



Air-conditioning Scroll Tandem & Trio assemblies

ZRT 96 K3 ... ZRT 760 K3**
ZRU 310 KC ... ZRU 570 KC**
ZRY 480 K3 ... ZRY 114 MC**

Application Guidelines



EMERSON
Climate Technologies

COPELAND TANDEM AND TRIO SCROLL COMPRESSORS - APPLICATION AND SERVICE INSTRUCTIONS

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1 Introduction

This bulletin describes the operating characteristics, design features, and application requirements for A/C Tandem (ZRT/ZRU) and Trio Scroll assemblies (ZRY) in the range from 8...90 hp. For additional information, please refer to the "Copeland Selection Software" accessible from the Copeland website at <http://www.ecopeland.com>.

There are several operating characteristics and design features described below that are different from those of the single Copeland Scroll compressor models.

Copeland Tandem and Trio Scroll compressors make possible great flexibility in system design for a wide range of applications. Since each compressor may be operated individually, this design provides simple, foolproof capacity reduction and maximum power savings, and greatly simplifies system control. In any well designed system, this kind of design offers a much greater factor of redundancy than a single compressor, and provides emergency protection for the product. In addition to greater reliability, one great advantage of the multiple compressor design over other large horsepower compressors is the fact that in the event of compressor damage, replacement of either compressor in the Tandem or Trio can be easily and quickly made with a Copeland scroll compressor stocked worldwide by Copeland wholesalers.

2 Safety Instructions

Only qualified personnel should install and repair COPELAND compressors.



- Refrigerant compressors must be employed only for the use they are made for.
- Only approved refrigerant and refrigerating oils must be used.
- Do not start the compressor until it is charged with refrigerant.
- Correctly used, the compressors and the pressure line piping may reach temperatures that may cause burning if touched.



- Wear safety goggles when working on open systems.
- If the refrigerant needs to be removed from the system, do not disperse it in the environment, use the correct equipment & method of removal.
- For storage, use original packaging and avoid collisions and tilting.



- Trained electrical personnel must connect the compressors and its accessories.
- All valid standards for connecting electrical and refrigeration equipment must be observed.
- Limit values for the supply voltage of the unit may not be exceeded.



- It is not allowed to run a test without the compressors being connected to the system and without refrigerant. It is of vital importance that the discharge stop valve has been fully opened before the compressors are started. If the discharge stop valve is closed or partly closed an unacceptable pressure with accordingly high temperatures may develop in the cylinder head. When operating with air the so-called diesel effect may occur, i.e. the air sucked in is mixed with oil gas and can explode due to the high temperature in the cylinder head, and thereby destroy the compressor(s).



3 Nomenclature

The model numbers of the Copeland Scroll compressors include the approximate nominal 60 Hz capacity at standard operating conditions. An example would be the ZRT180K3-TWD, which has approximately **180.000 Btu/hr** cooling capacity at the ARI high temperature air conditioning rating point when operated on 60 Hz. The letter "K" in the 5th place of the model number indicates that the number preceding it is to be multiplied by 1000. Note that the same compressor will have approximately 5/6 of this capacity or **150.000 Btu/hr** when operated on 50 Hz current.

Model designation

Z RT 144 K C E - T W D - 5 2 2
 1 2 3 4 5 6 7

Z RT 380 K 3 E - T W D - 9 7 0
 1 2 3 4 5 6 7

Z RY 570 K 3 E - T W D - X X X
 1 2 3 4 5 6 7

- 1 - compressor family: Z = Scroll
- 2 - Design: RT, RU = Tandem design, RY = Trio design
- 3 - nominal capacity [BTU/h] @ 60 Hz and ARI conditions (*see below) using multipliers "K" for 1000
- 4 - model variation
- 5 - oil type: E=POE oil, no value = mineral oil
- 6 - motor version
- 7- bill of material (BOM)

*ARI-Conditions:

evaporating temperature	7,2 °C	liquid subcooling	8,3 K
condensing temperature	54,4 °C	ambient temperature	35 °C
suction gas superheat	11 K		

Models

Tab. 1: Models

Model	hp	Assembly Type	Assembled by	
			Copeland	Customer
ZRT 96 - ZRT 162	8 - 13,5	Tandem	X	X
ZRT 180 – ZRT/U 380	15 - 30	Tandem	X	X
ZRU/T 480 ... 760	40 - 60	Tandem		X
ZRY 480 - ZRY 114 M	39 - 90	Trio		X

4 Qualified Refrigerants

Tab. 2: Refrigerants

Tandem/Trio Models	R407C	R134a	R22
ZRT 144 KC*...ZRT/U 760 KC*	X	X	X
ZRY 270 K3*...ZRY114 MC*	X	X	X

5 Compressor Handling

It is recommended that the plugs in the compressor line connections be left in place until the compressors are set into the unit. This reduces the chance of contaminants and moisture getting into the compressors especially if the compressors are charged with the more hygroscopic POE oil. If the compressors have two lifting tabs, both must be used for lifting. The discharge connection plug should be removed first before pulling the suction connection plug to allow the dry air pressure inside the compressors to escape. Pulling the plugs in this sequence prevents oil mist from coating the suction tube making brazing difficult. The copper suction tube should be cleaned before brazing.

6 Lubrication and Oil Removal

The compressors are supplied with an initial oil charge. The standard oil charge for use with refrigerants R407C and R134a is a polyolester (POE) lubricant Copeland 3MAF (32 cSt). In the field the oil level could be topped up with ICI Emkarate RL 32 CF, if 3MAF is not available. In R22 applications Suniso 3GS is used. Suniso 3GS is compatible with Texaco WF 32 and Fuchs KM.

