

# Application Guidelines

## Copeland Scroll™ Horizontal Compressors for Air-Conditioning Applications

ZRH49K\* to ZRH72K\*, ZBH30K\* to ZBH45K\*  
ZRHV45K\* & ZRHV72K\*

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## About these guidelines

The purpose of these guidelines is to provide guidance in the application of Copeland Scroll™ horizontal compressors in users' systems. They are intended to answer the questions raised while designing, assembling and operating a system with these products.

Besides the support they provide, the instructions listed herein are also critical for the proper and safe functioning of the compressors. Emerson cannot guarantee the performance and reliability of the product if it is misused in regard of these guidelines.

These application guidelines cover stationary applications. For transport or rail applications, other considerations such as high vibration and shocks, power supply characteristics, high ambient temperatures, frequent cycling etc. may apply. It is the responsibility of the system designer/planner to define the individual requirements to qualify the compressor and the complete system for their specific needs. Please contact the Application Engineering department at Emerson or your local Emerson representative for additional support.

## 1 Safety instructions







Copeland Scroll compressors are manufactured according to the latest European safety standards. Particular emphasis has been placed on the user's safety.

These compressors are intended for installation in systems according to the EC Machinery Directive MD 2006/42/EC. They may be put to service only if they have been installed in these systems according to instructions and conform to the corresponding provisions of legislation. For relevant standards please refer to the Manufacturers Declaration, available at [www.climate.emerson.com/en-gb](http://www.climate.emerson.com/en-gb).

These instructions should be retained throughout the lifetime of the compressor.

**You are strongly advised to follow these safety instructions.**

### 1.1 Icon explanation

 <p><b>WARNING</b> This icon indicates instructions to avoid personal injury and material damage.</p>	 <p><b>CAUTION</b> This icon indicates instructions to avoid property damage and possible personal injury.</p>
 <p><b>High voltage</b> This icon indicates operations with a danger of electric shock.</p>	 <p><b>IMPORTANT</b> This icon indicates instructions to avoid malfunction of the compressor.</p>
 <p><b>Danger of burning or frostbite</b> This icon indicates operations with a danger of burning or frostbite.</p>	<p><b>NOTE</b> This word indicates a recommendation for easier operation.</p>
 <p><b>Explosion hazard</b> This icon indicates operations with a danger of explosion.</p>	

### 1.2 Safety statements

- Refrigerant compressors must be employed only for their intended use.
- Only qualified and authorized HVAC or refrigeration personnel are permitted to install, commission and maintain this equipment.
- Electrical connections must be made by qualified electrical personnel.
- All valid standards for connecting electrical and refrigeration equipment must be observed.
- The national legislation and regulations regarding personnel protection must be observed.



**Use personal safety equipment.** Safety goggles, gloves, protective clothing, safety boots and hard hats should be worn where necessary.

## 1.3 General instructions



### WARNING

**System breakdown! Personal injuries!** Never install a system in the field and leave it unattended when it has no charge, a holding charge, or with the service valves closed without electrically locking out the system.

**System breakdown! Personal injuries!** Only approved refrigerants and refrigeration oils must be used.



### WARNING

**High shell temperature! Burning!** Do not touch the compressor until it has cooled down. Ensure that other materials in the area of the compressor do not come into contact with it. Lock and mark accessible sections.



### CAUTION

**Overheating! Bearing damage!** Do not operate compressors without refrigerant charge or without being connected to the system.



### CAUTION

**Contact with POE! Material damage!** POE lubricant must be handled carefully and the proper protective equipment (gloves, eye protection, etc.) must be used at all times. POE must not come into contact with any surface or material that it might damage, including without limitation, certain polymers, eg, PVC/CPVC and polycarbonate.



### IMPORTANT

**Transit damage! Compressor malfunction!** Use original packaging. Avoid collisions and tilting.

## 2 Product description

### 2.1 General information about Copeland Scroll™ compressors

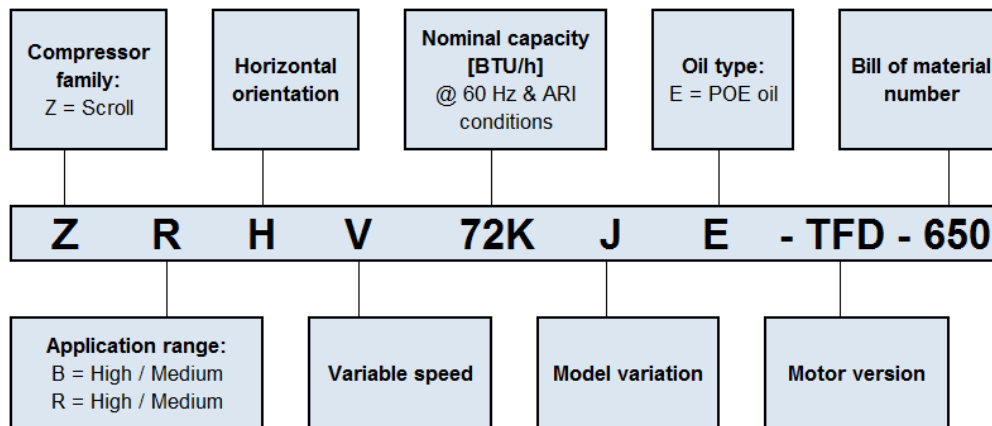
These application guidelines deal with Copeland Scroll horizontal compressors for air-conditioning and other applications with HFC refrigerants. This compressor range consists of models ZRH49KJE to ZRH72KJE and ZBH30KJE to ZBH45KJE fixed speed, and models ZRHV45KJE and ZBHV72KJE variable speed.

Compressor	Cooling capacity [kW]		Displacement [m³/h]	Motor
	R407C	R134a		
ZBH30KJE	10.0	7.0	11.7	TFD/TF5
ZBH38KJE	12.6	8.6	14.4	TFD/TF5
ZBH45KJE	14.8	10.2	17.1	TFD/TF5
ZBHV45KJE	14.8	10.2	17.1	TFD/TF5
ZRH49KJE	10.2	7.1	11.8	TFD/TF5
ZRH61KJE	13.0	8.9	14.5	TFD/TF5
ZRH72KJE	15.0	10.5	17.1	TFD/TF5
ZRHV72KJE	15.0	10.5	17.1	TFD/TF5

Table 1: Cooling capacity at 5°C/50°C/10K/0K

### 2.2 Nomenclature

The model designation contains the following technical information about the compressor:

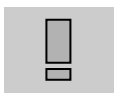


#### ARI conditions:

Evaporating temperature .....7.2°C                      Liquid sub-cooling .....8.3K  
 Condensing temperature .....54.4°C                     Ambient temperature.....35°C  
 Suction gas superheat.....11K

### 2.3 Application range

#### 2.3.1 Qualified refrigerants and oils



#### IMPORTANT

It is essential that the glide of refrigerant blends (primarily R407C) be carefully considered when adjusting pressure and superheat controls.

Oil recharge values can be taken from Copeland Scroll compressors brochures or Copeland™ brand products Select software available at [www.climate.emerson.com/en-gb](http://www.climate.emerson.com/en-gb).

Qualified refrigerants	R407C & R134a
Copeland brand products standard oil	Emkarate RL 32 3MAF
Servicing oils	Emkarate RL 32 3MAF Mobil EAL Arctic 22 CC

Table 2: Qualified refrigerants and oils

## 2.3.2 Application limits



### CAUTION

**Inadequate lubrication! Compressor breakdown!** The superheat at the compressor suction inlet must always be sufficient to ensure that no refrigerant droplets enter the compressor. For a typical evaporator-expansion valve configuration a minimum stable superheat of at least 5K is required.

**NOTE:** The application envelopes for all horizontal compressor models covered in these guidelines are available in Copeland brand products Select software at [www.climate.emerson.com/en-gb](http://www.climate.emerson.com/en-gb).

