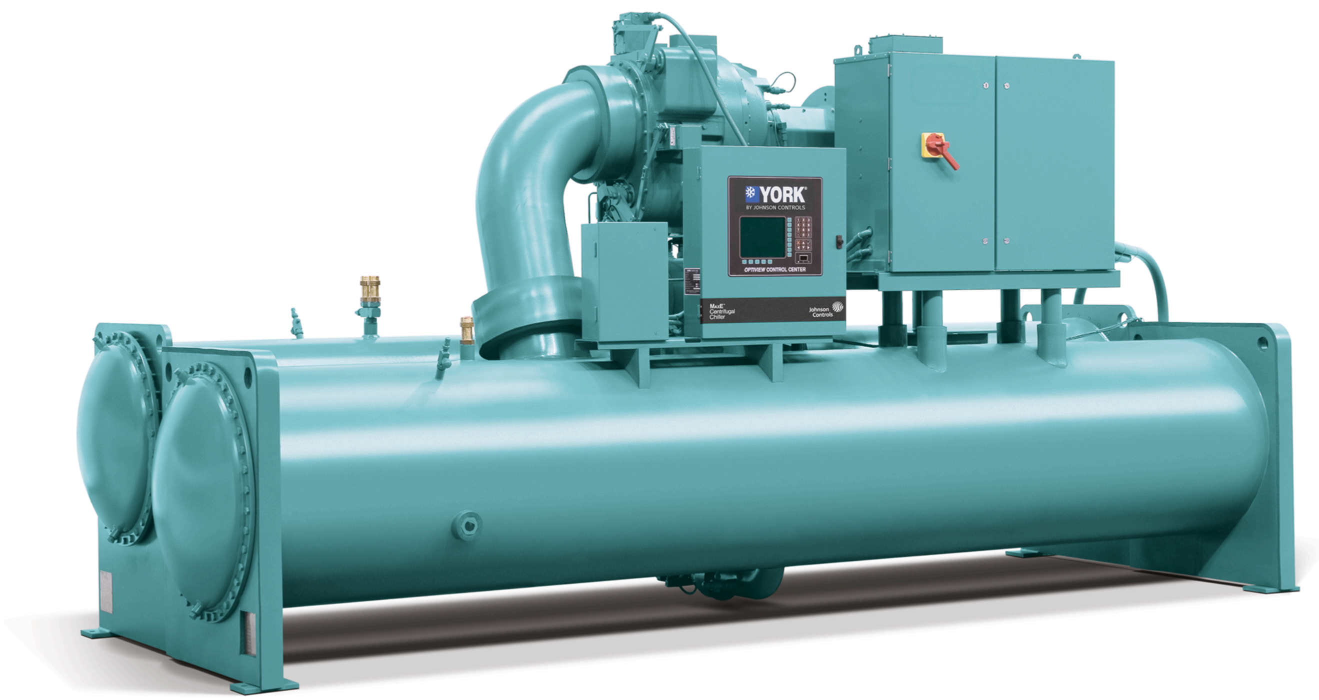
Model YK Style G, with R-134a, R-513A, or R-1234ze

With OptiView Control Center for Electromechanical Starter, Solid State Starter, and Variable Speed Drive



Operations and Maintenance

Issue Date: 2024-04-17

Form Number: 160.75-O1 (424)

Supersedes: 160.75-O1 (324)

Johnson Controls

Contents

General safety guidelines

Important: Read before proceeding.

This equipment is a relatively complicated apparatus. During rigging, installation, operation, maintenance, or service, individuals might be exposed to certain components or conditions including, but not limited to: heavy objects, refrigerants, materials under pressure, rotating components, and both high and low voltage. Each of these items has the potential, if misused or handled incorrectly, to cause bodily injury or death. It is the obligation and responsibility of rigging, installation, and operating and 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 rigging, installation, operating, and service personnel. It is expected that these individuals possess independent training that will enable them to perform their assigned tasks correctly and safely. It is essential that, before performing any task on this equipment, this individual must read and understand the on-product labels, this document and any referenced materials. This individual must also be familiar with and comply with all applicable industry and governmental standards and regulations relating to the task in question.

Safety symbols

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

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

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

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

Note: Highlights additional information useful to the technician in completing the work being performed correctly.

Wiring warning

WARNING

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

Refrigerant warning

WARNING

Working with chiller vessels which are designed to contain contents under pressure must only be conducted by fully qualified technicians who have been certified in accordance with EPA Section 608 of the Clean Air Act requirements for the US or equivalently the Federal Halocarbon Regulations and the Refrigerant Code of Practice for Canada. This equipment is only intended for installation in locations that are not accessible to the general public. Further, this equipment is not intended for use by persons (including children) with reduced physical, sensory or mental capabilities, or lack of experience and knowledge. Refrigerant R-1234ze is classified as an A2L refrigerant and must be handled in accordance with all governing regulations. Failure to meet this requirement can result in damage to equipment, release of refrigerant into the environment, contamination of the operating space for the equipment and pose a risk of personal injury or death. It is the responsibility of any service technician or operator to adhere to these requirements. See *160.00-AD10* for greater details regarding the application and use of A2L refrigerants.

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 or product owner. Updated manuals, if applicable, can be obtained by contacting the nearest Johnson Controls Service office or accessing the Johnson Controls Knowledge Exchange website at https://docs.johnsoncontrols.com/chillers/.

It is the responsibility of rigging, lifting, and operating and service personnel to verify the applicability of these documents to the equipment. If there is any question regarding the applicability of these documents, rigging, lifting, and operating and service personnel should verify whether the equipment has been modified and if current literature is available from the owner of the equipment before performing any work on the chiller.

Revision notes

Revisions made to this document are indicated in the following table. These revisions are to technical information, and any other changes in spelling, grammar, or formatting are not included.

Table 1: Revision notes

Affected pages	Description
8	*Form 50.40-O1* added to associated literature table (Table 2).
18	Updated Monthly inspections and Annual inspections, more often if necessary.
27	Added reference to *Form 50.40-O1* to Oil charge to replace previous oil application table.
49	Updated oil charging information in the Compressor section.
51–52	Updated Table 11, Maintenance requirements.

Associated literature

Table 2: Associated literature

Manual description	Form number
Operation – Variable Speed Drive – TM Model	160.00-O1
Operation and Maintenance – Solid State Starter (Mod B)	160.00-O2
Operation – Variable Speed Drive – VSD and LVD Model	160.00-O4
Floor Mounted MV SSS – Operation	160.00-O5
Unit Mounted MV SSS – Operation	160.00-O7
Operation – Variable Sped Drive – HYP Model	160.00-O10
Installation – Unit	160.75-N1
OptiView Control Center – Operation and Maintenance	160.54-O1
Wiring Diagram – Field Connections for YK Chiller (Style G) OptiView Control Center with Remote Low or Medium Voltage EMS or Unit Mounted Low or Medium Voltage SSS	160.75-PW1
Wiring Diagram – Field Connections for YK Chiller (Style G) OptiView Control Center with Remote Medium Voltage SSS	160.75-PW2
Wiring Diagram – Field Connections for YK Chiller (Style G) OptiView Control Center with Remote Medium Voltage VSD	160.75-PW3
Wiring Diagram – Field Control Modifications for YK Chiller (Style G)	160.75-PW4
Wiring Diagram – YK Chiller (Style G) OptiView Control Center with Remote Low or Medium Voltage EMS	160.75-PW5
Wiring Diagram – YK Chiller (Style G) OptiView Control Center with Unit Mounted Low or Medium Voltage SSS, Unit Mounted Low Voltage VSD with Modbus, or Remote Medium Voltage VSD	160.75-PW6
Wiring Diagram – YK Chiller (Style G) OptiView Control Center with LTC I/O Board with Remote Low or Medium Voltage EMS	160.75-PW7
Wiring Diagram – YK Chiller (Style G) OptiView Control Center with LTC I/O Board with Unit Mounted Low or Medium Voltage SSS, Unit Mounted Low Voltage VSD with Modbus or Remote Medium Voltage VSD	160.75-PW8
Renewal Parts – Unit	160.75-RP1
Renewal Parts – OptiView Control Center	160.54-RP1
YK Chiller Maintenance Requirements Chiller Log Sheet	160.54-MR1
Application Data - A2L Refrigerant Supplement for Johnson Controls Chillers	160.00-AD10

Table 2: Associated literature

Manual description	Form number
YORK Oil Application, Oil Change Interval and Oil Quality Limits Recommendations	50.40-O1
YK Centrifugal Liquid Chillers YORK Proactive Service Guide	160.76-PSG1

Conditioned based maintenance

Traditional chiller maintenance is based upon assumed and generalized conditions. In lieu of the traditional maintenance program, a Johnson Controls YORK conditioned based maintenance (CBM) program can be substituted. This CBM service plan is built around the specific needs for the chiller, operating conditions, and annualized impact realized by the chiller. Your local Johnson Controls Branch can propose a customized Planned Service Agreement that leverages real time and historical data, delivering performance reporting, corrective actions required and data enabled guidance for optimal operation and lifecycle assurance. The program will include fault detection diagnostics, operation code statistics, performance based algorithms and advance rules based rationale delivered by the Johnson Controls Connected Equipment Portal.

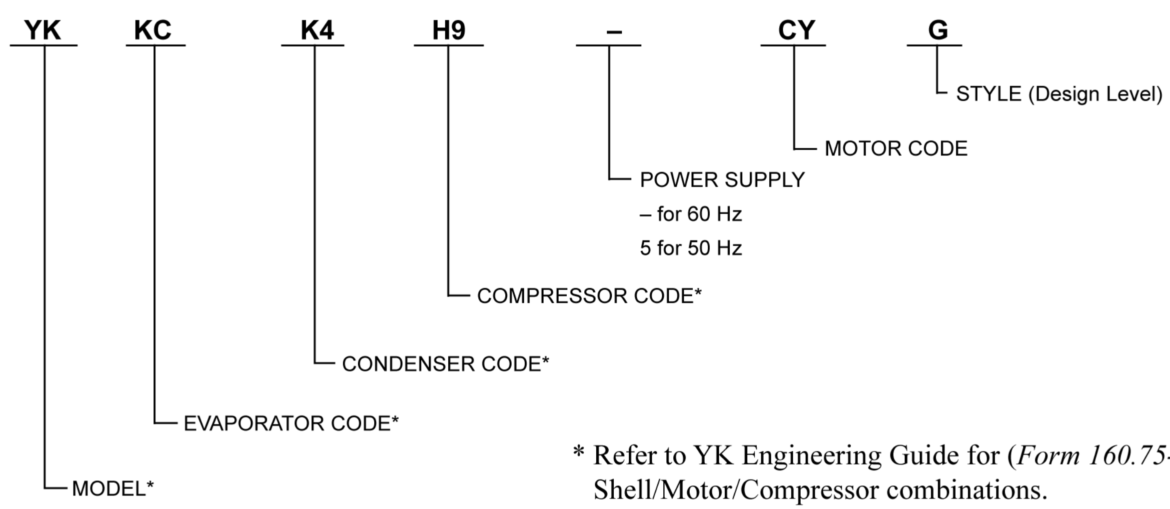
Proactive services

Throughout the life of your chiller you can take proactive measures to help prevent breakdowns and keep your unit in peak condition to prolong its lifespan. Proactive services are a smart addition to your chiller care program, and supplement existing maintenance.

Time-based proactive services

A variety of factors, including unstable power, extreme ambient conditions, and chilled water system issues can contribute to increased wear on certain unit components. To help ensure the system remains reliable, you can replace these components at set intervals before significant wear occurs. For detailed information on the specific time-based proactive services, along with other proactive services, refer to *YK Centrifugal Liquid Chillers YORK Proactive Service Guide (Form 160.76-PSG1)*.

Nomenclature



* Refer to YK Engineering Guide for (*Form 160.75-EG1*) Shell/Motor/Compressor combinations.

Description of system and fundamentals of operation

System operation description

The YORK Model YK Chiller is commonly applied to large air conditioning systems, but can be used on other applications. The chiller consists of an open motor mounted to a compressor with integral speed increasing gears, condenser, evaporator and variable flow control.

The chiller is controlled by a modern state-of-the-art microcomputer control center that monitors its operation. The Control Center is programmed by the operator to suit job specifications. Automatic timed start-ups and shutdowns are also programmable to suit nighttime, weekends, and holidays. The operating status, temperatures, pressures, and other information pertinent to operation of the chiller are automatically displayed and read on a graphic display. Other displays can be observed by pressing the keys as labeled on the Control Center. The chiller with the OptiView™ Control Center is compatible with an electromechanical starter, an optional YORK Solid State Starter, or an optional variable speed drive (VSD).

In operation, a liquid (water or brine to be chilled) flows through the evaporator, where boiling refrigerant absorbs heat from the liquid. The chilled liquid is then piped to fan coil units or other air conditioning terminal units, where it flows through finned coils, absorbing heat from the air. The warmed liquid is then returned to the chiller to complete the chilled liquid circuit.

Figure 1: Model YK chiller

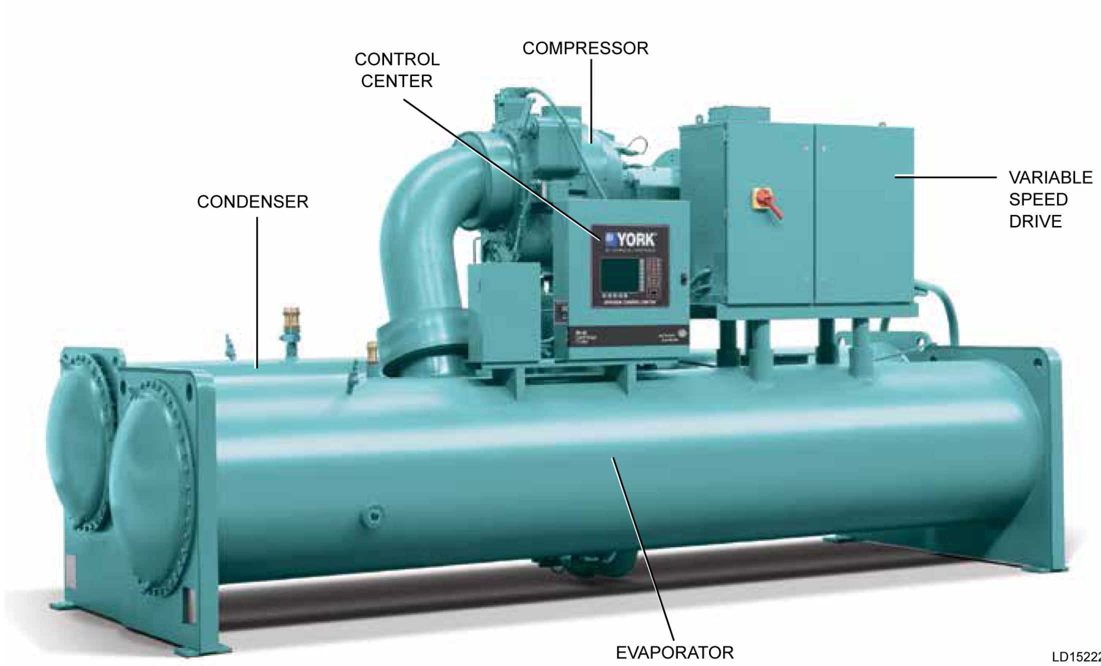
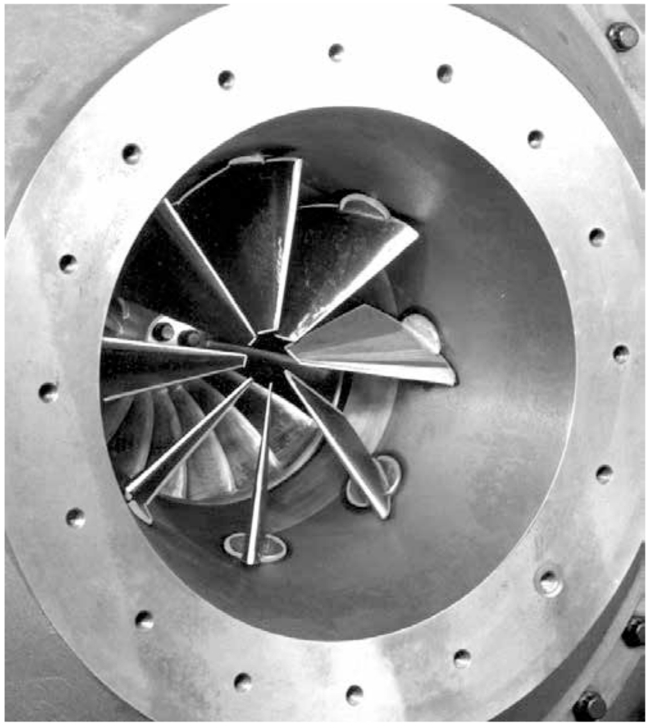


Figure 2: Compressor pre-rotation vanes



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The refrigerant vapor, which is produced by the boiling action in the evaporator, flows to the compressor where the rotating impeller increases its pressure and temperature and discharges it into the condenser. Water flowing through the condenser tubes absorbs heat from the refrigerant vapor, causing it to condense. The condenser water is supplied to the chiller from an external source, usually a cooling tower. The condensed refrigerant drains from the condenser into the liquid return line, where the variable orifice meters the flow of liquid refrigerant to the evaporator to complete the refrigerant circuit.