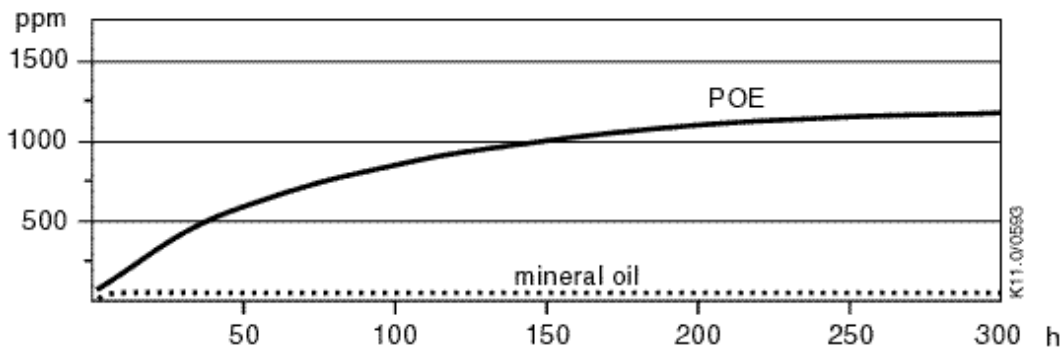


Fig. 1: Absorption of moisture in ester oil in comparison to mineral oil in [ppm] by weight at 25°C and 50% relative humidity. h = hours.

These oils may be used if an addition is required in the field. When a compressor is exchanged in the field it is possible that a major portion of the oil from the replaced compressor 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. To remove this excess oil an access valve has been added to the lower shell of the compressor. The compressor should be run for 10 minutes, shut down and the access valve opened until oil is somewhere between 1/4 to 1/3 of the sight glass. This operation should be repeated at least twice to make sure the proper oil level has been achieved. One disadvantage of POE is that it is far more hygroscopic than mineral oil (**Fig.1**). 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 Copeland contain oil with a low moisture content, and this may rise during the system assembling process. Therefore it is recommended that a properly sized filter-drier is 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 charge systems with POE containing no more than 50 ppm moisture content. If the moisture content of the oil in a refrigeration system reaches unacceptable 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; however, the moisture indicator will just show the moisture contents of the refrigerant. The actual moisture level of POE would be higher than the sight glass specifies. This is a result of the high hygroscopicity of the POE oil. Oil samples would have to be taken from the system and analyzed to determine the actual moisture content of the lubricant.

7 Accumulators

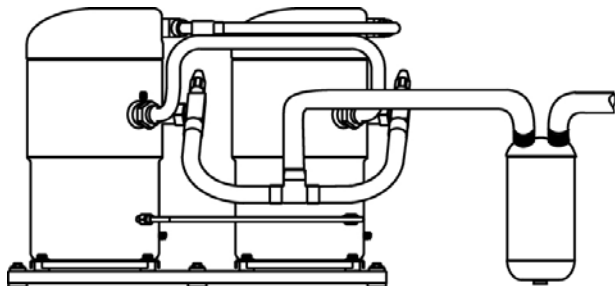


Fig. 2: Suction Accumulator

Due to the Copeland Scroll's inherent ability to handle liquid refrigerant in flooded start and defrost cycle operation, an accumulator is not required for durability in most systems, especially those systems designed with thermostatic expansion valves. However, large volumes of liquid refrigerant which repeatedly flood back to the compressor during normal off cycles or excessive liquid refrigerant floodback during defrost or varying loads, no matter what the system charge is, can dilute the oil. As a result, bearings are inadequately lubricated and wear may occur. If an accumulator must be used, an oil return orifice size in the range 2 mm² is recommended. A large-area protective screen no finer than 30 x 30 mesh (0.6 mm² openings) is required to protect this small orifice from plugging with system debris.

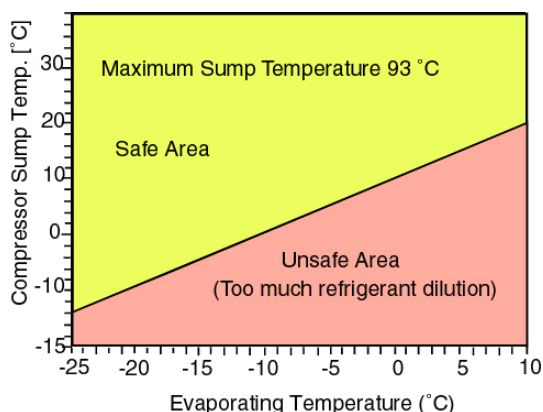


Fig. 3: Bottom Shell Temperature

Tests have shown that a small screen with a fine mesh can easily become plugged causing oil starvation to the compressor bearings. Accumulators are a standard item in air to air heat pumps and are used even when a thermostatic expansion valve is used to meter refrigerant in the heating mode. During low ambient conditions the oil returning from the outdoor coil will be very viscous and difficult to return through the accumulator if the expansion valve is working properly by maintaining superheat. To prevent slow oil return it may be possible to remove the accumulator from systems that use expansion valves in heating. To determine if the accumulator can be removed a defrost test must be done at an outdoor ambient of around 0 °C in a high humidity environment to ensure that excessive liquid does not flood back to the compressor during reversing valve operation, especially when coming out of defrost. Excessive flood back occurs when the sump temperature drops below the safe operation line shown in **Fig. 3** for more than 10 seconds.

8 Screens

The use of screens finer than 30 x 30 mesh (0.6 mm² openings) anywhere in the system is not recommended. 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.

9 Crankcase Heaters

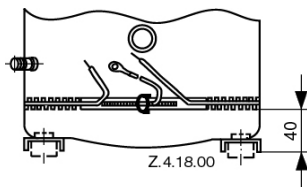


Fig. 4: Crankcase heater location

The crankcase heater must be mounted below the oil removal valve located on the bottom shell. **The crankcase heater must remain energized during compressor off cycles.**

The initial start in the field is a very critical period for any compressor because all load bearing surfaces are new and require a short break-in period to carry high loads under adverse conditions. **The crankcase heater must be turned on a minimum of 12 hours prior to starting the compressors.** This will prevent oil dilution and bearing stress on initial start up. If it is not feasible to turn on the crankcase heater 12 hours in advance of starting the compressors, then use one of the techniques listed below to prevent possible flooded-start damage to the compressors.

- 1) Direct a 500 watt heat lamp or other safe heat source (**do not use torch**) at the lower shell of the compressors for approximately 30 minutes to boil off any liquid refrigerant prior to starting; or
- 2) Bump start the compressor by manually energizing the compressors contactors for about one second. Wait five seconds and again manually energize compressors for one second. Repeat this cycle several times until the liquid in the shell has been boiled off and the compressors can be safely started and run continuously.