## 2.3.3 Comparison between ZRH\* and ZBH\* compressors

ZRH\* and ZBH\* horizontal compressor models are basically available in two BOM variations:

- **BOM 650** Compressor with brazing stub tubes, electrical box ready for molded plug IP65
- **BOM 651** Compressor with Rotalock connections, electrical box ready for molded plug IP65

Table 2 below describes the differences and similarities between ZRH\* and ZBH\* models:

Compressor version	BOM 650	BOM 651
ZRH*	Brazing stub tubes Electrical connection ready for molded plug IP65 Without oil sight glass Without oil service Schraeder valve	Rotalock connections Electrical connection ready for molded plug IP65 Without oil sight glass Without oil service Schraeder valve
ZRHV*	Brazing stub tubes Electrical connection ready for molded plug IP65 Without oil sight glass Without oil service Schraeder valve Variable speed	Rotalock connections Electrical connection ready for molded plug IP65 Without oil sight glass Without oil service Schraeder valve Variable speed
ZBH*	Brazing stub tubes Electrical connection ready for molded plug IP65 Oil sight glass Oil service Schraeder valve	Rotalock connections Electrical connection ready for molded plug IP65 Oil sight glass Oil service Schraeder valve
ZBHV*	Brazing stub tubes Electrical connection ready for molded plug IP65 Oil sight glass Oil service Schraeder valve Variable speed	Rotalock connections Electrical connection ready for molded plug IP65 Oil sight glass Oil service Schraeder valve Variable speed

Table 3: Differences and similarities between ZRH\* and ZBH\* horizontal scroll compressors

## 2.4 Special requirements for transport applications

Transport air-conditioning or refrigeration applications can be particularly sensitive and require experience and thorough case-by-case analysis. Compared to static applications, additional demands in terms of applicability to specific norm and standard requirements can arise. The system designer must pay particular attention to higher demands with regard to shock stress, high vibration levels, power supply and other installation characteristics.

The qualification for the parts and individual requirements, like system components, piping, piping layout, fixation, as well as a study about shock, vibration and load requirements must be carried out by the unit designer for the whole system. Emerson can provide support and assistance with individual projects.

2.5 Dimensions

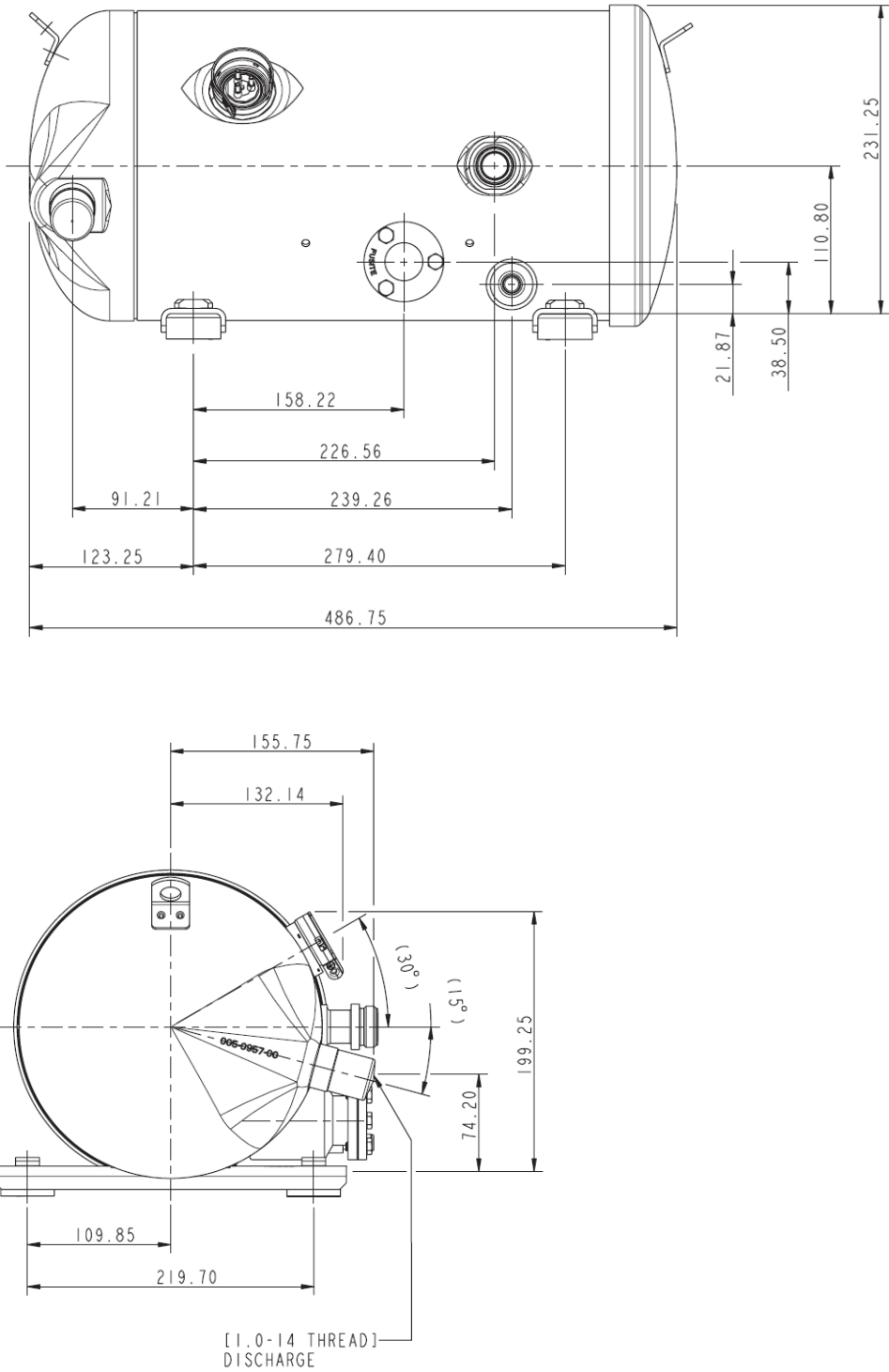


Figure 1: Dimensions of models ZBH30KJE to ZBH45KJE and ZBHV45KJE



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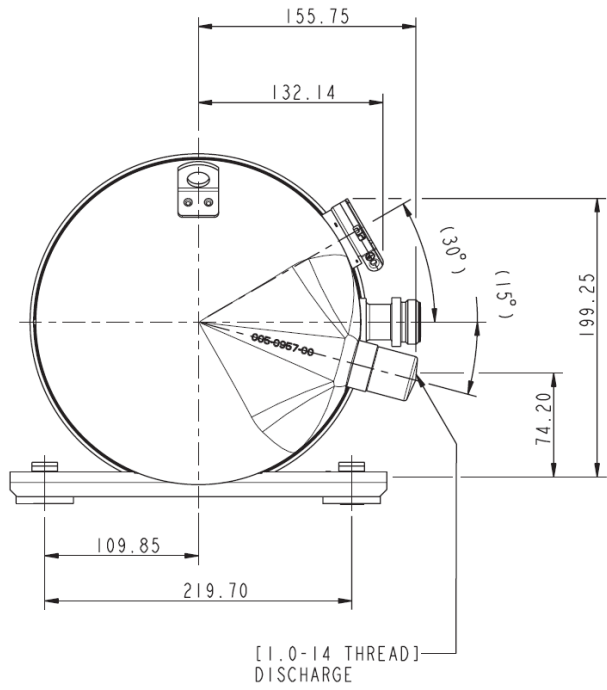
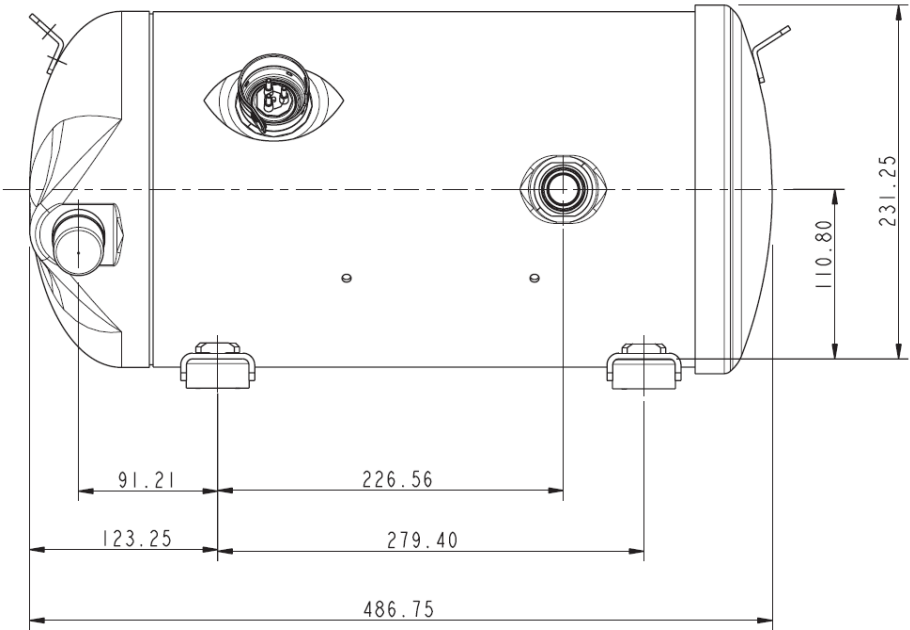


Figure 2: Dimensions of models ZRH42KJE to ZRH72KJE and ZRHV72KJE

### 3 Installation



**WARNING**  
**High pressure! Injury to skin and eyes possible!** Be careful when opening connections on a pressurized item.