The major components of a chiller are selected to handle the refrigerant, which is evaporated at full load design conditions. However, most systems are called upon to deliver full load capacity for only a relatively small part of the time the unit is in operation.

Capacity control

The major components of a chiller are selected for full load capacities, so capacity must be controlled to maintain a constant chilled liquid temperature leaving the evaporator. Pre-rotation vanes (PRV), located at the entrance to the compressor impeller, compensate for variation in load. See Figure 2.

The position of these vanes is automatically controlled through a lever arm attached to an electric motor located outside the compressor housing. The automatic adjustment of the vane position in effect provides the performance of many different compressors to match various load conditions from full load with vanes wide open to minimum load with vanes completely closed.

Figure 3: Refrigerant flow-through chiller (falling film evaporator)

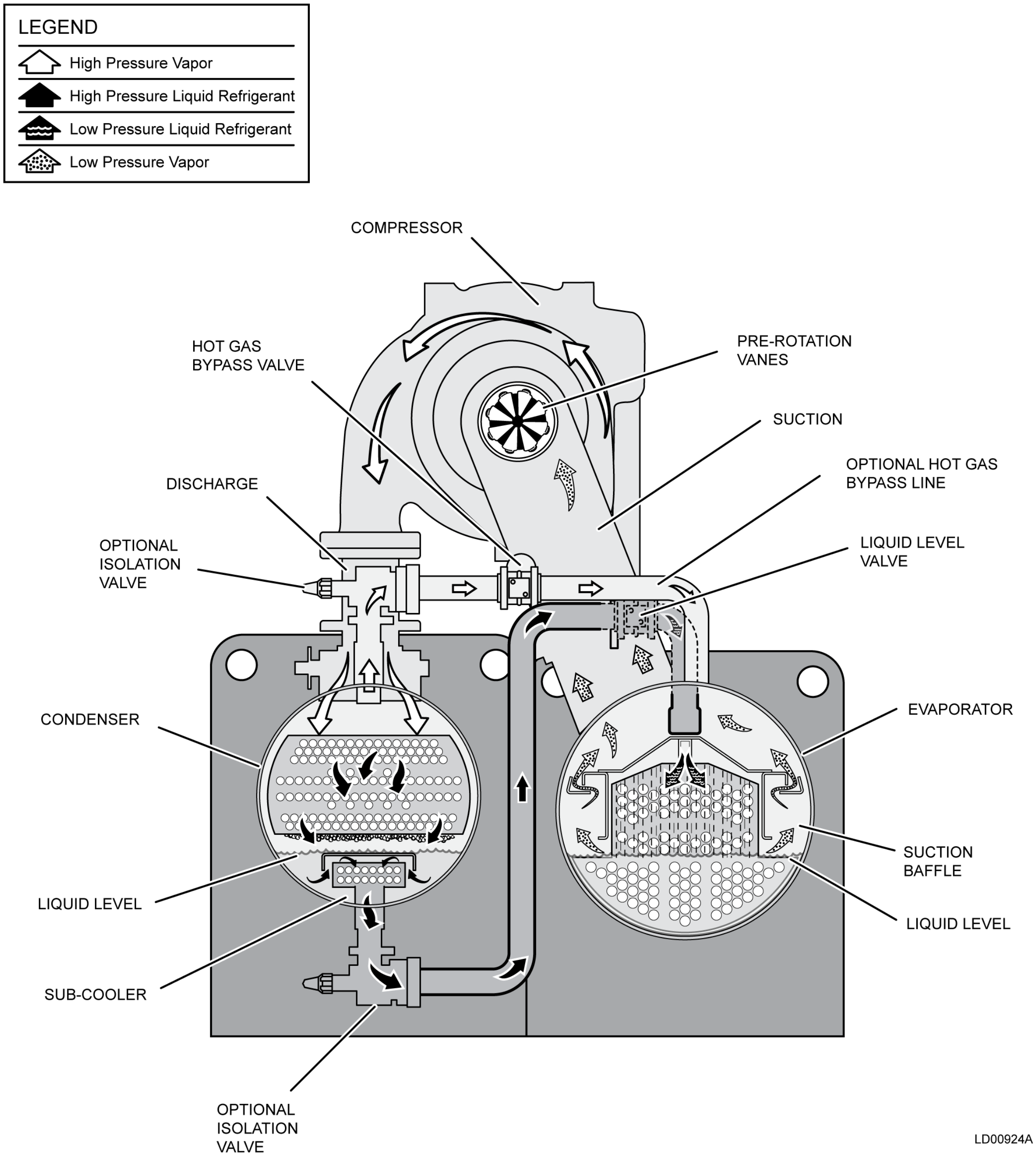
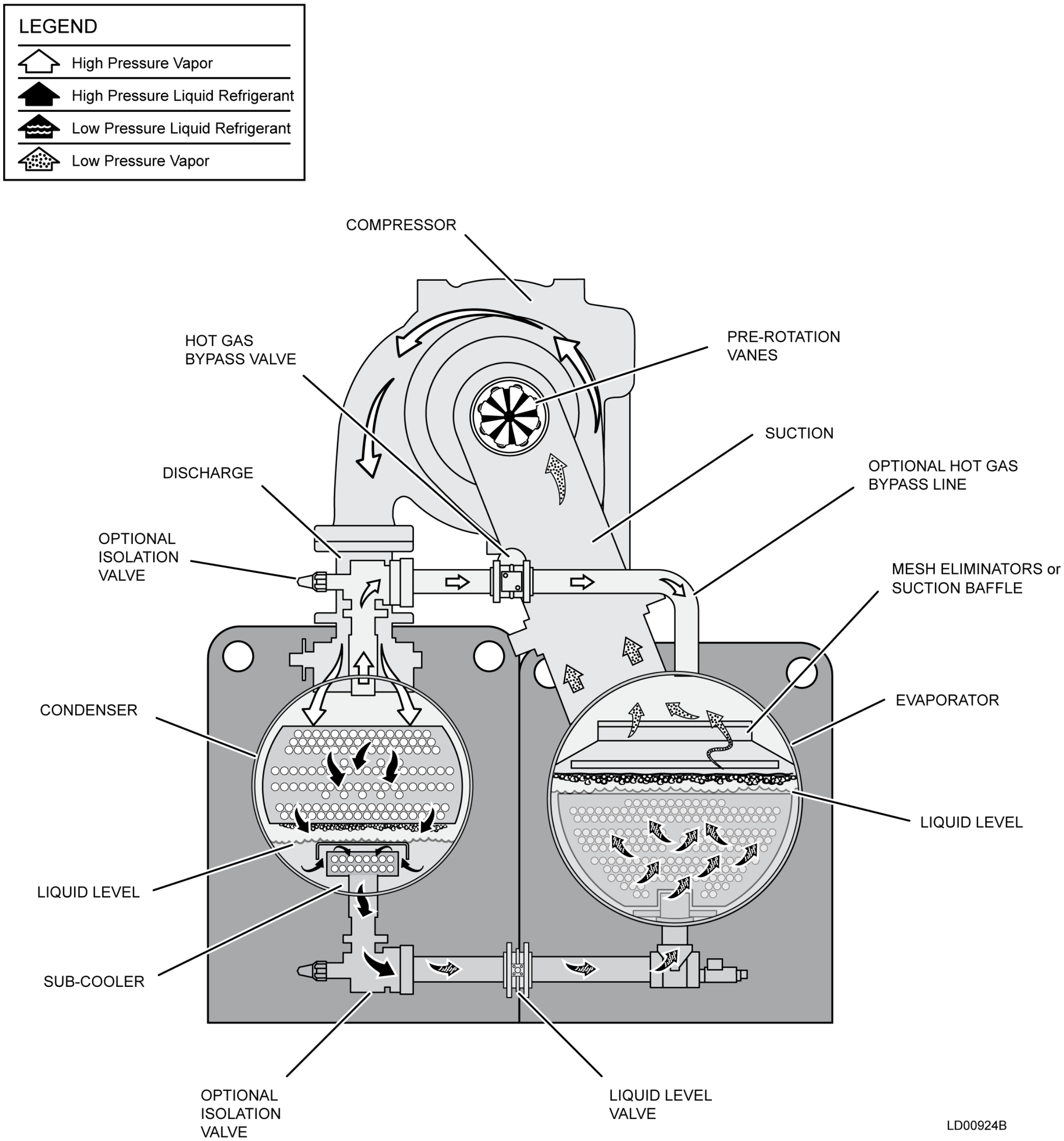


Figure 4: Refrigerant flow-through chiller (flooded evaporator)



System operating procedures

Oil heaters

If the oil heater is de-energized during a shutdown period, it must be energized for 12 hours before starting the compressor, or remove all the oil and recharge the compressor with new oil. See Charging the oil.

Oil heater operation

The oil heater operation is controlled by the OptiView Control Center. The heater is turned on and off to maintain the oil temperature differential to a value that is 50°F (10°C) above the condenser saturation temperature. This target value is maintained by the control panel.

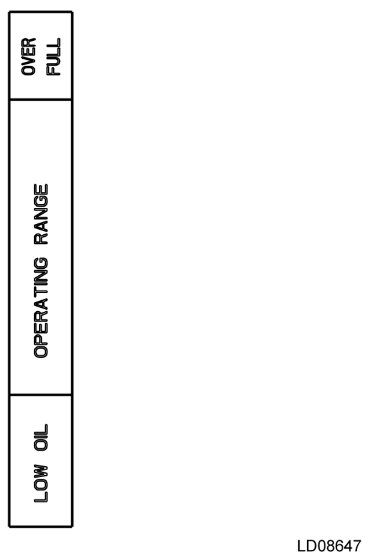
If the target value is greater than 160°F (71°C), the target defaults to 160°F (71°C). If the target value is less than 110°F (43.3°C), it defaults to 110°F (43.3°C).

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

Correct operating oil level: During operation, the oil level falls to the OPERATING RANGE identified on the vertical oil level indicator label. See Figure 5.

Figure 5: Oil level indicator



- If the oil level during operation is in the OVER FULL region of the oil level indicator, remove oil from the oil reservoir. This reduces the oil level to the OPERATING RANGE.
- If the oil level during operation is in the LOW OIL region of the oil level indicator, add oil to the oil reservoir. See Charging the oil.

CAUTION

Comply with EPA and local regulations when removing or disposing of refrigeration system oil.

Start-up procedure

Pre-starting

Before starting the chiller, observe the *OptiView™ Control Center – Operation and Maintenance (Form 160.54-O1).* Ensure that the display reads `SYSTEM READY TO START`.

CAUTION

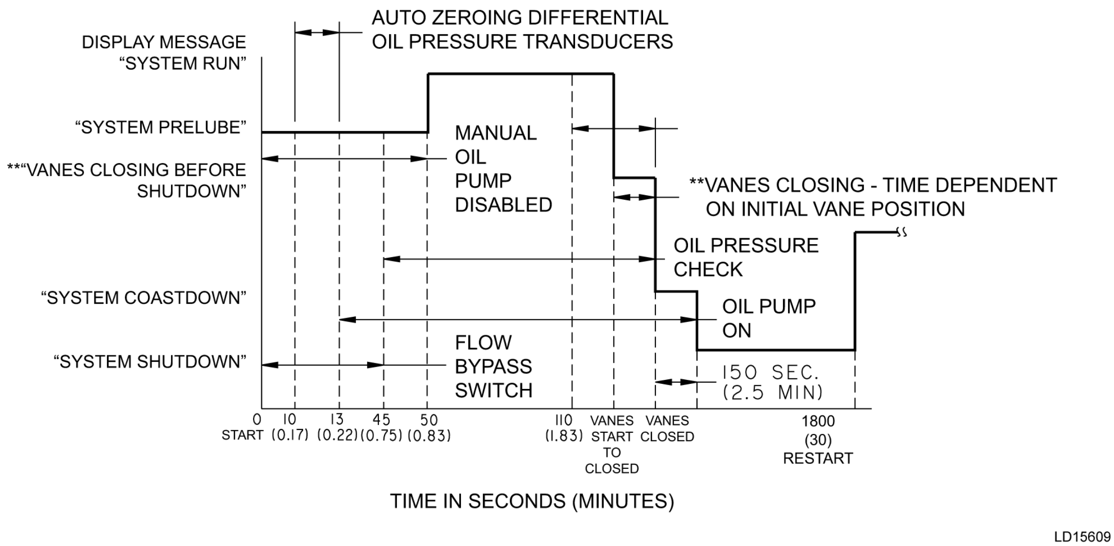
Vent any air from the chiller waterboxes prior to starting the water pumps. Failure to do so will result in pass baffle damage.

Start-up

1. If the chilled water pump is manually operated, start the pump. The Control Center does 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 starts automatically, and this step is not necessary.
2. To start the chiller, press the **Compressor Start** switch. This switch automatically spring returns to the **Run** position. If the unit was previously started, press the **Stop/Reset** side of the **Compressor** switch and then press the **Start** side of the switch to start the chiller. When the start switch is energized, the Control Center is placed in an operating mode and any malfunction is noted by messages on a graphic display.

