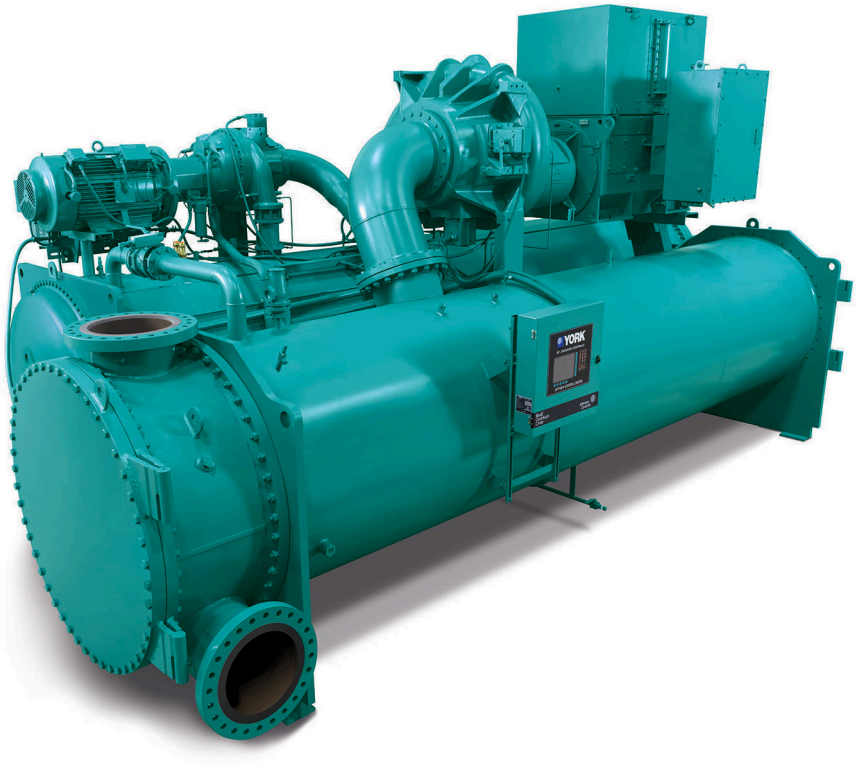
YK-EP Style B Centrifugal Chiller with Economizer Compressor, Installation and Reassembly

Field Reassembly - Forms 2, 3, and 7 Shipment for Model YK-EP Style B, 2,500–3,500 Tons, 8,800–12,300 kW, R-134a



Installation Guide

Form Number: 160.87-N1 (1223)

Issue Date: 2023-12-22

Supersedes: 160.87-N1 (420)

Contents

General safety guidelines

Important: Read before proceeding.

This equipment is a relatively complicated apparatus. During rigging, installation, operation, maintenance, or service, individuals may 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 improperly, to cause bodily injury or death. It is the obligation and responsibility of rigging, installation, and operating/service personnel to identify and recognize these inherent hazards, protect themselves, and proceed safely in completing their tasks. Failure to comply with any of these requirements could result in serious damage to the equipment and the property in which it is situated, as well as severe personal injury or death to themselves and people at the site.

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

Safety symbols

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

DANGER

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

WARNING

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

CAUTION

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

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

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 Johnson Controls' published specifications and must be performed only by a qualified electrician. Johnson Controls will NOT be responsible for damage/problems resulting from improper connections to the controls or application of improper control signals. Failure to follow this warning will void the manufacturer's warranty and cause serious damage to property or personal injury.

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. 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.

Changeability of this document

In complying with the 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/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/service personnel should verify whether the equipment has been modified and if current literature is available from the owner of the equipment prior to performing any work on the chiller.

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

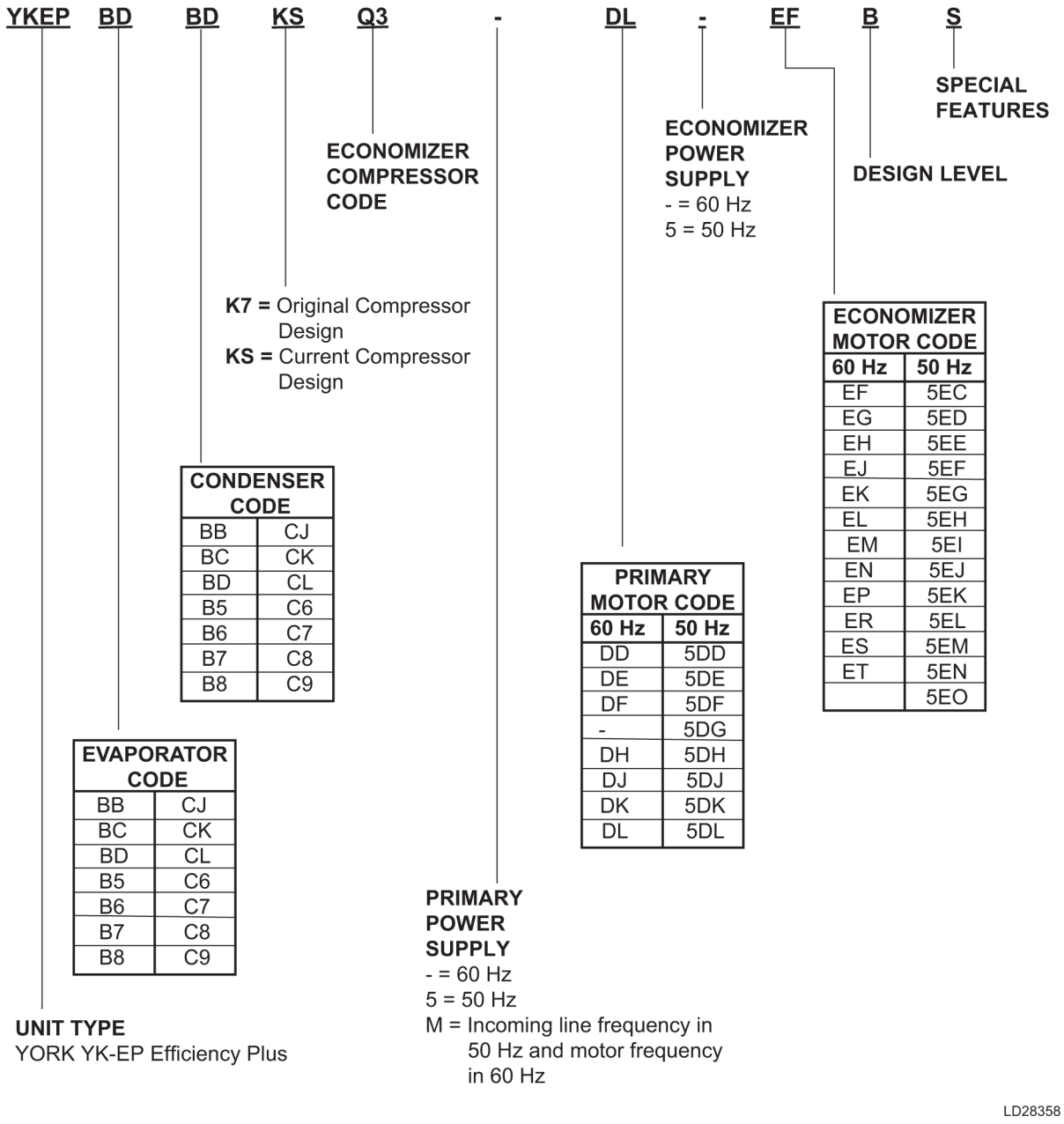
Affected pages	Description
6	Added refrigerant warning.

Associated literature

Table 2: Associated literature

Manual description	Form number
YK-EP Installation Checklist and Request for Startup Engineer	160.87-CL1
YK-EP Startup Checklist	160.87-CL2
YK-EP Maintenance Log Sheet	160.87-MR1
YK-EP Installation and Reassembly	160.87-N1
YK-EP Operation Manual	160.87-OM1
Wiring Diagram - YK-EP Style B Chillers with OptiView™ Control Center Water Pump Starters	160.87-PW1
Wiring Diagram - YK-EP Style B Chillers with OptiView™ Control Center Field Control Modifications	160.87-PW2
Wiring Diagram - YK-EP Style B Chillers with OptiView™ Control Center and Electromechanical Starter	160.87-PW4
Wiring Diagram - YK-EP Style B Chillers with OptiView™ Control Center and Modbus SSS/VSD	160.87-PW5
Wiring Diagram - YK-EP Style B Chillers Field Connections for Medium Voltage VSD	160.87-PW8
Wiring Diagram - YK-EP Style B Chillers with OptiView™ Control Center and Motor Monitoring	160.87-PW11
Wiring Diagram - YK-EP Style B Chillers with OptiView™ Control Center and Motor Space Heater	160.87-PW12
Liquid Cooled Solid State Starter - Operation	160.00-O2
Operation - Medium Voltage Variable Speed Drive (2300 V – 6600 V)	160.00-O6
Operation - Unit Mounted Medium Voltage Solid State Starter (2300 V – 4160 V)	160.00-O7
Operation - Medium Voltage Variable Speed Drive (10000 V – 13800 V)	160.00-O8
Long-Term Storage Requirements - General	50.20-NM1
Long-Term Storage Requirements - Field Preparation	50.20-NM5
Long-Term Storage - Periodic Checklist and Logs	50.20-CL5

Nomenclature



Introduction

General

This manual provides general and step-by-step instructions for rigging, reassembling, and installing a YK-EP Centrifugal Liquid Chiller.

The YK-EP unit can be shipped as a single factory assembled piped, wired package, requiring a minimum of field labor to make chilled water connections, condenser water connections, and electrical power connections. Refrigerant and oil are shipped separately.

A Johnson Controls service technician may supervise or perform the final leak testing, charging, and initial start-up and operation of all YK-EP chillers.

Components

YK-EP chillers are equipped with the following:

- Single-Stage Flash Economizer
- Primary Compressor: KS (Model YDHJ-119VDDN) or K7 (Model YDHJ-119VDD)
- Economizer Compressor: Q3 (Model HF416)
- YORK Unit-Mounted Low-Voltage Solid State Starter (LV-SSS) acting as the economizer compressor starter

The primary compressor starter, both compressor motors, the evaporator, and the condenser are job-specific. Table 3 lists all allowable motor code combinations for these components.

Figure 1 and Figure 2 identify the major YK-EP components.

Table 3: Available 60/50 Hz compressor/shell/motor combinations

Compressor code	Evaporator code	Condenser code	Motor codes - 60 Hz		
			Primary		
			Low voltage (SSS)	Medium voltage	
				EM / SSS / VSD	
KS/K7-Q3	BB, BC, BD, B5, B6, B7, B8, CJ, CK, CL, C6, C7, C8, C9		EF, EG, EH, EJ, EK, EL, EM, EN, EP, ER, ES, ET	-DD to -DL	
Voltage (V)			380 up to 480	2300 up to 4160	2300 up to 4160
Compressor code	Evaporator code	Condenser code	Motor codes - 50 Hz		
			Economizer		
			Low voltage (SSS)	Medium voltage	
				EM / SSS / VSD	
KS/K7-Q3	BB, BC, BD, B5, B6, B7, B8, CJ, CK, CL, C6, C7, C8, C9		5EC, 5ED, 5EE, 5EF, 5EG, 5EH, 5EI, 5EJ, 5EK, 5EL, 5EM, 5EN, 5EO	5DD to 5DL	
Voltage (V)			380 up to 415	2300 up to 3300	3300

Note: For unit voltages above 4160 V/60 Hz and 3300 V/50 Hz, contact your local Johnson Controls Service office for a specific selection.

Figure 1: YK-EP major components front view

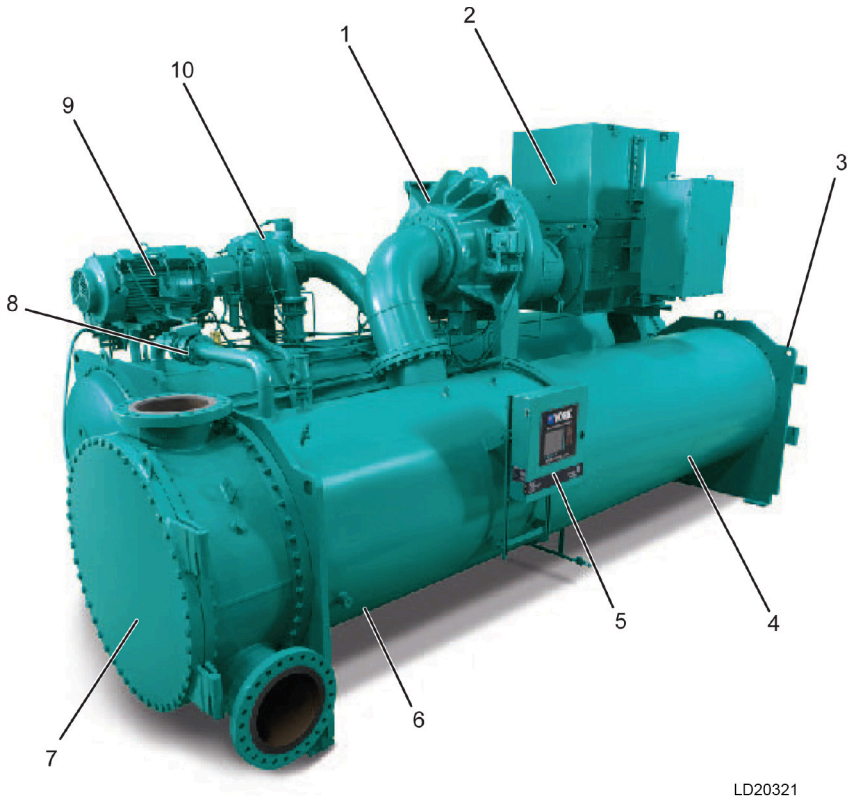


Table 4: Front view legend

Component	Description
1	Primary compressor
2	Open drive motor (primary)
3	Rigging location
4	Evaporator
5	OptiView™ panel
6	Sight glass
7	Marine waterboxes (optional)
8	Hot gas bypass (optional)
9	Open drive motor (economizer)
10	Economizer compressor

Figure 2: YK-EP major components rear view

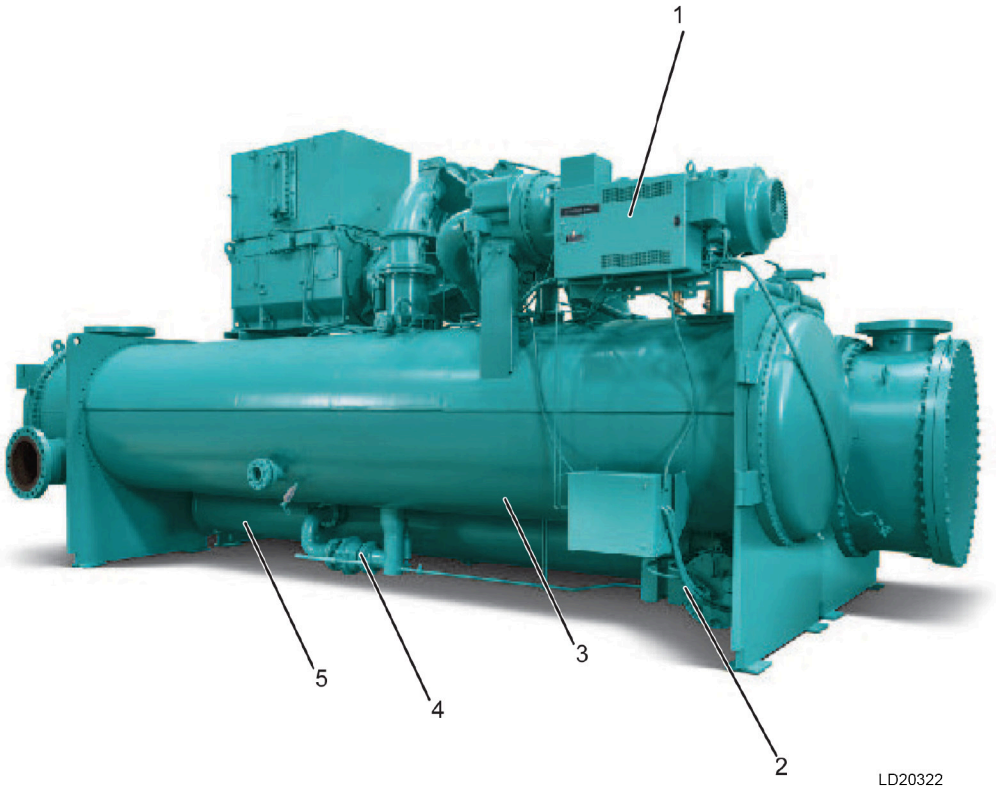


Table 5: Rear view legend

Component	Description
1	Economizer solid-state-starter
2	Oil pump
3	Condenser
4	Isolation valve
5	Economizer

Starters

The Q3 compressor motor is always equipped with a YORK Unit-Mounted Liquid Cooled Solid State Starter (LC-SSS).

The KS or K7 compressor motor can be equipped with one of three YORK starters, or a customer supplied starter.

Available YORK starters include the following:

- Floor-mounted Medium-Voltage Variable Speed Drive (MV-VSD), see Figure 3
- Unit-mounted MV-SSS, see Figure 4
- Floor-mounted MV-SSS

Customer-supplied starters must be floor-mounted.

Figure 3: Medium voltage VSD

LD15104

Figure 4: Medium voltage SSS

LD15105

Table 6 lists the available YORK and customer supplied starter options for the KS or K7 motor.

Table 6: YORK YK-EP primary compressor motor starter options

Starter options	Variable speed drive	Solid state		Across-the-line	Auto transformer	Primary reactor
Assembly	Floor mounted	Unit mounted	Floor mounted	Floor mounted	Floor mounted	Floor mounted
Voltage	Medium	Medium		Medium	Medium	Medium
60 Hz	2300 to 13800	2300-4160	2300 to 13200	2300 to 13200	2300 to 13200	2300 to 13200
50 Hz	3300 to 11000	3300	2300 to 11000	2300-4160	2300 to 11000	2300 to 11000

Shipment

This section describes how the units are shipped. Many limitations can affect the installation or rigging to the final location. Due to the overall size of the YK-EP chiller, the major components are separated after the final assembly. These major components are as follows: evaporator, condenser/economizer, primary driveline, secondary driveline, suction piping, and miscellaneous chiller components. These separated components must be reassembled at the final installation location.

Before shipping, the unit is completely assembled at the factory. Interconnecting piping is assembled and the complete unit is wired and leak-tested.

A protective covering is furnished on the drivelines, control center, VSD, and unit-mounted controls. Water nozzles are capped with fitted plastic enclosures.

The YK-EP chiller can be shipped in the following assemblies and subassemblies.

Form 2

Factory Assembled unit, shipped as one assembly. The unit will be shipped complete with leak testing, evacuation and charged with a holding charge of nitrogen. The unit will contain the factory assembled driveline assembly, economizer, control panel, wiring, oil piping, and if ordered optional unit mounted starters. See Figure 7 for more information.

Miscellaneous material – vibration isolators, refrigerant and oil will be shipped separately.

Form 3

Driveline Separate from shells. The unit will be shipped as three major assemblies. The unit is first factory assembled as a complete unit, refrigerant piped, wired, and leak tested then dismantled for shipment. See Figure 8 for more information.

The factory assembled primary driveline will be removed from the shells, and skidded for ease of installation. The secondary economizer driveline will also be removed and skidded for ease of installation.

All system wiring and refrigerant piping will remain on the unit. All shell openings are closed with flanges and the heat exchangers charged with dry nitrogen (2 to 3 psig or 115/122kPA).

Miscellaneous material – vibration isolators, refrigerant and oil will be shipped separately.

Form 7

Split shells. The unit is shipped as four major assemblies. The unit is first factory assembled as a complete unit, refrigerant piped, wired, and leak tested, then dismantled for shipment. The K3, K4, and KS or K7 compressor size units mandate the use of Form 7 shipment.

The primary driveline and economizer driveline assemblies are removed from the shells and skidded. See Figure 9.

Evaporator and condenser shells are separated at the tubes sheets, and skidded if ordered as the optional feature. Refrigerant lines between the shells are flanged and capped, requiring no welding.

All wiring integral with the compressor is left on it. All wiring harnesses on the shells are removed. All openings on the compressor and shells are closed and charged with dry nitrogen (2 to 3 psig, or 115 to 122 kPa).

Miscellaneous

The OptiView™ control center, primary suction line, secondary suction line, tubing, water temperature controls, wiring, oil, isolators, are packaged separately. Refrigerant charge is also shipped separately.

⚠ CAUTION

The Johnson Controls Warranty may be voided if the following restrictions are not followed:

1. No valves or connections should be opened under any circumstances. Such actions will result in the loss of the factory nitrogen charge.
2. Do not dismantle or unwrap the chiller for any reason except under the supervision of a Johnson Controls representative.
3. The YK-EP chiller is shipped dismantled; notify the nearest Johnson Controls office in ample time for a Johnson Controls representative to supervise rigging the unit to its operating position and the assembly of components. Refer to the *YK-EP Installation Checklist (Form 160.87-CL1)* for detailed instructions.
4. Do not make final power supply connections to the compressor motor drive or control center.
5. Do not charge the unit with refrigerant.
6. Do not attempt to start the system.
7. Do not run hot water (110°F/43°C maximum) or steam through the evaporator or condenser at any time.

ⓘ **Note:** YK-EP chillers MUST be reassembled by, or under the supervision of, a Johnson Controls representative.

ⓘ **Note:** When more than one chiller is involved, the major parts of each unit will be marked to prevent mixing of assemblies. Piping and wiring drawings to be furnished by Johnson Controls.

ⓘ **Note:** Refrigerant charges are shipped separately. Arrangements must be made with the local service office to ensure refrigerant is on-site when unit is ready to be charged.