Due to Copeland Scroll's inherent ability to handle liquid refrigerant in flooded conditions, no crankcase heater is required when the system charge does **not** exceed following values:

Tab. 3: System Charge

Model	System Charge [kg]
ZRT 96 K3*...ZRT 162 KC*	5,5
ZRU 180 K3*...ZRT 380 K3	12,0
ZRT 500 KC*	13,5
ZRT 620 KC*/ZRT 760 KC*	16,5

A crankcase heater is needed to drive out excessive amounts of refrigerant that have migrated into the shell during standstill periods and no accumulator is piped to provide free liquid drainage during the off cycle as shown in **Fig. 2**. For correct mounting location of such a heater please see **Fig. 4**.

10 Minimum Run Time

There is no set answer to how often scroll compressors can be started and stopped in an hour, since it is highly dependent on system configuration. There is no minimum off time, because the scrolls start unloaded, even if the system has unbalanced pressures. The most critical consideration is the minimum run time required returning oil to the compressor after startup. This is easily determined since these compressors are equipped with a sight glass. The minimum on time becomes the time required for oil lost on compressor startup to return to the compressor sump and restore a normal level in the sight glass. Cycling the compressor for a shorter time than this, for instance to maintain very tight temperature control can result in progressive loss of oil and damage to the compressor. The individual compressors that make up the tandem are wired independently using the electrical values of the single compressors. It is recommended that compressors be wired to change lead/lag position. This will ensure equal run time for both compressors, thereby increasing reliability.



11 Applications

Since each compressor motor operates independently, each compressor may be wired with a separate control system. If starting current limitation is a problem, a time delay relay may be used to stagger motor starting. Tandem or Trio Scroll compressors, because of their large capacity, are often installed in systems with larger refrigerant charges and long connecting lines, and adequate system protective devices must be installed. A generously sized liquid line filter-drier, and a heavy-duty suction line filter, both of the replaceable element type, are highly recommended for all these systems. Suction line filters prevent flux, dirt, chips of copper, and other contaminants from entering the compressor, and are undoubtedly the best investment in preventive maintenance that can be made. A suction line filter further provides both protection for the system in the event of a compressor failure, and a convenient means of installing a suction line filter-drier if required for system cleaning. A suction line accumulator should be installed wherever large fluctuations in system capacity and operating conditions are apt to occur, or in any system where liquid floodback is possible. On systems with long lines and large refrigerant charges, an adequately sized suction line accumulator is especially important. Motors in individual compressors may run at slightly different speeds, and it is possible as a result a resonant noise condition in the discharge lines may occasionally be encountered. This rarely occurs, but it may be prevented by the use of discharge line mufflers in the individual compressor discharge line. Care must be taken in sizing lines for multiple compressor applications to insure that system velocities are maintained at an adequate level to return oil to the compressor during periods when only one compressor is operating. If the load on individual evaporators can vary independently, it is advisable to run individual suction lines to a header near the compressor to maintain adequate suction line velocities.

12 Single Compressor Failure

The question frequently arises as to the effect on the remaining compressor in the event one compressor motor fails due to a motor burn. Unless the compressors are interlocked with a starting time delay relay, the compressor motors operate independently of each other, and the operative compressor can continue to run, circulating refrigerant through the system. There have been so few field failures of this nature to date, although there are thousands in operation, which is difficult to predict with absolute certainty just what may occur. Extensive laboratory testing and experience on the very few units on which one compressor motor has suffered a burn, indicates that on units equipped with adequate liquid line filter-driers and suction line filters at the time of failure, no harm is done to the operating compressor. There is little circulation of refrigerant and oil through the crankcase of the inoperative compressor(s), so any carbon, sludge, or other impurities will have little tendency to leave the scroll shell. There will be some mixing of oil through the equalization line and some slight amount of acid will undoubtedly be in circulation in the refrigerant. The percentage of contamination of the operating system is very small due to the relatively stagnant condition of the inoperative compressor, and any acid and contaminants in circulation will be effectively removed if the system is equipped with an adequate liquid line filter-drier and a suction line filter when the failure occurs. It is probable that pressure drop through the liquid line filter-drier will increase as contaminants are removed, the amount of increase being dependent on the filter-drier size and the nature of the motor burn. Although emergency operation is possible until replacement of the inoperative compressor, it is recommended that the replacement be made as soon as possible. Before removing the damaged compressor, the oil from all compressors should be removed and discarded. When the inoperative compressor is replaced, install a suitable suction line filter-drier and replace the liquid line filter-drier. The unit may be put back into operation immediately after the replacement is made, resulting in a minimum of down time.

13 Tandem & Trio Compressor Models

Tandem and Trio compressors consist of two or three compressors, which can be equal or different models within the ZR 48 K3*, ZR 61 KC*, ZR 72 KC*, ZR 81 KC*, ZR 90 K3*...ZR 380 KC* range and offer advantages over single compressors with equivalent capacity:

- efficient capacity control - through cycling one or two compressor(s),
- increased reliability - fewer starts/stops than a single large compressor,
- reduced load starting, whereby individual compressors can be started up with a time delay between them,
- redundancy - part load capacity if one or two compressor fail, reduced replacement costs.

The following tables show the approved Copeland Tandem- and Trio- configurations:

Tab. 4: Tandem & Trio configurations

Tandem Compressors	Nominal hp
ZRT 96 K3* = ZR 48 K3* + ZR 48 K3*	8
ZRT 122 KC* = ZR 61 KC* + ZR 61 KC*	10
ZRT 144 KC* = ZR 72 KC* + ZR 72 KC*	12
ZRT 162 KC* = ZR 81 KC* + ZR 81 KC*	13,5
ZRT 180 K3* = ZR 90 K3* + ZR 90 K3*	15
ZRT 220 K3* = ZR 11 M3* + ZR 11 M3*	18
ZRT 240 K3* = ZR 12 M3* + ZR 12 M3*	20
ZRT 280 K3* = ZR 12 M3* + ZR 16 M3*	23
ZRU 310 K3* = ZR 19 M3* + ZR 12 M3*	25
ZRT 320 K3* = ZR 16 M3* + ZR 16 M3*	26
ZRU 350 K3* = ZR 16 M3* + ZR 19 M3*	28
ZRT 380 K3* = ZR 19 M3* + ZR 19 M3*	38
ZRU 440 KC* = ZR 250 KC* + ZR 19 M3*	35
ZRU 500 KC* = ZR 310 KC* + ZR 19 M3	40
ZRT 500 KC* = ZR 250 KC* + ZR 250 KC*	40
ZRU 560 KC* = ZR 310 KC* + ZR 250 KC*	45
ZRU 570 KC* = ZR 19 M3* + ZR 380 KC*	45
ZRT 620 KC* = ZR 310 KC* + ZR 310 KC*	50
ZRT 760 KC* = ZR 380 KC* + ZR 380 KC*	60