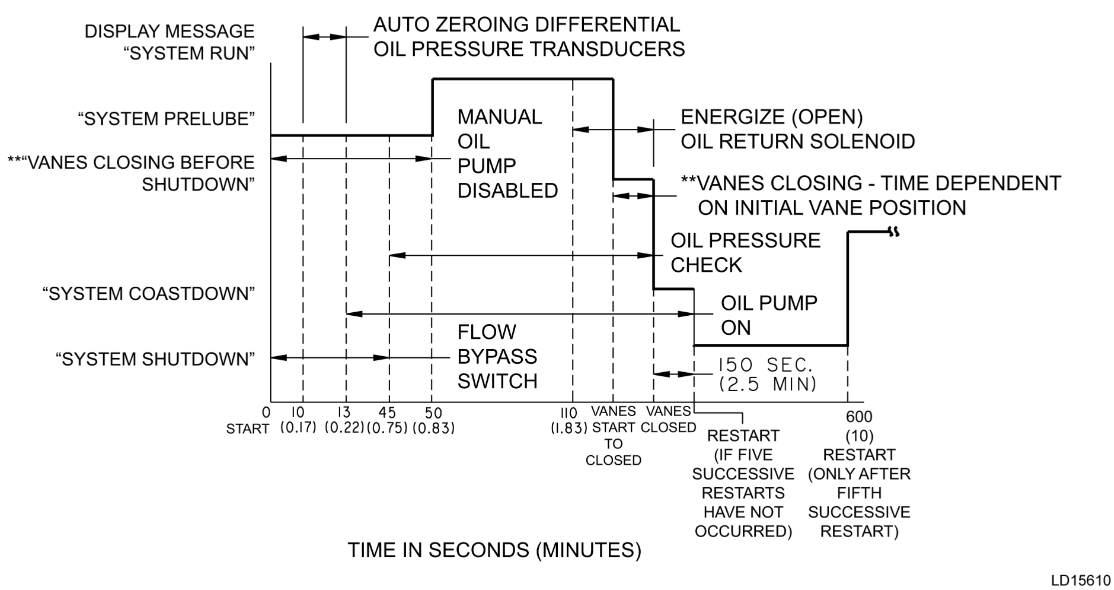
Chiller starting sequence and shutdown sequence

Figure 6: Chiller starting sequence and shutdown sequence (EM starter and solid state starter)



Note: ** Not for all shutdowns. Refer to *Display Messages* in the manual *OptiView™ Control Center – Operation and Maintenance (Form 160.54-O1).*

Figure 7: Chiller starting sequence and shutdown sequence (variable speed drive)



Note: ** Not for all shutdowns. Refer to *Display Messages* in the manual *OptiView™ Control Center – Operation and Maintenance (Form 160.54-O1).*

For display messages and information pertaining to the operation, refer to *OptiView™ Control Center – Operation and Maintenance (Form 160.54-O1)*.

Note: Any malfunctions which occur during STOP/RESET are also displayed.

Chiller operation

The unit capacity varies to maintain the leaving `Chilled Liquid Temperature` setpoint by the pre-rotation vanes, which are modulated by an actuator under the control of the microprocessor board. The vane control routine employs proportional plus derivative (rate) control action. A drop in chilled liquid temperature causes the actuator to close the pre-rotation vanes to decrease chiller capacity. When the chilled liquid temperature rises, the actuator opens the pre-rotation vanes to increase the capacity of the chiller.

However, the current draw (amperes) by the compressor motor is also limited to FLA setpoint by the microprocessor.

If the load continues to decrease, after the pre-rotation vanes are entirely closed, the chiller is shut down by the `Leaving Chilled Liquid – Low Temperature Control`.

The coolant temperature inside any liquid-cooled motor starter supplied by Johnson Controls must be maintained above the dewpoint temperature in the equipment room to prevent condensing water vapor inside the starter cabinet. An additional temperature-controlled throttle valve is needed in the flow path for the starter heat exchanger, to regulate cooling above the equipment room dewpoint for applications using cooling sources other than evaporative air-exchange methods, such as wells, bodies of water, and chilled water. The temperature control valve must be the type to open on increasing drive coolant temperature, fail-closed, and set for a temperature above dewpoint. It can be requested as factory-supplied on a chiller order by special quotation.

Condenser water temperature control

The YORK chiller is designed to use less power by taking advantage of lower than design 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:

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

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

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 can be as much as 25°F (13.9°C) colder than the standby return chilled water temperature. Cooling tower fan cycling normally provides adequate control of the entering condenser water temperature on most installations.

Heat recovery chillers and chillers using optional head pressure control would use a signal provided by the microprocessor to control main condenser bundle heat rejection or pressure, respectively.

Operating log sheet

Keep a permanent daily record of system operating conditions (temperatures and pressures) recorded at regular intervals throughout each 24 hour operating period.

An optional status printer is available for this purpose. Alternatively, Figure 8 shows a log sheet used by Johnson Controls Personnel for recording test data on chiller systems. It is available from the factory in pads of 50 sheets each under *Form 160.44-F6* and can be obtained through the nearest Johnson Controls office. Automatic data logging is possible by connecting the optional printer and programming the DATA LOGGER function.

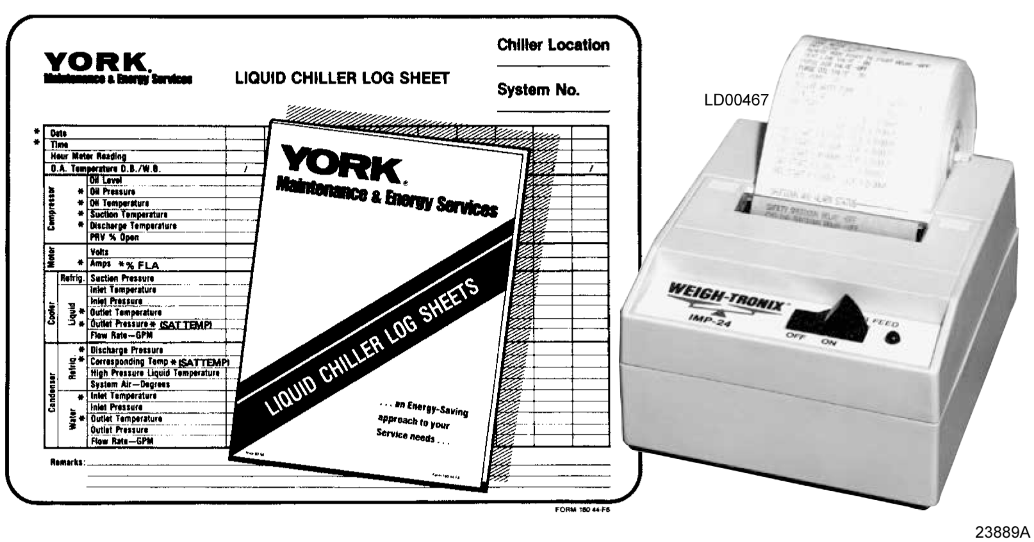
An accurate record of readings serves as a valuable reference for operating the system. Readings taken when a system is newly installed establish normal conditions with which to compare later readings.

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

Operating inspections

By following a regular inspection using the display readings of the Microcomputer Control Center, and maintenance procedure, the operator can avoid serious operating difficulty. Use the following list of inspections and procedures as a guide for maintenance.

Figure 8: Liquid chiller log sheets



ⓘ **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.

Daily inspections

1. Check the OptiView Control Center displays.
2. If the compressor is in operation, check the bearing oil pressure on the System Screen. Also check the oil level in the oil reservoir. Operating oil level must be within operating range of the oil indicator. Drain or add oil if necessary.
3. Check entering and leaving condenser water pressure and temperatures for comparison with job design conditions. Condenser water temperatures can be checked on the System Screen.
4. Check the entering and leaving chilled liquid temperatures and evaporator pressure for comparison with job design conditions 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 System Screen.

8. Check for any signs of dirty or fouled condenser tubes. The temperature difference between water leaving condenser and saturated condensing temperature must not exceed the difference recorded for a new unit by more than 4°F (2.2°C).

Weekly inspections

1. Check the refrigerant charge. See Checking the refrigerant charge during unit shutdown.

Monthly inspections

1. Leak check the entire chiller.
2. Check the oil return system operation.
3. Check the operation of the motor starter.
4. Check the sump heater and thermostat operation.
5. Check the three-phase voltage and current balance.
6. Verify the correct operation, setting, and calibration of safety controls.
7. Verify the condenser and evaporator water flows.
8. Perform a leak check and repair leaks as needed.

Annual inspections, more often if necessary

1. Chiller oil circuit:
    a. Conduct an oil analysis and record the results.
    b. Drain and replace the oil in accordance with *Form 50.40-O1*. See Charging the oil.
    c. Replace the oil filter or filters.
    d. Replace the filter driers in the oil eductor circuit.
2. Variable speed drive or starter:
    a. Check and tighten all electrical connections.
    b. Change the VSD inhibitor in accordance with the instructions in *Form 160.00-M12*.
    c. Clean the condenser/evaporator side of the VSD external heat exchanger.
    d. Replace or clean the starter or drive air filters where applicable.
3. Evaporator and condenser:
    a. Inspect and clean the water strainers.
    b. Inspect and clean the tubes as required.
    c. Inspect the end sheets.
4. Drive motor. See RAM motor lubrication or refer to *SI0305*.
    a. Clean the air passages and windings in accordance with the manufacturer instructions.
    b. Meg the motor windings. See Figure 17 for details.
    c. Lubricate in accordance with the motor manufacturer guidelines.
    d. Conduct vibration testing and record the results.
5. Compressor:
    - Conduct vibration testing and record the results.
6. Chiller systems:
    a. Inspect and service all chiller system electrical components as necessary.
    b. Perform refrigerant analysis.

Need for maintenance or service

If the system is malfunctioning in any manner, or the unit is stopped by one of the safety controls, consult Table 5. If you are unable to make the correct repairs or adjustments to start the compressor, after consulting this chart, or the trouble continues to hinder the performance of the unit, call the nearest Johnson Controls District Office. Failure to report persistent trouble could damage the unit and increase the cost of repairs.

Stopping the system

About this task:
The OptiView Control Center can be programmed to start and stop automatically (maximum, once each day) whenever required. Refer to the *OptiView Control Center – Operation and Maintenance (Form 160.54-O1)*. To stop the chiller, proceed as follows:

1. Push the soft shutdown key on the Home Screen on the OptiView panel or rapid stop with the **compressor stop/reset** switch. The compressor stops automatically. The oil pump continues to run for the coastdown period. The oil pump then stops automatically.
2. Stop the chilled water pump, if it is not wired into the microcomputer Control Center, in which case it shuts off automatically and simultaneously with the oil pump. The actual water pump contact operation is dependent upon the position of microboard jumper J54.
3. Open the switch to the cooling tower fan motors, if they are being used.
4. The compressor sump oil heater is energized when the unit is stopped.

Prolonged shutdown

About this task:
If the chiller is to be shut down for an extended period of time, for example, over the winter season, complete the following steps:

1. Test all of the 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. During long idle periods, periodically check the tightness of the system.
2. If freezing temperatures are encountered while the system is idle, carefully drain the cooling water from the cooling tower, the condenser, the condenser pump, and the chilled water system-chilled water pump and coils. Open the drains on the evaporator and condenser liquid heads to ensure complete drainage. If a variable speed drive is in use, drain its cooling system. If equipped with a solid state starter, drain the liquid from the starter cooling loop.
3. If freezing temperatures are encountered for periods longer than a few days, the refrigerant must be recovered to containers to prevent leakage from O-ring joints.
4. On the **Setup** screen, disable the clock. This conserves the battery.
5. Open the main disconnect switches to the compressor motor, condenser water pump, and the chilled water pump. Open the 115 V circuit to the Control Center.

System components description

The YORK Model YK centrifugal liquid chiller is completely factory-packaged including the evaporator, condenser, compressor, motor, lubrication system, OptiView Control Center, and all interconnecting unit piping and wiring.

Compressor

The compressor is a single-stage centrifugal type powered by an open-drive electric motor.

The rotor assembly consists of a heat-treated alloy steel drive shaft and impeller shaft with a cast aluminum, fully shrouded impeller. The impeller is designed for balanced thrust and is dynamically balanced and over-speed tested. The inserted type journal and thrust bearings are fabricated of aluminum alloy. Single helical gears with crowned teeth are designed so that more than one tooth is in contact at all times. 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.

The open-drive compressor shaft seal is a double bellows cartridge style with ceramic internal and atmospheric seal faces. The seal is oil-flooded at all times and is pressure-lubricated during operation.

Capacity control

Pre-rotation vanes (PRV) modulate chiller capacity from 100% to as low as 15% of design for normal air conditioning applications. Operation is by an external, electric PRV actuator which automatically controls the vane position to maintain a constant leaving chilled liquid temperature.

Compressor lubrication system

The chiller lubrication system consists of the oil pump, oil filter, oil cooler and all interconnecting oil piping and passages. There are main points within the compressor which must be supplied with forced lubrication as follows:

1. Compressor drive shaft (low speed):
    a. Shaft seal.
    b. Front and rear journal bearings – one on each side of driving gear.
    c. Low speed thrust bearing (forward and reverse).
2. Compressor driven shaft (high speed):
    a. Forward and reverse high speed thrust bearing.
    b. Two journal bearings.
3. Speed increasing gears:
    a. Meshing surfaces of drive and pinion gear teeth.

To provide the required amount of oil, under the necessary pressure to properly lubricate these parts, a motor driven submersible oil pump is located in a remote oil sump.

When you press the **compressor start** switch on the Control Center, the oil pump is immediately energized. After a 50 second pre-lube period, the compressor motor starts. The oil pump continues to run during the entire operation of the compressor, and for 150 seconds during the compressor coastdown.

The submerged oil pump 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.

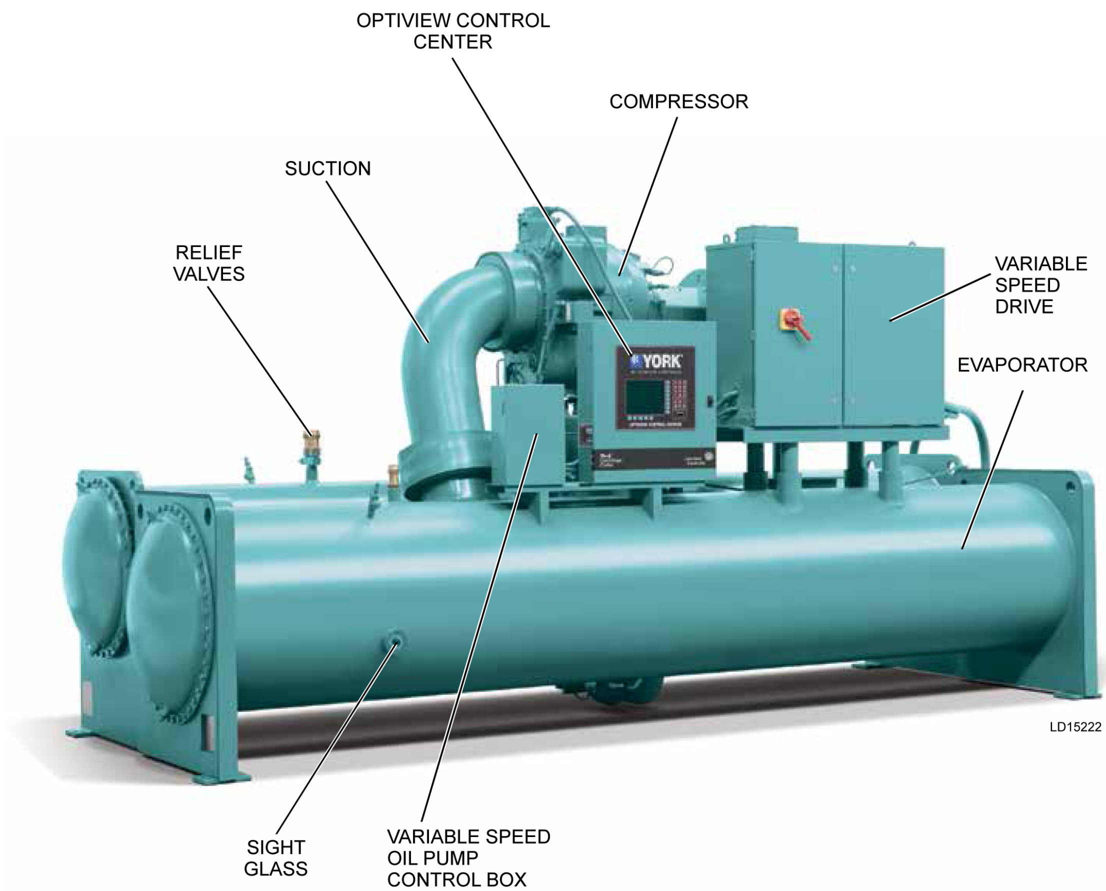
There is an emergency oil reservoir located at the highest point in the lubrication system internally in the compressor. It provides an oil supply to the various bearings and gears in the event of a system shutdown due to a power failure. The reservoir, located on the top of the compressor, allows the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