Primary driveline

The primary driveline (compressor/motor assembly) is removed from shells and skidded.

- All integral wiring is left on the compressor.
- All wiring harnesses on shells are removed.
- All openings on the compressor are closed and shipped charged with a 2 psig to 3 psig (115 kPa to 122 kPa) holding charge of dry nitrogen.

Economizer driveline

The economizer driveline (compressor/motor assembly) is removed from shells and skidded.

- All integral wiring is left on the compressor.
- All wiring harnesses on shells are removed.
- All openings on the compressor are closed and shipped charged with a 2 psig to 3 psig (115 kPa to 122 kPa) holding charge of dry nitrogen.

Shells

The evaporator and condenser are split apart at the tube sheets and prepared for shipping separately but not skidded. The condenser and economizer are joined at the factory and shipped as a single assembly.

- All conduit is left on the shells.
- Refrigerant lines between shells are flanged and capped, requiring no welding.
- All openings on the shells are closed and charged with a 2 psig to 3 psig (115 kPa to 122 kPa) holding charge of dry nitrogen.

Miscellaneous items

The following assemblies and items are shipped together:

- OptiView™ Control Center.
- Eight vibration isolation pads (or optional four spring isolators and brackets).
- VSD inhibitor, if the VSD is supplied.
- Other shipped loose items, including standard piping, economizer piping, water temperature controls, wiring, isolators, and similar components.

Variable Speed Drive (VSD) optional

If a VSD is supplied, it is skidded and shipped separately from the assembled chiller. The VSD is filled with glycol for shipping. The VSD Inhibitor is shipped with the other loose items.

Inspection

Check the unit shipment on arrival to ensure that all major components, boxes, and crates are received and that they are undamaged. Check all components against the packing list.

Damage

Check each unit on the trailer or rail car when received, before unloading, for any visible signs of damage. Report any damage or signs of possible damage to the transportation company immediately for their inspection.

Note: Johnson Controls is not responsible for any damage in shipment or at job site or loss of parts. Refer to *Shipping Damage Claims Form (Form 50.15-NM).*

Shortage

After inspecting the assemblies for damage, open all containers and check the contents against the packing list. Report any material shortage to Johnson Controls immediately. Refer to *Shipping Damage Claims Form (Form 50.15-NM)*.

Chiller data plate

A unit data plate is mounted on the control center assembly of each unit. The data plate provides the following information:

- Unit model number
- Design working pressure
- Water passes
- Refrigerant charge
- Serial numbers
- Motor power characteristics and connection diagrams

Additional information may be found on the motor data plates. Include this information when contacting the factory for problems related to the motor.

Long-term storage

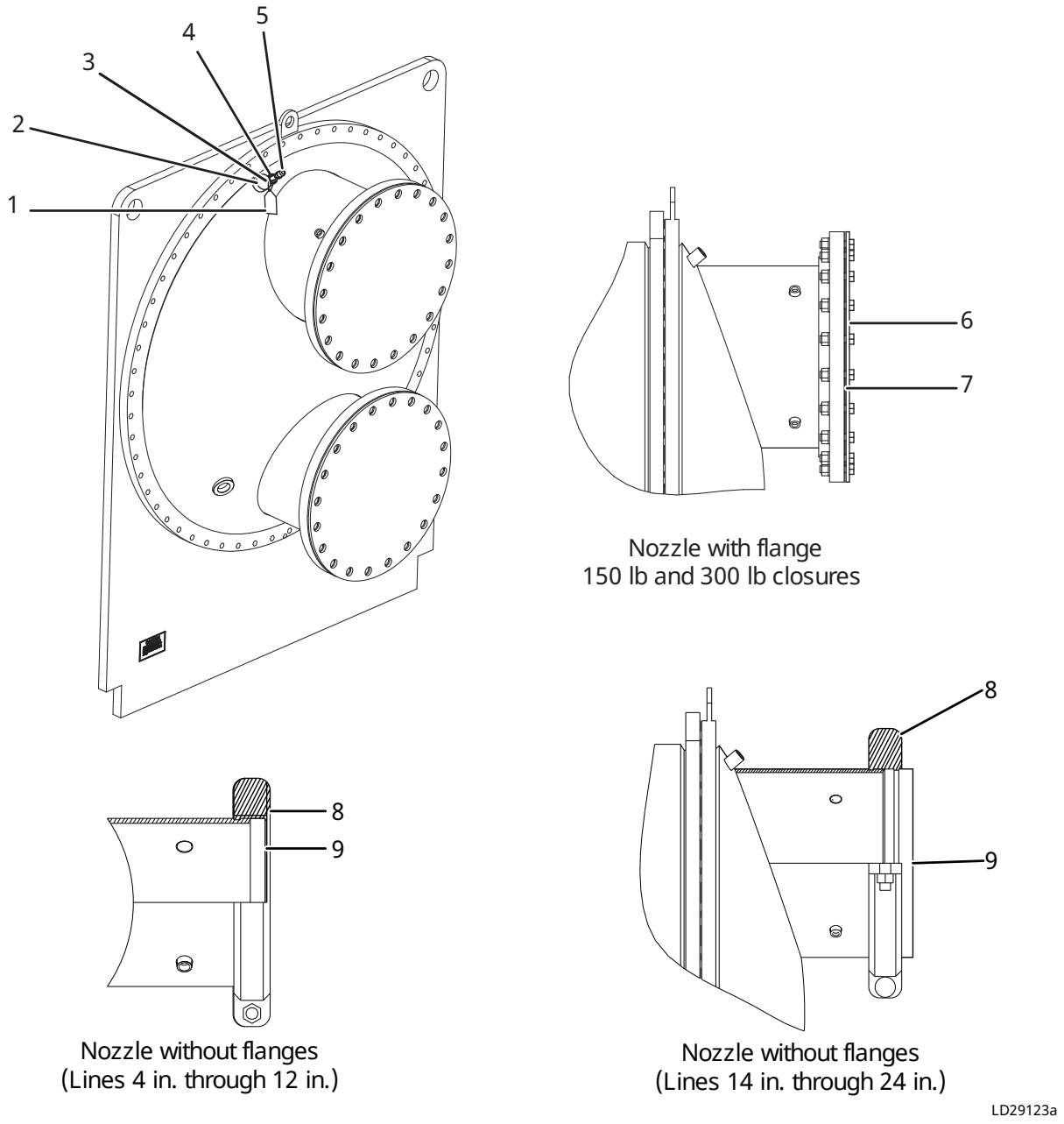
To protect the waterbox of pressure vessels from rusting, the tube side (water side) is purged and charged with nitrogen to a positive pressure of 5 psig to 7 psig.

Do not break the seal or remove closures until you are ready to set up. Relieve pressure as described in the following procedure, see Figure 5.

WARNING

Failure to follow the following procedures will cause severe personal injury or death to operators themselves or people on-site. It is the obligation and responsibility of operators to identify and recognize the inherent hazards of material under pressure and to protect themselves.

Figure 5: Long term storage - tube side



Item	Description
1	Tag warning Denison 8E
2	Gauge press 2 dia. 0-30
3	Tag glvst wire speed
4	Bush pipe 3/4 - 14 NPTE X
5	Valve, transducer 1/4 NPTE X
6	Flange cover
7	Gasket

Item	Description
8	Victaulic coupling
9	Sealing cap

Relieve pressure as follows:

1. Check the working space to make sure that it is open and has a good ventilation; if not, connect a hose or pipe to the valve (Item 5) and route it to outside.
2. Slowly open the valve (Item 5) until it is fully open.
3. Monitor the pressure gauge (Item 2). The pressure declines gradually.
4. When the pointer of the pressure gauge does not move and no nitrogen comes out of the valve (Item 5), it means that no positive pressure exists in the waterbox.
5. Remove the flange cover (Item 6) or sealing cap (Item 9).
6. Close the valve (Item 5) and remove the warning tag (Item 1).

Shipment Form 2/3/7/9

All openings on the compressor, shells including evaporator and condenser, and oil reservoir are closed and charged with nitrogen (2 psig to 3 psig). Removing the closures, sealing caps, or sealing plug under pressure is extremely dangerous, and may cause severe injury or death to the operator or people on-site.

⚠ WARNING

Before trying to remove the closures, caps, or plugs on compressor and shells, relieve the pressure in compressor, shells, or system that are charged with nitrogen by opening the valves on them slowly until fully open.

⚠ WARNING

When relieving the pressure from compressor, shells, or system, conduct the nitrogen to outside to prevent the potential risk of asphyxiation.

Shipment Form 1/10

The unit is shipped with refrigerant charge; it is not needed to relieve the pressure. Do not try to open any valves to relieve pressure or open closures, cap, or plugs on the compressor, shells, and elsewhere on the system.

Reclaim the refrigerant in the system before performing any service activity to the refrigeration system. Fully relieve system pressure and then repair.

DANGER

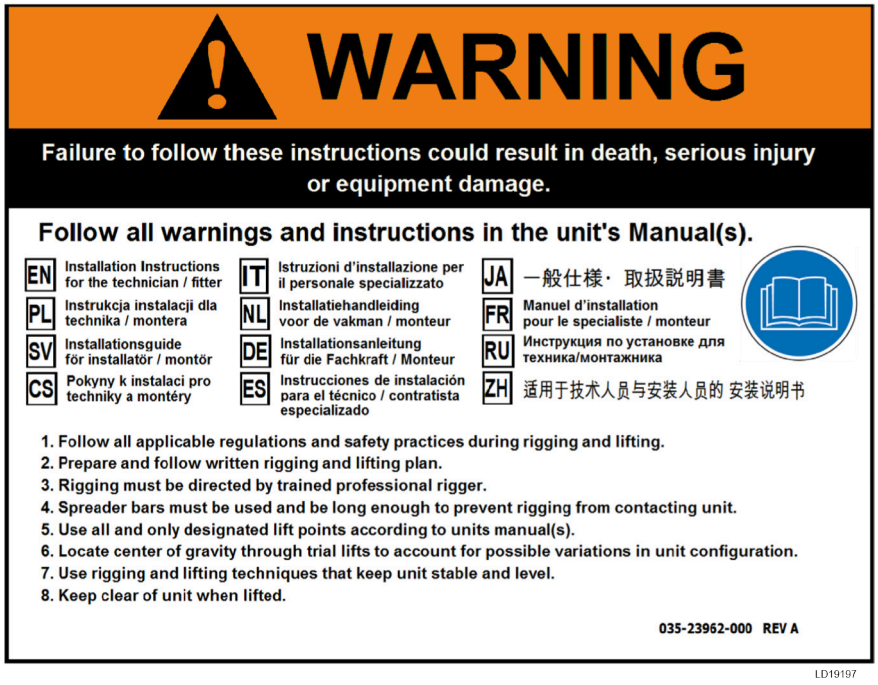
The unit is charged with tons of refrigerant. If an uncontrollable leak is found, inform all of the relevant people to evacuate from the building to prevent asphyxiation.

Never touch the refrigerant that is leaking, especially the liquid refrigerant; this will cause severe freezing to your hands or body.

Installation and reassembly

Rigging

Figure 6: Rigging warning



DANGER

Rigging and lifting should only be done by a professional rigger in accordance with a written rigging and lifting plan. The most appropriate rigging and lifting method will depend on job specific factors, such as the rigging equipment available and site needs. Therefore, a professional rigger must determine the rigging and lifting method to be used, and it is beyond the scope of this manual to specify rigging and lifting details.

Read this entire section before performing any installation or reassembly of the chiller.

The standard chiller is shipped as separate components on skids. It may be necessary to remove the skids so that riggers skates can be used under the unit end sheets to reduce overall height.

Each unit has four lifting holes (two in each end) in the end sheets. Use these lifting holes to lift the unit.

Care should be taken at all times during rigging and handling of the chiller to avoid damage to the unit and its external connections.

CAUTION

Do not lift the unit with slings around motor/compressor assembly or by means of eyebolts in the tapped holes of the compressor motor assembly. Do not turn a unit on its side for rigging. Do not rig vertically.

The rigging and operating weights are given in Table 7 as a guide in determining the weight of the unit for rigging. For exact unit weights, refer to the final sales order documents.

Figure 7: YK-EP chiller Form 2 shipment

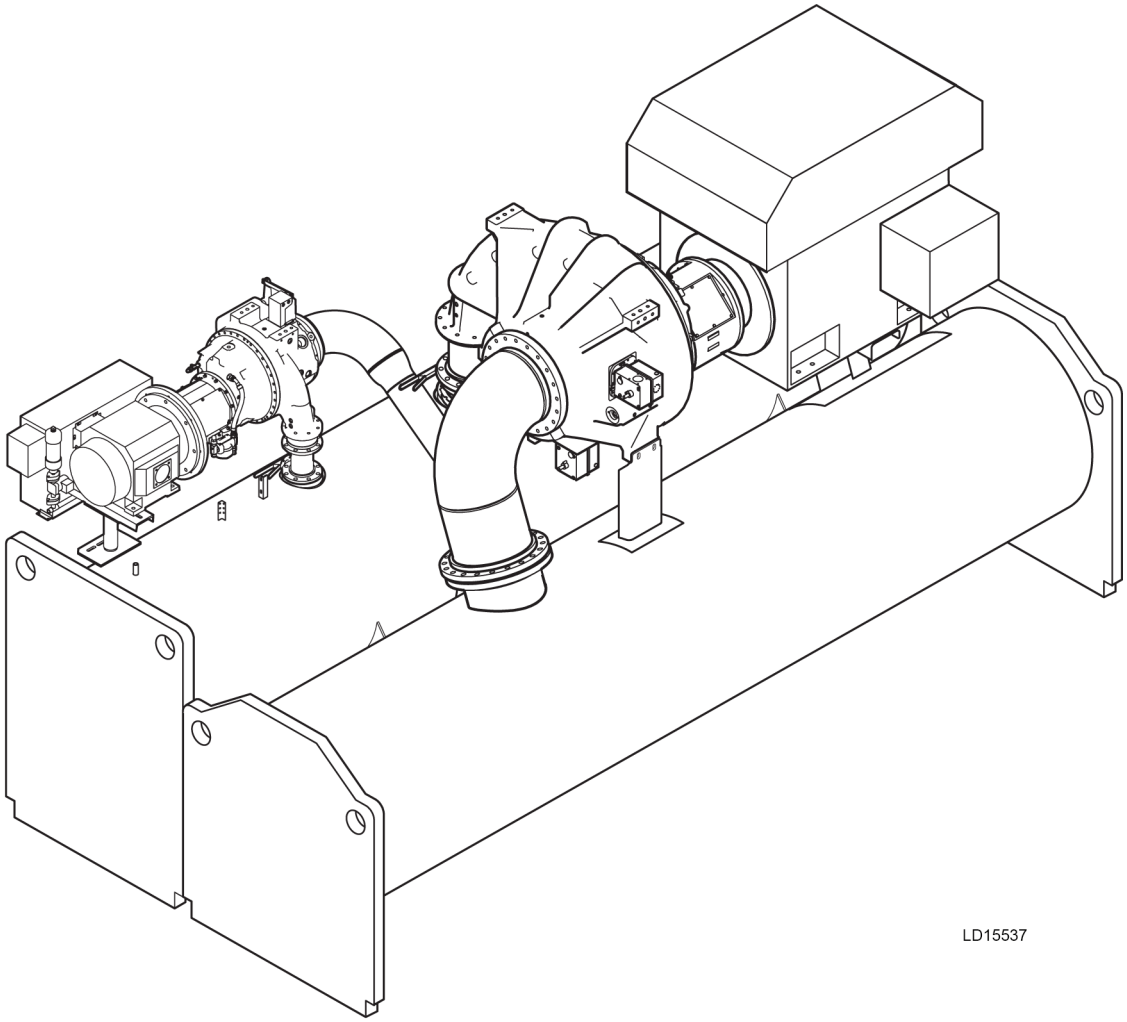


Figure 8: YK-EP chiller Form 3 shipment

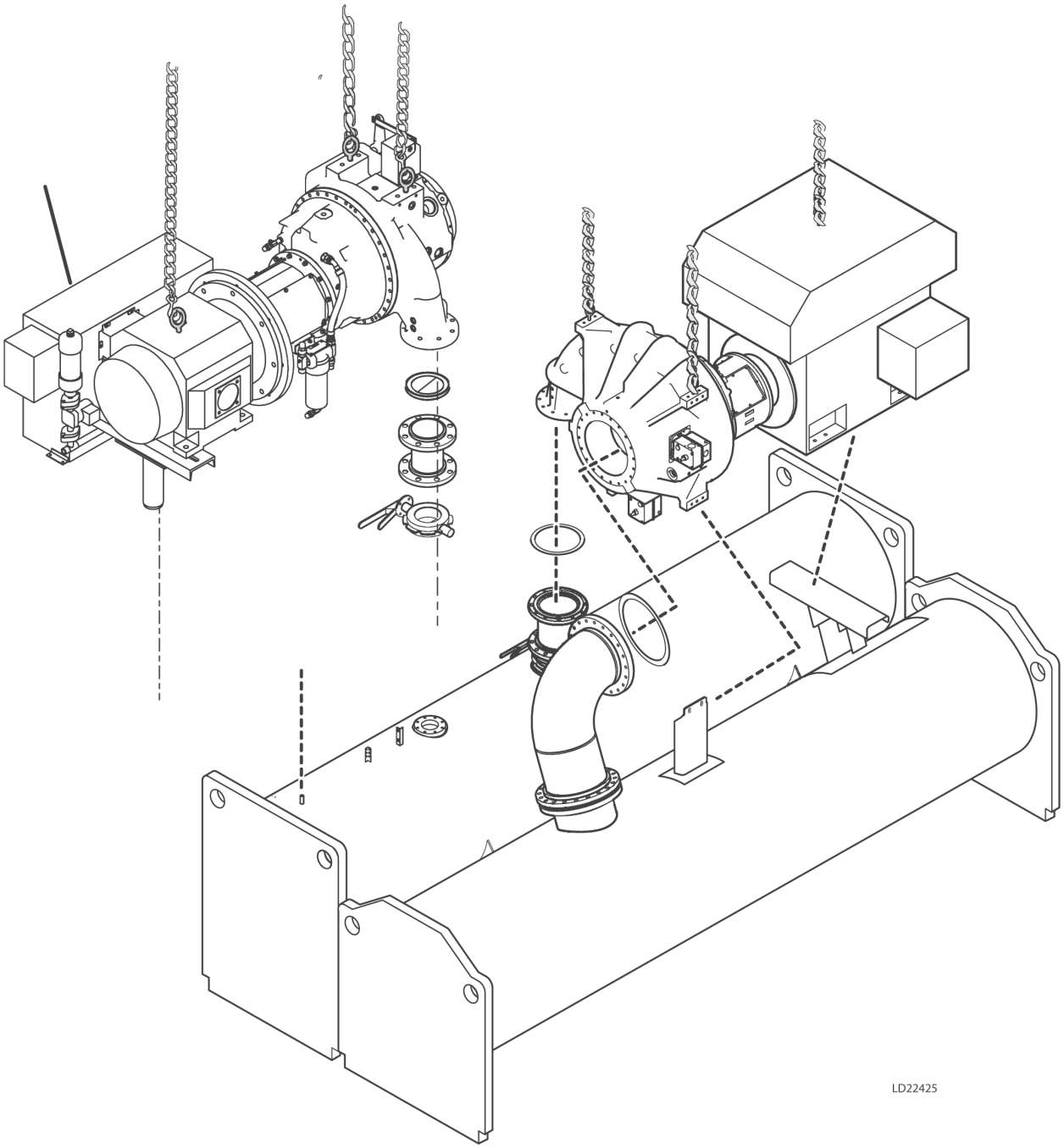
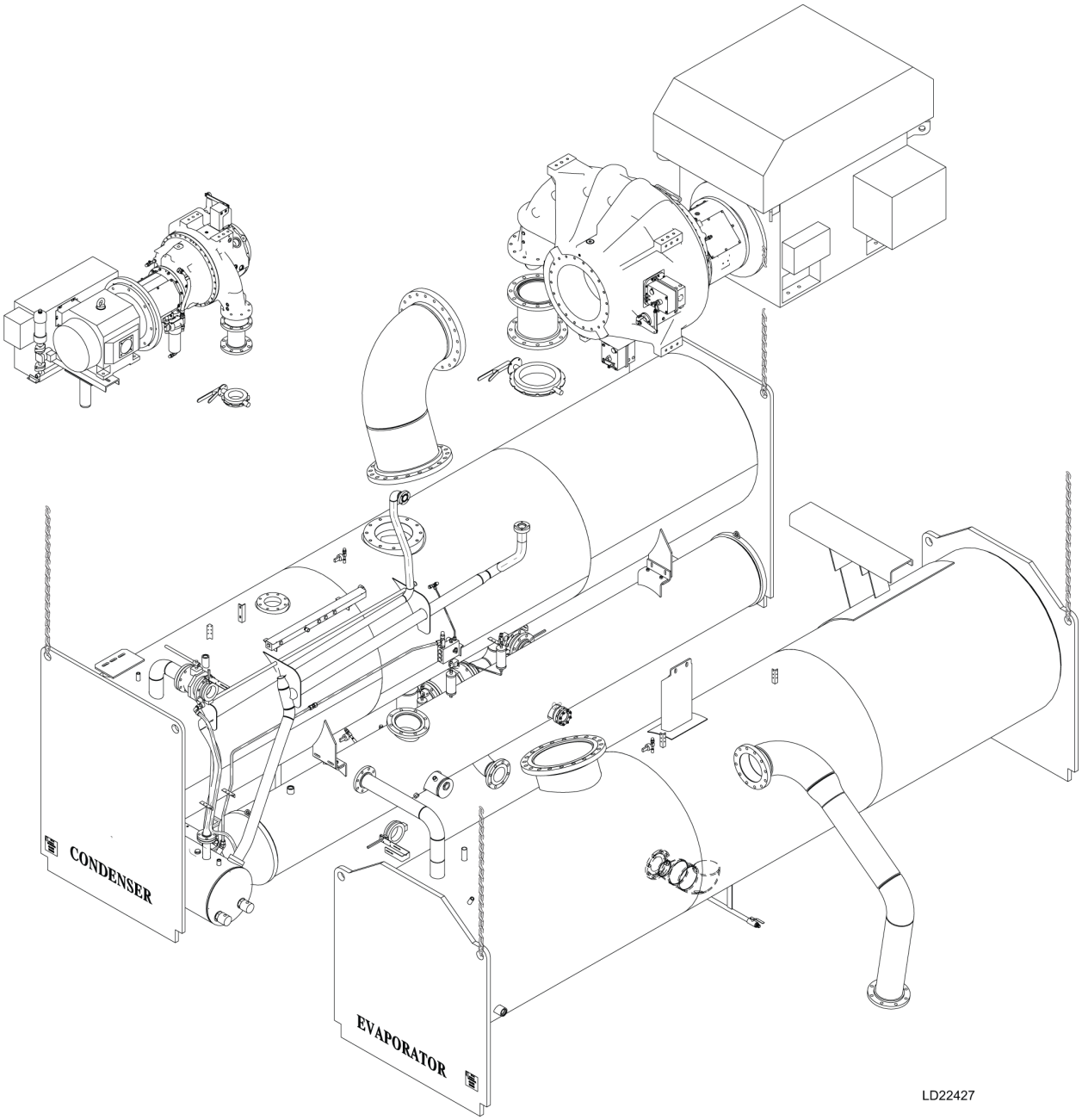