Trio Compressors	Nominal hp
ZRY 480 K3* = 3 x ZR 16 K3*	39
ZRY 570 K3* = 3 x ZR 19 M3*	45
ZRY 750 KC* = 3 x ZR 250 KC	60
ZRY 930 KC* = 3 x ZR 310 KC*	75
ZRY 114 MC* = 3 x ZR 380 KC*	90

14 Specifications

Cooling Capacity and Power Input

	Cooling Capacity	Power Input
3 Compressors running	3 x Single	3 x Single
2 Compressors running	1.99 x Single	2 x Single
1 Compressor running	0.98 x Single	1 x Single

These coefficients are applicable over the entire operating map. Refer to the Copeland Selection Software for single compressor performance data.

Sound power level

3 Compressors running	Single + 4,7 dBA
2 Compressors running	Single + 3 dBA
1 Compressor running	Single
At ARI for R22 and R407C, 50 Hz and 60 Hz	



15 Oil and Gas Equalization

When all compressors are operating in a Tandem design the flow of return gas and oil enters the header and divides with flow to the operating compressor(s). The oil sumps of the Tandem compressors ZRT 96K3* to ZRT 162 KC* are equipped with an adapter where an oil equalization line is connected. This ensures adequate oil levels in all compressors under all operating conditions. An extra connection for gas equalization keeps the pressures inside the compressor shells stable and prevents from oil level imbalances.

Tab. 5: Connection sizes

Models	ZRT 96 K3*...ZRT 162 KC*
Gas equalization line	7/8" brazing connection
Oil equalization line	9.5 mm brazing connection

The compressors in the range from 7.5...30 hp (single compressor) that make up the Tandem or Trio are the same as standard single compressors with the following additions:

Tab. 6: Connection sizes

	TANDEM	TRIO
Models	ZRT/(ZRU) 180/(310) K3*...ZRT 380 K3*	ZRY 480 K3*...ZRY 570 K3*
Oil and gas equalization line	7/8 " diameter tube at sight glass position	7/8 " diameter tube at sight glass position
Models	ZRT/(ZRU) 500/(440-690) KC*...ZRT 760 KC*	ZRY 750 KC*...ZRY 114 MC*
Oil and gas equalization line	1 3/8 " diameter tube at sight glass position	1 3/8 " diameter tube at sight glass position

When only one compressor is running, the pressure in the shell of the running compressor is slightly lower than suction pressure. There is a flow of refrigerant vapor through the shell of the idle compressor(s) into the oil/gas equalization line and into the shell of the running compressor. This flow can take oil from the idle compressor(s) into the shell of the running compressor. The two-phase oil/gas equalization line helps to balance the pressures between the shells and so maintain the same oil level in every compressor.

These compressors should be equipped fitted with an oil sight glass in the oil/gas equalization line. The oil level should be checked after initial system start-up and also periodically, when all compressors are off to ensure that the oil level is within the sight glass. Use the Schrader valve connection to adjust the oil level as needed, since the compressors are shipped with the oil level above the sight glass position.

16 Design

The compressors are rigidly mounted by means of steel grommets onto two rigid rails to form a Tandem or Trio unit. The reason for the rigid mounting is to keep the stresses in the tubing between the compressors at reasonable levels. The compressors should be mounted as close as possible to each other so as to keep the gas- and oil equalization lines as short as possible. The shorter the lines, the better the equalization. This unit should then be bolted to the installation base through isolating rubber grommets. It should be installed on a level surface to ensure proper equalization between the compressors. Install flexible hoses or vibration absorbers to connect the suction and discharge tubing to the system.

It is recommended that the unit is wired so that the lead compressor alternates between the two or three compressors. This will ensure an even life for all compressors and will give optimum reliability for the unit. It will also prevent an undesirable situation where compressor(s) lie idle for long periods of time during low load operation when only one compressor is required.

With increasing cooling capacity usually the pipework becomes more complex. In this case the installation of an oil separator may be recommended.

17 Piping

The system piping must be carefully designed to ensure that the gas velocity is sufficiently high under all circumstances so that oil is returned to the compressors, and as little as possible remains in the evaporator. High oil content in the evaporator leads to a loss of cooling and a lack of oil in the compressor. With a modulated Tandem unit running on one compressor the gas velocity will be 1/2 of when both compressors are running. Minimum velocities of 4 m/s in horizontal lines and 8 m/s in vertical lines are recommended. **Figure 5** shows typical Copeland Tandem arrangements.

Above the maximum system charges of refrigerant as indicated in **Section 9** a suction accumulator should be provided to protect the compressors from liquid refrigerant flood-back.

The discharge line connection of each compressor is provided with a non-return valve. These prevent the build-up of liquid refrigerant in the idle compressor during long periods of shutdown if this compressor is colder than the condensing temperature. In order to minimize vibration transmissions into the system it is recommended to install vibration absorbers into suction- as well as discharge lines.

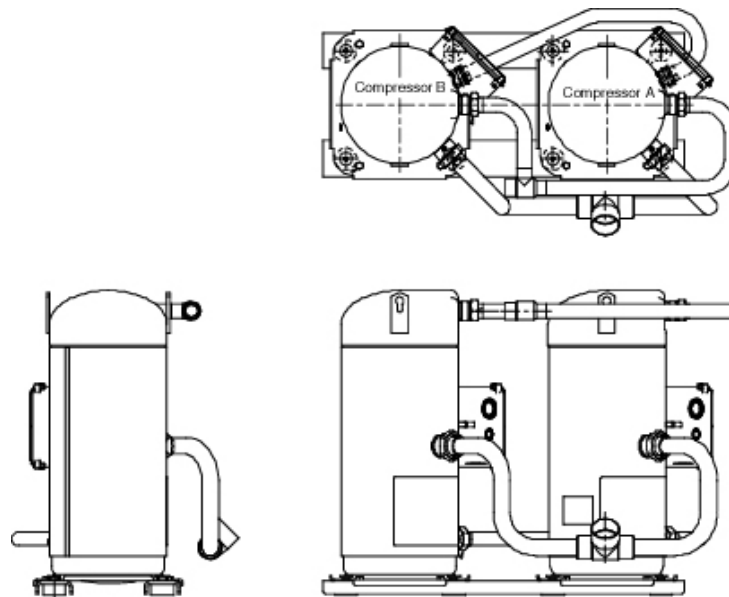


Fig. 5: Tandem configurations 40...60 hp (ZRT 500 KC*/ZRT 620 KC*/ZRT 760 KC*)