Oil pump

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

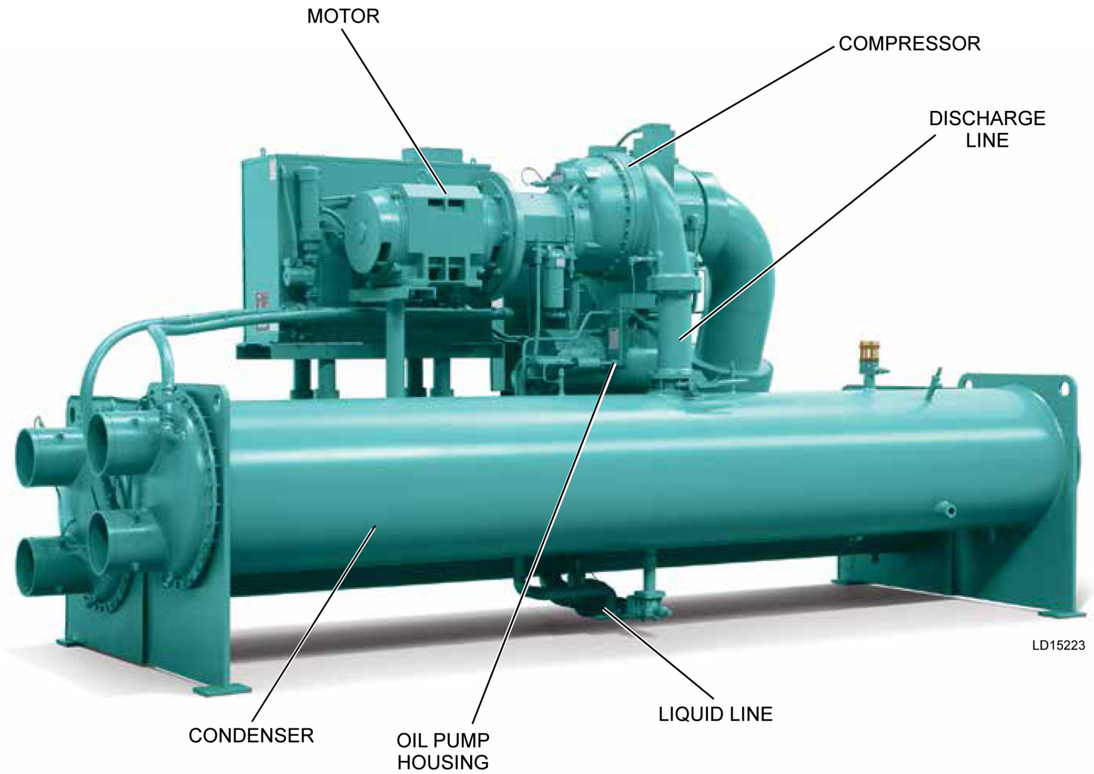
On a shutdown of the system for any reason, the oil pump operates and continues to run for 150 seconds. The system cannot restart during that time interval.

Figure 9: System components front view



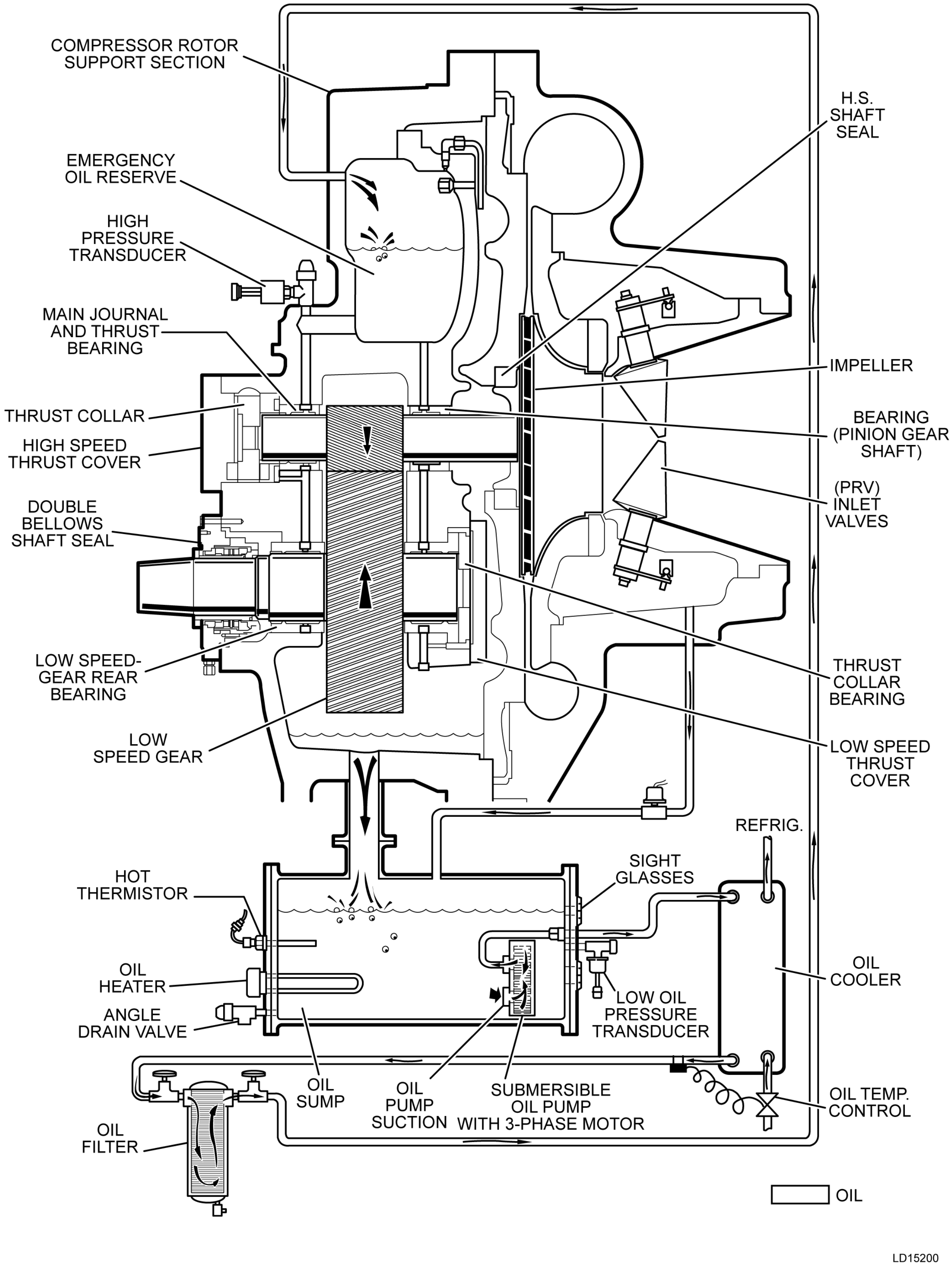
FRONT VIEW

Figure 10: System components rear view



REAR VIEW

Figure 11: Schematic drawing – (YK) compressor lubrication system



Oil heater

During long idle periods, the oil in the compressor oil reservoir tends to absorb as much 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 increases. If the quantity of refrigerant in the oil becomes excessive, violent oil foaming results 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 fluctuates with a possible temporary loss of lubrication. This causes the oil pressure safety cutout to actuate and stop the system. Refer to *OptiView™ Control Center – Operation and Maintenance (Form 160.54-O1)*.

Motor driveline

The compressor motor is an open-drip-proof, squirrel cage, induction type constructed to YORK design specifications. 60 Hz motors operate at 3570 rpm. 50 Hz motors operate at 2975 rpm.

The open motor is provided with a D-flange, cast iron adapter mounted to the compressor and is supported by a motor support.

The motor drive shaft is directly connected to the compressor shaft with a flexible disc coupling. This coupling has all metal construction with no wearing parts to assure long life, and no lubrication requirements to provide low maintenance.

For units using remote electromechanical starters, a terminal box is provided for field connected conduit. Motor terminals are brought through the motor casing into the terminal box. Jumpers are furnished for three-lead type of starting. Motor terminal lugs are not furnished. Overload and over current transformers are furnished with all units.

Heat exchangers

Evaporator and condenser shells are fabricated from rolled carbon steel plates with fusion welded seams.

Heat exchanger tubes are internally enhanced type.

The evaporator is a shell and tube type with customer process fluid flowing inside the tubes and refrigerant removing heat on the shell side through evaporation. Evaporator codes A* to K* utilize a hybrid falling film design. It contains a balance of flooded and falling film technology to optimize efficiency, minimize refrigerant charge, and maintain reliable control. A specifically designed spray distributor provides uniform distribution of refrigerant over the entire length to yield optimum heat transfer. The hybrid falling film evaporator design has suction baffles around the sides and above the falling film section to prevent liquid refrigerant carryover into the compressor.

Evaporators codes M* to Z* are flooded type, with a liquid inlet distributor trough underneath the tube bundle which provides uniform distribution of refrigerant over the entire shell length to yield optimum heat transfer. Flooded evaporator designs have a suction baffle on M* shells with H9 compressors and an aluminum mesh eliminator on K* to Z* shells with K compressors located above the tube bundle to prevent liquid refrigerant carryover into the compressor.

A 1 1/2 in. (38 mm) liquid level sight glass is conveniently located on the side of the shell to aid in determining correct refrigerant charge. The evaporator shell contains a dual refrigerant relief valve arrangement set at 180 psig (12.4 barg) on H and K compressor models; 235 psig (16.2 barg) on P and Q compressor models; or single-relief valve arrangement, if the chiller is supplied with optional refrigerant isolation valves. A 1 in. (25.4 mm) refrigerant charging valve is provided. 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 is offered, on M and larger condensers, in lieu of the baffle, to provide dynamic pressure recovery and enhanced chiller efficiency. An integral sub- cooler 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).

The removable waterboxes 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 waterbox to provide the required pass arrangements. Stub- out water nozzle connections with ANSI/AWWA C-606 grooves are welded to the waterboxes. These nozzle connections are suitable for ANSI/AWWA C-606 couplings, welding or flanges, and are capped for shipment. Plugged 3/4 in. (19 mm) drain and vent connections are provided in each waterbox.

Refrigerant flow control

Refrigerant flow to the evaporator is controlled by a variable orifice.

A level sensor senses the refrigerant level in the condenser and outputs an analog voltage to the microboard that represents this level (0% = empty; 100% = full). Under program control, the microboard modulates a variable orifice to control the condenser refrigerant level to a programmed setpoint. Other setpoints affect the control sensitivity and response. These setpoints must be entered at chiller commissioning by a qualified service technician. Only a qualified service technician can modify these settings.

While the chiller is shut down, the orifice is in the fully open position causing the sensed level to be approximately 0%. When the chiller is started, after the vane motor end switch (VMS) opens when entering **SYSTEM RUN**, if the actual level is less than the level setpoint, a linearly increasing ramp is applied to the level setpoint. This ramp causes the setpoint to go from the initial refrigerant level (approximately 0%) to the programmed setpoint over a programmable period of time.

If the actual level is greater than the setpoint when the VMS opens, there is no pulldown period, it immediately begins to control to the programmed setpoint.

While the chiller is running, the refrigerant level is normally controlled to the level setpoint. However, anytime the vanes fully close (VMS closes), normal level control is terminated, any refrigerant level setpoint in effect is cancelled and the outputs to the level control are constantly open.

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 is required to isolate the refrigerant.

CAUTION

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

Optional hot gas bypass

Hot gas bypass is optional and is used to eliminate compressor surge during light load or high head operation. The OptiView control panel automatically modulates the hot gas valve open and closed as required. Adjustment of the hot gas control valve must be performed by a qualified service technician following the Hot Gas Set-up procedure.

Note: Changes in chilled water flow require re-adjustment of the hot gas control to ensure correct operation.

OptiView Control Center

The OptiView Control Center is factory-mounted, wired and tested. The electronic panel automatically controls the operation of the unit in meeting system cooling requirements while minimizing energy usage. For detailed information on the OptiView Control Center, see System operating procedures.

Solid state starter (optional)

The solid state starter is a reduced voltage starter that controls and maintains a constant current flow to the motor during start-up. It is mounted on the chiller. Power and control wiring between the starter and chiller are factory installed. The starter enclosure is NEMA-1 with a hinged access door with lock and key. Electrical lugs for incoming power wiring are provided.

Variable speed drive (optional)

A variable speed drive can be factory packaged with the chiller. It is designed to vary the compressor motor speed and pre-rotation vane position by controlling the frequency and voltage of the electrical power to the motor. Operational information is contained in *Form 160.00-O1*, *Form 160.00-O4*, and *Form 160.00-O10*, depending on the model of drive used on the chiller. The control logic automatically adjusts motor speed and compressor pre-rotation vane position for maximum part load efficiency by analyzing information fed to it by sensors located throughout the chiller.

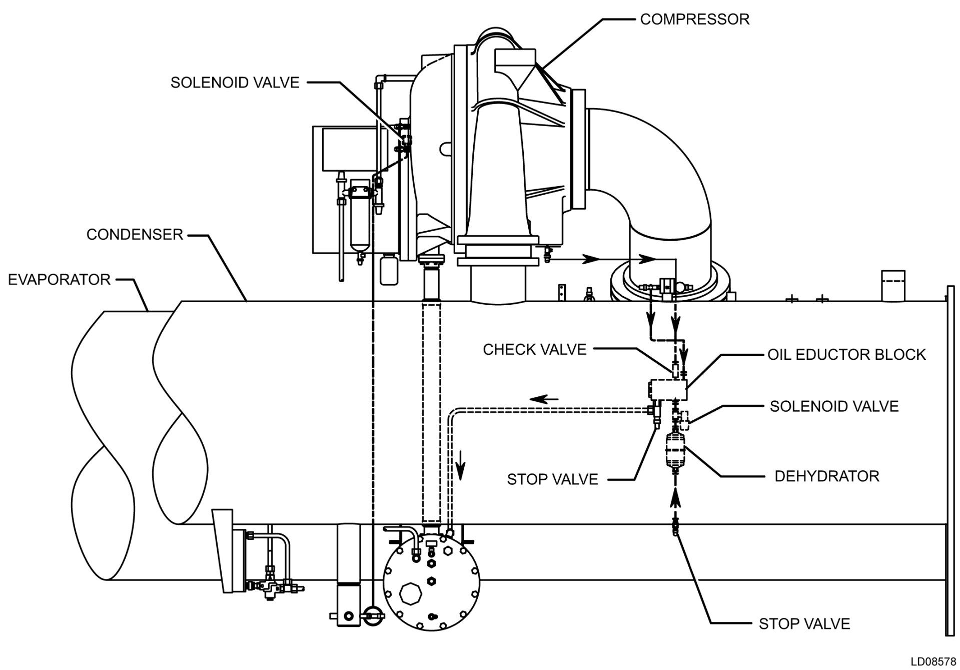
Operational maintenance

Oil return system

The oil return system continuously maintains the correct oil level in the compressor oil sump. See Figure 12.