Figure 9: YK-EP chiller Form 7 shipment



Weights

Table 7: Approximate unit weight including motor only (without waterbox)*

Shells	Shipping weight, lb (kg)	Operating weight, lb (kg)	Shells	Shipping weight, lb (kg)	Operating weight, lb (kg)
B5-B5	76,946 (34,902)	91,793 (41,637)	**C6-B5**	82,766 (37,542)	98,451 (44,657)
B5-BD	84,164 (38,176)	100,493 (45,583)	**C6-BD**	88,534 (40,158)	105,702 (47,946)
B5-C6	75,371 (34,188)	90,302 (40,960)	**C6-C6**	81,191 (36,828)	96,960 (43,980)
B5-CL	82,961 (37,630)	100,651 (45,654)	**C6-CL**	88,781 (40,270)	107,309 (48,675)
B6-B5	77,933 (35,350)	92,964 (42,168)	**C7-B5**	83,993 (38,099)	99,916 (45,321)
B6-BD	81,901 (37,150)	98,414 (44,640)	**C7-BD**	87,961 (39,898)	105,367 (47,794)
B6-C6	76,358 (34,635)	91,473 (41,491)	**C7-C6**	82,418 (37,384)	98,425 (44,645)
B6-CL	83,948 (38,078)	101,822 (46,186)	**C7-CL**	90,008 (40,827)	108,774 (49,339)
B7-B5	78,715 (35,704)	93,891 (42,588)	**C8-B5**	85,306 (38,694)	101,487 (46,034)
B7-BD	82,683 (37,504)	99,342 (45,061)	**C8-BD**	89,274 (40,494)	106,937 (48,506)
B7-C6	77,140 (34,990)	92,400 (41,912)	**C8-C6**	83,731 (37,980)	99,996 (45,357)
B7-CL	84,730 (38,433)	102,749 (46,606)	**C8-CL**	91,321 (41,422)	110,345 (50,052)
B8-B5	79,518 (36,069)	94,848 (43,022)	**C9-B5**	86,279 (39,135)	102,651 (46,562)
B8-BD	83,486 (37,869)	100,298 (45,494)	**C9-BD**	90,247 (40,935)	108,101 (49,034)
B8-C6	77,943 (35,354)	93,357 (42,346)	**C9-C6**	84,704 (38,421)	101,160 (45,885)
B8-CL	85,533 (38,797)	103,706 (47,040)	**C9-CL**	92,294 (41,864)	111,509 (50,580)
BB-B5	78,949 (35,811)	93,384 (42,358)	**CJ-B5**	87,260 (39,580)	108,172 (49,066)
BB-BD	82,917 (37,610)	98,834 (44,830)	**CJ-BD**	91,228 (41,380)	113,622 (51,538)
BB-C6	77,374 (35,096)	91,893 (41,682)	**CJ-C6**	85,685 (38,866)	106,681 (48,390)
BB-CL	84,964 (38,539)	102,241 (46,376)	**CJ-CL**	93,275 (42,309)	117,030 (53,084)
BC-B5	80,593 (36,556)	95,179 (43,172)	**CK-B5**	88,362 (40,080)	104,268 (47,295)
BC-BD	84,561 (38,356)	100,629 (45,645)	**CK-BD**	92,330 (41,880)	109,718 (49,767)
BC-C6	79,018 (35,842)	93,688 (42,496)	**CK-C6**	86,787 (39,366)	102,777 (46,619)
BC-CL	86,608 (39,285)	104,036 (47,190)	**CK-CL**	94,377 (42,809)	113,126 (51,313)
BD-B5	82,411 (37,381)	97,231 (44,103)	**CL-B5**	89,390 (40,547)	105,629 (47,912)
BD-BD	86,379 (39,181)	102,681 (46,575)	**CL-BD**	93,358 (42,346)	111,080 (50,385)
BD-C6	80,836 (36,667)	95,740 (43,427)	**CL-C6**	87,815 (39,832)	104,138 (47,236)
BD-CL	88,426 (40,109)	106,089 (48,121)	**CL-CL**	95,405 (43,275)	114,487 (51,930)

Note:

*For total unit weight, add an additional twice desired evaporator waterbox weight plus twice condenser waterbox weight.

This table does not include UM starter weights, presented in the performance page for each selection.

The following evaporator waterbox weights are to be added to the standard unit weights shown in Table 7.

Table 8: Evaporator waterbox weights*

Shells	Shipping weight add - lbs (kg)			Operating weight add - lbs (kg)		
	1-Pass	2-Pass	3-Pass	1-Pass	2-Pass	3-Pass
B_-__ (compact)	563 (256)	1,253 (569)	652 (296)	2,742 (1,244)	3,432 (1,557)	2,831 (1,285)
C_-__ (compact)	667 (303)	1,468 (666)	774 (352)	4,199 (1,905)	5,000 (2,268)	4,306 (1,954)
B_-__ (marine)**	3,011 (1,366)	3,700 (1,679)	3,134 (1,422)	8,348 (3,787)	7,135 (3,237)	8,028 (3,642)
C_-__ (marine)**	4,227 (1,918)	5,087 (2,308)	4,390 (1,992)	12,178 (5,524)	9,839 (4,463)	11,772 (5,340)

Note:

*Waterbox weights are for each (one) side of the shell.

**Marine waterbox weight includes the weight of the cover plate.

The following condenser waterbox weights are to be added to the standard unit weights shown in Table 7.

Table 9: Condenser waterbox weights*

Shells	Shipping weight add - lbs (kg)			Operating weight add - lbs (kg)		
	1-Pass	2-Pass	3-Pass	1-Pass	2-Pass	3-Pass
__-B_ (compact)	426 (194)	913 (415)	467 (212)	1,642 (745)	2,129 (966)	1,683 (764)
__-C_ (compact)	644 (293)	1,370 (622)	708 (322)	2,406 (1,092)	3,132 (1,421)	2,470 (1,121)
__-B_ (marine)**	3,024 (1,372)	3,478 (1,578)	3,069 (1,393)	8,305 (3,768)	6,141 (2,786)	7,300 (3,312)
__-C_ (marine)**	3,527 (1,600)	4,251 (1,929)	3,620 (1,643)	11,022 (5,000)	8,436 (3,827)	10,133 (4,597)

Note:

*Waterbox weights are for each (one) side of the shell.

**Marine waterbox weight includes the weight of the cover plate.

Unit installation and reassembly

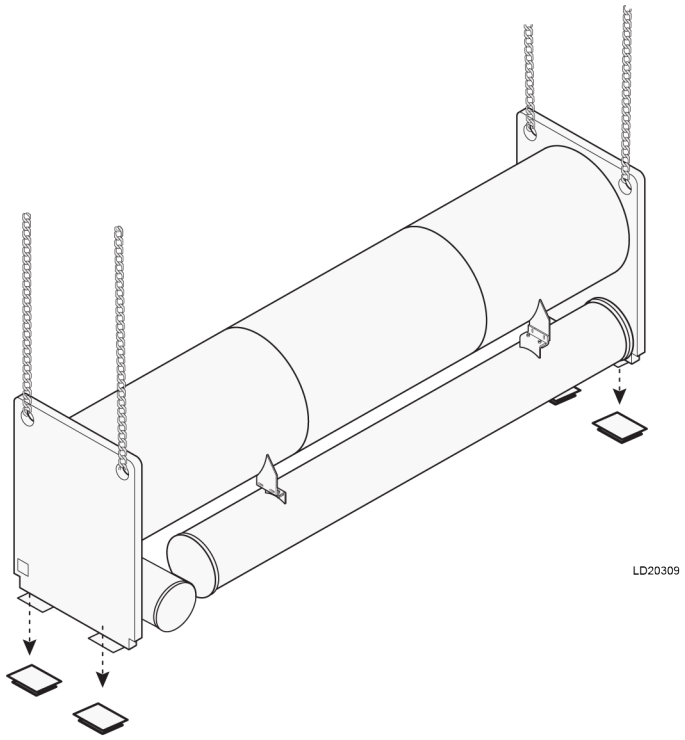
The following is a list of procedures for installing and reassembling the YK-EP chiller. These procedures differ from standard YK chiller installation and must be performed in the order they are presented to allow for connections which must be made prior to rigging the evaporator.

1. Determine the final location.
2. Install the condenser/economizer assembly and rig to final location.
3. Install vibration isolators to the condenser/economizer assembly.
4. Install the economizer driveline.
5. Install the economizer suction pipe.
6. Install the economizer relief piping.
7. Apply the insulation to economizer (optional).
8. Install the evaporator and rig to final location.
9. Install vibration isolators to the evaporator.
10. Bolt the condenser and evaporator together.
11. Level the unit.
12. Install the primary driveline.
13. Rig the primary compressor to condenser.
14. Install the primary compressor starter.
15. Make refrigerant and oil piping connections.

16. Install the control panel.

    Note: When installing refrigerant piping, see Assembly of SAE straight thread O-ring port fittings.

Figure 10: YK-EP chiller with KS or K7 and Q3 compressors



Determine final location

The rigging and operating weights, are provided in Table 7. Dimensions are shown in Figure 44 and Table 16.

Units may be located on upper floor levels providing the floor is capable of supporting the total unit operating weight and if optional spring isolators are used.

The chiller should be located in an indoor location where temperatures range from 40°F to 110°F (4.4°C to 43.3°C).

CAUTION

Sufficient clearance to facilitate normal service and maintenance work must be provided around and above the unit. In particular, space must be provided at either end to permit cleaning or replacement of evaporator and condenser tubes. A properly located doorway or other sufficiently large opening may be used.

Foundation requirements

A level floor, mounting pad or foundation must be provided by others, capable of supporting the operating weight of the unit.

Clearance requirements

The following clearances should be adhered to:

Table 10: Clearance requirements

Location	Clearance
Rear and above unit	2 ft (61 cm)
Front of unit	3 ft (91 cm)
Tube removal	25 ft (7.6 m) either end

Note: Assemble units under the supervision of a Johnson Controls representative.

Refrigerant tubing reassembly

Use the following procedure to reassemble the chiller refrigerant piping.

Assembly of SAE straight thread O-ring port fittings

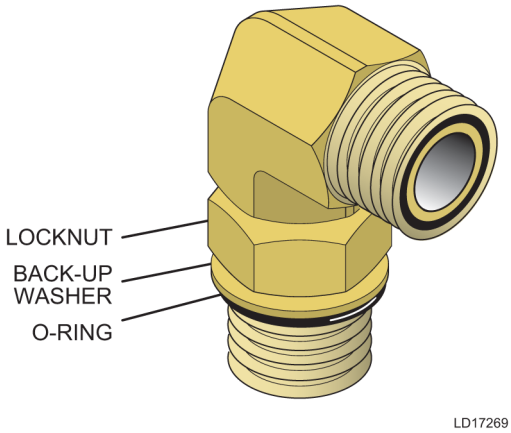
About this task:
The male and female ends of SAE straight thread O-ring ports have UN/UNF straight threads. An elastomeric O-ring is fitted to the male end. See Figure 11.

During assembly, the O-ring is firmly inserted between the angular sealing surface of the female port and the shoulder of the male end. Sealing is affected and maintained by the O-ring compression, which results from the clamping force generated by tightening.

The straight threads do not offer sealing action. They provide the resistance (holding power) for service pressure.

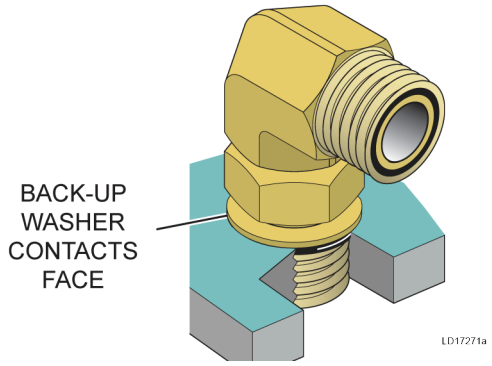
1. Inspect to ensure that both matching parts are free of burrs, nicks, scratches, or any foreign particles.
2. Install the O-ring on the port end of fitting, if it is not preinstalled. Take care not to nick the O-ring.
3. Lubricate the O-ring with a light coat of synthetic Polyolester (POE) oil or POE grease.
4. Back off the locknut as far as possible. Make sure that the back-up washer is not loose and is pushed up as far as possible.

Figure 11: Adjustable end fitting



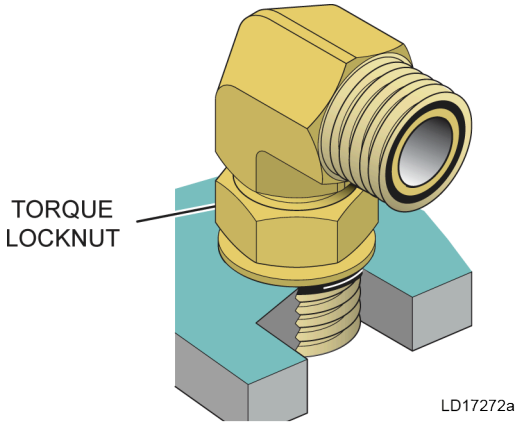
5. Screw fitting into port until the back-up washer contacts the face of the port (see Figure 12). Light wrenching may be necessary.

Figure 12: Screw fitting into port



6. To align the tube end of fitting to accept the incoming tube or hose assembly, unscrew by required amount, but not more than one full turn.
7. Using two wrenches, hold the fitting in the desired position and tighten the locknut (see Figure 12) to the appropriate torque value shown in Table 11.

Figure 13: Torque fitting



8. Inspect to ensure that O-ring is not pinched and the back-up washer seats flat on the face of the port.

Table 11: Assembly torque

Tube size	SAE straight thread size (O-ring part number)	SAE straight thread torque (ft-lb)
1/4 in.	7/16-20 (028-12961-001)	15
3/8 in.	9/16-18 (028-12961-003)	35
1/2 in.	3/4-16 (028-12961-004)	60
5/8 in.	7/8-14 (028-12961-005)	100
3/4 in.	1 1/16-12 (028-12961-006)	135
1 in.	1 5/16-12 (028-12961-008)	200
1-1/4 in.	1 5/8-12 (028-12961-017)	250

Table 11: Assembly torque

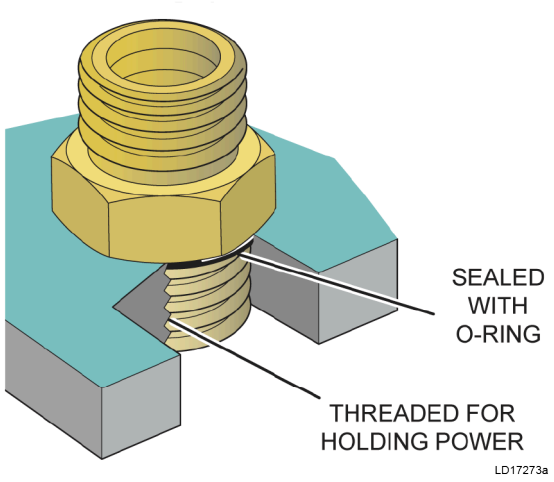
Tube size	SAE straight thread size (O-ring part number)	SAE straight thread torque (ft-lb)
1-1/2 in.	1 7/8-12 (028-12961-020)	305
**	2 1/4-12 (028-12961-)	225

Note: ** = SAE sightglass

Straight non-adjustable end assembly

1. Inspect to ensure that both matching parts are free of burrs, nicks, scratches or any foreign particles.
2. Install O-ring on port end of fitting, if it is not pre-installed. Use care not to nick the O-ring.
3. Lubricate O-ring with a light coat of synthetic Polyolester (POE) oil or POE grease.
4. Screw fitting into port until the hex flat contacts the port face (see Figure 12). Light wrenching may be necessary.
5. Tighten to the specified size and torque found in Table 11.

Figure 14: SAE straight thread O-ring port



Assembly of O-ring face seal fittings

The male end and female nut of face seal fittings have UN/UNF straight threads. An elastomeric O- ring is fitted into the grooved male end. During assembly, the O-ring is firmly sandwiched between the sealing surfaces. Sealing is maintained by the O-ring compression which results from the clamping force generated by tightening the nut. The straight threads do not offer sealing action, but they do provide the resistance (holding power) for service pressure.

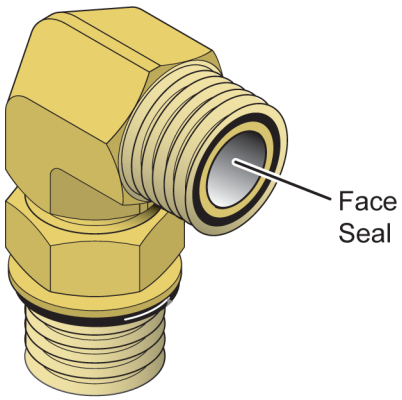
O-ring face seal assembly

1. Inspect to ensure that both matching parts are free of burrs, nicks, scratches, or any foreign particles.
2. Install the O-ring in the grooved face seal end of fitting, if it is NOT pre-installed. Use care not to nick the O-ring.
3. Lubricate the O-ring with a light coat of synthetic Polyolester (POE) oil or POE grease.
4. Thread the nut by hand, and tighten it to the appropriate torque value shown in Table 12.

Table 12: Face seal torque

Face seal tube-side thread size (O-ring part number)	Face seal tube-side torque (ft-lb)
9/16-18 (028-12961-011)	10-12
11/16-16 (028-12961-012)	18-20
13/16-16 (028-12961-013)	32-35
1-14 (028-12961-014)	46-50
1-3/16-12 (028-12961-015)	65-70
1-7/16-12 (028-12961-016)	92-100
1-11/16-12 (028-12961-022)	125-140
2-12-UN2A (028-12961-019)	150-165

Figure 15: Face seal



Install condenser/economizer assembly

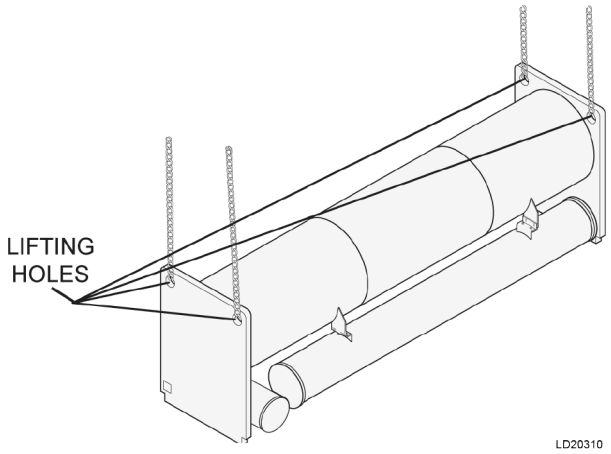
Rig to final location

Care should be taken at all times during rigging and handling of the condenser/economizer assembly to avoid damage to it and its external connections.

It may be necessary to remove the skids so that rigger's skates can be used under the unit end sheets to reduce overall height.

1. Affix rigging chains from overhead lift to the four lifting holes (two at the top of each end sheet) of the assembly as shown in Figure 16.
2. Lift the assembly by means of an overhead lift to the unit's final location on the floor or mounting pad.
3. Suspend rigging and install vibration isolators.

Figure 16: Rigging the condenser



Install vibration isolators

Two types of isolators can be installed and adjusted to ensure that the chiller is properly leveled and aligned on the floor: neoprene pads or spring isolators.

Neoprene pad isolators

If the unit is to be placed on pads, the condenser and evaporator shells will each ship with two mounting feet welded to the bottom of each end sheet. The unit mounting feet must make direct contact with the neoprene. One pad is used for each mounting foot on the unit. See Figure 18.

Spring isolators

If the unit will be mounted where vibration transmission to the adjacent floor is not acceptable, use spring isolators. If spring isolators will be used, the condenser and evaporator shells will each ship with one spring mounting foot welded to the outside edge of each end sheet - one for each outside edge of the complete chiller, as shown in Figure 19.

Installing neoprene isolator pads

Use the following procedure to install neoprene isolators pads for the condenser/economizer assembly:

1. Place each isolator pad rubber-side down according to the location of the mounting feet and overall dimension of the condenser as shown in Figure 17.
2. After the isolator pads have been placed into position on the floor, determine the unloaded thickness of the pad and lower the condenser/economizer assembly onto the pads as shown in Figure 17.