18 Assembling of ZRT/(U) 180 K3*...ZRT 380 K3* (15 to 30 hp) Tandem compressors (BOM 870/871)

Tab. 7: Torque

Connection	Position	Torque [Nm]
M10	A	40 – 50
Rotalock 3/4"	B	40 – 50
Rotalock 1"1/4	D ¹	70 – 80
Rotalock 1"3/4	C / D ¹	135 – 160
Rotalock 2"1/4	C ¹	165 – 190
Sight glass fitting	NI	15 – 20
Mounting bolts 5/16", M 9	A	27 max

¹Rotalock size depends on tandem displacement

- 1 Mount both compressors on the rails according to torque for M10 (see Fig. 6).
- 2 Remove rubber plugs from suction and discharge connections
- 3 Position the suction line (with teflon gasket) without tightening.
- 4 Position the discharge line (with teflon gasket) without tightening.
- 5 Tighten the suction and discharge Rotalock according to the torque (see Fig. 6).
- 6 Tilt the two compressors backwards.
- 7 Remove both sight glasses. Position adapters from gas/oil equalization line with teflon gasket. Tighten according to torque (see Fig. 6).

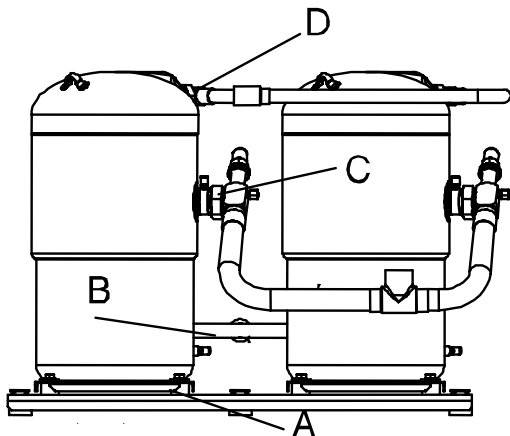


Fig. 6: Tightening positions

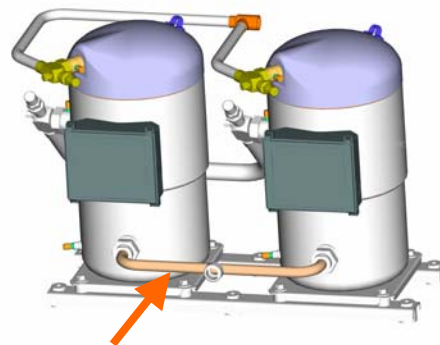


Fig. 7: Oil and gas equalization line

19 Assembling of Tandem models ZRT 500 KC* to ZRT 760 KC* (40 to 60 hp)

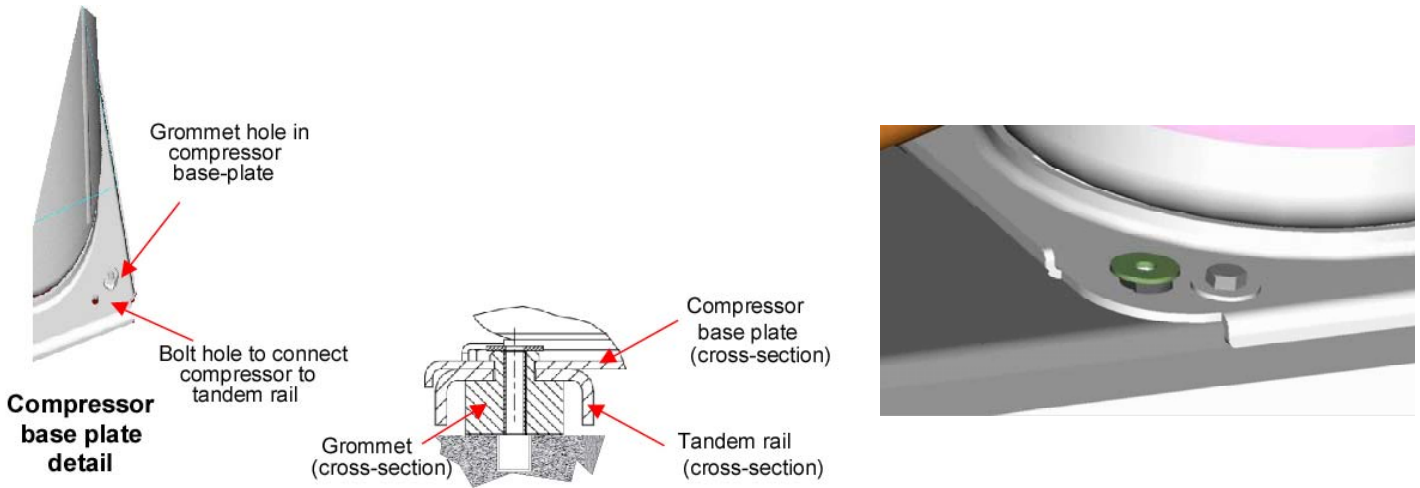


Fig. 8: Mounting of rubber grommets

The ZRT 500 KC* (40 hp) to ZRT 760 KC*(60 hp) Tandem designs incorporate also a “2-phase” tube which connects the compressors via the sight glass fittings by a 1” 3/8 diameter tube (see **Fig 7**). This design allows both proper crankcase pressure and oil level balance between the two compressors.

The assembling of the oil/gas equalisation line is similar to the mounting of the gas/oil balance line on smaller tandem units as described in **Section 18**. To monitor the oil level, a sight glass might be fitted in this gas/oil equalization line. The dimensions and the shape of this tube can be taken from the drawing package provided by Copeland in case you want to build the Tandem. The suction and discharge tube designs as well as the rail design are available with this package, too.