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.

Figure 12: Oil return system



Changing the dehydrator

To change the dehydrator, use the following procedure:

1. Isolate the dehydrator at the stop valves.
2. Remove the dehydrator. See Figure 12.
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.

Oil charge

All YORK compressors have specific oil requirements based on the duty of the chiller and the refrigerant type. It is important that the oil requirements are met to ensure long reliable operation of the compressor. Any deviation from the specified oil may lead to premature compressor component failures and will void the warranty coverage of the compressor at a minimum. Refer to *Form 50.40-O1* for guidelines regarding oil change intervals, oil quality, operational quantities, application, and storage.

New YORK refrigeration oil must be used in the centrifugal compressor. Because oil absorbs moisture when exposed to the atmosphere, it must be kept tightly capped until used.

Table 3: Oil quantity

Compressor model	Nominal oil quantity required
Q3 through Q8	11.0 gal
H, P8, P9, K1 through K4	17.5 gal
K7	24.0 gal

Table 4: Oil part numbers

Oil type	5 gal P/N	1 gal P/N
H	011-00549-000	011-00586-000
J	011-00558-000	n/a
K	011-00533-000	011-00560-000

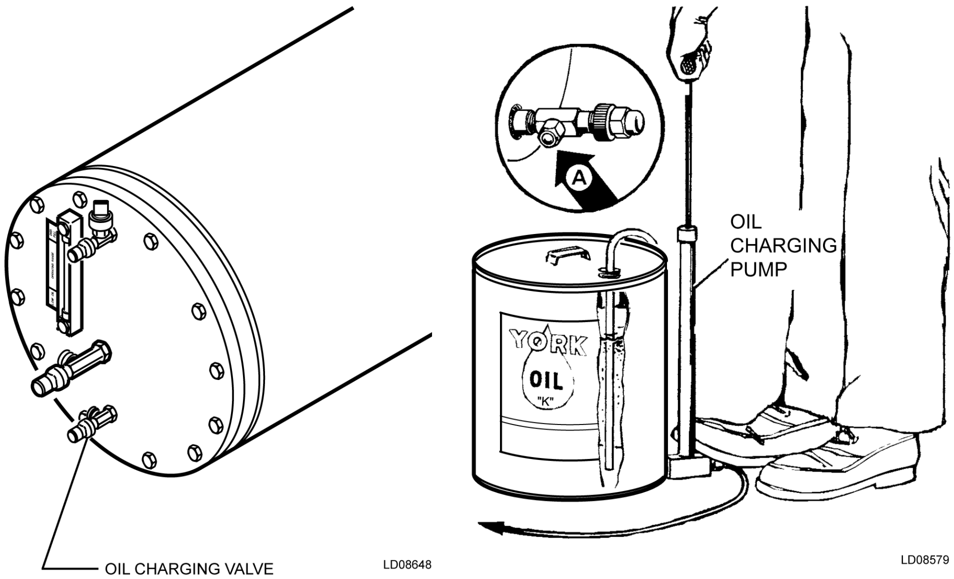
Charging the oil

About this task:
During operation, the compressor oil level must be maintained in the operating range identified on the vertical oil level indicator. If the oil level falls into the lower sight glass, it is necessary to add oil to the compressor oil reservoir. Charge the oil into the oil reservoir using the YORK Oil Charging Pump – YORK P/N 470-10654-000. To charge oil into the oil reservoir, complete the following steps:

1. Shut down the unit.
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 (A) located on the remote oil reservoir cover plate. See Figure 13. 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 keeps the concentration of refrigerant in the oil to a minimum.

What to do next:
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 lowers 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 13: Charging oil reservoir with oil



Troubleshooting

Table 5: Operation analysis chart

Results	Possible cause	Remedy
1. Symptom: Abnormally high discharge pressure		
The temperature difference between the condensing temperature and water off condenser is higher than normal.	Air in condenser.	
High discharge pressure.	Condenser tubes dirty or scaled.	Clean the condenser tubes. Check water conditioning.
	High condenser water temperature.	Reduce the condenser water inlet temperature. Check the cooling tower and water circulation.
The 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 correct value.
2. Symptom: Abnormally low suction pressure		
The temperature difference between the leaving chilled water and refrigerant in evaporator is greater than normal, with high discharge temperature.	Insufficient charge of refrigerant.	Check for leaks and charge refrigerant into the system.
	Variable orifice problem.	Remove the obstruction.
The temperature difference between the leaving chilled water and refrigerant in the evaporator is greater than normal, with normal discharge temperature.	Evaporator tubes dirty or restricted.	Clean the evaporator tubes.
The temperature of chilled water is too low with low motor amperes.	Insufficient load for system capacity.	Check the pre-rotation vane motor operation and setting of the low water temperature cutout.
3. Symptom: High evaporator pressure		
High chilled water temperature.	Pre-rotation vanes fail to open.	Check the pre-rotation vane motor positioning circuit.
	System overload.	Make sure that the vanes are wide open, without overloading the motor, until the load decreases.
4. Symptom: No oil pressure when System Start button pressed		
Low oil pressure displayed on Control Center; compressor does not start.	Oil pump is running in the wrong direction.	Check the rotation of oil pump (Electrical Connections).
	Oil pump is not running.	Troubleshoot electrical problem with oil pump VSD.
5. Symptom: 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 the low or high oil pressure transducer.
6. Symptom: 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 the oil pump is run without an oil supply, it vibrates and becomes extremely noisy.	Oil not reaching pump suction inlet in sufficient quantity.	Check the oil level.
	Worn or failed oil pump.	Repair or replace the oil pump.
7. Symptom: Reduced oil pump capacity		
Oil pump pumping capacity.	Excessive end clearance pump. Other worn pump parts.	Inspect and replace all worn parts.
	Partially blocked oil supply inlet.	Check the oil inlet for a blockage.
8. 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 the oil filter.

Table 5: Operation analysis chart

Results	Possible cause	Remedy
9. Symptom: Oil pressure system ceases to return an oil or refrigerant sample		
Oil refrigerant return not functioning.	Filter-drier in oil return system dirty.	Replace the old filter-drier with a new filter-drier.
	Jet or orifice of oil return jet clogged.	Remove the jet, and inspect for dirt. Remove all dirt using solvent and replace.
10. 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 or connectors.	Replace the oil pressure transducer.

Maintenance

Renewal parts

Order all replacement parts at EasyParts (www.solutionnavigator.com).

Checking system for leaks

Leak testing

The refrigerant side of the system is carefully pressure tested and evacuated at the factory.

After the system has been charged, use a leak detector that is compatible with the refrigerant to ensure that that all of the joints are tight.

If any leaks are indicated, repair them immediately. At times, you can stop leaks by ensuring that face seal nuts and flange bolts are correctly torqued. However, for any major repair, the refrigerant charge must be removed and the system leak checked using reliable methods like a pressure test.

See Handling refrigerant for dismantling and repairs for more details.

Leak testing during operation

After the system has been charged, the system must be carefully leak tested with a compatible leak detector to ensure that all joints are tight. The acceptable leak detector limit setting is 0.1 oz/year for all refrigerants used in the YK chiller family. Be certain that the leak detection device being used is compatible with the refrigerant contained in the chiller.

If any leaks are indicated, 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.

Conducting a system pressure test

With the refrigerant charge removed and all known leaks repaired, charge the system with a small amount of refrigerant mixed with dry nitrogen. You can then use an electronic leak detector to detect any leaks too small to be found by the soap test.

⚠ WARNING

Care must be taken not to exceed the rated pressure of the unit refrigerant pressure relief valves.

Conducting the gas pressure hold test

1. Install a high-quality high-resolution analog pressure gauge on one of the shells to monitor the system pressure over time. Ensure that the pressure gauge has a resolution of 2 psi (0.14 bar) increments with a dial face at 3 in. (76 mm) in diameter or greater.
2. Before proceeding, ensure that the unit is at the initial evacuation level of 5 mmHg.

   Important: To prevent freezing of any moisture that may be in the system, do not go below 5 mmHg. See System evacuation for more details.

3. With the system in a vacuum, slowly charge nitrogen vapor only into the system.
4. Slowly build up the system pressure with dry nitrogen to design working pressure (DWP) as found on the chiller vessel data plates:
   a. Allow the pressure to remain in the chiller based on Figure 14. This table provides hold

times for pressure hold testing based on the vessel diameter and length.

b. For a unit with no loss of pressure, proceed to unit evacuation.
c. For units where a leak is suspected and there is any amount of drop in recorded pressure, proceed to either of the leak detection methods Conducting the soap bubble visual gas leak test or Optional trace gas leak test.

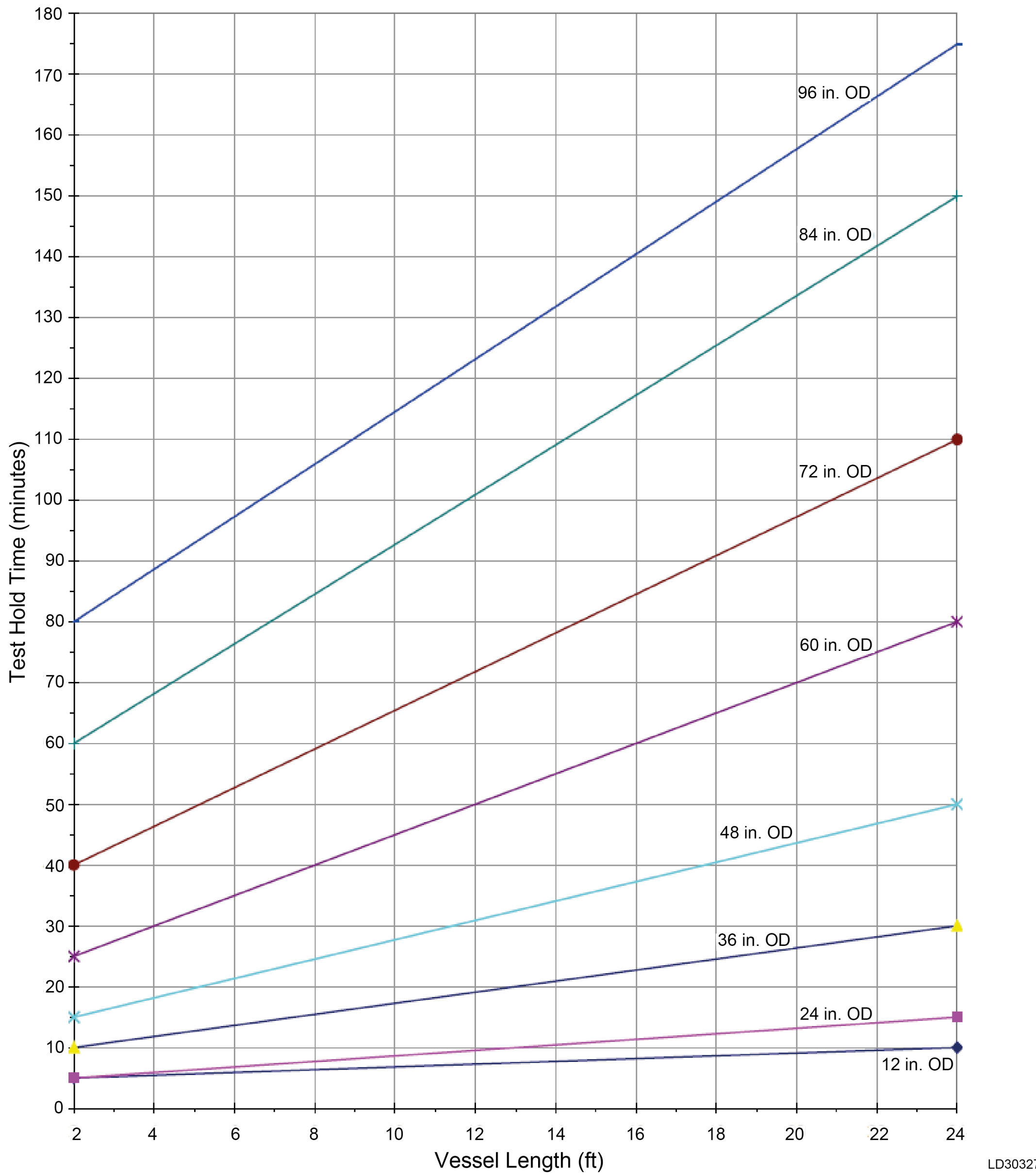
Conducting the soap bubble visual gas leak test

1. Install a high quality high resolution analog pressure gauge on one of the shells to monitor the system pressure over time. Ensure that the pressure gauge has a resolution of 2 psi increments with a dial face at 3 in. (76 mm) in diameter or greater.
2. Before proceeding, check that the unit is at the initial evacuation level of 5 mmHg.

   Important: To prevent freezing of any moisture that may be in the system, do not go below 5 mmHg. See System evacuation for more details.

3. With the system evacuated, charge the system with dry nitrogen to 100 psig (690 kPa).
4. Mix together soap and water. This solution forms bubbles when leaking vapor passes through it.
5. Use the soap solution to test around each unit fitting joint and weld seams carefully and thoroughly.
6. To enhance the test, use an ultrasonic leak detector. These devices are reliable at finding leaks in low pressure testing where soap bubble testing may not provide results.
7. When all leaks have been identified, vent the nitrogen vapor, make the necessary repairs to the chiller and repeat the gas pressure hold test until a satisfactory hold test is achieved.

Figure 14: Leak test hold time



Optional trace gas leak test

1. Install a high-quality high-resolution analog pressure gauge on one of the shells to monitor the system pressure over time. Ensure that the pressure gauge has a resolution of 2 psi increments with a dial face at 3 in. (7.6 cm) in diameter or greater.
2. Before proceeding, check that the unit is at the initial evacuation level of 5 mmHg.

   Important: To prevent freezing of any moisture that may be in the system, do not go below 5 mmHg. See System evacuation for more details.

3. With the system evacuated, charge with a vapor only for a 10% trace gas (R-134a) into the chiller until the system pressure reaches 10 psig (69 kPa).
   - When using a refrigerant based trace gas, you must always charge with vapor only to reach the initial 10 psig pressure.

- The use of trace gas must adhere to local policies in regards to venting or recovery of the gas. This is dependent on the gas that is selected.
- It is important that a suitable gas detection device is used that can detect the trace gas that is selected.
- Set the gas detection limit for 10% R-134a based trace gas to 0.078 oz/Yr R-143a.

4. Add dry nitrogen into the chiller until the pressure reaches 100 psig (690 kPa).
5. To make sure that the concentration of trace gas has reached all parts of the system, slightly open the oil sump drain service valve and test for the presence of the trace gas with a leak detector. Continue to vent in this manner until the trace gas is detected and close the service valve.
6. Before beginning the trace gas testing, ensure that any vented gas has been adequately vented from the chiller area so that there are no false positive indications. It may be necessary to reset the test probe in an outdoor space.
7. Test around each joint and factory weld carefully and thoroughly.
8. To check for tube or tube joint leaks, complete the following steps:
   a. Isolate and drain the condenser and evaporator waterboxes.
   b. Purge the waterboxes and tubes with dry nitrogen through the vents or drains until the detector does not indicate any evidence of refrigerant.
   c. Close the vents and drains and wait an hour.
   d. Open a drain and insert the leak detector.
9. If a tube leak is suspected, complete the following steps:
   a. The waterboxes must be removed to facilitate application of the soap solution to the tubesheets.
   b. To test for tube wall leaks, insert a rubber cork in both ends of each tube, and leave pressurized for at least 8 hours.
   c. If a leak is present, the pressure pushes the cork out of the tube. If this occurs, the tube must be plugged or have other options explored.
   d. If a tube or tubesheet leak is confirmed, contact product technical support (PTS) for guidance on repair procedures.
10. When all leaks have been identified, recover the test gas as applicable, make the necessary repairs, repeat the leak tests, evacuate the chiller, and perform the time based pressure hold test.