#### 3.1 Compressor handling

##### 3.1.1 Transport and storage



**WARNING**  
**Risk of collapse! Personal injuries!** Move compressors only with appropriate mechanical or handling equipment according to weight. Keep in the upright position. Respect stacking loads according to **Figure 3**. Check the tilting stability and if needed take action to ensure the stability of the stacked loads. Keep the packaging dry at all times.

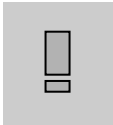


Respect the maximum number of identical packages which may be stacked on one another, where "n" is the limiting number:

- **Transport: n = 1**
- **Storage: n = 2**

Figure 3: Maximum stacking loads for transport and storage

##### 3.1.2 Positioning and securing



**IMPORTANT**  
**Handling damage! Compressor malfunction!** Only use the lifting eyes whenever the compressor requires positioning. Using discharge or suction connections for lifting may cause damage or leaks.

The lifting tabs are located on the side of the compressor shell end caps.

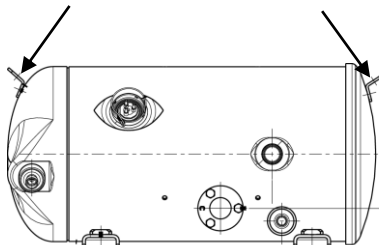


Figure 4: Handling of a horizontal scroll compressor

**NOTE: It is essential to use the lifting tabs to maintain the compressor in the horizontal position during handling, installation or removal in order to avoid damage to the compressor.**

Horizontal scroll compressors have a holding charge and are factory filled with dry air. It is recommended to remove the discharge connection plug first before pulling the suction connection plug to allow the dry air pressure inside the compressor to escape.

Care must be taken when removing the plugs from the discharge and suction connections, because oil mist might come out and coat the suction tube, making the brazing process on the copper-coated tubes difficult. The copper-coated steel suction tube should be cleaned before brazing.

The plugs must be removed as late as possible before brazing so that the air humidity does not affect the oil characteristics.

No object, eg, a swaging tool should be inserted deeper than 51 mm into the suction tube as it might damage the suction screen and motor.

##### 3.1.3 Installation location

Ensure the compressors are installed on a solid level base.

## 3.1.4 Mounting parts

ZRH\* and ZBH\* horizontal Scroll compressors can be mounted solidly on the chassis using steel spacers. Alternatively, rubber mounting parts of different hardness can be used. The unit designer should make a choice after observing the shock/vibration test results.

A kit of soft rubber grommets is supplied in the standard delivery of the horizontal scroll compressor. Depending on the applications, other or harder mounting parts might be required.

The rubber mounting part kit typically consists of rubber grommets, metal washers and metal sleeves. The metal sleeve inside is a guide designed to hold the grommet in place. It should not be used as a load-bearing member, and application of excessive torque to the bolts can crush the sleeve. Its inner diameter is approximately 8.5 mm to fit, e.g., an M8 screw.

For the soft rubber mounting parts kit, the recommended mounting torque is  $13 \pm 1$  Nm. It is critically important that the grommet is not compressed. A clearance space of approximately 2 mm between the bottom of the washer and the top of the grommet spacer is recommended.

The hard rubber mounting parts kit contains two metal washers, which have to be positioned above the rubber grommet and the metal sleeve. The bolt must be tightened until positive contact occurs between the bolt head and the washer, ensuring that both are securely clamped together. The recommended mounting torque is  $18 \pm 1$  Nm.

The metal sleeve inside helps to hold the grommet in place.

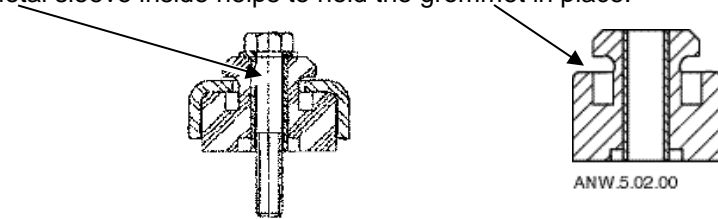


Figure 5: Installation of soft rubber mounting parts

**NOTE:** Use the advised torque below to avoid crushing the sleeve.

**NOTE:** For an overview of ident numbers, various mounting part alternatives and other accessories, please refer to the Emerson spare parts software available at [www.climate.emerson.com/en-gb](http://www.climate.emerson.com/en-gb).

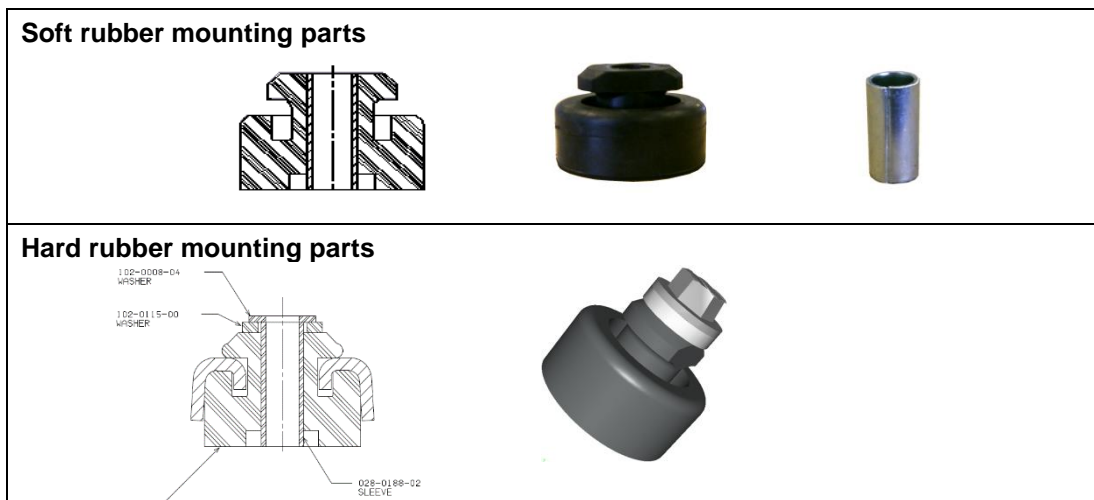


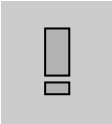
Figure 6: Mounting parts with sleeve and washer

**NOTE:** For more information please refer to Technical Information C7.11.2 "Scroll Mounting Parts".

## 3.2 Brazing procedure

### IMPORTANT

**Blockage! Compressor breakdown!** Maintain a flow of oxygen-free nitrogen through the system at very low pressure during brazing. Nitrogen displaces the air and prevents the formation of copper oxides in the system. If allowed to form, the copper oxide material can later be swept through the system and block screens such as those protecting capillary tubes, thermal expansion valves, and accumulator oil return holes.



**IMPORTANT**

**Contamination or moisture! Bearing failure!** Do not remove the plugs until the compressor is set into the unit. This minimises any entry of contaminants and moisture.

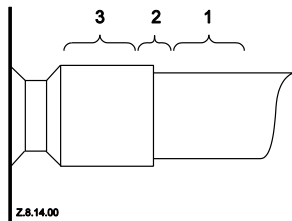


Figure 7: Suction tube brazing

Copeland Scroll compressors have copper-plated steel suction and discharge tubes. These tubes are far more robust and less prone to leaks than copper tubes. Due to the different thermal properties of steel and copper, brazing procedures may have to be changed from those commonly used.

Refer to **Figure 7** and the procedure below for the brazing of the suction and discharge lines to a scroll compressor.

- The copper-coated steel tubes on scroll compressors can be brazed in approximately the same manner as any copper tube.
- Recommended brazing materials: any silfos material is recommended, preferably with a minimum of 5% silver. However, 0% silver is acceptable.
- Be sure tube fitting inner diameter and tube outer diameter are clean prior to assembly.
- Using a double-tipped torch, apply heat in area 1.
- As the tube approaches brazing temperature, move the torch flame to area 2.
- Heat area 2 until braze temperature is attained, moving the torch up and down and rotating around the tube as necessary to heat the tube evenly. Add braze material to the joint while moving the torch around the joint to flow braze material around the circumference.
- After the braze material flows around the joint, move the torch to heat area 3. This will draw the braze material down into the joint. The time spent heating area 3 should be minimal.
- As with any brazed joint, overheating may be detrimental to the final result.