A tandem assembly design must assure that both compressors receive sufficient oil during all running conditions. In order to assure that oil from one compressor can freely flow to the other through the oil equalization line, the suction pressures must be equalized between the 2 compressors while one or both compressors are running. On smaller Copeland Tandem designs the gas pressure equalization was accomplished with a separate line connected above the oil level.

Compressors in Tandem applications should be hard mounted to a common base to reduce stress on the tubing between the compressors. This reduces the chance of stress fractures and subsequent refrigerant leaks. With smaller Copeland scrolls, metal spacers are used between the compressor and the rails.

The 20 to 30 hp scrolls use a new approach to secure the compressor to rails. The base plates of the scrolls have 4 holes which one uses to bolt the compressor to the tandem rails. No metal spacers are needed. (see **Fig. 8**).

Rubber grommets are used to connect the tandem assembly to the system base to isolate the system from any vibration (see **Fig. 9**).

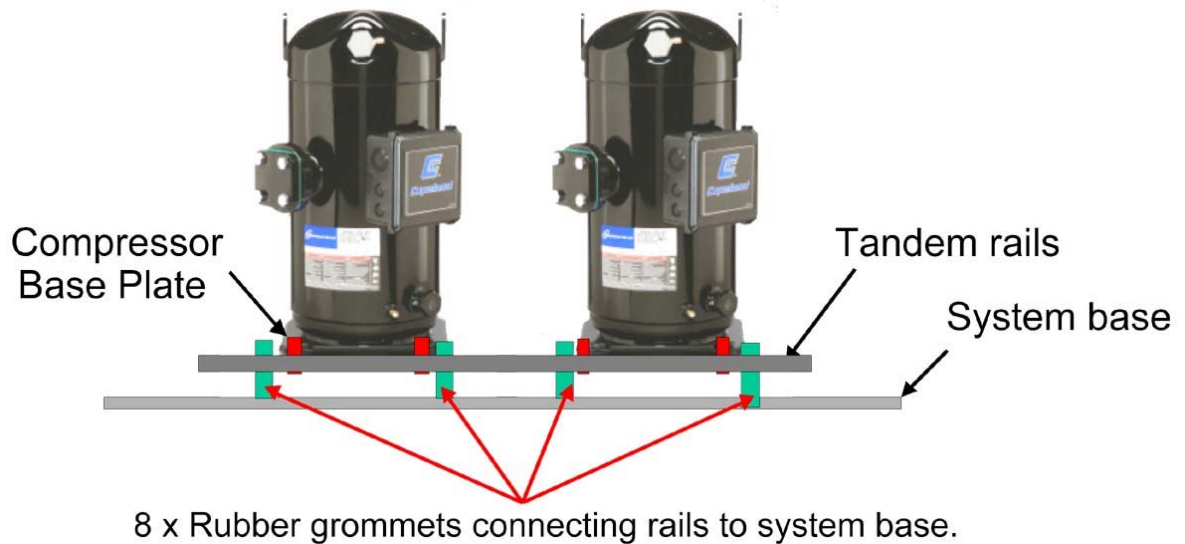


Fig. 9: Mounting of Tandem unit to the ground

Alternative design without an intermediate base or rails and with the connection of the compressors directly to the base of the unit with hard or soft mountings is not recommended. This is because of the possible transmission of noise and vibration to the unit, or high stress on the tubes and compressor fittings at compressor start-stop. However, this kind of application can be reviewed & approved by Application Engineering.

Transportation

The tandem must be lifted so that the lifting chains go straight up from the hanger tabs. If the tandem is hoisted from a single point so that the chain makes a "V" the mounting rails will bend and possibly collapse. (See **Fig 10**).



Fig. 10: Lifting

20 Assembling of Uneven Tandems ZRU 440 KC* to ZRU 690 KC*

When assembling Tandem compressors of different sizes in displacement, the different mass flow rates may have an impact on the internal pressures inside the compressor shells. This might have an influence on the correct balance of gas and oil via the equalization line. To achieve proper balance across the entire operating envelope Copeland has extensively tested those designs and determined for which model gas a flow restriction is required. The flow restrictors need to be placed inside the brazing adaptor of the suction tube connection before it is brazed to the common suction line as shown in the following table:

Tab. 8: Flow washer

Tandem model	Compressor models	Flow washer position	Dimensions flow washer OD/ID [mm]
ZRU 440 KC*	ZR 250 KC* + ZR 19 M3*	ZR 19 M3*	41.15/29
ZRU 500 KC*	ZR 310 KC* + ZR 19 M3*	ZR 19 M3*	41.15/28
ZRU 560 KC*	ZR 310 KC* + ZR 250 KC*	ZR 250 KC*	41.15/35
ZRU 570 KC*	ZR 19 M3* + ZR 380 KC*	ZR 19 M3*	41.15/24
ZRU 690 KC*	ZR 380 KC* + ZR 310 KC*	ZR 310 KC*	41.15/30