System evacuation

Vacuum dehydration

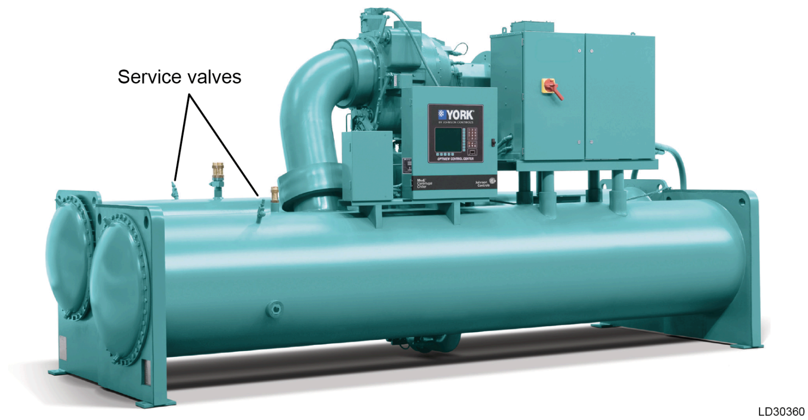
Before performing the final evacuation and system charging, it is necessary to obtain a sufficiently dry system. The following instructions provide an effective method for evacuating and dehydrating a system in the field. Although there are several methods of dehydrating a system, the following method produces one of the best results, and provides accurate readings as to the extent of dehydration.

The equipment required for this method of dehydration consists of the following items:

- High resolution vacuum gauge (microns below 500)
- Chart that shows the relationship between dew point temperature and pressure in microns (vacuum), see Table 6
- Vacuum pump capable of pumping a suitable vacuum on the system

Follow the dehydration steps as closely as possible to prevent moisture becoming trapped in the system. If you apply too deep of a vacuum, any trapped moisture might freeze and not be exhausted as vapor. Failure to remove all of the moisture can create acids in the refrigerant circuit. This may damage internal system components over time causing premature failures of items such as oil pump motors and any other devices sensitive to acid contact.

Figure 15: Service valves



The service valves in the previous figure are to be used for all vapor connection processes. This includes evacuation, vacuum guage connection, and vapor charging.

Table 6: System pressures

Gauge	Absolute			Boiling temperatures of water (°F)
Inches of mercury (Hg) below one standard atmosphere (in.)	psia	Millimeters of mercury (Hg)	Microns	
0	14.696	760.0	760,000	212
10.24	9.629	500.0	500,000	192
22.05	3.865	200.0	200,000	151
25.98	1.935	100.0	100,000	124
27.95	0.968	50.0	50,000	101
28.94	0.481	25.0	25,000	78
29.53	0.192	10.0	10,000	52
29.67	0.122	6.3	6,300	40
29.72	0.099	5.0	5,000	35
29.842	0.039	2.0	2,000	15
29.882	0.019	1.0	1,000	+1
29.901	0.010	0.5	500	–11
29.917	0.002	0.1	100	–38
29.919	0.001	0.05	50	–50
29.9206	0.0002	0.01	10	–70
29.921	0	0	0	

Note:

- One standard atmosphere = 14.696 psia = 760 mm Hg absolute pressure at 32°F = 29.921 in. Hg absolute at 32°F
- psig = pound per square inch gauge pressure = pressure above atmosphere
- psia = pound per square inch absolute pressure = sum of gauge plus atmospheric pressure
- Shell volume = $L*\pi * r^2$= (Length in feet)*(3.1416)*(radius squared) = cubic feet

Note: Water freezes at 32°F.

Dehydration

The dehydration process is only needed if the following has occurred. It must only be performed after the system has been thoroughly leak checked so that there is confidence in the vacuum decay related to moisture boiling off:

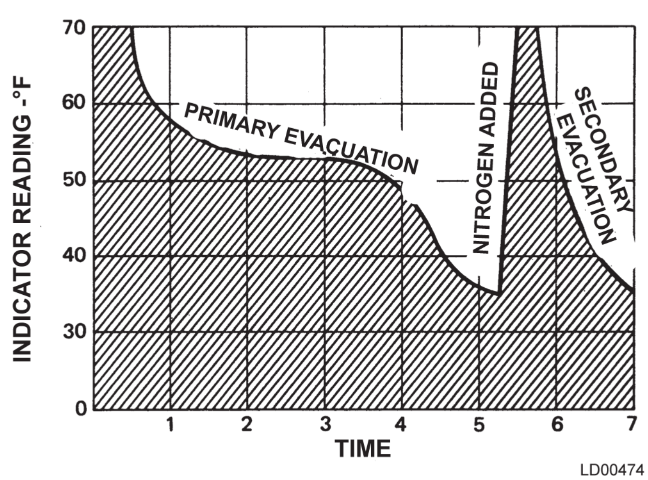
1. The nitrogen holding charge on shipments other than Form 1 has been lost.
2. The system has been open to the atmosphere for any length of time.
3. Tube leaks have introduced moisture to the refrigerant circuit.
4. Indications of moisture contamination have appeared in any of the sight glasses.

Dehydration of a refrigerant system can be obtained by the evacuation method because the water present in the system reacts much as a refrigerant would. It is not always possible to pull down the vacuum pressure in the system to a point where its saturation temperature is considerably below that of the equipment room temperature due to low ambient room conditions and other factors. As a result, you may need to use an external heat source or warm water flow through at least one vessel to raise the vessel internal temperature. This allows heat to flow into the system and help 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 temperature of the vessels, capacity and efficiency of the vacuum pump, the room temperature and the quantity of water present in the system. You can use an external heat source to shorten the dehydration time, as discussed in the previous paragraph. If you use a vacuum gauge as suggested, the corresponding saturation temperature can be used as a reference. If the system has been pressure tested and found to be tight before evacuation, then the saturation temperature recordings should follow a curve similar to the typical saturation curve in Figure 16.

The temperature of any trapped water in the chiller drops as the pressure decreases, until the boiling point is reached. At this point, the temperature levels off and remains at this level until all of the water in the shell is vaporized. When this final vaporization has occurred, the pressure and temperature continue to drop until eventually a temperature of 35°F (1.6°C) or a pressure of 5,000 µm. Because vacuum pumps have the capacity to overcome the boiling rate of the trapped moisture, do not go below this pressure at this point.

Figure 16: 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 must be introduced into the system to bring it to atmospheric pressure. The indicator temperature returns to approximately ambient temperature.

Close off the system again, and start the second evacuation. The relatively small amount of moisture left is carried out through the vacuum pump and the temperature or pressure shown by the indicator drops uniformly until it reaches a temperature of 35°F (1.6°C) or a pressure of 5000 µm.

When the vacuum indicator registers this temperature or pressure, it is a positive sign that the system is 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 system can be evacuated to 35°F (1.6°C) or 5,000 µm. During the primary or dehydration evacuation, keep a careful watch on the vacuum level, and do not let it fall below 5,000 µm which is equivalent to 35°F (1.6°C).

If the pressure temperature relationship is allowed to fall to 32°F (0°C), the water in the system freezes, and the result is a faulty pressure reading. Use the following steps as a guide to the steps for dehydration:

1. Connect a high capacity vacuum pump, with indicator, to the system using the vapor connections as shown in Figure 15 and start the pump.
2. Open wide all system valves. Make sure that all valves to the atmosphere are closed with flare caps in place if applicable.
3. Operate the vacuum pump until a pressure of 5,000 µm is reached. See Table 6 for corresponding pressure and temperature values to avoid freezing any trapped moisture in the system.
4. Close the system charging valve connection to the vacuum pump to start the 8-hour vacuum hold test. Note the time and pressure.
5. Hold the vacuum obtained in Step 4 in the system for 8 hours. Even a slight rise in pressure can indicate a leak , the presence of moisture, or both. It is important to check for pressure change with the chiller at the same temperature. Pressure changes proportional to temperature and affects results.
6. To determine if it is moisture or a leak, a pressure rise test must be conducted. Evacuate the system to 5,000 µm again and perform another hold test. If the pressure rise goes to 0 psig, that indicates that a leak is present. During the hold period, if moisture is present, the pressure stabilizes at some level below atmosphere and should correspond to the room ambient temperature or the heat being applied to the vessel. See Table 6 for values.
7. Acceptable vacuum pressure rise is 150 µm for the first 60 minutes.
8. If the vacuum does not hold for within the limits defined in Step 6, you must find and repair the leak. For cases where leaks cannot be identified while pressurized but vacuum hold tests indicate that there is a leak, in most cases this can be traced to an elastomeric (O-ring sealing) issue.
9. When the 5,000 µm vacuum hold test is successful, you can perform a final evacuation.

Performing the final evacuation

After the pressure test and vessel dehydration have been completed, conduct the final evacuation as follows:

1. Connect a high capacity vacuum pump, with indicator, to the system using the vapor connections as shown in Figure 15 and start the pump.
2. Open wide all system valves. Make sure that all valves to the atmosphere are closed with flare caps in place if applicable.
3. Operate the vacuum pump to evacuate the system to the best attainable vacuum. The vacuum must be less than 500 µm but if that cannot be attained, a vacuum at 1,000 µm or lower is acceptable.

4. Close the system charging valve connection to the vacuum pump to start the 8-hour vacuum hold test. Note the time and pressure.
5. Hold the vacuum obtained in Step 4 in the system for 8 hours. Any rise that exceeds the limits in Step 6 can indicate a leak, the presence of moisture, or both. It is important to check for pressure change with the chiller at the same temperature. Pressure changes proportional to temperature and affects results. To determine if it is moisture or a leak, a pressure rise test must be conducted. Evacuate the system to 5,000 µm again and perform another hold test. If the pressure rise goes to 0 psig, that indicates that a leak is present. During the hold period, if moisture is present, the pressure stabilizes at some level below atmosphere and should correspond to room ambient temperature or the heat being applied to the vessel. See Table 6 for values.
6. An acceptable vacuum pressure rise is 150 µm per 60 minutes:
   - 1000TR 1,000 µm
   - See factory standard
7. If the vacuum does not hold within the limits defined in Step 6, you must locate the leak and repair it. For cases where leaks cannot be identified while pressurized but vacuum hold tests indicate that there is a leak, in most cases this can be traced to an elastomeric (O-ring sealing) issue.
8. When the 500 µm hold test is successful, you can charge the system using the steps described in Refrigerant charging.

Refrigerant charging

Before beginning, it is critical to establish that the vapor portion of the refrigerant container or cylinder has not been contaminated with other gases that are not R-134a, R-513A, or R-1234ze, including air. Use the appropriate saturation property table (Table 7, Table 8, or Table 9) to determine that the saturation pressure and ambient temperature of the refrigerant in the container indicate that the gas pressure coincides with the corresponding temperature.

You must only admit refrigerant vapor from the top of the drum or cylinder to the system until the system pressure is raised above the corresponding saturation pressure at the highest freezing point of the chiller liquids. This is to avoid the possibility of freezing liquid within any of the chiller tubes when charging an evacuated system. For water with R-134a at 32°F, that pressure is 28 psig. See Table 7. For water with R-513A at 32°F, that pressure is 32 psig. See Table 8. For water with R-1234ze at 32°F, that pressure is 17 psig. See Table 9.

Before charging, establish the starting weight for the refrigerant cylinder. After the chiller is vapor charged to the appropriate saturation pressure, it may be necessary to use a refrigerant pump to draw vapor from the chiller and discharge it to the vapor connection of the refrigerant cylinder. This process aids in creating a pressure differential for pushing the refrigerant liquid from the cylinder to the chiller.

While charging, every precaution must be taken to prevent air from entering the system. Make up a suitable charging connection from new copper tubing or from properly selected flexible charging hoses to fit between the system charging valve and the fitting on the charging drum. This connection must be as short as possible but long enough to permit sufficient flexibility for changing drums. It must also contain a tee fitting with a valve to serve as a connection point to a vacuum pump to evacuate the charging lines. Evacuate the charging connection each time the lines are disconnected for changing cylinders or any of the components of the charging process.

The charging line must also contain a sight-glass so that when liquid charging is performed, you can monitor the charging line to determine when the liquid is no longer being transferred to the chiller.

The refrigerant charge is specified for each chiller model on the unit data plate or in the Factory Order Form (FOF) that is provided for every new sale. Charge the chiller based on the amount specified in the FOF less 10%. For example, for a chiller that requires 1200# of refrigerant, the initial refrigerant charge is 1080#, 1200 - 120 = 1080. This allows room to trim the charge as outlined in Checking and trimming the refrigerant charge.

Charge the refrigerant in accordance with the method shown in this section. Record the weight of the refrigerant charged after the initial charging. Use the next section for trimming the chiller for optimum operation based on the defined indicators, like discharge superheat, sub-cooling, and approaches.

Table 7: R-134a pressure to saturated temperature conversion

Pressure psig (bar)	Dew point temperature °F (°C)	Pressure psig (bar)	Dew point temperature °F (°C)	Pressure psig (bar)	Dew point temperature °F (°C)
0.0 (0.0)	-14.9 (-26.1)	135.0 (9.31)	105.0 (40.6)	270.0 (18.62)	152.0 (66.7)
5.0 (0.34)	-3.0 (-19.4)	140.0 (9.65)	107.2 (41.8)	275.0 (18.96)	153.4 (67.4)
10.0 (0.69)	6.7 (-14.1)	145.0 (10.0)	109.4 (43.0)	280.0 (19.31)	154.7 (68.2)
15.0 (1.03)	14.9 (-9.5)	150.0 (10.34)	111.5 (44.2)	285.0 (19.65)	156.1 (68.9)
20.0 (1.38)	22.2 (-5.4)	155.0 (10.69)	113.6 (45.3)	290.0 (19.99)	157.4 (69.7)
25.0 (1.72)	28.7 (-1.8)	160.0 (11.03)	115.6 (46.4)	295.0 (20.34)	158.7 (70.4)
30.0 (2.07)	34.6 (1.4)	165.0 (11.38)	117.6 (47.6)	300.0 (20.68)	160.0 (71.1)
35.0 (2.41)	40.0 (4.4)	170.0 (11.72)	119.6 (48.7)	305.0 (21.03)	161.3 (71.8)
40.0 (2.76)	45.0 (7.2)	175.0 (12.07)	121.5 (49.7)	310.0 (21.37)	162.5 (72.5)
45.0 (3.10)	49.6 (9.8)	180.0 (12.41)	123.3 (50.7)	315.0 (21.72)	163.8 (73.2)
50.0 (3.45)	54.0 (12.2)	185.0 (12.76)	125.2 (51.8)	320.0 (22.06)	165.0 (73.9)
55.0 (3.79)	58.1 (14.5)	190.0 (13.10)	126.9 (52.7)	325.0 (22.41)	166.2 (74.6)
60.0 (4.14)	62.0 (16.7)	195.0 (13.44)	128.7 (53.7)	330.0 (22.75)	167.4 (75.2)
65.0 (4.48)	65.7 (18.7)	200.0 (13.79)	130.4 (54.7)	335.0 (23.10)	168.6 (75.9)
70.0 (4.83)	69.2 (20.7)	205.0 (14.13)	132.1 (55.6)	340.0 (23.44)	169.8 (76.6)
75.0 (5.17)	72.6 (22.6)	210.0 (14.48)	133.8 (56.6)	345.0 (23.79)	171.0 (77.2)
80.0 (5.52)	75.9 (24.4)	215.0 (14.82)	135.5 (57.5)	350.0 (24.13)	172.1 (77.8)
85.0 (5.86)	79.0 (26.1)	220.0 (15.17)	137.1 (58.4)	355.0 (24.48)	173.3 (78.5)
90.0 (6.21)	82.0 (27.8)	225.0 (15.51)	138.7 (59.3)	360.0 (24.82)	174.4 (79.1)
95.0 (6.55)	84.9 (29.4)	230.0 (15.86)	140.2 (60.1)	365.0 (25.17)	175.5 (79.7)
100.0 (6.89)	87.7 (30.9)	235.0 (16.20)	141.8 (61.0)	370.0 (25.51)	176.6 (80.3)
105.0 (7.24)	90.4 (32.4)	240.0 (16.55)	143.3 (61.8)	375.0 (25.86)	177.7 (80.9)
110.0 (7.58)	93.0 (33.9)	245.0 (16.89)	144.8 (62.3)	380.0 (26.20)	178.8 (81.6)
115.0 (7.93)	95.5 (35.3)	250.0 (17.24)	146.3 (63.5)	385.0 (26.54)	179.9 (82.2)
120.0 (8.27)	98.0 (36.7)	255.0 (17.58)	147.7 (64.3)	390.0 (26.89)	180.9 (82.7)
125.0 (8.62)	100.4 (38.0)	260.0 (17.93)	149.2 (65.1)	395.0 (27.23)	182.0 (83.3)
130.0 (8.96)	102.7 (39.3)	265.0 (18.27)	150.6 (65.9)	400.0 (27.58)	183.0 (83.9)

