIT
Capacity	Tons Refrigerant Effect (ton)	3.516	Kilowatts (kW)
Power	Horsepower	0.7457	Kilowatts (kW)
Flow Rate	Gallons / Minute (gpm)	0.0631	Liters / Second (l/s)
Length	Feet (ft)	304.8	Meters (m)
	Inches (in)	25.4	Millimeters (mm)
Weight	Pounds (lbs)	0.4538	Kilograms (kg)
Velocity	Feet / Second (fps)	0.3048	Meters / Second (m/s)
Pressure Drop	Feet of Water (ft)	2.989	Kilopascals (kPa)
	Pounds / Square Inch (psi)	6.895	Kilopascals (kPa)

TEMPERATURE

To convert degrees Fahrenheit (°F) to degrees Celsius (°C), subtract 32° and multiply by 5/9 or 0.5556.

Example: (45.0°F - 32°) x 0.5556 = 27.2°C

To convert a temperature range (i.e., a range of 10°F) from Fahrenheit to Celsius, multiply by 5/9 or 0.5556.

Example: 10.0°F range x 0.5556 = 5.6 °C range

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