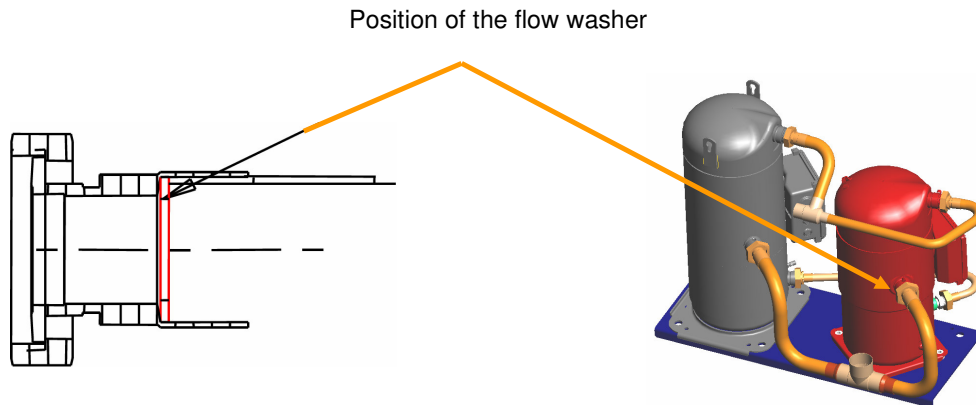


Fig. 11: Flow washer position for proper shell pressure balance

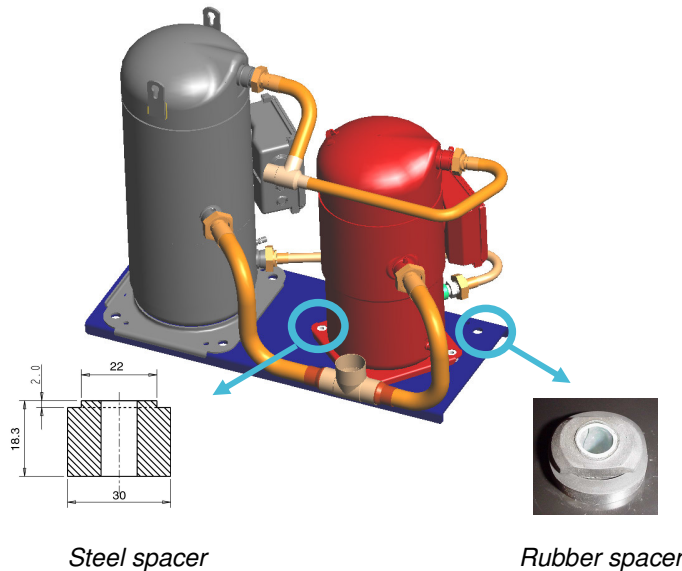


Fig. 12: Mounting elements

21 Assembling of Trio Arrangements

The following part of this guideline reviews the design of using Copeland Scroll compressors in a Trio arrangement. It is the customer's responsibility to test their particular trio design and ensure it works within their system specifications. Copeland provides application guidelines and design of trio units, but does not provide fully assembled Trios.

22 Layout

The overall compressors and tubing layout must be as indicated in **Figure 13**.

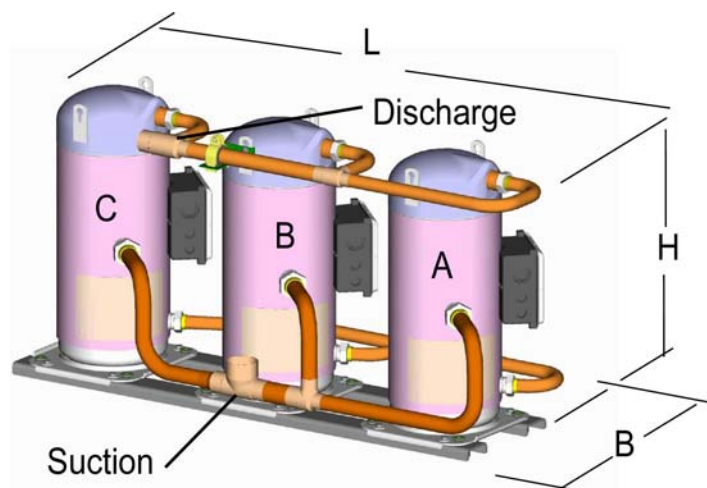


Fig. 13: Trio assembly layout

A design with symmetrical suction tubing and gas & oil equalization is necessary to ensure low tubing stress, proper gas & oil equalization and symmetrical compressor operation. It is also recommended the use of intermediate rails or a base between compressors and base of the system, with hard mountings (metal spacers ZRY480 K3*/570 K3*) between compressors and rails, and soft mountings between rails and base of the unit. The hard mountings are necessary to avoid stress on the tubing and on the compressor fittings at compressor start-stop. The soft mountings are necessary to avoid the transmission of noise and vibration to the unit. Nothing is required between the compressor and rail for ZRY 750-114 MC* (see Tandem layout).

A complete drawing package is available for the Copeland Trio design.

Details of Copeland Trio dimensions are given in the following table.

Tab. 9: Trio Dimensions

Trio Dimensions	Length L	Width B	Height H	Suction T-Fitting		Discharge T-Fitting	
	mm	mm	mm	Inch	mm	Inch	mm
ZRY480 K3* Rotalock	1396	510	552	2 1/8"	54	1 1/8"	28
ZRY480 K3* Braze	1391	510	552	2 1/8"	54	1 1/8"	28
ZRY570 K3* Rotalock	1408	509	598	2 3/8"	60	1 3/8"	35
ZRY570 K3* Braze	1372	503	598	2 3/8"	60	1 3/8"	35
ZRY750 KC* Rotalock	1534	597	750	3 1/8"	79	2 1/8"	54
ZRY930 KC* -114 MC*	1560	643	750	3 5/8"	92	2 1/8"	54



23 Controls

The control of a Trio unit shall comply with the following specifications:

- Any sequence of start/stop combination of compressors is allowed.
- For each individual compressor, the maximum number of starts is 10 /hour.
- It is recommended to wait 5 seconds before starting or stopping another compressor.
- It is recommended not to start or stop 2 or 3 compressors together.

24 Rails for Trios

Rails

The use of an intermediate base or rails between the compressor and the base of the unit is recommended.

Trio assembly must be handled with care. The use of a spreader bar is recommended, with each compressor connected to the bar in such a way to avoid stress on the tubes and bending the rails.

It is recommended the use of clamps to give adequate support and stiffness to the Trio assembly during lifting.

The clamps can be positioned around the compressor below the suction tube, and tightened with M10 bolts. Typically the compressor clamps can be made from 25 mm metal strips and clamp supports from 20 mm angle. The clamps can be assembled and disassembled as required.

To move the Trio assembly, use one chain for each lifting tab of the compressors.

Assembly Procedure

- Loosely mount the three compressors on the common base plate or rails, then tighten the mounting bolts to 1 to 5 Nm.
- Remove the rubber plugs from suction, discharge and gas equalization connections just before the assembly to prevent moisture from entering the compressors. **Do not** remove the sight glass for oil equalization ports at this point.

Rotalock Adapter design

Assemble (with Teflon gasket) without tightening (any sequence):

- Suction line.
- Discharge line.

Once the tubing is aligned, tighten to the following torque:

(Nm)

Thread 1" $\frac{3}{4}$	135 – 160
Thread 2" $\frac{1}{4}$	165 – 190

Brazing Fitting design

Braze the tubes on the compressor with the following sequence:

- Suction line.
- Discharge line.

- Tilt the unit backward to keep the oil from flowing out through the oil equalization port. Remove the sight glass for oil equalization. Assemble the oil/gas equalization line (recommended torque 40 to 50 Nm)
- Tighten the connection of the compressor to the rails.
- Use the soft mounting parts for the installation of the Trio assembly to the base of the system.