Table 8: R-513A pressure to saturated temperature conversion

Pressure psig (bar)	Temp. avg. °F (°C)	Pressure psig (bar)	Temp. avg. °F (°C)	Pressure psig (bar)	Temp. avg. °F (°C)	Pressure psig (bar)	Temp. avg. °F (°C)
0.0 (0.0)	-20.5 (-29.1)	130 (8.96)	99.3 (37.4)	260 (17.93)	146.7 (63.8)	390 (26.89)	179.1 (81.7)
5.0 (0.34)	-8.4 (-22.4)	135 (9.31)	101.6 (38.7)	265 (18.27)	148.1 (64.5)	395 (27.23)	180.2 (82.3)
10.0 (0.69)	1.4 (-17.0)	140 (9.65)	103.9 (39.9)	270 (18.62)	149.6 (65.3)	400 (27.58)	181.2 (82.9)
15.0 (1.03)	9.8 (-12.3)	145 (10.0)	106.1 (41.2)	275 (18.96)	151.0 (66.1)	405 (27.92)	182.3 (83.5)
20.0 (1.38)	17.2 (-8.2)	150 (10.34)	108.3 (42.4)	280 (19.31)	152.4 (66.9)	410 (28.27)	183.3 (84.1)
25.0 (1.72)	23.8 (-4.5)	155 (10.69)	110.4 (43.5)	285 (19.65)	153.7 (67.6)	415 (28.61)	184.3 (84.6)
30.0 (2.07)	29.8 (-1.2)	160 (11.03)	112.4 (44.7)	290 (19.99)	155.1 (68.4)	420 (28.96)	185.4 (85.2)
35.0 (2.41)	35.3 (1.8)	165 (11.38)	114.5 (45.8)	295 (20.34)	156.4 (69.1)	425 (29.30)	186.4 (85.8)
40.0 (2.76)	40.4 (4.6)	170 (11.72)	116.4 (46.9)	300 (20.68)	157.7 (69.8)	430 (29.65)	187.4 (86.3)
45.0 (3.10)	45.1 (7.3)	175 (12.07)	118.4 (48.0)	305 (21.03)	159.0 (70.6)	435 (29.99)	188.4 (86.9)
50.0 (3.45)	49.5 (9.7)	180 (12.41)	120.3 (49.1)	310 (21.37)	160.3 (71.3)	440 (30.34)	189.4 (87.4)
55.0 (3.79)	53.7 (12.1)	185 (12.76)	122.2 (50.1)	315 (21.72)	161.6 (72.0)	445 (30.68)	190.3 (87.4)
60.0 (4.14)	57.7 (14.2)	190 (13.10)	124.0 (51.1)	320 (22.06)	162.9 (72.7)	450 (31.03)	191.3 (88.5)
65.0 (4.48)	61.5 (16.4)	195 (13.44)	125.8 (52.1)	325 (22.41)	164.1 (73.4)	455 (31.37)	192.2 (89.0)
70.0 (4.83)	65.1 (18.4)	200 (13.79)	127.6 (53.1)	330 (22.75)	165.3 (74.1)	460 (31.72)	193.2 (89.6)
75.0 (5.17)	68.5 (20.3)	205 (14.13)	129.3 (54.1)	335 (23.10)	166.6 (74.8)	465 (32.06)	194.1 (90.1)
80.0 (5.52)	71.9 (21.2)	210 (14.48)	131.0 (55.0)	340 (23.44)	167.8 (75.4)	470 (32.41)	195.1 (90.6)
85.0 (5.86)	75.0 (23.9)	215 (14.82)	132.7 (55.9)	345 (23.79)	168.9 (76.1)	475 (32.75)	196.0 (91.1)
90.0 (6.21)	78.1 (25.6)	220 (15.17)	134.3 (56.8)	350 (24.13)	170.1 (76.7)	480 (33.09)	196.9 (91.6)
95.0 (6.55)	81.0 (27.2)	225 (15.51)	136.0 (57.8)	355 (24.48)	171.3 (77.4)	485 (33.44)	197.8 (92.1)
100.0 (6.89)	83.9 (28.8)	230 (15.86)	137.6 (58.7)	360 (24.82)	172.4 (78.0)	490 (33.78)	198.7 (92.6)
105.0 (7.24)	86.6 (30.3)	235 (16.20)	139.1 (59.5)	365 (25.17)	173.6 (78.7)	495 (34.13)	199.6 (93.1)
110.0 (7.58)	89.3 (31.8)	240 (16.55)	140.7 (60.4)	370 (25.51)	174.7 (79.3)	500 (34.47)	200.4 (93.6)
115.0 (7.93)	91.9 (33.3)	245 (16.89)	142.2 (61.2)	375 (25.86)	175.8 (79.9)	505 (34.82)	201.3 (94.1)
120.0 (8.27)	94.4 (34.7)	250 (17.24)	143.7 (62.1)	380 (26.20)	176.9 (80.5)		
125.0 (8.62)	96.9 (36.5)	255 (17.58)	145.2 (62.9)	385 (26.54)	178.0 (81.1)		

Table 9: R-1234ze pressure to saturated temperature conversion

Pressure psia (bar)	Temperature °F (°C)	Pressure psia (bar)	Temperature °F (°C)	Pressure psia (bar)	Temperature °F (°C)
30.13 (2.08)	30 (-1.1)	65.30 (4.50)	71 (21.7)	125.26 (8.64)	112 (44.4)
30.76 (2.12)	31 (-0.6)	66.43 (4.58)	72 (22.2)	127.10 (8.76)	113 (45.0)
31.40 (2.16)	32 (0.0)	67.58 (4.66)	73 (22.8)	128.97 (8.89)	114 (45.6)
32.05 (2.21)	33 (0.6)	68.74 (4.74)	74 (23.3)	130.86 (9.02)	115 (46.1)
32.70 (2.25)	34 (1.1)	69.91 (4.82)	75 (23.9)	132.77 (9.15)	116 (46.7)
33.37 (2.30)	35 (1.7)	71.11 (4.90)	76 (24.4)	134.70 (9.29)	117 (47.2)
34.05 (2.35)	36 (2.2)	72.31 (4.99)	77 (25.0)	136.65 (9.42)	118 (47.8)
34.74 (2.40)	37 (2.8)	73.54 (5.07)	78 (25.6)	138.62 (9.56)	119 (48.3)
35.44 (2.44)	38 (3.3)	74.78 (5.16)	79 (26.1)	140.62 (9.70)	120 (48.9)
36.15 (2.49)	39 (3.9)	76.03 (5.24)	80 (26.7)	142.63 (9.83)	121 (49.4)
36.87 (2.54)	40 (4.4)	77.30 (5.33)	81 (27.2)	144.67 (9.97)	122 (50.0)
37.61 (2.59)	41 (5.0)	78.59 (5.42)	82 (27.8)	146.73 (10.12)	123 (50.6)
38.35 (2.64)	42 (5.6)	79.89 (5.51)	83 (28.3)	148.81 (10.26)	124 (51.1)
39.11 (2.70)	43 (6.1)	81.21 (5.60)	84 (28.9)	150.91 (10.40)	125 (51.7)
39.87 (2.75)	44 (6.7)	82.54 (5.69)	85 (29.4)	153.03 (10.55)	126 (52.2)
40.65 (2.80)	45 (7.2)	83.89 (5.78)	86 (30.0)	155.18 (10.70)	127 (52.8)
41.44 (2.86)	46 (7.8)	85.26 (5.88)	87 (30.6)	157.35 (10.85)	128 (53.3)
42.24 (2.91)	47 (8.3)	86.65 (5.97)	88 (31.1)	159.54 (11.00)	129 (53.9)
43.06 (2.97)	48 (8.9)	88.05 (6.07)	89 (31.7)	161.75 (11.15)	130 (54.4)
43.88 (3.03)	49 (9.4)	89.47 (6.17)	90 (32.2)	163.99 (11.31)	131 (55.0)
44.72 (3.08)	50 (10.0)	90.90 (6.27)	91 (32.8)	166.25 (11.46)	132 (55.6)
45.57 (3.14)	51 (10.6)	92.36 (6.37)	92 (33.3)	168.54 (11.62)	133 (56.1)
46.43 (3.20)	52 (11.1)	93.83 (6.47)	93 (33.9)	170.84 (11.78)	134 (56.7)
47.30 (3.26)	53 (11.7)	95.32 (6.57)	94 (34.4)	173.17 (11.94)	135 (57.2)
48.19 (3.32)	54 (12.2)	96.82 (6.68)	95 (35.0)	175.53 (12.10)	136 (57.8)
49.09 (3.38)	55 (12.8)	98.34 (6.78)	96 (35.6)	177.91 (12.27)	137 (58.3)
50.00 (3.45)	56 (13.3)	99.89 (6.89)	97 (36.1)	180.31 (12.43)	138 (58.9)
50.93 (3.51)	57 (13.9)	101.45 (6.99)	98 (36.7)	182.74 (12.60)	139 (59.4)
51.87 (3.58)	58 (14.4)	103.02 (7.10)	99 (37.2)	185.19 (12.77)	140 (60.0)
52.82 (3.64)	59 (15.0)	104.62 (7.21)	100 (37.8)	187.66 (12.94)	141 (60.6)
53.78 (3.71)	60 (15.6)	106.23 (7.32)	101 (38.3)	190.16 (13.11)	142 (61.1)
54.76 (3.78)	61 (16.1)	107.87 (7.44)	102 (38.9)	192.69 (13.29)	143 (61.7)
55.75 (3.84)	62 (16.7)	109.52 (7.55)	103 (39.4)	195.24 (13.46)	144 (62.2)
56.75 (3.91)	63 (17.2)	111.19 (7.67)	104 (40.0)	197.81 (13.64)	145 (62.8)
57.77 (3.98)	64 (17.8)	112.88 (7.78)	105 (40.6)	200.42 (13.82)	146 (63.3)
58.80 (4.05)	65 (18.3)	114.59 (7.90)	106 (41.1)	203.04 (14.00)	147 (63.9)
59.85 (4.13)	66 (18.9)	116.32 (8.02)	107 (41.7)	205.70 (14.18)	148 (64.4)
60.91 (4.20)	67 (19.4)	118.07 (8.14)	108 (42.2)	208.37 (14.37)	149 (65.0)
61.99 (4.27)	68 (20.0)	119.83 (8.26)	109 (42.8)	211.08 (14.55)	150 (65.6)
63.07 (4.35)	69 (20.6)	121.62 (8.39)	110 (43.3)	213.81 (14.74)	151 (66.1)
64.18 (4.42)	70 (21.1)	123.43 (8.51)	111 (43.9)	216.57 (14.93)	152 (66.7)

Checking and trimming the refrigerant charge

It is important that the amount of chiller refrigerant charge is verified to meet the specified amount as found in the chiller factory order form (FOF). Reference this document or the unit sales order screen on the chiller control panel to determine the amount charge required based on the chiller rating.

During operation, the refrigerant charge level is correct when the Evaporator Approach (STD), Condenser Approach (STD), Sub-Cooling, and Compressor Discharge Superheat are at the design values for the condition. For new sales after 2016, these design values are included as part of the FOF. For older units that are not included on the FOF, they are provided upon request from the chillers sales engineer from the chiller rating program. These depend on tube selection, chilled fluid type, operating head, and operating condition. The following equations define these parameters. Condenser level/Sub-cooling is detected by the liquid level sensor and controlled to the programmed set-point by the chiller control logic.

Equations:

- Evaporator approach = (LCHLT) - (EST)
- Discharge superheat = (CDT) - (CST)

Definitions (based on OptiView panel operation data):

- EST = Evaporator saturation temperature
- LCHLT = Leaving evaporator liquid temperature
- CDT = Compressor discharge temperature
- CST = Condenser saturation temperature

The parameters can be viewed on the OptiView Control Center. The chiller must be at full load design operating conditions so that the correct refrigerant charge level can be properly determined when operating. When the correct condenser level is set to maintain the design sub-cooling, the evaporator approach and discharge superheat are a function of the amount of charge that are now maintained in the evaporator. To lower evaporator STD and compressor discharge superheat, the refrigerant charge is added to the system. If greater details are needed, contact product technical support (PTS) for guidance.

Checking the refrigerant charge during unit shutdown

The refrigerant charge is specified for each chiller model. Charge the correct amount of refrigerant and record the level in the evaporator sight glass. This is only an effective method if the chiller is a flooded evaporator and has been idle at normal ambient conditions for greater than 24 hours. If there has been water flow in either circuit in that time, this not a valid method.

The refrigerant charge level must be checked after the pressure and temperature have equalized between the condenser and evaporator. This may be 24 hours or more after the compressor and water pumps are stopped. The level is visible in the sight glass.

Trimming can only be performed when the chiller is operational using design operating criteria to evaluate the charge amount.

Charge the refrigerant in accordance with the method described in Checking and trimming the refrigerant charge. Observe the refrigerant level and record the level recorded after initial charging.

Handling refrigerant for dismantling and repairs

If it becomes necessary to open any part of the refrigerant system for repairs, it is 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 evaporator/compressor while making any necessary repairs.

Megging the motor

Proceed in accordance with the type of starter.