Figure 17: Neoprene pads

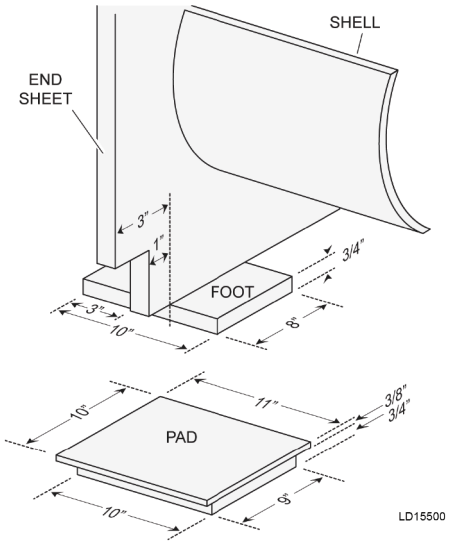
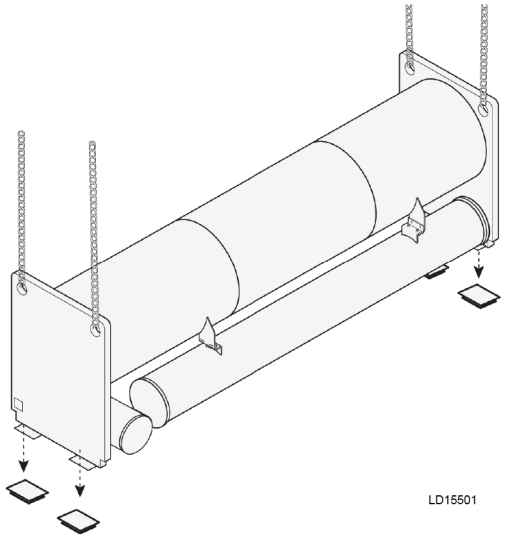


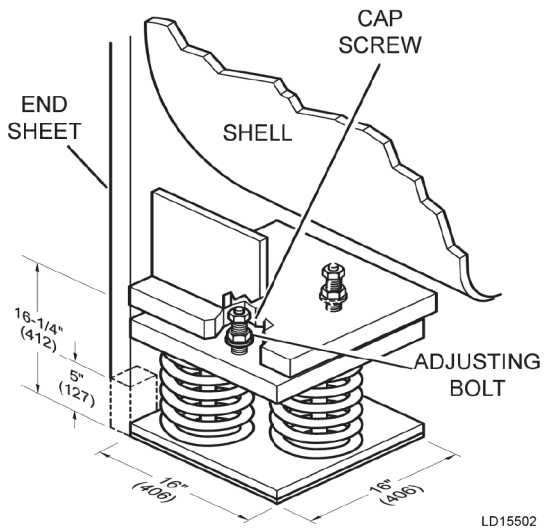
Figure 18: Lowering the condenser



Installing spring isolators

1. While the unit is still suspended, bolt two of the spring isolators to the outside ends of the condenser end sheet by inserting the cap screw(s) through the hole(s) in the mounting bracket into the tapped hole in the top of the isolator leveling bolt(s) as shown in Figure 19.

Figure 19: Spring isolators



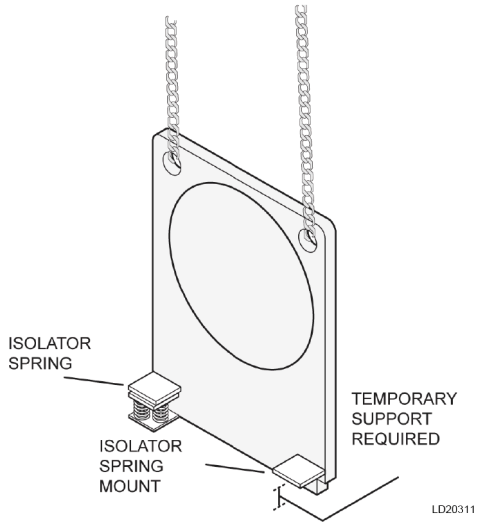
Note:

In order to keep the unit level, support is required for the two edges of the end sheet that do not have springs. Tools to provide this support will vary with the job.

When the condenser and evaporator are rigged and bolted together, the supports should be removed for the final leveling process.

2. Lower the condenser/economizer assembly to its final location.
3. Support the side of the assembly that does not have spring isolators installed, as shown in Figure 20.

Figure 20: Lower condenser

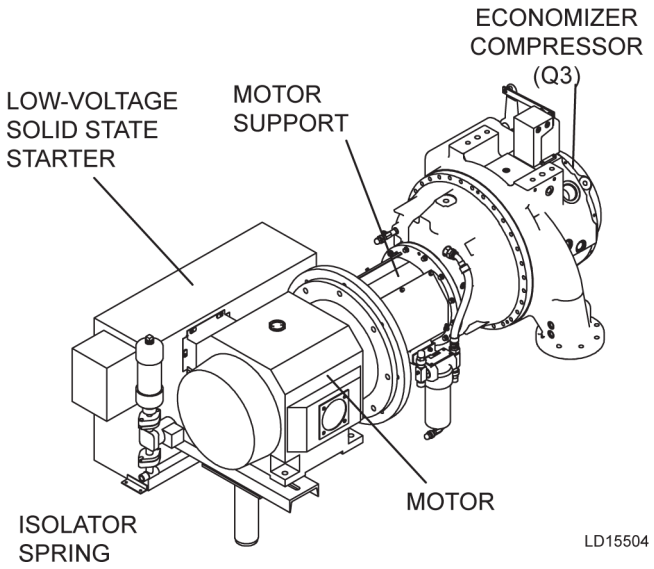


Install economizer driveline

Note: It is difficult to connect economizer piping after the condenser and evaporator are rigged to their final locations. Therefore, the economizer connections should be made after rigging the condenser but BEFORE rigging the evaporator.

The economizer driveline ships assembled and consists of the Q3 economizer compressor, the motor, the motor coupling, and the LVSSS as shown in Figure 21.

Figure 21: Economizer compressor assembly



Rigging economizer compressor to condenser

1. Install the isolation valve (optional), spool piece, and check valve to the condenser flange for the economizer compressor, as shown in Figure 22.
2. Lift the assembly by means of an overhead lift and remove packing materials. See Table 13 for driveline weights.
3. Carefully lower the compressor/motor assembly on to the discharge check valve and supports on the condenser.
4. Fasten the assembly loosely to the support brackets.

Figure 22: Rigging economizer compressor

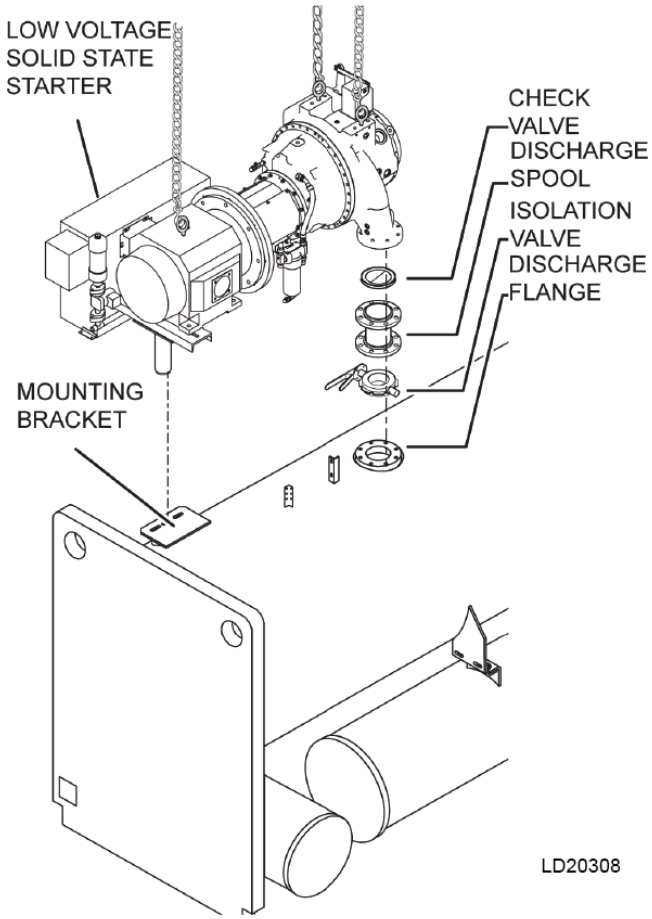


Table 13: Economizer driveline weights, lb (kg)

60 Hz motor code	50 Hz motor code	Weight, lb (kg)	Q3	LVSSS	Motor support	Complete driveline
EF	5EC	959 (435)	1,679 (762)	300 (136)	229 (104)	3,167 (1,437)
EG	5ED	1,367 (620)				3,575 (1,622)
Eh	5EE	1,610 (730)				3,818 (1,732)
EJ	5EF	1,653 (750)				3,861 (1,751)
EK	5EG	1,764 (800)				3,972 (1,802)
EL	5EH	2227 (1012)				4,435 (2,014)
EM	5EI	2293 (1042)				4,501 (2,044)
EN	5EJ	2293 (1042)				4,501 (2,044)
EP	5EK	2380 (1082)				4,588 (2,084)
ER	5EL	2425 (1102)				4,633 (2,104)
ES	5EM	2469 (1122)				4,677 (2,124)
ET	5EN	2491 (1132)				4,699 (2,134)
	5EO	2534 (1152)				4,742 (2,154)

Installing economizer suction pipe

See Figure 23 when performing the following procedure.

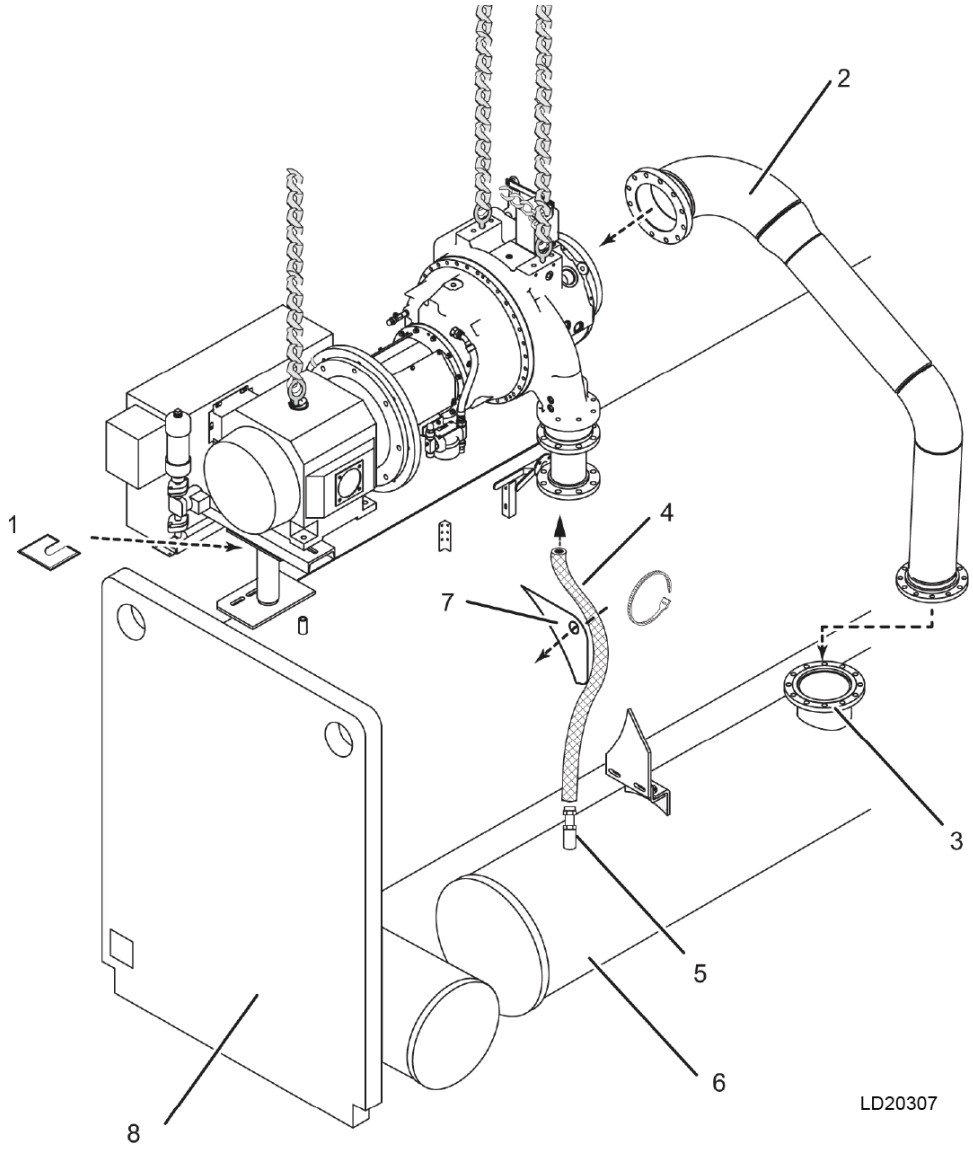
1. Bolt the suction pipe to the economizer compressor and to the flange on the economizer.
2. Tighten flanges at both ends of the suction line and discharge flange.
3. Tighten connections to the support brackets.
4. Shim the motor at the T-Bar to ensure no bending stress on the driveline.
5. Fasten compressor/motor assembly with the proper hardware.

Installing economizer relief piping

It is the customer's responsibility to plan and install relief piping for the evaporator, condenser, and economizer. Relief piping to the economizer must be installed before rigging the evaporator. A flexible line is supplied (shipped in loose parts) that allows connection between the economizer relief valve and the chiller vent piping system. See Figure 23.

1. Secure one end of the flexible line to the relief valve on the economizer. Support the relief valve with a backup wrench when installing any threaded connections to ensure no undue torque or bending is applied to the valve body.
2. Tie-wrap the other end of the flexible line to the small hole in the vent line bracket located on the condenser so it will be available for joining with the other relief piping when installed after the evaporator and condenser are rigged.

Figure 23: Installing the economizer suction pipe and relief line



Item	Description
1	Shims
2	Economizer suction pipe
3	Economizer suction flange
4	Flexible economizer relief line
5	Economizer relief valve
6	Economizer
7	Vent line bracket
8	Condenser

Applying insulation to economizer (optional)

Units are factory-furnished and anti-sweat insulated on order at additional cost. This includes all low temperature surfaces except the two cooler liquid heads.
If the unit is to be field insulated, apply the insulation to the economizer and its piping before the evaporator is placed in position. If the evaporator is to be field insulated, apply insulation while it is suspended, before it is lowered into place.
Insulation of the type specified for the job, or minimum thickness to prevent sweating of 30°F (-1°C) surfaces, should be furnished (by others) and applied as follows:

1. Clean all surface areas to be insulated to ensure that they are free of oil, dirt, and dust.
2. All seams and joints in the insulation are to be cut square, glued, taped, and seal glued, including to metal joints which are accessible.
3. Use 2 in. (51 mm) wide tape throughout, with the exception of 90° seams and joints on contoured surfaces where 3/4 in. (19 mm) wide tape is to be used.

What to do next:
Apply insulation to all areas shown in heavy outline in Figure 24 and Figure 25. Be sure to allow for valve access.

Figure 24: Insulating the economizer and economizer suction pipe (side view)

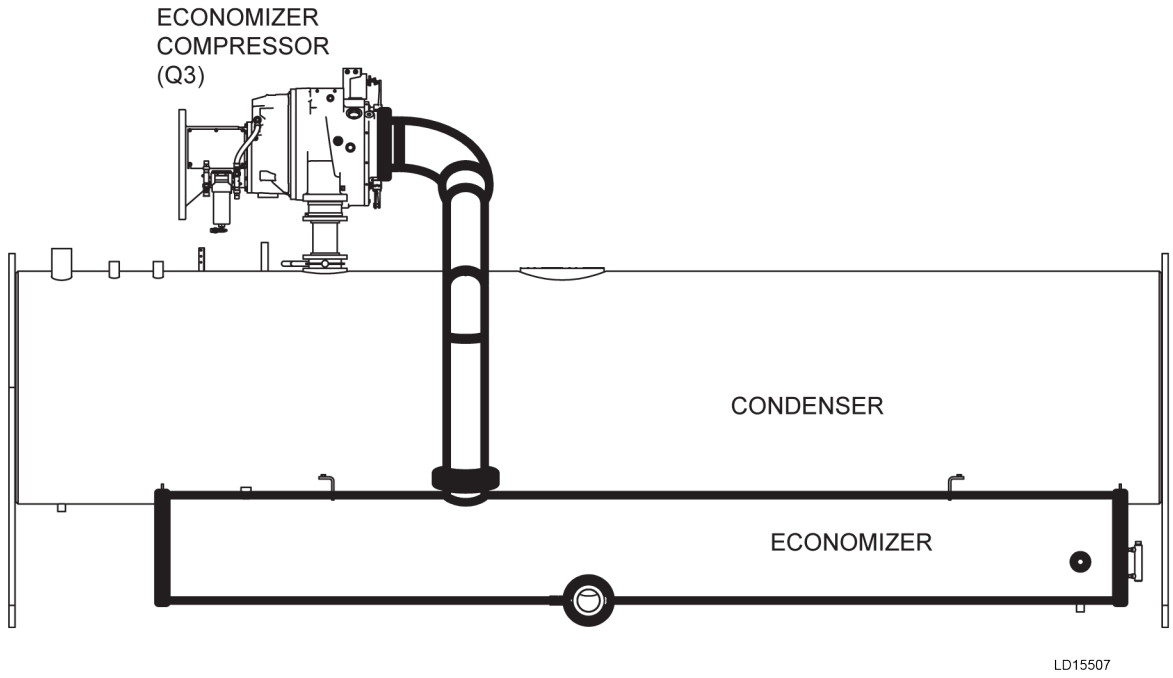
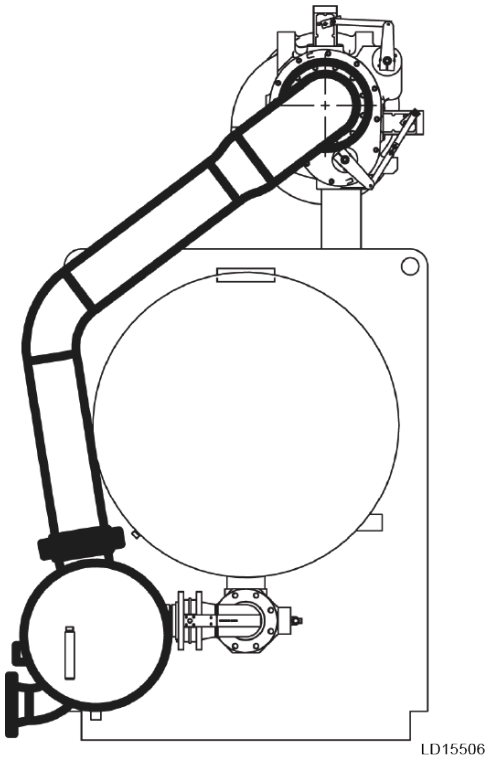


Figure 25: Insulating the economizer and economizer suction pipe (front view)



Install evaporator

Rig to final location

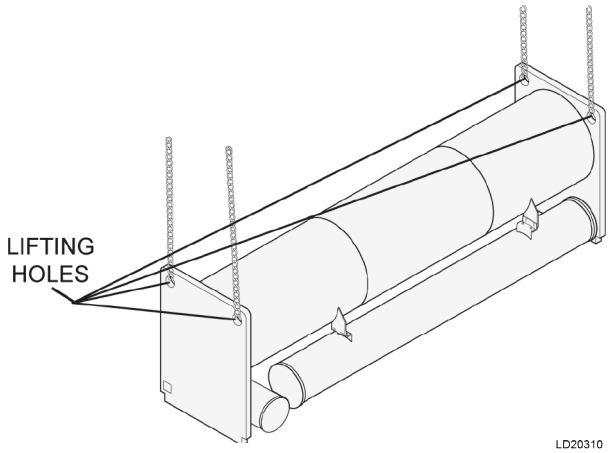
Care should be taken at all times during rigging and handling of the evaporator to avoid damage to the assembly and its external connections.

When optional skids are used it may be necessary to remove the skids so rigger's skates can be used under the unit end sheets to reduce overall height.

1. Affix rigging chains from overhead lift to the four lifting holes (two at the top of each end sheet) of the evaporator as shown in Figure 26.
2. Lift the evaporator by means of an overhead lift to the unit's final location on the floor or mounting pad.
3. Suspend rigging and install vibration isolators.

   Note: If ordered, the evaporator is insulated at the factory.

Figure 26: Rigging the evaporator



Install vibration isolators to the evaporator

Follow the appropriate procedure to install either neoprene pad or spring isolators to the evaporator.

Installing neoprene isolator pads

1. Place each isolator pad rubber-side down according to the location of the mounting feet and overall dimension of the evaporator as shown in Figure 27.
2. After the isolator pads have been placed into position on the floor, determine the unloaded thickness of the pad and lower the evaporator beside the condenser/economizer assembly onto the pads as shown in Figure 27.