**To disconnect:**

- Heat joint areas 2 and 3 slowly and uniformly until the braze material softens and the tube can be pulled out of the fitting.

**To reconnect:**

- Recommended brazing materials: Silfos with minimum 5% silver or silver braze used on other compressors. Due to the different thermal properties of steel and copper, brazing procedures may have to be changed from those commonly used.

**NOTE:** Since the discharge stub contains a check valve, care must be taken not to overheat it to prevent brazing material from flowing into it.

**3.3 Shut-off valves and adaptors**



**CAUTION**

**Leaking system! System breakdown!** It is strongly recommended to periodically re-torque all pipe and fixing connections to the original setting after the system has been put into operation.

Copeland Scroll horizontal compressors are delivered either with stub or Rotalock connections depending on the bill of material that has been selected.

Braze connections can be converted to Rotalock by means of adaptors. Rotalock shut-off valves are available for the suction as well as discharge sides. Using either straight or angled adaptors provides a way to convert a Rotalock into a brazing connection.

Refer to **Table 3** for proper tightening torques:

Connection	Torque [Nm]
Rotalock 1" – 14 UNS	70 - 80
Rotalock 1 ¼" – 12 UNF	110 - 135
Rotalock 1 ¾" – 12 UNF	135 - 160

Table 4

**NOTE:** More information about adaptors and shut-off valves can be found in the "Spare parts list" available at [www.climate.emerson.com/en-gb](http://www.climate.emerson.com/en-gb).

## 3.4 Accumulators



### CAUTION

**Inadequate lubrication! Bearing destruction!** Minimise liquid refrigerant returning to the compressor. Too much refrigerant dilutes the oil. Liquid refrigerant can wash the oil off the bearings leading to overheating and bearing failure.

Irrespective of system charge, oil dilution may occur if large amounts of liquid refrigerant repeatedly flood back to the compressor, for example during:

- normal off cycles;
- defrost;
- varying loads.

In such a case an accumulator must be used to reduce floodback to a safe level that the compressor can handle. The use of accumulators is dependent on the application. If an accumulator must be used, the oil-return orifice should be from 1 to 1.4 mm in diameter, depending on compressor size and compressor floodback results.

The size of the accumulator depends upon the operating range of the system and the amount of subcooling and subsequent head pressure allowed by the refrigerant control. If an accumulator is used, it is recommended that it be sized to hold from 50% to 70% of the system charge.

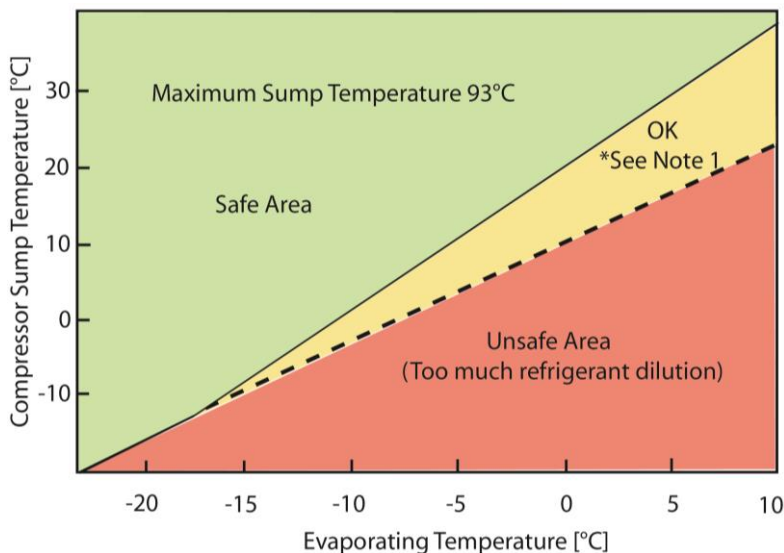


Figure 8: Oil dilution chart for operation

**Note 1: Low load operation may be acceptable in the yellow marked area. For further information, please contact the Application Engineering department.**

## 3.5 Screens



### CAUTION

**Screen blocking! Compressor breakdown!** Use screens with at least 0.6 mm openings.

The use of screens finer than 30 x 30 mesh (0.6 mm openings) anywhere in the system should be avoided with these compressors. Field experience has shown that finer mesh screens used to protect thermal expansion valves, capillary tubes or accumulators can become temporarily or permanently plugged with normal system debris and block the flow of either oil or refrigerant to the compressor. Such blockage can result in compressor failure.

## 3.6 Mufflers

External mufflers, normally applied to piston compressors in the past, may not be required for Copeland Scroll compressors. Individual system tests should be performed to verify acceptability of sound performance. If adequate attenuation is not achieved, use a muffler with a larger cross-sectional area to inlet area ratio. A ratio of 20:1 to 30:1 is recommended.

A hollow shell muffler will work quite well. Locate the muffler at minimum 15 to maximum 45 cm from the compressor for the most effective operation. The farther the muffler is placed from the compressor within this range, the more effective. Choose a muffler with a length of 10 to 15 cm.

## 4 Electrical connection

### 4.1 General recommendations

The compressor terminal box has a wiring diagram on the inside of its cover. Before connecting the compressor, ensure the supply voltage, the phases and the frequency match the nameplate data.

### 4.2 Electrical installation



**WARNING**

**Conductor cables! Electrical shock!** Shut off power supply before and between each test.

#### 4.2.1 Molded plug connection



**WARNING**

**Electric arc! Explosion hazard!** Removing the molded plug cable while under load or electrically energized will create arcing between the connection pins and the cable connectors. Always shut off power supply before attaching or removing the molded plug cable from the connection pins.

The molded plug connector must be smoothly pushed by hand towards the connection pins of the compressor. Never use a tool to knock the molded plug connector on the terminal pins as this could damage the glass inserts of the pins.

It is mandatory to secure the molded plug cable on the connection pins with a retainer.

Any rework on the terminal pins is strictly prohibited.



**WARNING**

**Electrical shock hazard! Serious personal injuries and/or system breakdown!** Use qualified molded plug cables with grounding connection only. Make sure to connect the grounding first before attaching the molded plug cable to the connection pins of the compressor. When removing the molded plug cable from the connection pins, disconnect the grounding last.

ZRH\* and ZBH\* horizontal Scroll compressors are equipped with electrical connection pins ready for molded plug connection. This version is compliant with all CE and safety regulations and its protection class is IP65. The molded plug kit includes an O-ring, a grounding connection and a retainer (see **Figures 9 to 11**).



Figure 9: Circle fence with motor terminals



Figure 10: Power cable molded plug (IP65)

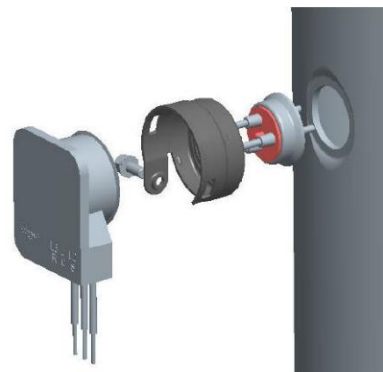


Figure 11: Connecting the molded plug power cable to the connection pins

#### 4.2.2 Assembly of the molded plug cable

- Make sure to use only qualified molded plug power cables with grounding connection.
- Check that the O-ring on the molded plug connector is in place and not damaged.
- Shut off power supply.
- Check that the circle fence is clean and dry before connecting the molded plug power cable.
- For molded plug cables with grounding: connect the grounding of the molded plug power cable to the compressor circle fence.

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- Attach the molded plug connector to the compressor connection pins. Smoothly push the molded plug connector by hand as far as possible towards the pins. Never use a tool to knock the molded plug as this could damage the glass inserts of the pins.
- For molded plug cables with retainer: secure the connection with the retainer.

## 4.2.3 Removing the molded plug cable

- Shut off power supply.
- For molded plug cables with retainer: remove the retainer from the connection.
- Remove the molded plug connector from the connection pins.
- For molded plug cables with grounding: disconnect the grounding from the compressor circle fence.

**NOTE:** To select the appropriate molded plug power cables, please refer to the Emerson spare parts software available at [www.climate.emerson.com/en-gb](http://www.climate.emerson.com/en-gb).