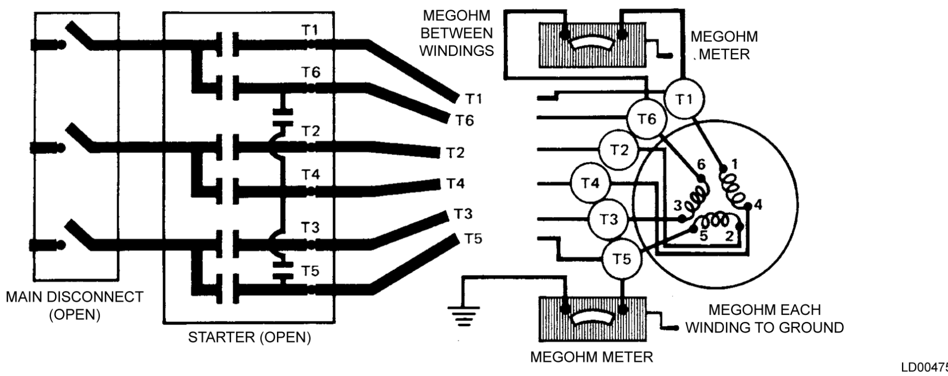
Megging the motor with a mechanical starter

While the main disconnect switch and compressor motor starter are open, meg the motor as follows:

1. Using a megohm meter (megger), meg between phases and each phase to ground. See Figure 17. Interpret these readings using the graph shown in Figure 19.
2. If readings fall below the shaded area, remove the external leads from the motor and repeat the test.

   Note: Meg the motor with the starter at ambient temperature after 24 hours of idle standby.

Figure 17: Megging the motor windings - mechanical starter



Megging the motor with a VFD powered or solid state soft starter

1. Disconnect power leads from VFD or solid state starter to the motor. This is required so that only the motor is subjected to the applied voltage from the megger tester.
2. Using a megohm meter (megger), meg between phases and each phase to ground. See Figure 18. Interpret these readings using the graph in Figure 19.

Figure 18: Megging the motor - VFD or solid state soft started motors

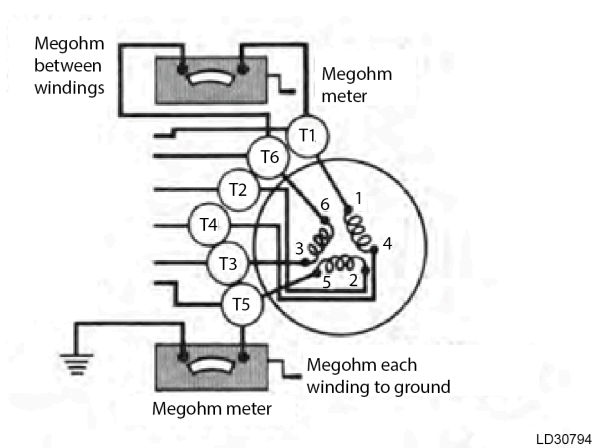
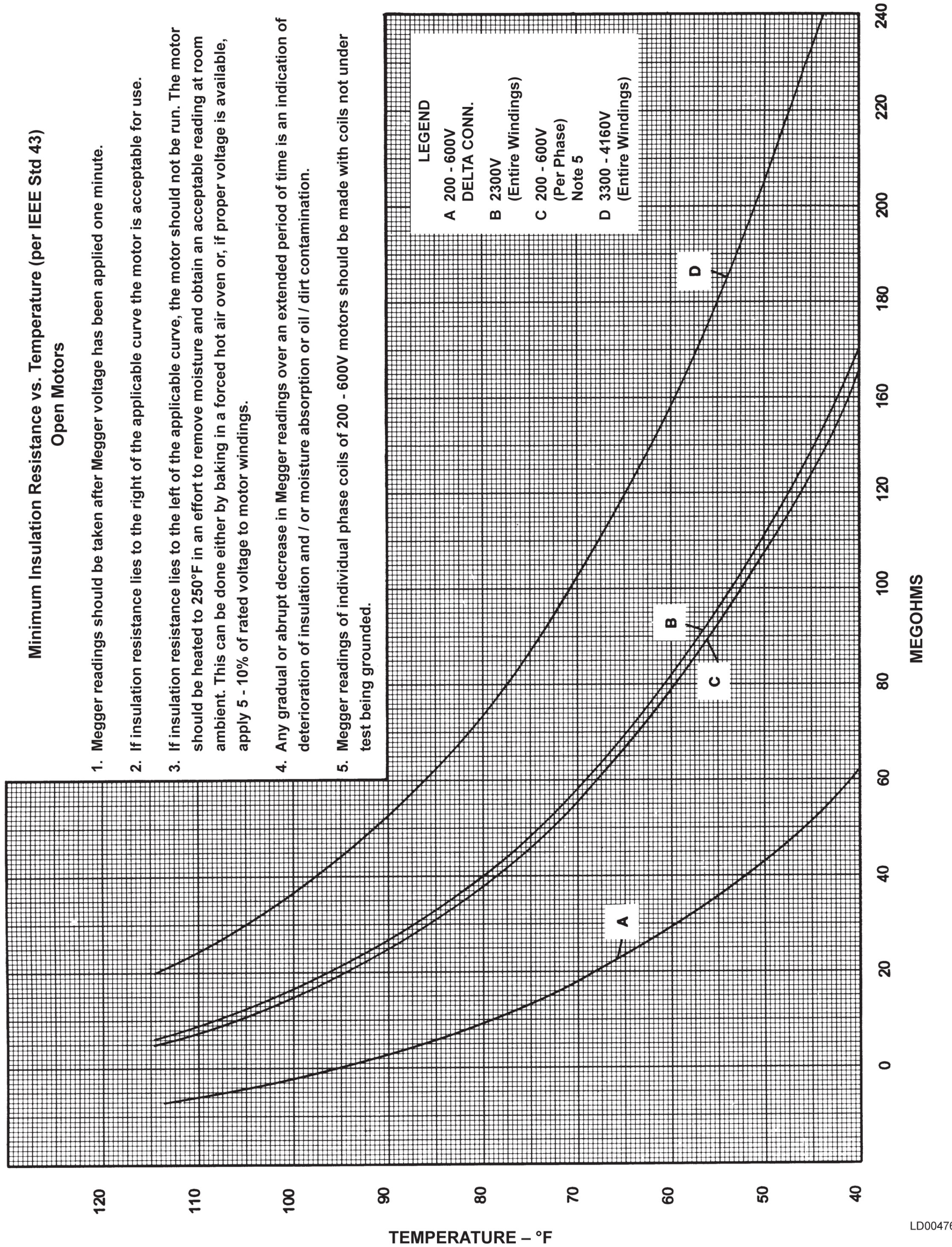


Figure 19: Motor starter temperature and insulation resistances



Condensers and evaporators

Maintenance of the 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. Correct maintenance such as tube cleaning, and testing for leaks, is covered in this section.

Chemical water treatment

Because the mineral content of the water circulated through evaporators and condensers varies with almost every source of supply, it is possible that the water being used 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 that can 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 correct treatment for the particular water condition.

Cleaning evaporator and condenser tubes

Evaporator

It is difficult to determine by any particular test if the possible lack of performance of the water evaporator is due to fouled tubes alone or due to a combination of troubles. Trouble that is caused by fouled tubes is indicated when, over a period of time, the cooling capacity decreases and the split increases. The split is the temperature difference between water leaving the evaporator and the refrigerant temperature in the evaporator.

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. An excessive quantity of oil in the evaporator can also contribute to erratic performance.

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 may also be due to foul gas buildup. Purging removes the foul gas revealing the effect of fouling.

Tube fouling

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

1. **Rust or sludge** Finds its way into the tubes where it accumulates. 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** Occurs 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 consists of dirt and sludge, it can usually be removed by a brushing process. Drain the water sides of the circuit that needs 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 in. pipe with a few small holes at the brush end and connecting the other end by means of a hose to the water supply.

The tubes must always be brush cleaned before acid cleaning.

Acid cleaning of tubes

If the tubes are fouled with a hard scale deposit, they may require acid cleaning. Before acid cleaning, it is important to clean the tubes using the brushing process first. If the relatively loose foreign material is removed before the acid cleaning, the acid solution has less material to dissolve and flush from the tubes. This results in a more satisfactory cleaning job and a potential saving of time.

WARNING

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

In many major cities, commercial organizations now offer a specialized service of acid cleaning evaporators and condensers. Consider using this type of company if acid cleaning is required. 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.

Testing for evaporator and condenser tube leaks

About this task:
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 severe rusting and corrosion. If a tube leak is indicated, the exact location of the leak can be determined by completing the following steps:

1. Remove the heads and listen at each section of tubes for a hissing sound that would indicate gas leakage. This assists in locating the section of tubes to be further investigated. 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 must be investigated.
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. As soon as the tubes are clear, drive a cork into each end of the tube. Pressurize the dry system with 50 psig to 100 psig (345 kPa 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. Allow the evaporator or condenser to remain corked up to 12 hours 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, it is necessary to make a very thorough test with the leak detector.

4. After the tubes have been corked for 12 hours to 24 hours, carefully test each tube. Two operators work at both ends of the evaporator, with one operator 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 is 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 ensures that any leakage travels through the tube to the detector.
5. Mark any leaking tubes for later identification.
6. If any of the tube sheet joints are leaking, the leak is indicated by the detector. If a tube sheet leak is suspected, its exact location can be found by using a soap solution. A continuous buildup of bubbles around a tube indicates a tube sheet leak.

Compressor

Maintenance for the compressor assembly consists of completing 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 a serious problem caused by incorrect 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 (OP), 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 to accumulate 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 the presence of a Johnson Controls Service Technician.

Electrical controls

For information covering the OptiView Control Center operation, refer to the *OptiView Control Center – Operation and Maintenance (Form 160.54-O1)*.

Preventive maintenance

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

Important: If a unit failure occurs due to incorrect 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 its functioning parts to keep it operating at its peak efficiency. Perform the following maintenance when prescribed.

Compressor

1. **Oil filter:** When oil pump VSD frequency increases to 55 Hz to maintain target oil pressure. When you change the oil filter, inspect it thoroughly for any aluminum particles indicating possible bearing wear. If aluminum particles are found, bring this to the attention of the nearest Johnson Controls office for their further investigation.
2. **Oil changing:** Each chiller and its operating conditions are unique, so Johnson Controls recommends as a best practice to change the oil if oil testing results indicate any of the parameters are outside of the limits that are published in *Form 50.40-O1*. Contact your local Johnson Controls office for guidance in understanding these limits.

Compressor motor

1. Check the motor mounting screws frequently to insure tightness.
2. Meg the motor windings annually to check for any deterioration of the windings.

Greased bearings

Motor Operation and Maintenance manuals are supplied with the chillers providing maintenance schedules and instructions for the specific motors. The following are lubrication schedules for the most common motors:

RAM motor lubrication

Frames 143T through 256T are furnished with double sealed ball bearings, pre-lubricated prior to installation. Grease fittings are not supplied and bearings are designed for long life under standard conditions.

Frames 284T through 587UZ are furnished with double shielded or open ball or roller bearings. It is necessary to relubricate anti-friction bearings periodically. See Table 10

Table 10: Bearing lubrication

Frame size	Standard 8 hr day	Continuous 24 hr day	Grease quantity, oz
143T to 256T	7 years	3 years	1
284TS to 286TS	210 days	70 days	1
324TS to 587USS	150 days	50 days	2

Note: On frame sizes 143T to 256T, it is best practice to change bearings at these intervals. However, removing the seal, cleaning, and refilling the bearing and the cavity with industry-standard grease can relubricate these bearings.

The following greases can be used for standard applications at an operating ambient temperature from -30°C to 50°C:

- Chevron® SRI grease (Chevron Corporation)
- UNIREX® N 2 grease (Exxon Mobil Corporation)
- POLYREX® grease (Exxon Mobil Corporation)
- Shell® Dolium R grease (Shell Oil Company)

For lubrication of TECO-Westinghouse motors:

- Relubricate at 1000 operating hour intervals.
- Refer to manufacturer for applicable greases.
- Motors with shaft diameters less than 2 3/8 in. (60 mm) require 1 oz of grease per bearing, while motors with shaft diameters between 2 3/8 in. (60 mm) and 3 in. (76 mm) require 1.5 oz of grease per bearing.

WARNING

It is best practice not to mix different greases.

Note: Additional information on motor lubrication and other service issues can be found in the A-C Motors Instruction Manual.

Leak testing

Leak test the unit monthly. Repair any leaks found immediately.

Evaporator and condenser

The major portion of the maintenance of the condenser and evaporator involves maintaining the water side of the condenser and evaporator in a clean condition.

The use of untreated water in cooling towers, closed water systems, for example, frequently results in one or more of the following conditions:

1. Scale formation
2. Corrosion or rusting
3. Slime and algae formation

Providing correct water treatment ensures a longer and more economical life of the equipment. Perform these tasks to determine the condition of the water side of the condenser and evaporator tubes.

1. Clean the condenser tubes annually or earlier if conditions warrant. If the temperature difference between the water off the condenser and the condenser liquid temperature is more than 4°F (2.2°C) greater than the difference recorded on a new unit, it is a good indication that the condenser tubes require cleaning. See Maintenance in this manual for condenser tube cleaning instructions.
2. Under normal circumstances, the evaporator tubes do 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 waterbox requiring gasket replacement or refrigerant may have leaked from the chiller.

3. Evaluate heat recovery condenser tubes in a similar manner to evaporator tubes when the heating circuit is a treated, closed loop. Fouling could be detected as the ability to meet heat load requirements decreases.

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, check the nozzle of the eductor for any foreign particles that may be obstructing the jet.

Electrical controls

1. Inspect all electrical controls for obvious malfunctions.
2. **Do not** change the factory settings of controls (operation and safety). If the settings are changed without Johnson Controls approval, the warranty will be jeopardized.

Table 11: Maintenance requirements

Maintenance requirements for YORK YK chillers					
Procedure	**Daily**	**Weekly**	**Monthly** [3]	**Yearly**	**Other**
Record the operating conditions on applicable Log Form.	X				
Check the oil levels.	X				
Check the refrigerant levels.		X			
Check the oil return system operation.			X		
Check the operation of the motor starter.			X		
Check the sump heater and thermostat operation.			X		
Check the three-phase voltage and current balance.			X		
Verify proper operation, setting, and calibration 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 the motor windings.				X	
Replace the oil filter and oil return filter and driers.				X	
Clean or backflush the heat exchanger (VSD, SSS applications).				X	
Replace the starter coolant (VSD, SSS applications).				X	
Replace or clean the starter air filters if applicable.				X [2]	
Perform oil analysis on the compressor lube oil. [1]				X	
Perform refrigeration analysis. [1]				X	
Perform vibration analysis.				X	
Clean the tubes.				X[2]	
Check the compressor thrust end-play of the low speed shaft. [4]				X	
For HYP Model VSDs only, conduct Smart Sensor annual test.				X	
Perform eddy current testing and inspect the tubes.					2–5 years
Change compressor oil.					Refer to *50.40-O1*
Lubricate the motor.	Refer to motor manufacturer's recommendations				

Note: For the operating and maintenance requirements listed in the previous table, refer to the appropriate service literature, or contact your local Johnson Controls Service Office. The equipment owner must maintain a record on file of all procedures being successfully carried out (as well as operating logs), should proof of adequate maintenance be required at a later date for warranty 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.
3. Monthly items are still required and appear on OptiView as a quarterly maintenance warning item.
4. Ensure limits are within the published limits of the appropriate compressor service manual.

Unit conversion

The following factors can be used to convert from imperial to the most common SI metric values.

Table 12: SI metric conversion

Measurement	Multiply imperial unit	By factor	To obtain metric unit
Capacity	Tons refrigerant effect (ton)	3.516	Kilowatts (kW)
Power	Horsepower (hp)	0.7457	Kilowatts (kW)
Flow rate	Gallons / minute (gpm)	0.0631	Liters / second (L/s)
Length	Feet (ft)	0.3048	Meters (m)
	Inches (in.)	25.4	Millimeters (mm)
Weight	Pounds (lb)	0.4536	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 = 7.22°C

To convert a temperature range (that is, 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