Figure 27: Neoprene pads

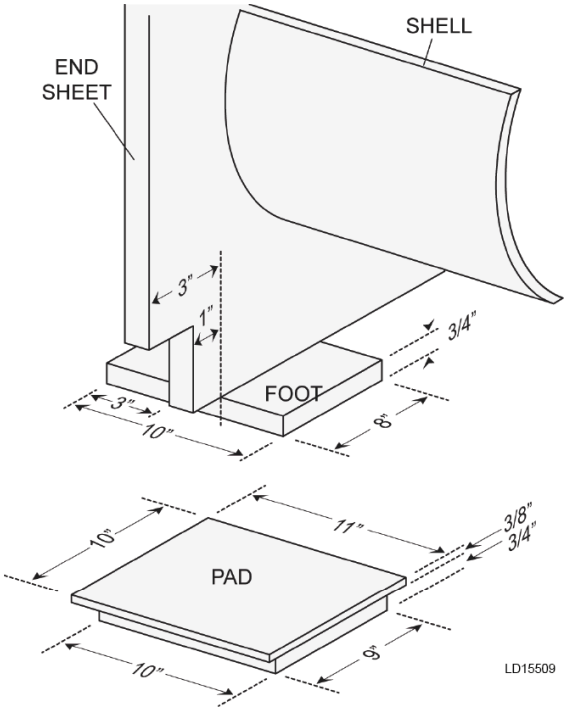
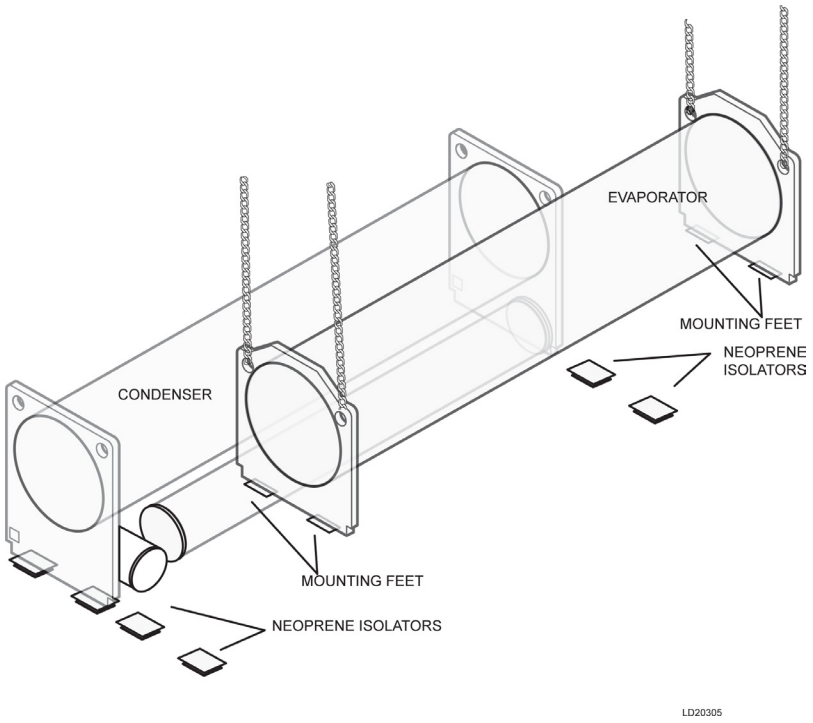


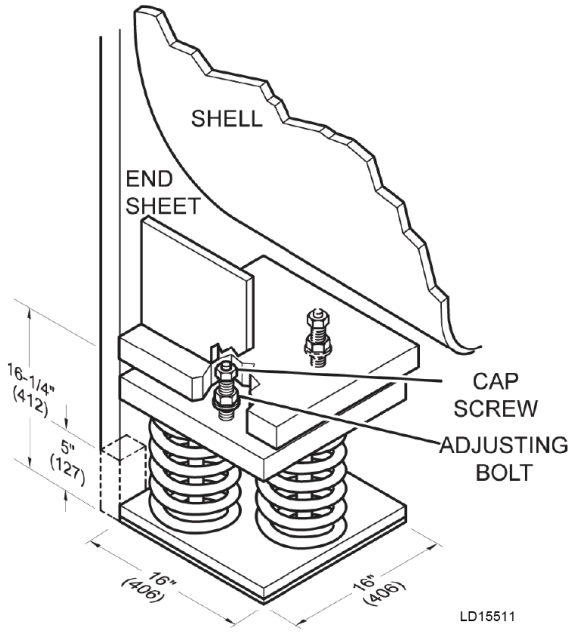
Figure 28: Evaporator mounting on pad isolators



Installing optional spring isolators

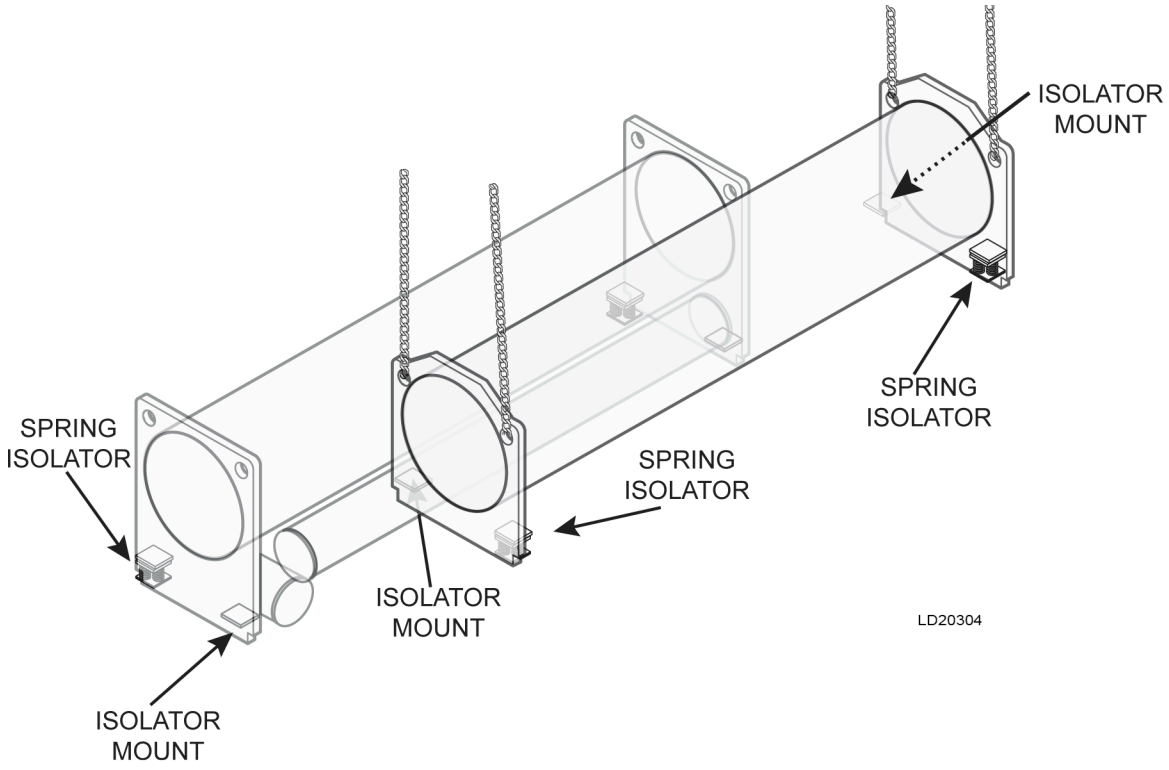
1. While the unit is still suspended by the rigging, bolt two of the spring isolators to the outside ends of the evaporator end sheet by inserting the cap screw(s) through the hole(s) in the mounting bracket into the tapped hole in the top of the isolator leveling bolt(s) as shown in Figure 29.

Figure 29: Spring isolators



2. Lower the evaporator assembly to its final location next to the condenser/economizer assembly.
3. Support the side of the evaporator that does not have spring isolators installed as shown in Figure 30.
4. The unit should now be supported by spring isolators in the four outer edges of the chiller.
5. The inside edges of the condenser/economizer assembly and the evaporator should be supported at an equal height by the shims or jacks used to support them.

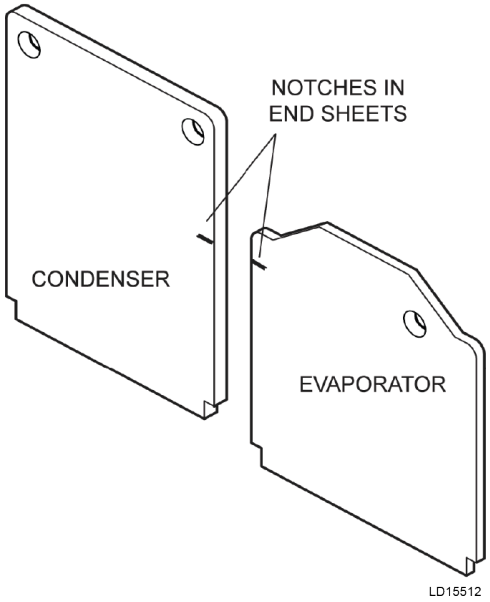
Figure 30: Evaporator mounting on spring isolators



Bolting condenser and evaporator together

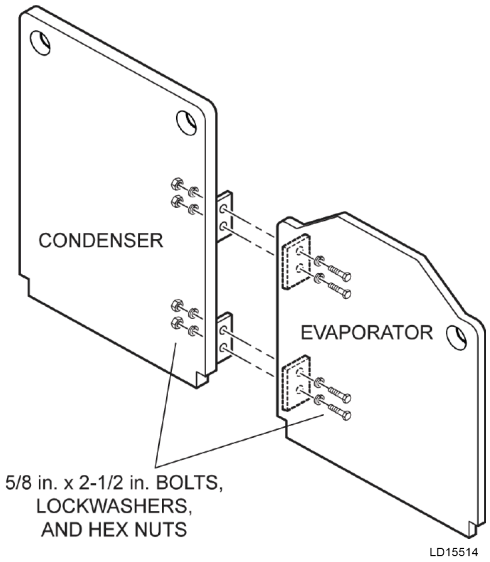
1. If isolator springs are used, adjust springs and temporary supports so that the bolt holes in both end sheets align and the outside surfaces of the end sheets are flush.

Figure 31: Alignment marks on end shells



2. Bolt the tube sheets together as shown in Figure 32. See Table 14 for correct torque values.

Figure 32: Bolting the shells together



3. When the condenser and evaporator are both placed and bolted together, the supports should be removed for the final leveling process.

Table 14: Torque values

Bolt size (in.)		Torque (ft-lb)
1/4 in.	HEX HD	10
	12pt or SOC HD	14
3/8 in.		35
1/2 in.		45
5/8 in.		55
3/4 in.		70

Note: Unless otherwise specified, all screws must be tightened to the following torque values with lightly oiled threads.

Lubricated with oil and graphite on male and female threads and under bolt heads. Do NOT use Molykote.

Leveling the unit

1. Level shells in both directions.
   - The longitudinal alignment of the shell should be checked by placing a level on the top of the shell, next to the discharge connection. The transverse alignment should be checked by placing a level on the tops of both end sheets.
2. If isolation springs are used, rotate the leveling bolts one turn at a time, in sequence, until the unit end sheets are clear of the floor and the unit is level.
   - If the leveling bolts are not long enough to level unit due to an uneven or sloping floor or foundation, steel shims (grouted, if necessary) must be added beneath the isolator assemblies as necessary.
3. If isolation pads are used, all must be checked for the proper deflection while checking to see if the unit is level.
   a. Each pad should be deflected approximately 0.1 in. to 0.2 in. (2.5 mm to 5 mm). If an isolation pad is under-deflected, place shims between the unit tube sheet and the top of the pad to equally deflect all pads.
   b. The unit must be level within 1/4 in. (6 mm) from one end to the other end and from front to the rear. If the chiller is not level within the amount specified, lift it and place shims between the isolation pad and the chiller tube sheets. Shims are furnished by the installer.
4. After shell is leveled, wedge and shim each corner of the shell to solidly support it while assembling the other parts.

Install primary driveline

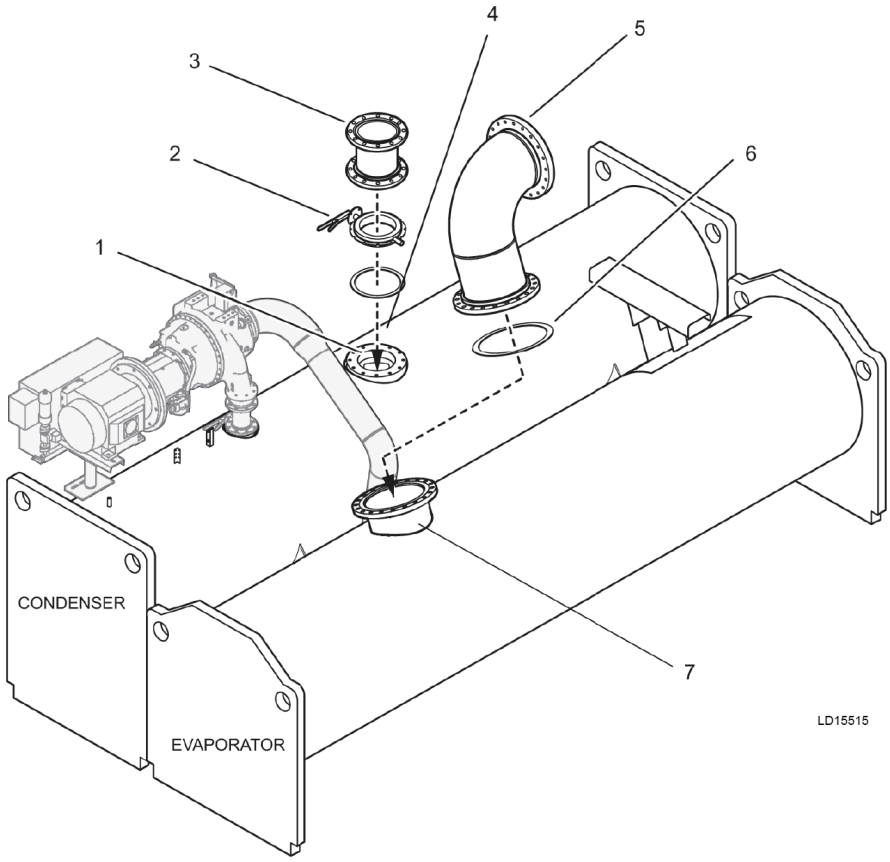
The primary compressor assembly ships assembled and consists of the KS or K7 compressor and selected motor. The primary compressor starter is installed after the compressor is installed and piped.

See Figure 34 while installing the primary compressor.

Preparing connections

1. Place the gasket and the suction elbow onto the suction flange on the evaporator.
2. Optionally, place the isolation valve onto the discharge flange on the condenser.
3. Place primary discharge spool onto the discharge flange on the condenser with gasket (or directly onto the isolation valve if present).

Figure 33: Install primary driveline (prepare connections)



Item	Description
1	Discharge flange (condenser)
2	Optional isolation valve
3	Discharge spool
4	Ring gasket (only used without isolation valve)
5	Suction elbow
6	Ring gasket
7	Suction flange (evaporator)

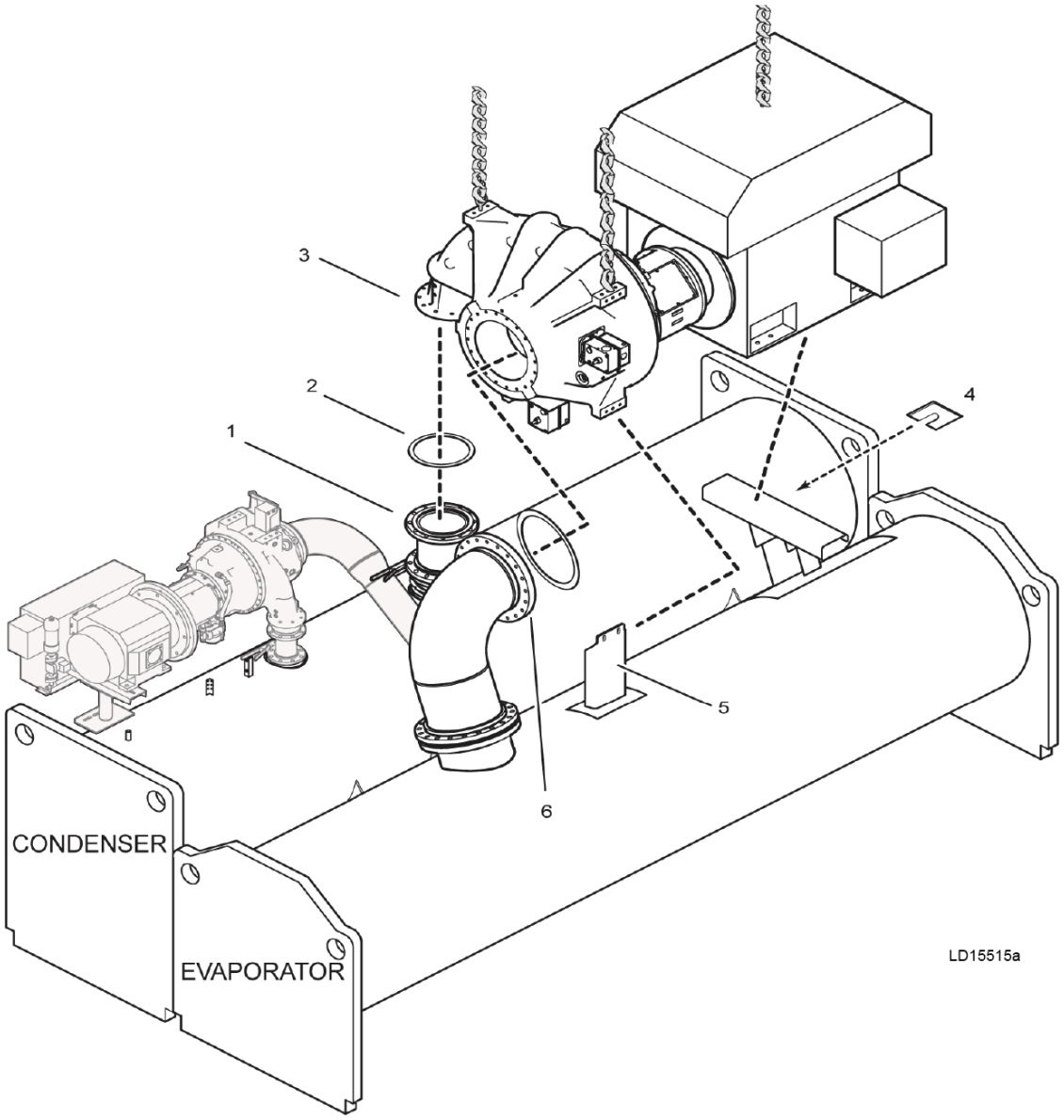
Table 15: Primary driveline component weights

60 Hz motor weight, lb (kg)		50 Hz motor weight, lb (kg)		Motor support	KS/K7 compressor, lb (kg)	60 Hz driveline weight	50 Hz driveline weight
DD	7,300 (3,318)	**5DD**	7,300 (3,318)	350 (159)	9,100 (4,128)	16,750 (7,598)	16,750 (7,598)
DE	7,300 (3,318)	**5DE**	7,500 (3,409)			16,750 (7,598)	16,750 (7,598)
DF	7,500 (3,409)	**5DF**	7,500 (3,409)			16,750 (7,598)	16,750 (7,598)
		5DG	7,900 (3,591)				17,350 (7,870)
DH	7,500 (3,409)	**5DH**	11,250 (5,114)			16,950 (7,688)	20,700 (9,389)
DJ	8,500 (3,864)	**5DJ**	11,750 (5,341)			17,950 (8,142)	21,200 (9,616)
DK	11,750 (5,341)	**5DK**	12,750 (5,795)			21,250 (9,639)	22,200 (10,070)
DL	12,750 (5,795)	**5DL**	13,250 (6,023)			22,200 (10,070)	22,700 (10,297)

Rigging primary compressor to condenser

1. Lift the assembly by means of an overhead lift and remove packing materials. See Table 15 for driveline weights.
2. Lightly lubricate the o-ring with POE oil or grease and place it onto the discharge spool on the condenser (see Figure 34, Item 2).
3. Carefully lower the compressor/motor assembly onto the discharge spool and the compressor support bracket and keep the assembly suspended.
   Fasten the compressor discharge flange to the discharge spool on the condenser and suction elbow flange, keeping both parallel and aligned. Ensure gasket is in place between compressor and suction elbow.
4. Bolt the compressor to the support bracket.
5. Shim the motor to avoid any bending stress on the driveline and bolt it to the T-Bar support.

Figure 34: Install primary driveline (rig primary compressor)



Item	Description
1	Discharge spool
2	O-ring
3	Compressor discharge flange
4	Shims
5	Compressor support bracket
6	Suction elbow flange

Install primary compressor starter

If the primary compressor starter is third-party supplied, refer to the installation instructions provided with the starter. Refer to *OptiView™ Control Center and MODBUS SSS/VSD Wiring Diagrams (Form 160.87-PW5).*

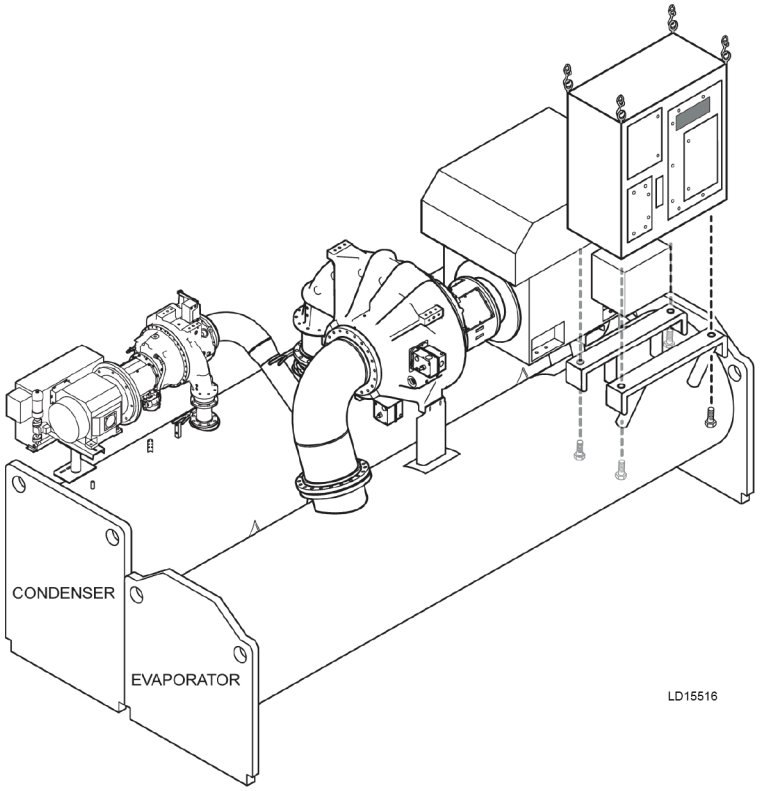
ⓘ **Note:** Installation of a factory-supplied Floor Mounted MV-VSD, Floor Mounted MV-SSS or Unit Mounted MV-SSS must be performed by a qualified Johnson Controls technician.