25 How to Connect Tandem and Trio Assemblies to the System

Once the Tandem or Trio design has been pre-assembled it needs to be connected to the system. Various tests have been conducted at Copeland in order to determine the optimum configuration making sure that the oil is properly returned and distributed from the system back to the compressors. There is a minimum requirement in terms of the height of the suction return line towards the T-fitting and the inclination and alignment of the oil equalization line. An optimum height of the vertical connection to the T-fitting should be at least 450 mm. The inclination of the oil balance line must not exceed 10mm. The following illustrations show how the design should ideally look like to meet these requirements.

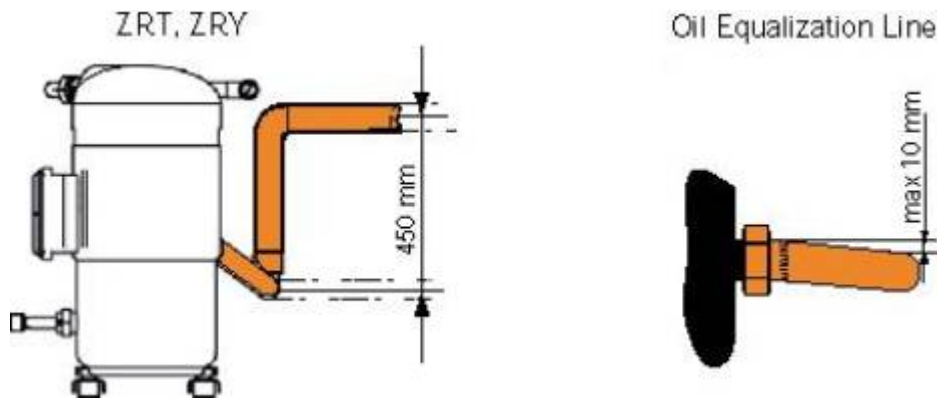


Fig. 14: Piping design for proper oil return and maximum inclination of oil equalization line – ZRT, ZRY

When commissioning the system, the oil circulation must be observed thoroughly, making sure that no oil has been trapped somewhere within the system, particularly under part load conditions. The oil level in the sight glass must remain constant once the system runs at its set point conditions.

26 Operating Envelopes

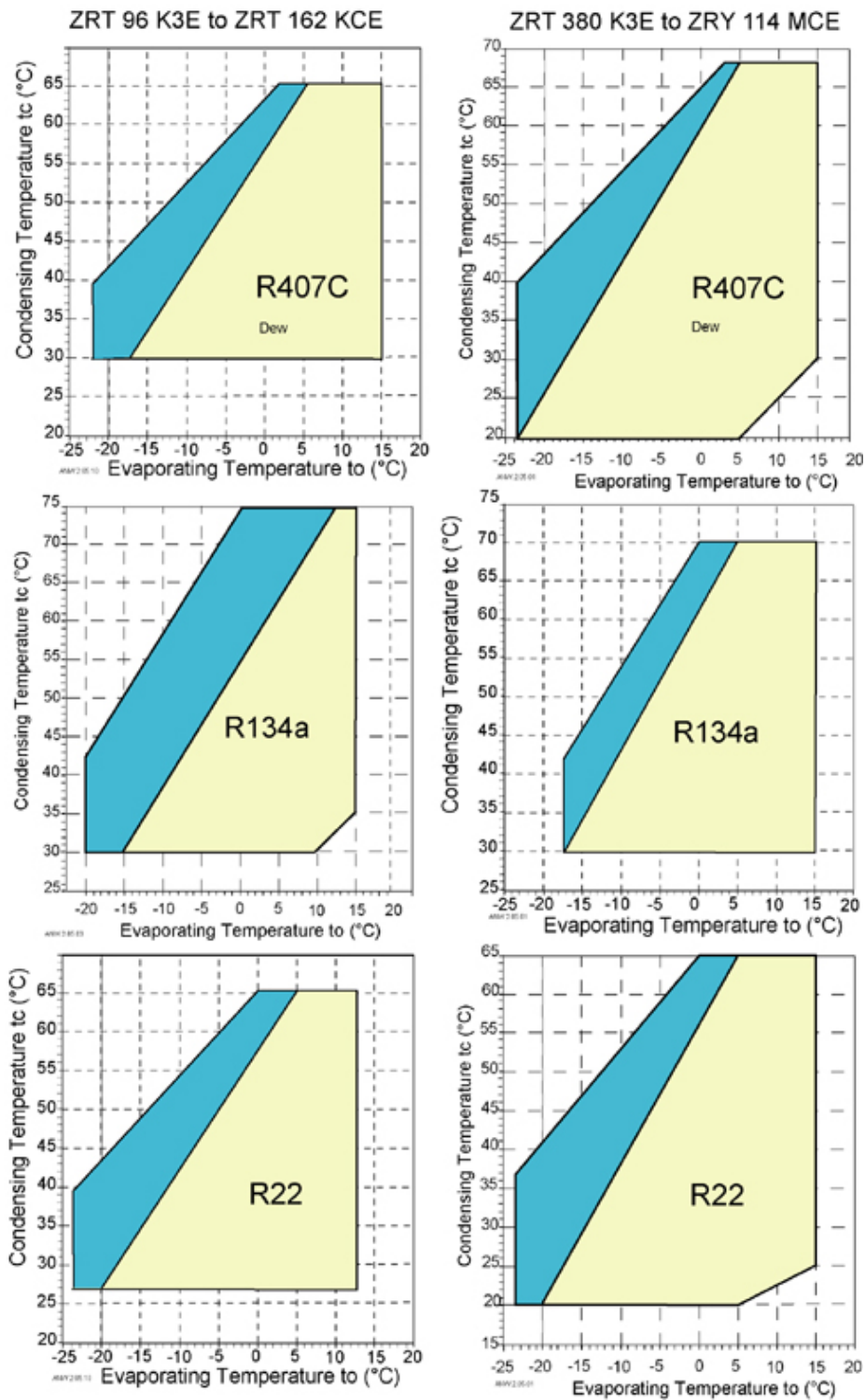


Fig. 15: Application ranges

If you have any questions about the above, please contact your local Copeland Sales Office.

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