## 4.2.4 Wiring diagram

Three-phase compressors (TF\*) with internal motor protection:

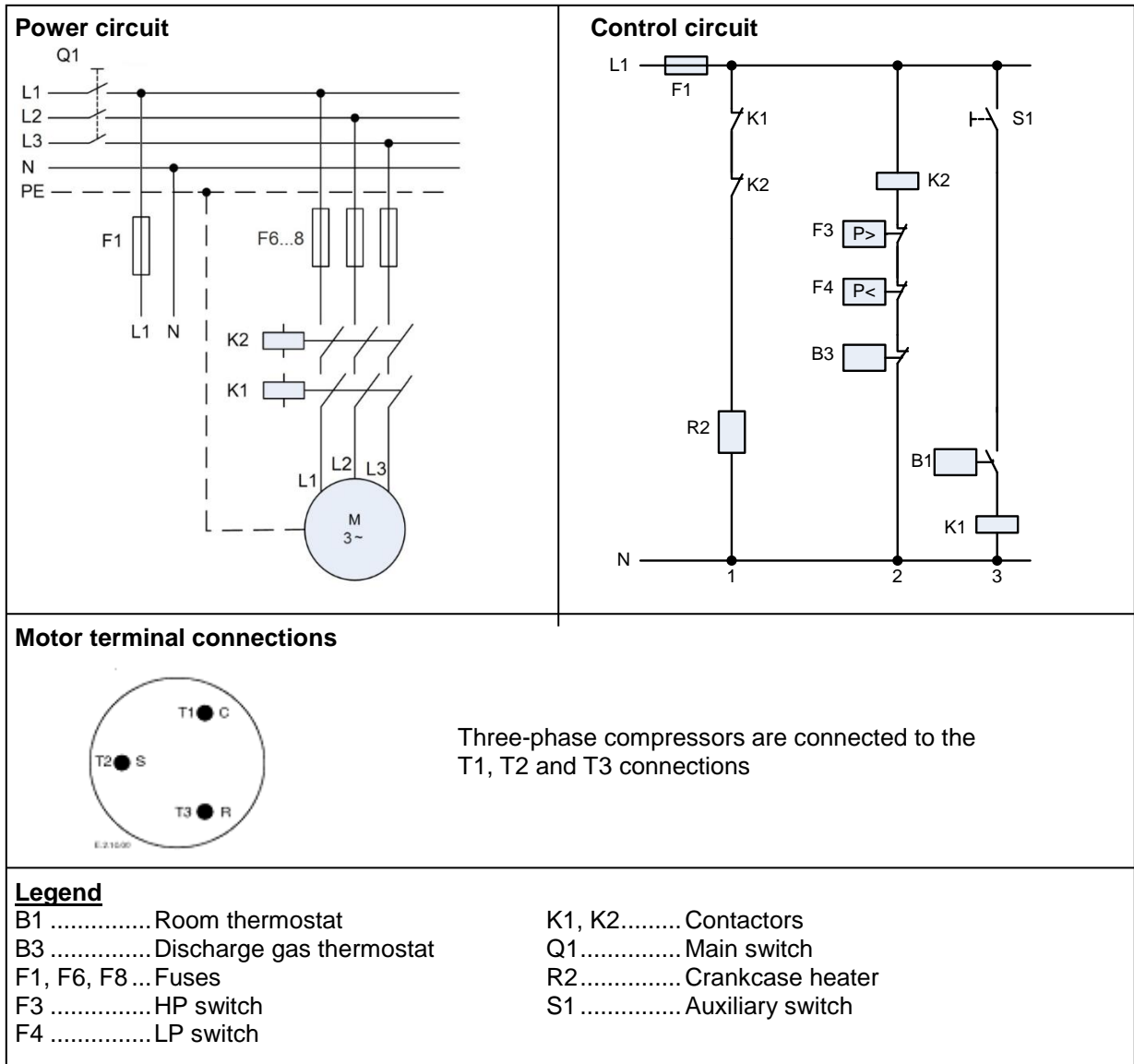


Figure 12: Wiring diagrams for three-phase compressors with internal motor protection

## 4.2.5 Motor winding

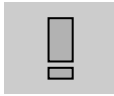
ZRH\* and ZBH\* horizontal Scroll compressors have a three-phase induction motor. All three-phase motors are connected in star.

The motor insulation material is class "B" according to IEC 34-1 or DIN 57530.

**4.2.6 Protection devices**

Independently from the internal motor protection, fuses must be installed before the compressor. The selection of fuses has to be done according to VDE 0635, DIN 57635, IEC 269-1 or EN 60-269-1.

**4.2.7 Crankcase heater**



**IMPORTANT**

**Oil dilution! Bearing malfunction!** Turn the crankcase heater on 12 hours before starting the compressor.

A crankcase heater is required with ZRH\* and ZBH\* horizontal Scroll compressors if the system configuration enables large amounts of refrigerant to condense in the compressor and to be absorbed by the oil during standstill periods. A crankcase heater is always required when the system charge exceeds 4.5 kg.

**The crankcase heater must be turned on a minimum of 12 hours prior to starting the compressor.** This will prevent oil dilution and bearing stress on initial start-up.

The crankcase heater should be positioned on the right-hand side of the compressor, a few centimetres away from the position of the electrical connection.

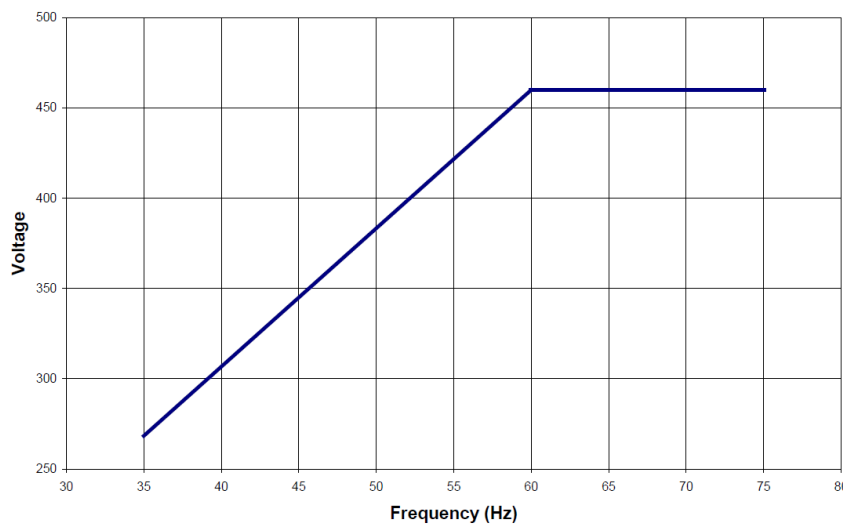
**Caution:** Crankcase heaters must be properly grounded!

**4.3 Inverter operation**

Copeland Scroll horizontal compressors ZRH49K\* to ZRH72K\* and ZBH30K\* to ZBH45K\* are limited to fixed speed operation at either 50 or 60 Hz.

Compressor models ZRHV72K\* and ZBHV45K\* can be operated on inverter-derived power over the range of 35 to 75 Hz. The inverter drives used to power these compressors must comply with the provisions of technical specification IEC 600034-17. In particular, the motor input voltage must be limited to 1.35 kV/microsecond line-to-line impulse voltage. These provisions are required to avoid motor insulation breakdown, to limit motor heating, and to extend motor lifetime.

The compressor operating voltage must vary with frequency according to the diagram shown in **Figure 13**. The value of the voltage should be 7.67 multiplied by the operating frequency over the range of 35 to 60 Hz. From 60 to 75 Hz, the voltage should be a constant 460 volts. Matching voltage to frequency according to these guidelines will prevent motor saturation and overheating.



**Figure 13: Voltage versus operating frequency ZRHV72KJE-TFD and ZBHV45KJE-TFD**

Operating compressor models ZRH49K\* to ZRH72K\* and ZBH30K\* to ZBH45K\* over a defined frequency range will result in different application envelopes (see **Figures 14 & 15**). These envelopes are more restricted at lower operating speeds. This is to prevent overloading and overheating of the compressor motor during low-speed operation.