Rig MV-SSS to unit

If the primary compressor starter is a Johnson Controls Unit-Mounted MV-SSS, rig the starter to the unit as shown in Figure 35. Wiring must be completed by a qualified Johnson Controls technician.

ⓘ **Note:** MV-SSS = 1675 pounds (760 kg)

Figure 35: Install primary compressor starter



Piping connections

After the unit is leveled (and wedged in place for optional spring isolators), the piping connections may be made: chilled water, condenser water, and refrigerant relief. The piping should be arranged with offsets for flexibility, and adequately supported and braced independently of the unit to avoid strain on the unit and vibration transmission.

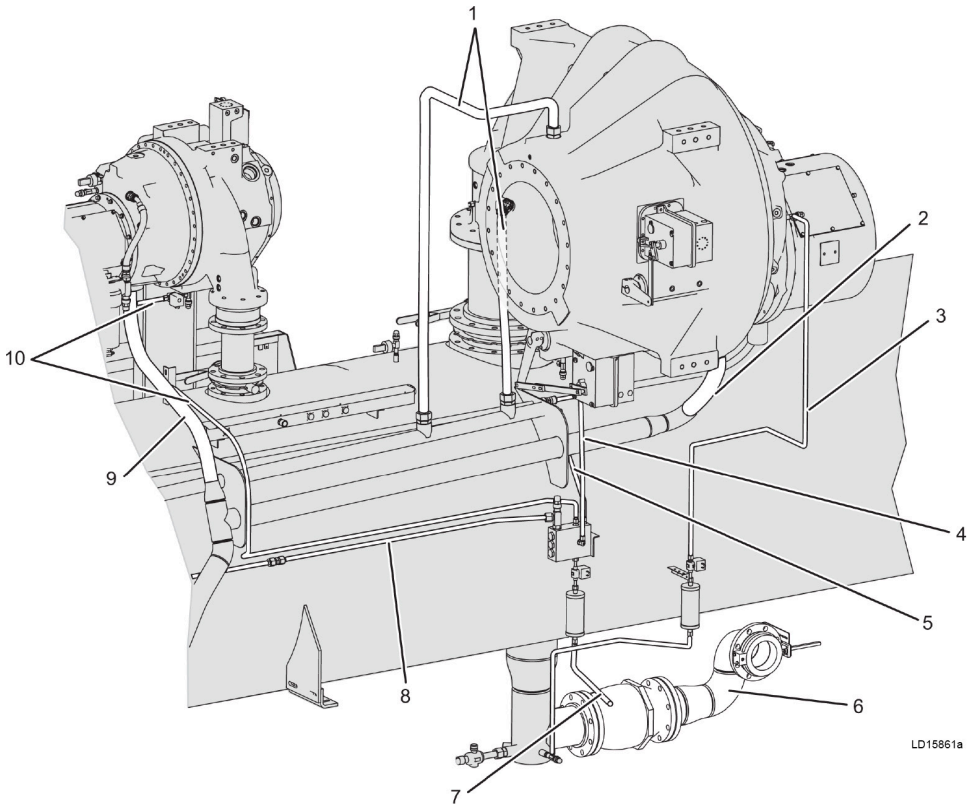
Hangers must allow for alignment of pipe. Isolators (by others) in the piping and hangers are highly desirable, and may be required by specifications, in order to effectively utilize the vibration isolation characteristics of the vibration isolation mounts of the unit.

Check for piping alignment

Upon completion of piping, a connection in each line as close to the unit as possible should be opened, by removing the flange bolts or coupling and checked for piping alignment. If any of the bolts are bound in their holes, or if the connection springs are out of alignment, the misalignment must be corrected by properly supporting the piping or by applying heat to anneal the pipe.

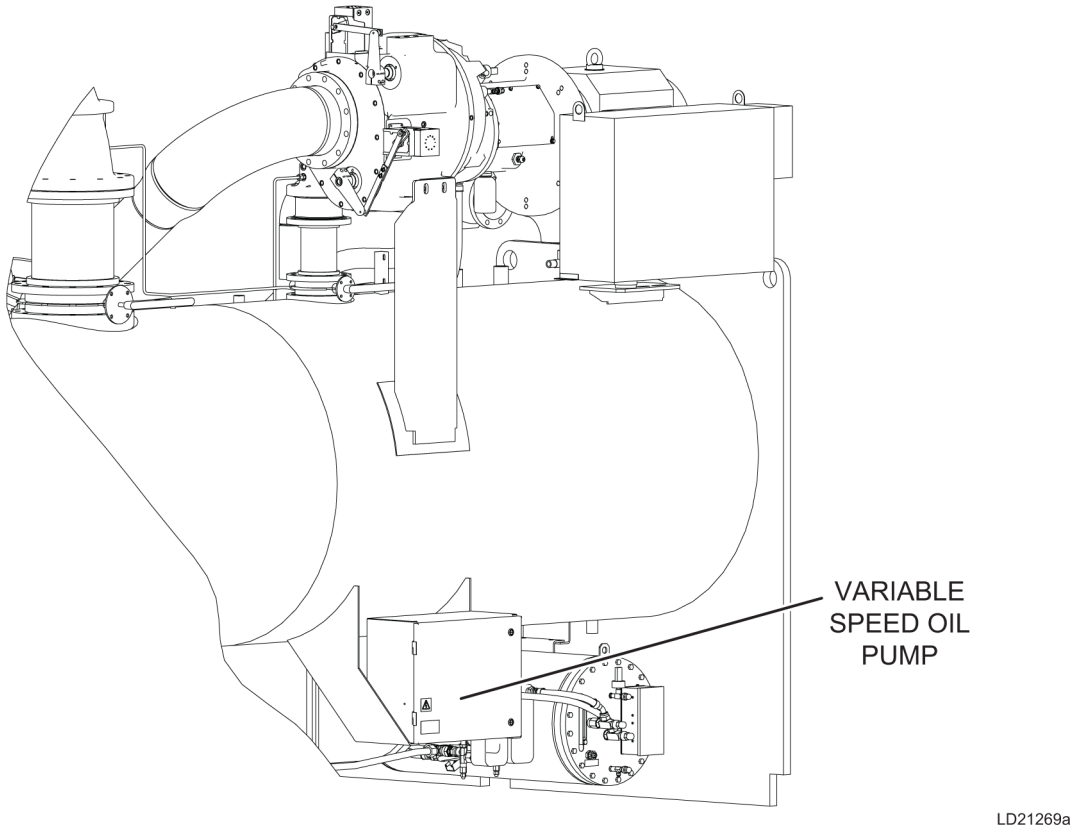
Make the following connections as shown in Figure 36 and Figure 37.

Figure 36: Oil line and refrigerant piping connections



Item	Description
1	KS/K7 compressor vent lines
2	KS/K7 compressor oil drain line
3	KS/K7 compressor gear cooling
4	KS/K7 compressor PRV housing oil return
5	Gas supply
6	Refrigerant liquid piping
7	Evaporator oil return
8	Oil eductor outlet to sump
9	Q3 compressor oil drain line
10	Q3 compressor PRV housing oil return

Figure 37: Oil line and refrigerant piping connections



Oil line piping

1. Between compressor oil drain flanges and oil sump flange
2. Evaporator oil return to eductor
3. Economizer compressor PRV housing oil return to eductor
4. Primary compressor PRV housing oil return to eductor

Refrigerant piping

1. Refrigerant liquid piping between evaporator and condenser
2. Primary compressor gear cooling
3. Oil sump vent lines to compressors
4. Oil cooler refrigerant out to evaporator

Evaporator and condenser water piping

The evaporator and condenser liquid heads of chiller have nozzles which are grooved, suitable for welding 150 psig (1.14 MPa) DWP flanges or the use of flexible couplings. Factory mounted flanges are optional. If welding is done on the nozzles, flow switches, condenser level sensor, and water temperature thermistors should be disconnected and the welding ground MUST be good contact located at the head to prevent current damage to the devices.

The nozzles and water pass arrangements are furnished in accordance with the job requirements (refer to Product Drawings) furnished with the job. Standard units are designed for 150 psig (1.14 MPa) DWP on the water side. If job requirements are for greater than 150 psig (1.14 MPa) DWP, check the unit data plate before applying pressure to evaporator or condenser to determine if the chiller has provisions for the required DWP.

Inlet and outlet connections are identified by labels placed adjacent to each nozzle.

Chilled water piping

Foreign objects which could lodge in, or block flow through, the evaporator and condenser tubes must be kept out of the water circuit. All water piping must be cleaned or flushed before being connected to the chiller pumps, or other equipment.

Permanent strainers (supplied by others) are required in both the evaporator and condenser water circuits to protect the chiller. Strainers also protect the pumps, tower spray nozzles, chilled water coils and controls, and other components. The strainer must be installed in the entering chilled water and condenser liquid line, directly upstream of the chiller.

Water piping circuits should be arranged so that the pumps discharge through the chiller, and should be controlled as necessary to maintain essentially constant chilled and condenser water flows through the unit at all load conditions.

If pumps discharge through the chiller, the strainer may be located upstream from pumps to protect both pump and chiller. Piping between strainer, pump, and chiller must be carefully cleaned before start-up. If pumps are remotely installed from chiller, strainers should be located directly upstream of the chiller.

Stop valves

Stop valves may be provided (by others) in the evaporator and condenser water piping adjacent to the unit to facilitate maintenance. Thermometer wells and pressure taps should be provided (by others) in the piping as close to the unit as possible to facilitate operating check.

Flow switches

Thermal-type water flow switches are factory mounted in the chilled and condensed water nozzles and are factory wired to the YK-EP Control Panel. These solid-state flow sensors have a small internal heating element and use the cooling effect of the flowing fluid to sense when flow has been established.

Waterbox drain and vent valves

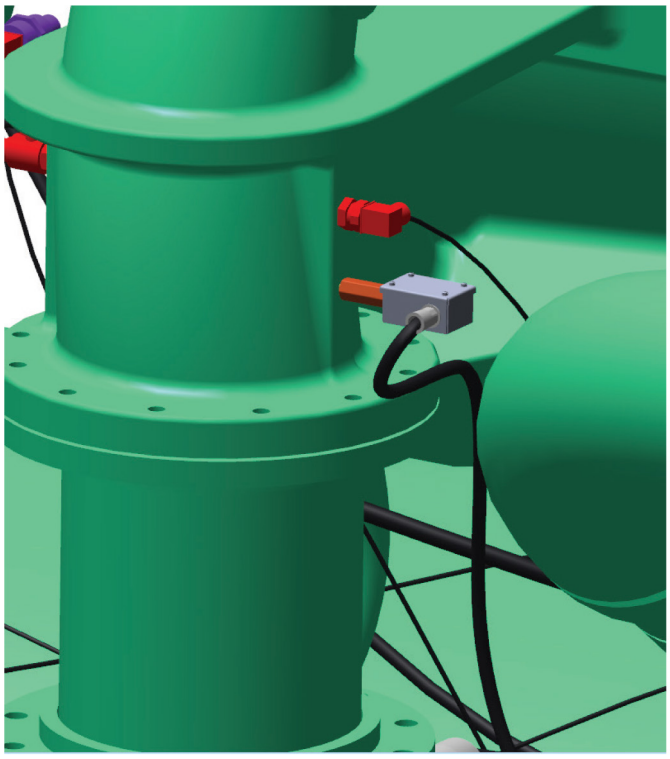
Drain and vent valves should be installed (by others) in the connections provided in the evaporator and condenser liquid heads. These connections may be piped to drain if required.

Checking piping circuits and venting air

After the water piping is completed but before any waterbox insulation is applied, tighten and torque the nuts on the liquid head flanges to maintain between 30 ft-lb and 60 ft-lb. (41 N•m and 81 N•m). Gasket shrinkage and handling during transit cause nuts to loosen. If water pressure is applied before tightening is done, the gaskets may be damaged and have to be replaced. Fill the chilled and condenser water circuits, operate the pumps manually and carefully check the evaporator and condenser water heads and piping for leaks. Repair leaks as necessary.

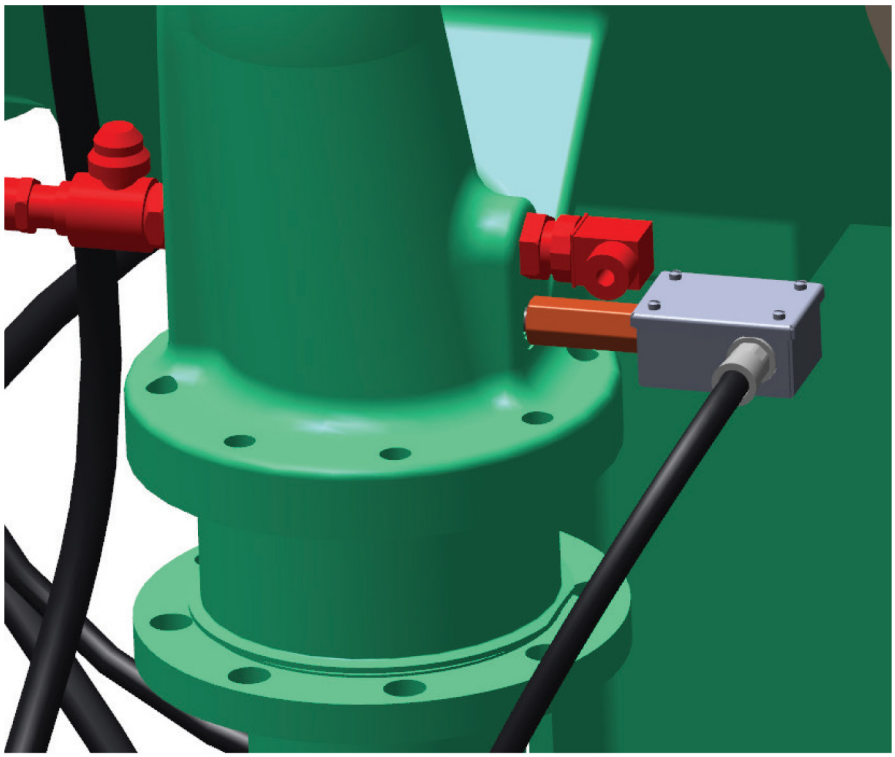
Before initial operation of the unit both water circuits should be thoroughly vented of all air at the high points.

Figure 38: Primary high pressure cutout



LD28356

Figure 39: Economizer high pressure cutout



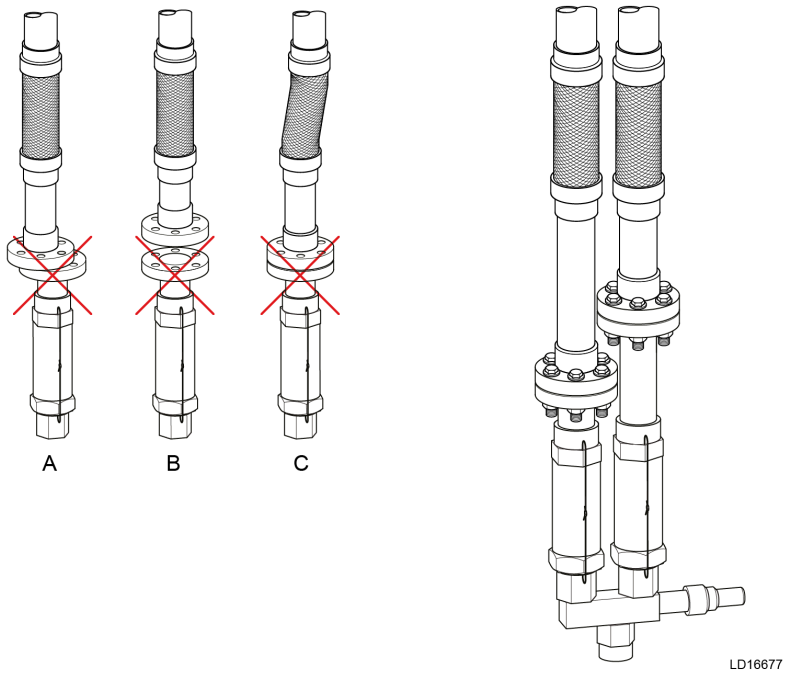
LD28357

Refrigerant relief piping

Each chiller is equipped with dual pressure relief valves on the condenser, two dual relief valves on the evaporator (or two single relief valves on the evaporator if the optional refrigerant isolation valves are ordered), and a relief valve on the economizer. The dual relief valves on the condenser are redundant and allow changing of either valve while the unit is fully charged. The purpose of the relief valves is to quickly relieve excess pressure of the refrigerant charge to the atmosphere, as a safety precaution in the event of an emergency such as fire. They are set to relieve at an internal pressure as noted on the pressure vessel data plate, and are provided in accordance with ASHRAE 15 safety code and ASME or applicable pressure vessel code.

Sized to the requirements of applicable codes, a vent line must run from the relief device to the outside of the building. This refrigerant relief piping must include a cleanable, vertical leg dirt trap to catch vent stack condensation. Vent piping must be arranged to avoid imposing a strain on the relief connection and should include one flexible connection.

Figure 40: Typical refrigerant vent piping

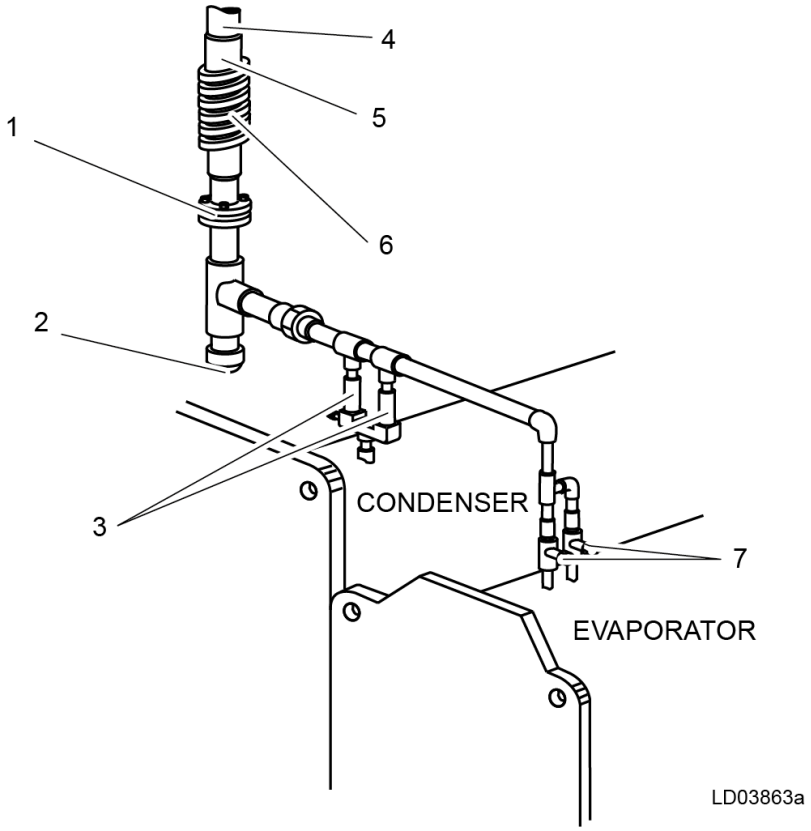


Item	Description
A	Horizontal misaligned
B	Vertical offset
C	Compressed

Note: When installing relief piping, there must NOT be any piping strain. Relief piping must be properly aligned and supported to eliminate any possible piping strain.

Note: When installing relief piping, an ANSI flange or a piping union must be used to make a servicable piping connection.

Figure 41: Typical refrigerant vent piping (cont'd)



Item	Description
1	Flanged joint to permit piping disassembly
2	Condensation trap
3	Dual relief valves
4	Vent to atmosphere
5	Support vent piping to avoid strain on relief piping
6	Flexible connection
7*	Relief valves

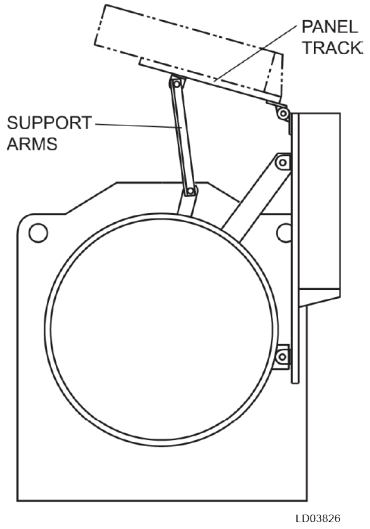
ⓘ **Note:** * Shells may be furnished with one or two relief valves, depending on shell sizes.

OptiView™ panel positioning

The OptiView™ Control Center is placed in a position above the evaporator for shipping. To move the control center into position for operation, complete the following steps:

1. While supporting the control center, remove the hardware between the support arms and the evaporator.

Figure 42: OptiView™ panel positioning



2. Swing the control center into a vertical position. See Figure 42.
3. Slide the control center down the guide rails to the proper position. Tighten securely.
4. Discard unused hardware.

Control wiring

After installation of the control center, control wiring must be completed between unit components and control center, solid state starter, or variable speed drive, when used, using wiring harness furnished. Refer to *YK-EP Field Connections Manual* based on starter type and configuration. See Associated literature.

Field wiring connections for commonly encountered control modifications (by others) if required, are shown in the *YK-EP Unit Wiring and Field Control Modifications Manual (Form 160.87-PW2)*.

Note: No deviations in unit wiring from that shown on drawings furnished shall be made without prior approval of the Johnson Controls representative.

Installation check – request for start-up service

The services of a Johnson Controls representative will be furnished to check the installation and supervise the initial start-up and operation on all chillers installed within the Continental United States.

After the unit is installed, piped and wired as described in this Instruction, but before any attempt is made to start the unit, the Johnson Controls District Office should be advised so that the start-up service, included in the contract price, can be scheduled. Notify the Johnson Controls office using the *YK-EP Installation Checklist and Request Form (Form 160.87-CL1)*.

YORK®	YK-EP STYLE B CENTRIFUGAL CHILLER WITH ECONOMIZER COMPRESSOR	
INSTALLATION CHECKLIST	New Release	Form 160.87-CL1 (317)

INSTALLATION CHECKLIST AND REQUEST FOR AUTHORIZED STARTUP ENGINEER

CUSTOMER: _____ JOB NAME: _____

ADDRESS: _____ LOCATION: _____

PHONE: _____ CUSTOMER ORDER NO: _____

JCI TEL NO: _____ JCI ORDER NO: _____ JCI CONTRACT NO: _____

CHILLER MODEL NO: _____ **UNIT SERIAL NO**: _____

The work (as checked below) is in process and will be completed by: _____ / _____ / _____
Month Day Year

The following work must be completed in accordance with installation instructions:

A. YORK CHILLER

1. Unit assembled (if shipped dismantled) and refrigerant piping installed under Johnson Controls supervision ☐
2. Vibration isolator mounts so that the unit is level, and isolators equally deflected ☐
3. If using a monitoring alarm, it is installed, functional and operationally ready for service ☐

B. WATER PIPING

1. Condenser water piping installed between condenser, pumps and cooling tower ☐
2. Chilled water piping installed between evaporator, pumps, and cooling coils ☐
3. Make-up and fill lines installed to cooling tower and chilled water system ☐
4. All water piping checked for strain – Piping should not spring when connections are broken at unit ☐
5. Water piping leak tested and flushed, with water strainers cleaned after flushing. Piping systems filled with water and trapped air vented ☐
6. Chilled and condenser water flow available to meet unit design requirements ☐

C. REFRIGERANT RELIEF PIPING (When Required)

1. Refrigerant relief piping (with flexible connections) installed from unit to atmosphere (per local building code) ☐

D. ELECTRICAL WIRING

1. ECONOMIZER STARTER ☐
   a. Main and control power supply available ☐
   b. Wiring completed from main power supply to solid state starter – but not cut to length or connected to starter ☐
2. PRIMARY COMPRESSOR ☐
   c. Main power supply available ☐
3. CONTROL CENTER ☐
   a. Jumper wires installed ☐
   b. External control wiring completed from the control center to chilled water flow switches or interlocks in accordance with the wiring diagram ☐
   c. Power available and wiring completed to the following starters and motors, and rotation of each checked ☐

   NOTE: <u>DO NOT</u> check compressor motor rotation.
   1. Chilled water pump(s) ☐
   2. Condenser water pump(s) ☐
   3. Cooling tower fan ☐

E. TESTING, EVACUATION AND CHARGING (Under Johnson Controls Supervision)

1. R-134a available for testing ☐
2. Dry Nitrogen available for testing ☐
3. A high vacuum pump available for evacuation and dehydration of system ☐
4. Refrigerant (Supplied by Johnson Controls) ☐
5. Unit (ready to be) (has been) pressure tested, evacuated, dehydrated and charged ☐

F. CONDITIONS

1. York oil for compressor on job..... ☐
2. Cooling load available for testing and operating unit ..... ☐
3. Personnel available for final wiring connections ..... ☐
4. Personnel available for start-up and testing..... ☐
5. Owners operating personnel for instruction ..... ☐
   a. Names:
      1. _____
      2. _____
      3. _____

CONTRACTOR'S RESPONSIBILITIES AND INSTRUCTIONS TO USE FORM

This installation checklist provides a quick way to check if all necessary installation work was completed in accordance with all applicable installation instructions in Form 160.87-N1, and when completed, acts as a request for Johnson Controls to furnish start-up supervision.

Complete this form as follows:

1. Fill out the top of page 1.
2. Check off each item as required. Cross out (x) items that do not apply.
3. Enter names, initials, and date of the operating personnel who completed the checklist.
4. **Bottom of Form:** Enter the date that the Johnson Controls start-up technician should be at the job site and the name(s) of the supervisor(s) to be contacted.
5. Retain one copy in files and send one copy to customer.

With reference to the terms of the above contract, we are requesting the presence of your JCI Authorized Representative at the job site on _____ / _____ / _____ to start the system and instruct operating personnel. Have the JCI representative contact: _____
Month Day Year Name/Phone

TERMS: We understand that the services of the Johnson Controls Authorized Representative will be furnished in accordance with the contract for a period of time of not more than _____ consecutive normal working hours, and we agree that a charge of _____ per diem plus travel expenses will be made to Johnson Controls if services are required for longer than _____ consecutive normal hours or if repeated calls are required, through no fault of Johnson Controls.

Customer/Contractor Signature: _____

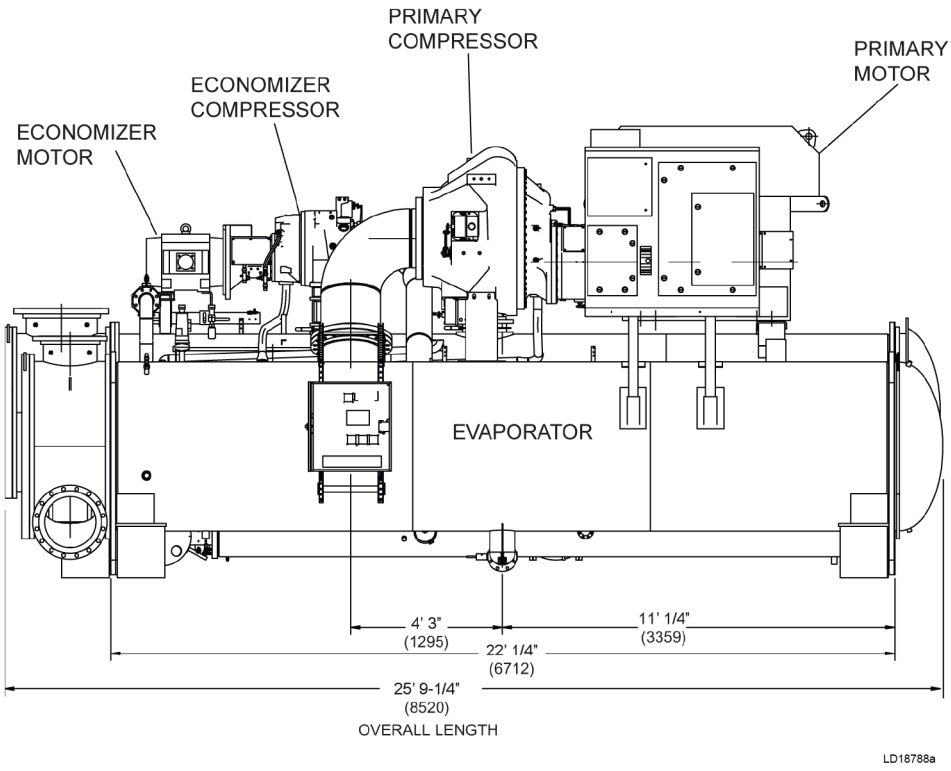
Title: _____

Form Completed by: _____

Dimensions and nozzle arrangements

This section provides general unit dimensions as well as nozzle arrangements and locations. Use this information as a quick guide to assist rigging preparations. Exact unit dimensions and nozzle arrangement for the purchased chiller can be found in the final sales order documentation.

Figure 43: Chiller dimensions (side view)



SIDE VIEW

Figure 44: Chiller dimensions (end view)

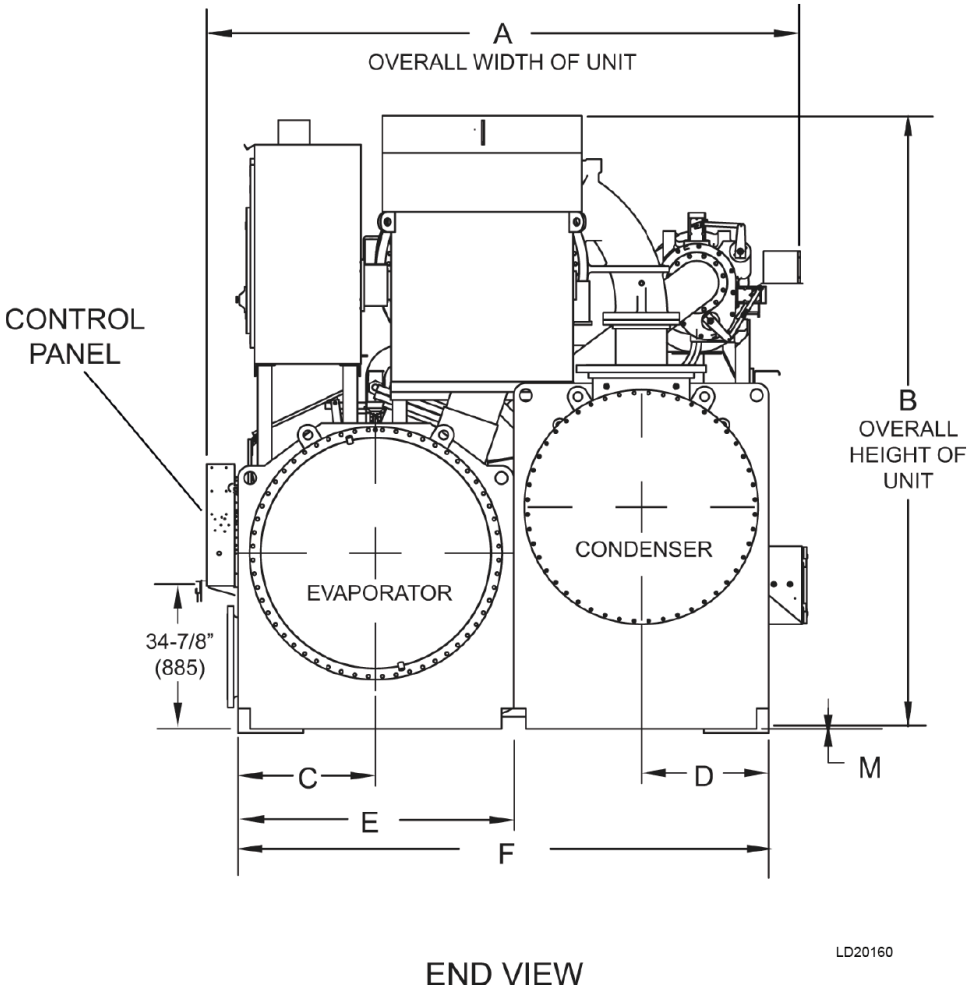


Table 16: Unit - shell dimensions

Evaporator - condenser shell codes, ft-in (mm)		
Dimension	**B-B**	**C-C**
A	12' 6" (3,810)	13' 3" (4,039)
B*	12' 11-7/8" (3,959)	13' 1-3/4" (3,994)
C	2' 10" (864)	3' 1-1/2" (954)
D	2' 7-1/2" (802)	2' 10" (864)
E	5' 8" (1,728)	6' 3" (1,905)
F	10' 11" (3,328)	11' 11" (3,633)

Note:

*Add 6 in. (15 cm) to the height of the unit if it is mounted on shipping skids.

1. All dimensions are approximate. Certified dimensions are available on request.
2. For all waterboxes (compact boxes shown above), determine overall unit length by adding waterbox depth to tube sheet length.

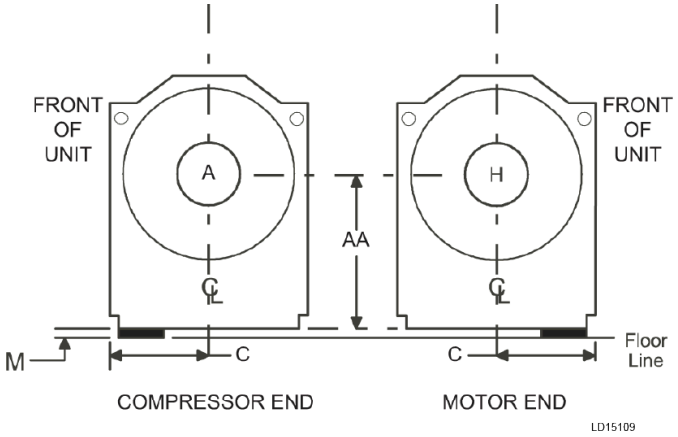
3. Water nozzles can be located on either end of unit. Add 1/2 in. to nozzle length for flanges connections.
   * Add dimension "M dimension" as shown in Table 17 for the appropriate isolator type.
4. Use of motors with motor hoods may increase overall unit dimensions.
5. Tubesheets are provided with jacking point notches.
6. Control panel in the shipment position will reduce overall width by 8 in. (203 mm).

Table 17: Additional operating height clearance to floor, ft-in. (mm)

Type of chiller mounting	M dimension, ft-in. (mm)
Neoprene pad isolators	1 (25)
Spring isolators 1 in. deflection	1 (25)
Direct mount	3/4 (19)

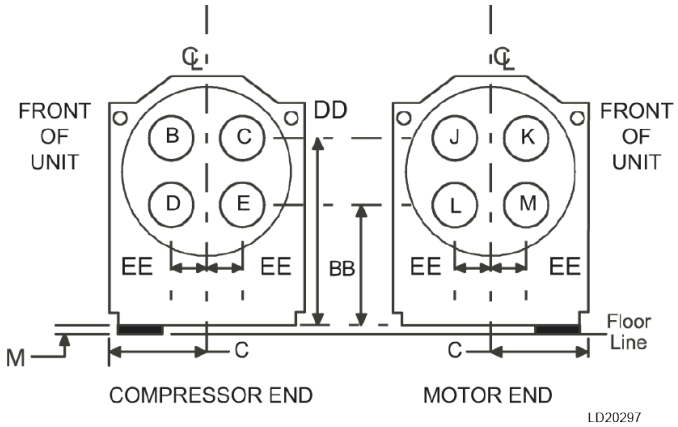
Evaporator nozzle arrangements compact waterboxes

Figure 45: Evaporators - compact waterboxes (1 pass nozzle arrangements)



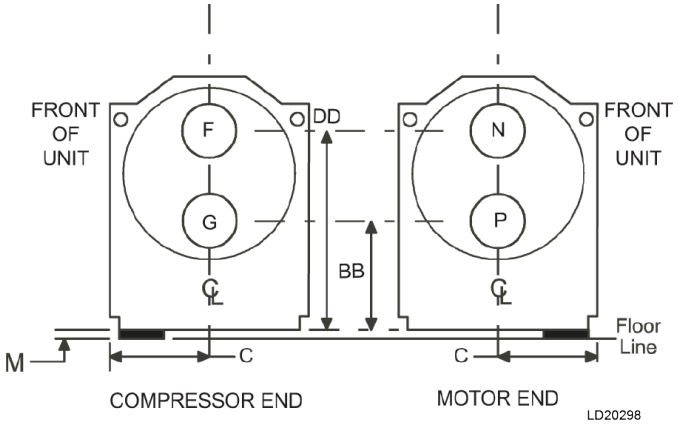
IN	OUT
A	H
H	A

Figure 46: Evaporators - compact waterboxes (2 pass nozzle arrangements)



IN	OUT
D	C
E	B
L	K
M	J

Figure 47: Evaporators - compact waterboxes (3 pass nozzle arrangements)



IN	OUT
G	N
P	F

Table 18: Compact waterboxes - 150 psig (1.14 MPa)

Evaporator shell code	Nozzle pipe size (in.)			Evaporator nozzle dimensions in ft-in. (mm)						
	No. of passes				1-pass	2-pass			3-pass	
	1	2	3	C	AA*	BB*	DD*	EE	BB*	DD*
B	20"	18"	14"	2' 10". (864)	3' 7-1/4" (1,099)	2' 5-1/4" (743)	4' 11-3/4" (1,519)	0' 10-1/2" (268)	2' 1-3/4" (656)	5' 3-1/4" (1,607)
C	20"	18"	14"	3' 1-1/2" (954)	3' 11-3/4". (1,214)	2' 9-3/4" (859)	5' 4" (1,626)	0' 11" (280)	2' 9-3/4" (859)	5' 9-7/8" (1,776)

Note:

* Add dimension "M dimension" as shown in Table 17 for the appropriate isolator type.

1. Standard water nozzles are furnished as welding stub-outs with ANSI/AWWA C-606 grooves, allowing the option of welding, flanges, or use of ANSI/AWWA C-606 couplings. Factory-installed, class 150 (ANSI B16.5, round slip-on, forged carbon steel with 1/16 in. (2mm) raised face), water flanged nozzles are optional (add 1/2 in. (13mm) to nozzle length). Companion flanges, nuts, bolts, and gaskets are not furnished.
2. One-, two- and three-pass nozzle arrangements are available only in pairs shown and for all shell codes. Any pair of evaporator nozzles may be used in combination with any pair of condenser nozzles.
3. Evaporator and condenser water must enter the waterbox through the bottom connection to achieve rated performance.
4. Connected piping should allow for removal of compact waterboxes for tube access and cleaning.
5. Standard 150 psig (1.14 MPa) design pressure boxes shown.

Figure 48: Evaporator nozzle dimensions compact waterboxes

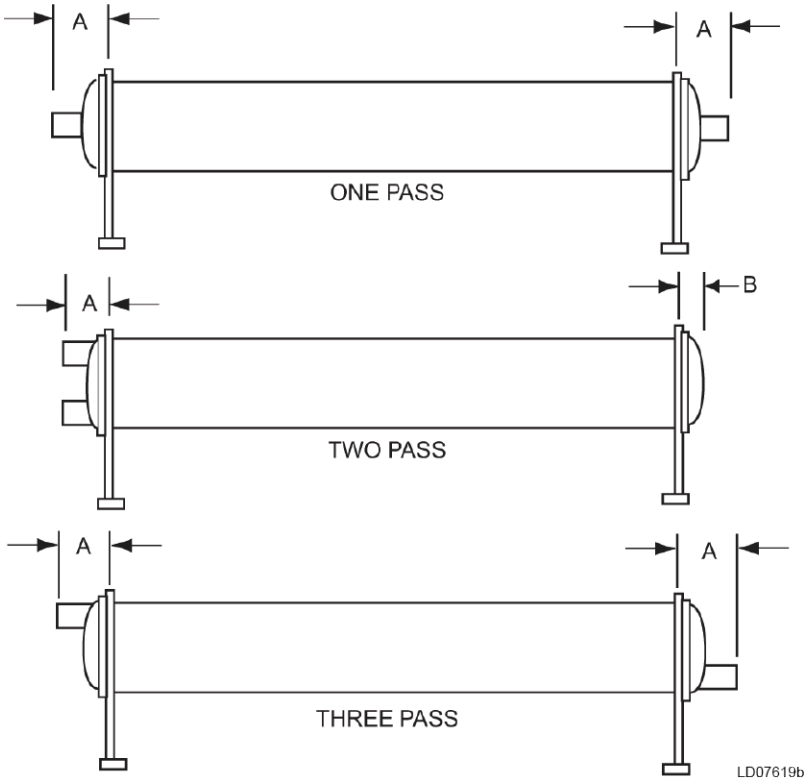
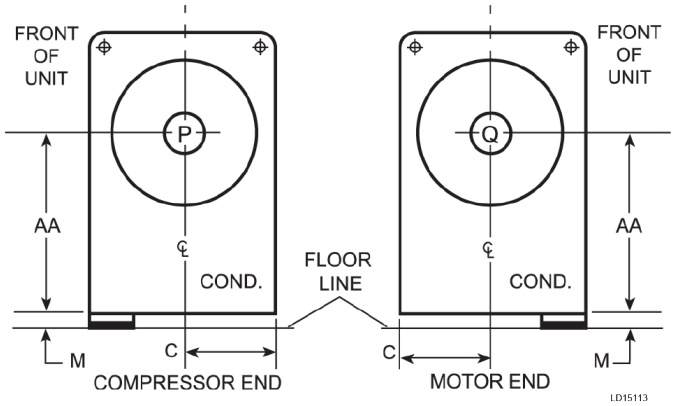


Table 19: Waterbox dimensions, ft-in. (mm)

Compressor code	Evaporator shell code	A	B
K, Q	B	1' 11-5/8" (600)	1' 4-3/8" (416)
K, Q	C	2' 1" (635)	1' 6-1/4" (464)

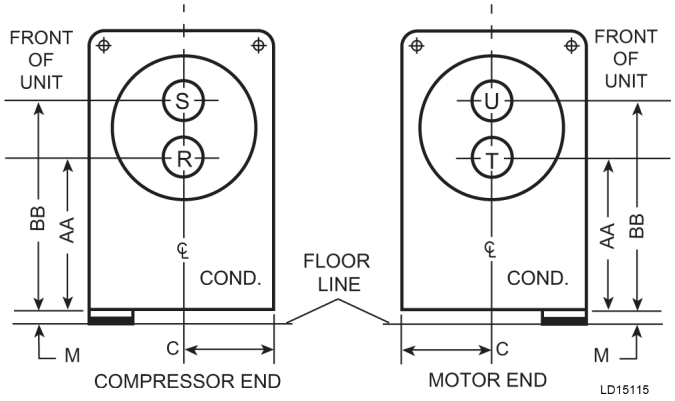
Condenser nozzle arrangements compact waterboxes

Figure 49: Condensers - compact waterboxes (1 pass nozzle arrangements)



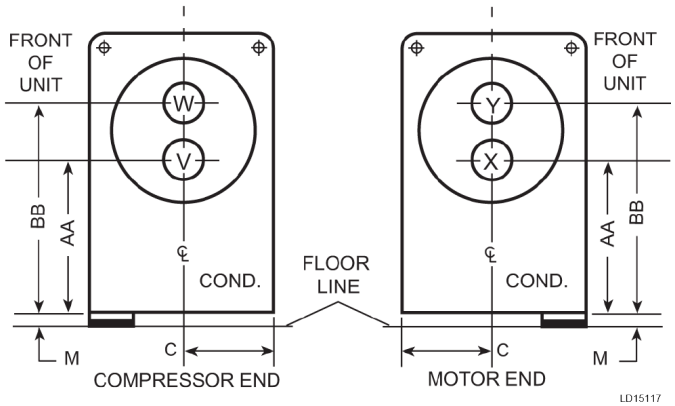
IN	OUT
P	Q
Q	P

Figure 50: Condensers - compact waterboxes (2 pass nozzle arrangements)



IN	OUT
R	S
T	U

Figure 51: Condensers - compact waterboxes (3 pass nozzle arrangements)



IN	OUT
V	Y
X	W

Table 20: Compact waterboxes - 150 psig (1.14 MPa)

Condenser shell code	Nozzle pipe size			Condenser nozzle dimensions in ft-in (mm)					
	No. of passes				1-Pass	2-Pass		3-Pass	
	1	2	3	C	AA*	AA*	BB*	AA*	BB*
B	24"	18"	16"	2' 7-1/2" (802)	4' 6-5/8" (1,389)	3' 4-1/8" (1,020)	5' 9-1/8" (1,756)	3' 4-1/8" (943)	5' 9-1/8" (1,756)
C	24"	20"	16"	2' 10" (864)	4' 8-3/8" (1,432)	3' 4-3/8" (1,026)	6' 0-3/8" (1,839)	3' 4-3/8" (1,026)	6' 0-3/8" (1,839)

Note:

*Add dimension "M dimension" as shown in Table 17 for the appropriate isolator type.