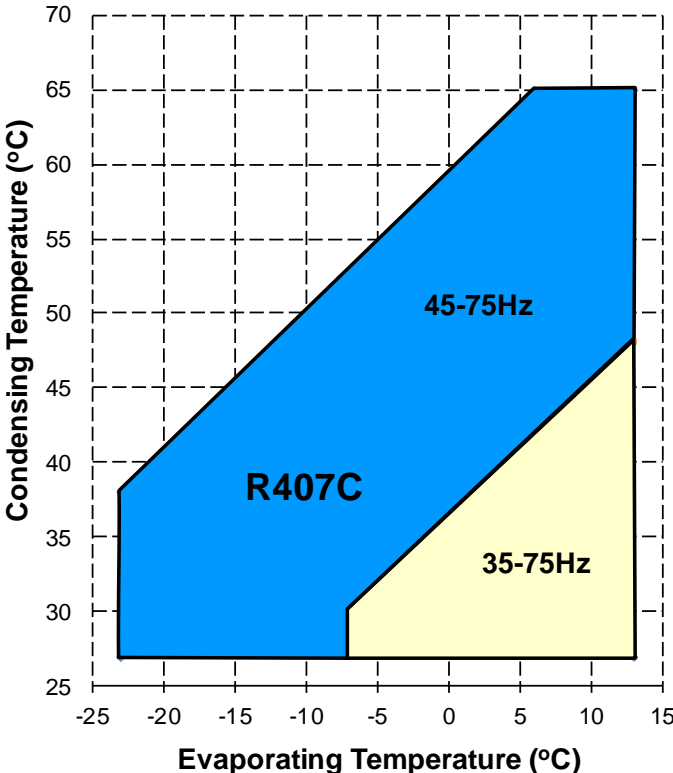


Figure 14: Operating envelope for variable speed ZRHV72KJE and ZBHV45KJE with R407C

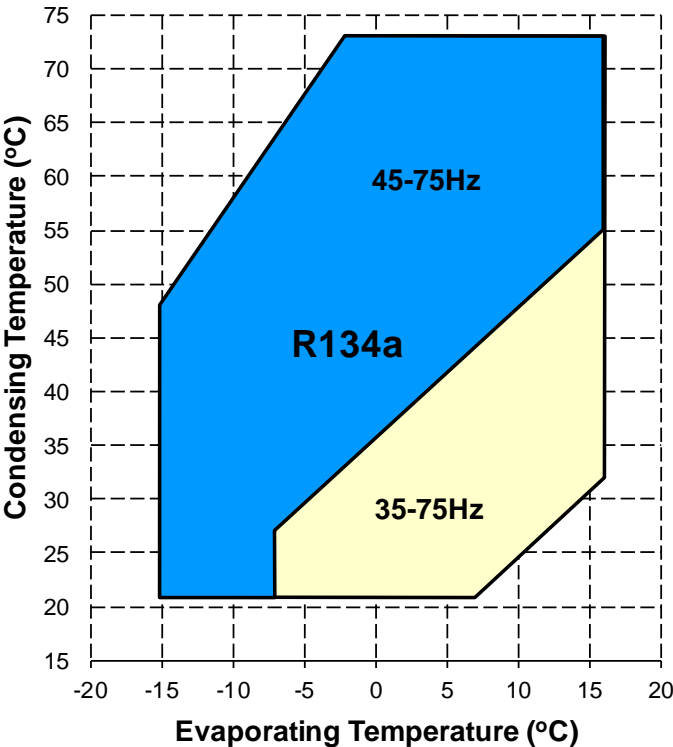


Figure 15: Operating envelope for variable speed ZRHV72KJE and ZBHV45KJE with R134a

## 4.4 Pressure safety controls

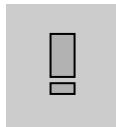
### 4.4.1 High-pressure protection

The cut-out setting for the high-pressure control shall be determined according to regional standards, usually EN 378, part 2 in Europe.

The maximum pressure value for the individual compressor type, PS high side, is printed on the nameplate of the compressor.

The high-pressure cut-out should have a manual reset feature for the highest level of system protection.

### 4.4.2 Low-pressure protection



#### IMPORTANT

**Loss of system charge and lubrication! Bearing malfunction! Compressor breakdown!** A low-pressure control is highly recommended. Do not bridge or by-pass the low-pressure cut out.

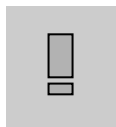
The minimum cut-out setting shall be determined according to the refrigerant and to the allowed operation envelope – see technical data in Select software at [www.climate.emerson.com/en-gb](http://www.climate.emerson.com/en-gb). For example, a minimum cut-out setting of 1.0 bar(g) is required for ZRH\* and ZBH\* compressors using R407C.

The low-pressure cut-out should have a manual reset feature for the highest level of system protection.

### 4.4.3 Internal pressure relief valve

ZRH(V)\* and ZBH(V)\* horizontal compressors do NOT have any internal pressure relief valve. To ensure safe operation, a high-pressure control must be used in all applications.

## 4.5 Discharge gas temperature protection



#### IMPORTANT

**Inadequate lubrication! Scroll set damage!** All ZRH\* and ZBH\* horizontal Scroll compressors must be equipped with an external discharge gas temperature protection.

Internal discharge temperatures can reach unacceptable values under some extreme operating conditions (such as loss of refrigerant injection charge or extremely high compression ratio). This could cause compressor damage.




The discharge thermostat dedicated to ZRH\* and ZBH\* horizontal Scroll compressors has a cut-out setting of 105°C ± 4K with closing at 88°C ± 8K. It should be installed approximately 120 mm from the discharge valve outlet (see assembly instructions below).

To ensure proper functioning and to avoid false readings, the discharge line thermostat must be installed and insulated according to the procedure and recommendations hereunder.

### Assembly of the discharge line thermostat

<ul style="list-style-type: none"> <li>Install the discharge line thermostat on the discharge tube 120 mm from top cap.</li> </ul>	
<ul style="list-style-type: none"> <li>Snap the retainer clip over the tube and onto the thermostat.</li> <li>The thermostat should be placed on the discharge tube so that its body is in upward position on a horizontal tube installation.</li> <li>Ensure that the thermostat is not tilted.</li> </ul>	

# COPELAND SCROLL™

<ul style="list-style-type: none"> <li>▪ The wire must not be in contact with the top cap of the compressor or the discharge tube. Care should be taken to route wires so that they do not come into contact with sharp objects.</li> </ul>	
<ul style="list-style-type: none"> <li>▪ To avoid any impact on tripping temperature by the ambient, the discharge line thermostat must be insulated.</li> <li>▪ Wrap thermal insulation around the pipe left and right of the thermostat and secure it with plastic straps.</li> </ul>	
<ul style="list-style-type: none"> <li>▪ Wrap a second layer of insulation around the first one and around the thermostat, and secure it with plastic straps.</li> </ul>	

## 4.6 Motor protection

Conventional inherent internal line break motor protection Klixon is provided with all compressor models covered in these guidelines.

The protector reacts to a combination of motor current and motor winding temperature. The internal protector protects against single phasing. Time must be allowed for the motor to cool down before the protector will reset.

## 4.7 High-potential testing



### WARNING

**Conductor cables! Electrical shock!** Shut off power supply before high-potential testing.



### CAUTION

**Internal arcing! Motor destruction!** Do not carry out high-voltage or insulation tests if the compressor housing is under vacuum.

Emerson subjects all Scroll compressors to a high-voltage test after final assembly. Each motor phase winding is tested, according to EN 0530 or VDE 0530 part 1, at a differential voltage of 1000V plus twice the nominal voltage. Since high-voltage tests lead to premature ageing of the winding insulation additional tests of that nature are not recommended.

If it has to be done for any reason, a lower voltage must be used. Disconnect all electronic devices, eg, motor protection module, fan speed control, etc prior to testing.

## 5 Start-up & operation



### WARNING

**Diesel effect! Compressor destruction!** The mixture of air and oil at high temperature can lead to an explosion. Avoid operating with air.



### IMPORTANT

**Oil dilution! Bearing malfunction!** Turn the crankcase heater on 12 hours before starting the compressor.

### 5.1 Strength pressure test

The compressor has been strength-tested in the factory. It is not necessary for the customer to strength- or leak-test the compressor again although the compressor will normally be exposed to the testing made as part of system testing.

### 5.2 Tightness/pressure test



### WARNING

**High pressure! Personal injuries!** Consider personal safety requirements and refer to test pressures prior to test.



### WARNING

**System explosion! Personal injuries! DO NOT USE** other industrial gases.



### CAUTION

**System contamination! Bearing malfunction!** Use only dry nitrogen or dried air for pressure testing.

If using dry air do not include the compressor in the pressure test – isolate it first. Never add refrigerant to the test gas (as leak indicator).