1. Standard water nozzles are furnished as welding stub-outs with ANSI/AWWA C-606 grooves, allowing the option of welding, flanges, or use of ANSI/AWWA C-606 couplings. Factory-installed, class 150 (ANSI B16.5, round slip-on, forged carbon steel with 1/16 in. [2 mm] raised face), water flanged nozzles are optional (add 1/2 in. [13 mm] to nozzle length). Companion flanges, nuts, bolts, and gaskets are not furnished.
2. One-, two- and three-pass nozzle arrangements are available only in pairs shown and for all shell codes. Any pair of evaporator nozzles may be used in combination with any pair of condenser nozzles.
3. Evaporator and condenser water must enter the waterbox through the bottom connection to achieve rated performance.
4. Connected piping should allow for removal of compact waterboxes for tube access and cleaning.
5. Standard 150 psig (1.14 MPa) design pressure boxes shown.

Figure 52: Condensers nozzle dimensions compact waterboxes

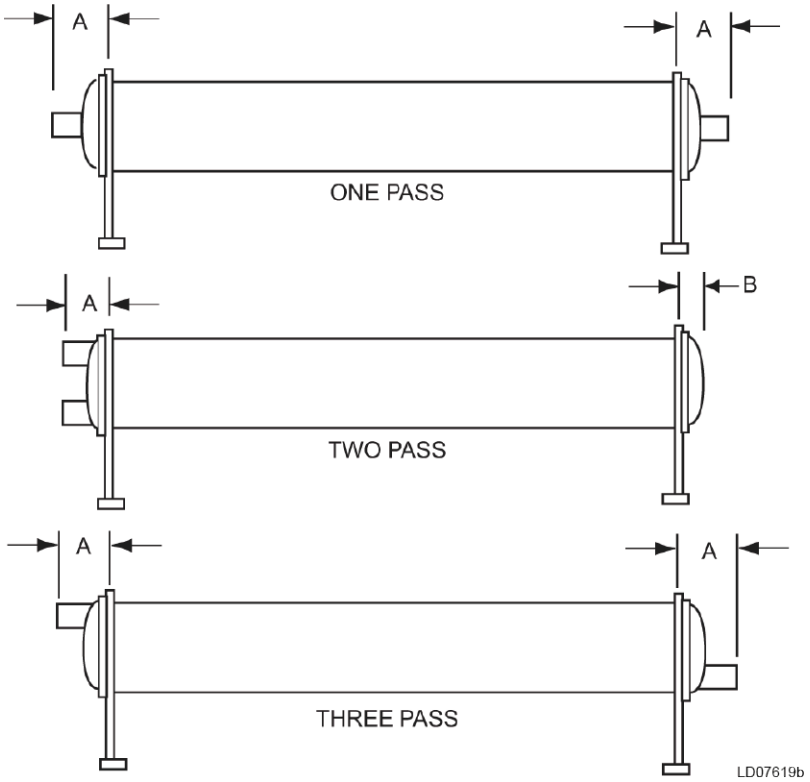


Table 21: Waterbox dimensions, ft-in. (mm)

Compressor code	Condenser shell code	A	B
K, Q	B	1' 10-1/2" (573)	1' 3-3/8" (391)
K, Q	C	1' 11-5/8" (602)	1' 4-3/8" (416)

Evaporator nozzle arrangements marine waterboxes

1 Pass		2 Pass		3 Pass	
IN	**OUT**	**IN**	**OUT**	**IN**	**OUT**
1	6	2	3	5	10
6	1	7	8	9	4

Figure 53: Evaporators - marine waterboxes (1-pass nozzle arrangements)

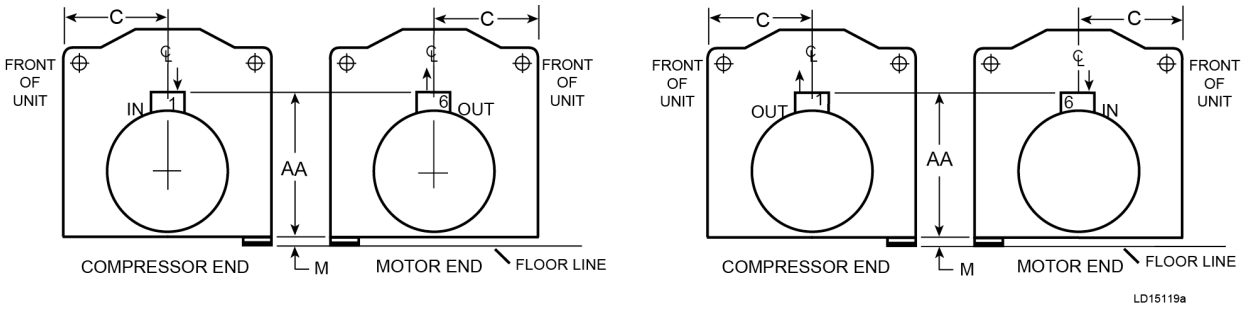


Figure 54: Evaporators - marine waterboxes (2-pass nozzle arrangements)

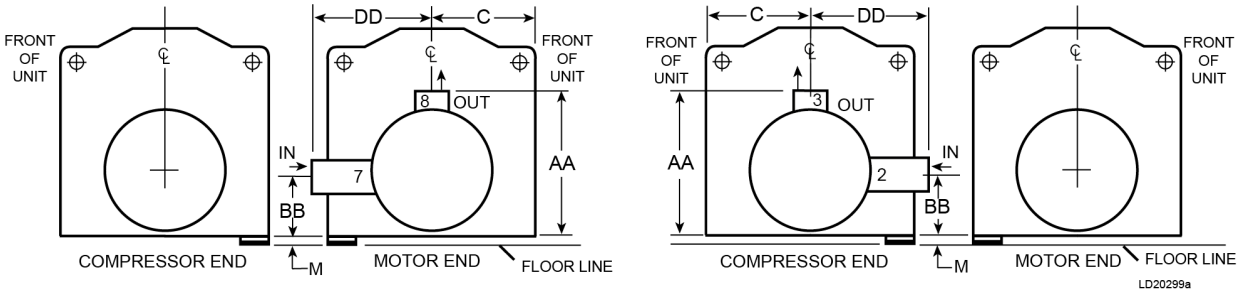


Figure 55: Evaporators - marine waterboxes (3-pass nozzle arrangements)

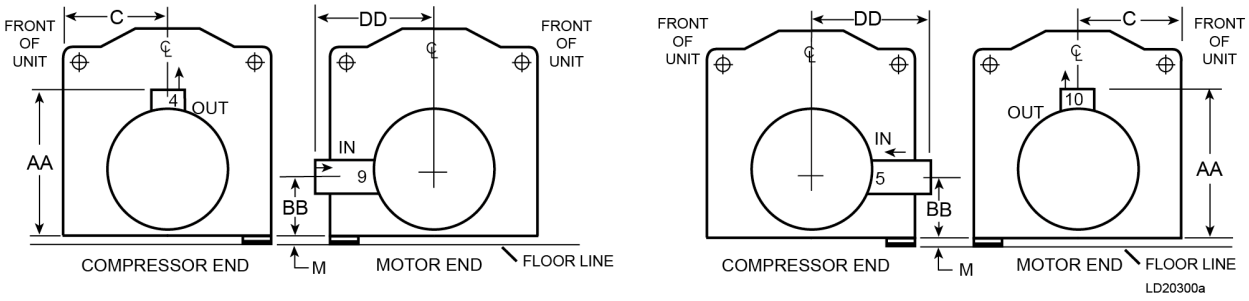


Table 22: Marine waterboxes - 150 psig (1.14 MPa)

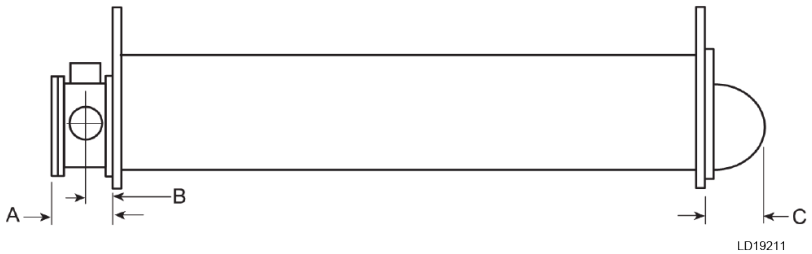
Evaporator shell code	Nozzle pipe size				Evaporators nozzle dimensions in ft-in. (mm)						
	No. of passes				1-Pass	2-Pass			3-Pass		
	1	2	3	C	AA*	AA*	BB*	DD	AA*	BB*	DD
B	20"	18"	14"	2' 10" (864)	6' 9-5/8" (2,075)	6' 9-5/8" (2,075)	1' 7-1/2" (497)	3' 0-1/8" (918)	6' 9-5/8" (2,075)	1' 7-1/2" (497)	3' 0-1/8" (918)
C	20"	18"	14"	3' 1-1/2" (954)	7' 5-1/8" (2,264)	7' 5-1/8" (2,264)	2' 1" (635)	3' 0-3/4" (935)	7' 5-1/8" (2,264)	2' 1" (635)	3' 0-3/4" (935)

Note:

*Add dimension "M dimension" as shown in Table 17 for the appropriate isolator type.

1. All dimensions are approximate. Certified dimensions are available upon request.
2. Standard water nozzles are Schedule 40 pipe size, furnished as welding stub-outs with ANSI/AWWA C-606 grooves, allowing the option of welding, flanges, or use of ANSI/AWWA C-606 couplings. Factory-installed, class 150 (ANSI B16.5, round slip-on, forged carbon steel with 1/16 in. (2 mm) raised face), water flanged nozzles are optional (add 1/2 in. (13 mm) to nozzle length). Companion flanges, nuts, bolts, and gaskets are not furnished.
3. One-, two-, and three-pass nozzle arrangements are available only in pairs shown and for all shell codes. Any pair of evaporator nozzles may be used in combination with any pair of condenser nozzles. Compact waterboxes on one heat exchanger may be used with Marine Water Boxes on the other heat exchanger.

Figure 56: Evaporator nozzle dimensions marine waterboxes



Evaporator shell code	Pass	Evaporator nozzle dimensions in ft-in. (mm)		
		A	B	C
B	1	2' 8" (813)	1' 2-5/8" (373)	n/a
B	2	2' 6" (762)	1' 1-5/8" (348)	1' 4-3/8" (416)
B	3	2' 6" (762)	1' 1-5/8" (348)	n/a
C	1	2' 8-1/2" (826)	1' 2-5/8" (373)	n/a
C	2	2' 6-1/2" (775)	1' 1-1/2" (343)	1' 6-1/4" (464)
C	3	2' 6-1/2" (775)	1' 1-1/2" (343)	n/a

Condenser nozzle arrangements marine waterboxes

1 Pass		2 Pass		3 Pass	
IN	**OUT**	**IN**	**OUT**	**IN**	**OUT**
11	16	12	13	15	20
16	11	17	18	19	14

Figure 57: Condensers - marine waterboxes (1-pass nozzle arrangements)

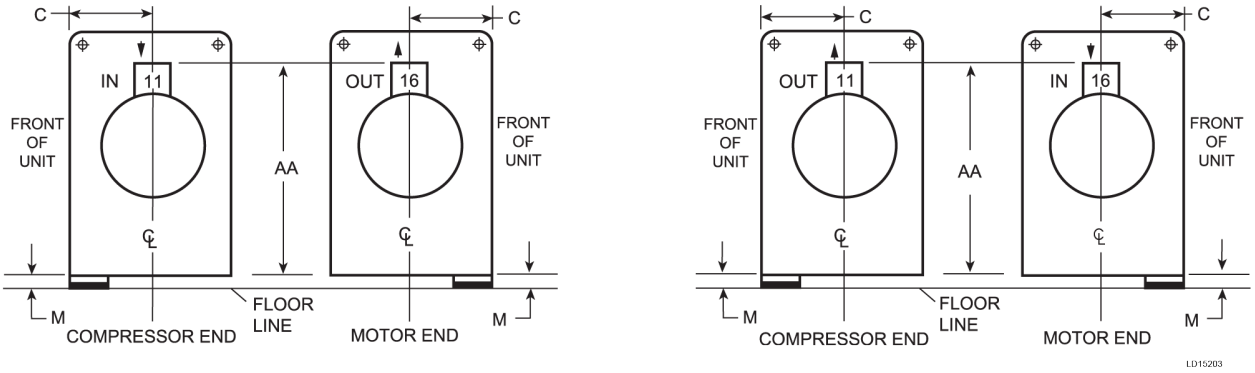


Figure 58: Condensers - marine waterboxes (2-pass nozzle arrangements)

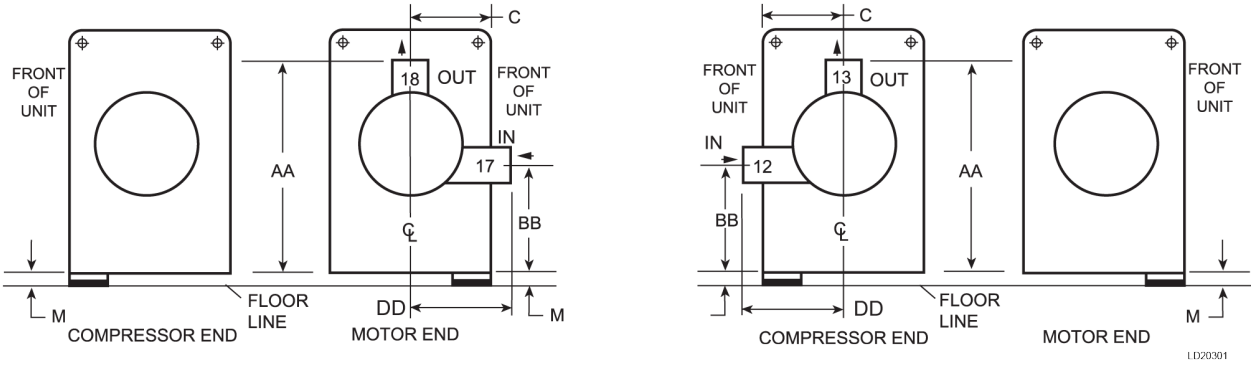


Figure 59: Condensers - marine waterboxes (3-pass nozzle arrangements)

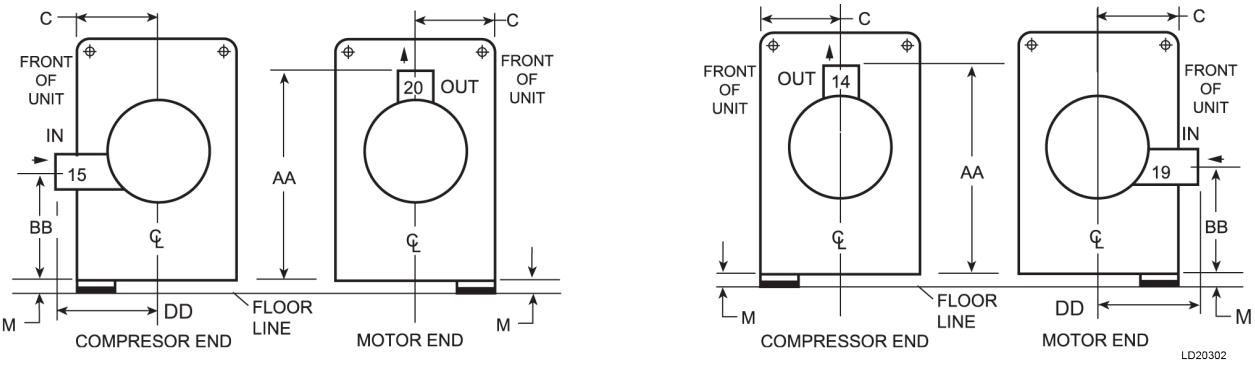


Table 23: Marine waterboxes - 150 psig (1.14 MPa)

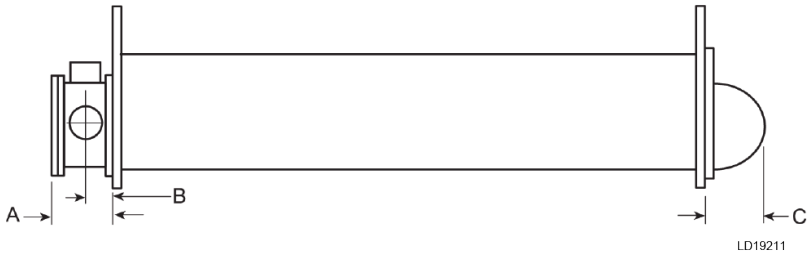
Condenser shell code	Nozzle pipe size				Condensers nozzle dimensions in ft-in. (mm)						
	No. of passes				1-Pass	2-Pass			3-Pass		
	1	2	3	C	AA*	AA*	BB*	DD	AA*	BB*	DD
B	24"	18"	16"	2' 7-1/2" (802)	7' 5-3/8" (2,271)	7' 5-3/8" (2,271)	3' 1-1/8" (943)	2' 10" (864)	7' 5-3/8" (2,271)	3' 1-1/8" (943)	2' 10" (864)
C	24"	20"	16"	2' 10" (864)	7' 9-1/4" (2,369)	7' 9-1/4" (2,369)	3' 3" (991)	2' 11-1/2" (903)	7' 9-1/4" (2,369)	3' 3" (991)	2' 11-1/2" (903)

Note:

*Add dimension "M dimension" as shown in Table 17 for the appropriate isolator type.

1. All dimensions are approximate. Certified dimensions are available upon request.
2. Standard water nozzles are Schedule 40 pipe size, furnished as welding stub-outs with ANSI/AWWA C-606 grooves, allowing the option of welding, flanges, or use of ANSI/AWWA C-606 couplings. Factory-installed, class 150 (ANSI B16.5, round slip-on, forged carbon steel with 1/16 in. (2 mm) raised face), water flanged nozzles are optional (add 1/2 in. (13 mm) to nozzle length). Companion flanges, nuts, bolts, and gaskets are not furnished.
3. One-, two-, and three-pass nozzle arrangements are available only in pairs shown and for all shell codes. Any pair of evaporator nozzles may be used in combination with any pair of condenser nozzles. Compact waterboxes on one heat exchanger may be used with Marine Water Boxes on the other heat exchanger.
4. Condenser water must enter the waterbox through the bottom connection for proper operation of the sub-cooler to achieve rated performance.

Figure 60: Condensers nozzle dimensions marine waterboxes



Condenser shell code	Pass	Condenser nozzle dimensions ft-in. (mm)		
		A	B	C
B	1	2' 11-3/4" (909)	1' 4-1/2" (421)	n/a
B	2	2' 5-3/4" (756)	1' 1-1/2" (344)	1' 3-3/8" (391)
B	3	2' 5-3/4" (756)	1' 1-1/2" (344)	n/a
C	1	3' (915)	1' 4-1/2" (421)	n/a
C	2	2' 8" (813)	1' 2-1/2" (674)	1' 3-3/8" (391)
C	3	2' 8" (813)	1' 2-1/2" (674)	n/a

Unit conversion

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

Table 24: SI metric conversion

Measurement	Multiply English unit	By factor	To obtain metric unit
Capacity	Tons refrigerant effect (ton)	3.516	Kilowatts (kW)
Power	Horsepower	0.7457	Kilowatts (kW)
Flow rate	Gallons / minute (gpm)	0.0631	Liters / second (l/s)
Length	Feet (ft)	0.3048	Meters (m)
	Inches (in.)	25.4	Millimeters (mm)
Weight	Pounds (lbs)	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 (i.e., a range of 10°F) from Fahrenheit to Celsius, multiply by 5/9 or 0.5556.

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