### 5.3 System evacuation

Before the installation is put into commission, it has to be evacuated with a vacuum pump. Proper evacuation reduces residual moisture to 50 ppm. During the initial procedure, suction and discharge shut-off valves on the compressor remain closed. The installation of adequately sized access valves at the furthest point from the compressor in the suction and liquid lines is advisable. Pressure must be measured using a vacuum pressure (Torr) gauge on the access valves and not on the vacuum pump; this serves to avoid incorrect measurements resulting from the pressure gradient along the connecting lines to the pump.

Evacuating the system only on the suction side of a Scroll compressor can occasionally result in a temporary no-start condition for the compressor. The reason for this is that the floating seal could axially seal with the scroll set, with the higher pressure on the floating seal. Consequently, until the pressures equalise, the floating seal and scroll set can be held tightly together. The installation should be evacuated down to 0.3 mbar.

Subsequently, the factory holding charge of dry air in the compressor is released to the ambient. The shut-off valves are opened and the installation, including the compressor, are once more evacuated as described after the system has been recharged with dry nitrogen. The highest demands are placed on the leak-proof design of the installation and on leak-testing methods – please refer to EN 378.

### 5.4 Preliminary checks – Pre-starting

Discuss details of the installation with the installer. If possible, obtain drawings, wiring diagrams, etc. It is ideal to use a check-list but always check the following:

- Visual check of the electrics, wiring, fuses etc.
- Visual check of the plant for leaks, loose fittings such as TXV bulbs etc.
- Compressor oil level
- Calibration of HP & LP switches and any pressure actuated valves
- Check setting and operation of all safety features and protection devices
- All valves in the correct running position
- Pressure and compound gauges fitted
- Correctly charged with refrigerant
- Compressor electrical isolator location & position

## 5.5 First start

It is good practice to stop the compressor after 15 minutes running on full or part load then check the oil levels in both sight glasses. The oil levels should be halfway up the sight glasses. This is to ensure that any oil carried over into the system is being returned to the compressor and the compressor is not short of oil.

## 5.6 Charging procedure



### CAUTION

**Low suction pressure operation! Compressor damage!** Do not operate with a restricted suction. Do not operate with the low-pressure cut-out bridged. Do not operate compressor without enough system charge to maintain at least 0.5 bar(g) suction pressure. Allowing pressure to drop below 0.5 bar(g) for more than a few seconds may overheat scrolls and cause early drive bearing damage.

The system should be liquid-charged through the liquid-receiver shut-off valve or through a valve in the liquid line. The use of a filter drier in the charging line is highly recommended. Because scrolls have discharge check valves, the system should be liquid-charged on both the high and low sides simultaneously to ensure a positive refrigerant pressure is present in the compressor before it runs. The majority of the charge should be placed in the high side of the system to prevent bearing washout during first-time start on the assembly line.

## 5.7 Initial start-up



### CAUTION

**Oil dilution! Bearing malfunction!** It is important to ensure that new compressors are not subjected to liquid abuse. Turn the crankcase heater on 12 hours before starting the compressor.



### CAUTION

**High discharge pressure operation! Compressor damage!** Do not use compressor to test opening setpoint of high-pressure cut-out. Bearings are susceptible to damage before they have had several hours of normal running in.

Liquid and high-pressure loads could be detrimental to new bearings. It is therefore important to ensure that new compressors are not subjected to liquid abuse and high-pressure run tests. It is not good practice to use the compressor to test the high-pressure switch function on the production line. Switch function can be tested with nitrogen prior to installation and wiring can be checked by disconnecting the high-pressure switch during the run test.

## 5.8 Rotation direction

Scroll compressors, like several other types of compressors, will only compress in one rotational direction. Three-phase compressors will rotate in either direction depending upon phasing of the power. Since there is a 50-50 chance of connecting power in such a way as to cause rotation in the reverse direction, **it is important to include notices and instructions in appropriate locations on the equipment to ensure proper rotation direction when the system is installed and operated.**

Observing that suction pressure drops and discharge pressure rises when the compressor is energized allows verification of proper rotation direction. There is no negative impact on durability caused by operating three-phase Copeland Scroll compressors in the reversed direction for a short period of time (under one hour) but oil may be lost. Oil loss can be prevented during reverse rotation if the tubing is routed at least 15 cm above the compressor. After several minutes of operation in reverse, the compressor's protection system will trip due to high motor temperature. The operator will notice a lack of cooling. However, if allowed to repeatedly restart and run in reverse without correcting the situation, the compressor will be permanently damaged.

All three-phase scroll compressors are identically wired internally. Therefore, once the correct phasing is determined for a specific system or installation, connecting properly phased power leads to the identified compressor terminals will ensure proper rotation direction.

## 5.9 Starting sound

During the very brief start-up, a clicking sound is audible, resulting from initial contacting of the spirals; it is normal. Due to the design of the Copeland Scroll, the internal compression components always start unloaded even if system pressures are not balanced. In addition, since internal compressor pressures are always balanced at start-up, low-voltage starting characteristics are excellent for Copeland Scroll compressors.

## 5.10 Deep vacuum operation



### CAUTION

**Vacuum operation! Compressor damage!** Scroll compressors should never be used to evacuate a refrigeration or air-conditioning system.

The scroll compressor can be used to pump down refrigerant in a unit as long as the pressures remain within the operating envelope. Low suction pressures could result in overheating of the scrolls and permanent damage to the compressor drive bearing.

## 5.11 Refrigerant migration

Liquid migration to the compressor and consequent flooded starts after standstill, especially in a cool ambient, must be avoided. The most common way to achieve proper control in stationary applications is the use of a crankcase heater and a "pumpdown cycle", which isolates the refrigerant from the compressor at shutdown.

In some mobile applications, a crankcase heater might not be effective all the time, because there could be installations without power supply. This could lead to situations where there will be no voltage present during extended off-cycle periods. A pumpdown cycle in combination with an additional check valve in the discharge line could be an alternative to reduce and limit off-cycle refrigerant migration to the compressor. This extra-low leak check valve must be qualified for discharge line service.

For further support, please contact the Application Engineering department at Emerson or your local Emerson representative.

## 5.12 Pumpdown cycle

A pumpdown cycle may be used in conjunction with the crankcase heater to control refrigerant migration at standstill.

ZRH\* and ZBH\* horizontal scroll compressors are equipped with an internal check valve inside the discharge connection of the compressor housing. The internal check valve is mainly designed to stop extended reverse rotation and to prevent high-pressure gas from leaking rapidly into the low side after shut-off. As the standard check valve is not 100% gas tight, **a separate external check valve must be added to the discharge line if pumpdown is used.** The main aim for the additional external check valve is to prevent liquid refrigerant from migrating into the compressor through the discharge line. The check valve can also prevent frequent recycling due to leak-back.

Copeland Scroll compressors trap a considerable volume of high-pressure gas between the muffler plate and the top cap. When the compressor shuts down, the trapped gas will expand back into the suction side of the system. This can cause a pulse of pressure to propagate down the suction line and can cause the low-pressure switch to reset. The compressor must not be allowed to short-cycle. Short-cycling can result in a low-oil situation and compressor damage. The electrical circuitry should be arranged in such a way that compressor restart is triggered by demand from the thermostat rather than by a low-pressure switch reset.

If system control allows, the system can be set to pump down for a fixed number of seconds after the setpoint is reached and the liquid line solenoid valve is closed. The exact time should be determined by testing. The system should pump down until the pressure is close to the cut-out pressure of the low-pressure switch. It is not necessary to pump down into nearly a vacuum to remove all liquid refrigerant from the low side. If the low-pressure switch opens, the pumpdown should stop immediately.

## 5.13 Shell temperature

The top shell and discharge line can briefly but repeatedly reach temperatures above 177°C if the compressor cycles on its internal protection devices. This only happens under rare circumstances and can be caused by the failure of system components such as the condenser or evaporator fan or loss of charge and depends upon the type of expansion control. Care must be taken to ensure that wiring or other materials that could be damaged by these temperatures do not come in contact with the shell.

## 5.14 Minimum run time

Emerson recommends a maximum of 10 starts per hour. There is no minimum off time because scroll compressors start unloaded, even if the system has unbalanced pressures. The most critical consideration is the minimum run time required to return oil to the compressor after start-up. To establish the minimum run time, obtain a sample compressor equipped with a sight tube (available from Emerson) and install it in a system with the longest connecting lines that are approved for the system. The minimum on time becomes the time required for oil lost during compressor start-up to return to the compressor sump and restore a minimal oil level that will ensure oil pick-up through the crankshaft. Cycling the compressor for a shorter period than this, for instance to maintain very tight temperature control, will result in progressive loss of oil and damage to the compressor.

## 5.15 Shut-off sound

Scroll compressors incorporate a device that minimizes reverse rotation. The residual momentary reversal of the scrolls at shut off will cause a clicking sound, but it is entirely normal and has no effect on compressor durability.

## 5.16 Oil level

The oil level should be maintained at mid-point of the sight glass. If an oil regulator is used the level should be set within the top half of the sight glass.

The oil level must be carefully monitored during system development, and corrective action should be taken if the compressor oil level falls below the centre of the sight-glass. The compressor oil level should be checked with the compressor "off" to avoid the sump turbulence when the compressor is running.

## 6 Maintenance & repair

### 6.1 Exchanging the refrigerant

Qualified refrigerants and oils are given in section 2.3.1.

It is not necessary to replace the refrigerant with new unless contamination due to an error such as topping up the system with an incorrect refrigerant is suspected. To verify correct refrigerant composition, a sample can be taken for chemical analysis. A check can be made during shut down by comparing the refrigerant temperature and pressure using precision measurements at a location in the system where liquid and vapour phases are present and when the temperatures have stabilised.

In the event that the refrigerant needs replacing, the charge should be recovered using a suitable recovery unit.

### 6.2 Replacing a compressor



#### CAUTION

**Inadequate lubrication! Bearing destruction!** Exchange the accumulator after replacing a compressor with a burned-out motor. The accumulator oil return orifice or screen may be plugged with debris or may become plugged. This will result in starvation of oil to the new compressor and a second failure.

#### 6.2.1 Compressor replacement

When a compressor is exchanged in the field, a major portion of the oil may remain in the system. While this may not affect the reliability of the replacement compressor, the extra oil will add to rotor drag and increase power usage. The compressor should be run for 10 minutes, shut down and the extra oil removed via the Schraeder valve when fitted (only ZBH). This operation should be repeated at least twice to make sure the proper oil level is achieved. The oil level should be maintained halfway up the sight glass.

In the case of a motor burnout, the majority of contaminated oil will be removed with the compressor. The rest of the oil is cleaned through the use of suction and liquid line filter driers. A 100% activated alumina suction line filter drier is recommended but must be removed after 72 hours. **It is highly recommended that the suction accumulator be replaced if the system contains one.** This is because the accumulator oil-return orifice or screen may be plugged with debris or may become plugged shortly after a compressor failure. This will result in starvation of oil to the replacement compressor and a second failure. When a single compressor or tandem is exchanged in the field, it is possible that a major portion of the oil may still be in the system. While this may not affect the reliability of the replacement compressor, the extra oil will add to rotor drag and increase power usage.

#### 6.2.2 Start-up of a new or replacement compressor

Rapid charging only on the suction side of a scroll-equipped system or condensing unit can occasionally result in a temporary no start condition for the compressor. The reason for this is that, if the flanks of the compressor happen to be in a sealed position, rapid pressurisation of the low side without opposing high-side pressure can cause the scrolls to seal axially. As a result, until the pressures eventually equalise, the scrolls can be held tightly together preventing rotation. The best way to avoid this situation is to charge on both the high and low sides simultaneously at a rate which does not result in axial loading of the scrolls.

A minimum suction pressure of 1.75 bar must be maintained during charging. Allowing pressure to drop below 0.5 bar for more than a few seconds may overheat scrolls and cause early drive bearing damage. Never install a system in the field and leave it unattended when it has no charge, a holding charge, or with the service valves closed without securely electrically locking out the system. This will prevent unauthorised personnel from accidentally operating the system and potentially ruining the compressor by operating with no refrigerant flow. **Do not start the compressor while the system is in a deep vacuum.** Internal arcing may occur when a scroll compressor is started in a vacuum causing burnout of the internal lead connections.



## 6.3 Lubrication and oil removal



### CAUTION

**Chemical reaction! Compressor destruction!** Do not mix up ester oils with mineral oil and/or alkyl benzene when used with chlorine-free (HFC) refrigerants.

The compressor is supplied with an initial oil charge. The standard oil charge for use with refrigerants R407C / R134a is a polyolester (POE) lubricant Emkarate RL 32 3MAF. In the field the oil level could be topped up with Mobil EAL Arctic 22 CC if 3MAF is not available. See nameplate for original oil charge shown in litres. A field recharge is from 0.05 to 0.1 litre less.

One disadvantage of POE is that it is far more hygroscopic than mineral oil (see **Figure 16**). Only brief exposure to ambient air is needed for POE to absorb sufficient moisture to make it unacceptable for use in a refrigeration system. Since POE holds moisture more readily than mineral oil it is more difficult to remove it through the use of vacuum. Compressors supplied by Emerson contain oil with low moisture content, and it may rise during the system assembling process. Therefore it is recommended that a properly-sized filter-drier be installed in all POE systems. This will maintain the moisture level in the oil to less than 50 ppm. If oil is charged into a system, it is recommended to use POE with a moisture content no higher than 50 ppm.

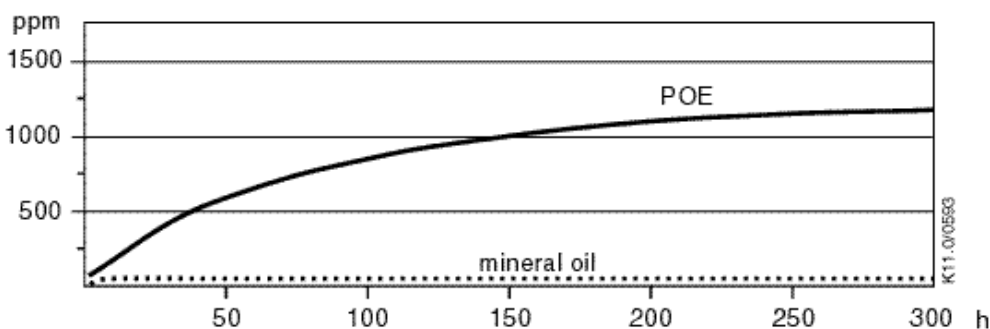


Figure 16: Absorption of moisture in ester oil in comparison to mineral oil in ppm by weight at 25°C and 50% relative humidity (h=hours)

If the moisture content of the oil in a refrigeration system reaches unacceptably high levels, corrosion and copper plating may occur. The system should be evacuated down to 0.3 mbar or lower. If there is uncertainty as to the moisture content in the system, an oil sample should be taken and tested for moisture. Sight glass/moisture indicators currently available can be used with the HFC refrigerants and lubricants. The moisture indicator will just show the moisture content of the refrigerant. The actual moisture level of POE would be higher than the sight glass indicates. This is due to the high hygroscopicity of POE oil. To determine the actual moisture content of the lubricant, samples have to be taken from the system and analysed.

**NOTE: ZRH\* and ZBH\* horizontal scroll compressors are fitted with an internal oil pump.**

**NOTE: Rotalock valves should be periodically re-torqued to ensure that leak tightness is maintained.**

## 6.4 Oil additives

Although Emerson cannot comment on any specific product, from our own testing and past experience, we do not recommend the use of any additives to reduce compressor bearing losses or for any other purpose. Furthermore, the long term chemical stability of any additive in the presence of refrigerant, low and high temperatures, and materials commonly found in refrigeration systems is complex and difficult to evaluate without rigorously controlled chemical laboratory testing. The use of additives without adequate testing may result in malfunction or premature failure of components in the system and, in specific cases, in voiding the warranty on the component.

## 6.5 Unbrazing system components



### WARNING

**Explosive flame! Burning!** Oil-refrigerant mixtures are highly flammable. Remove all refrigerant before opening the system. Avoid working with an unshielded flame in a refrigerant charged system.

Before opening up a system it is important to remove all refrigerant from both the high and low sides of the system. If the refrigerant charge is removed from a scroll-equipped unit from the high side only,

it is possible for the scrolls to seal, preventing pressure equalization through the compressor. This may leave the low side shell and suction line tubing pressurized. If a brazing torch is then applied to the low side while the low side shell and suction line contain pressure, the pressurized refrigerant and oil mixture could ignite when it escapes and contacts the brazing flame. To prevent this occurrence, it is important to check both the high and low sides with manifold gauges before unbrazing. Instructions should be provided in appropriate product literature and assembly (line repair) areas. If compressor removal is required, the compressor should be cut out of system rather than unbrazed.

## 7 Dismantling & disposal

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### Removing oil and refrigerant:

- Do not disperse in the environment.
- Use the correct equipment and method of removal.
- Dispose of oil and refrigerant properly.

Dispose of compressor properly.

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