Copeland Scroll

Air-conditioning Scroll Tandem & Trio assemblies

Application Guidelines

EMERSON
Climate Technologies

Copeland Tandem and Trio Scroll Compressors

Application and Service Instructions

1 Introduction

This bulletin describes the operating characteristics, design features, and application requirements for A/C Tandem (ZRT, ZZ) and Trio Scroll assemblies (ZRY) in the range from 8…50 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.

These Copeland Scroll compressors are designed for air conditioning and heat pump usage but will work well in other applications that correspond to the operating requirements and envelope of A/C and heat pump usage (see operating envelope **Section 17**).
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.

Models

Model	HP	Assembly Type	Assembled by	
			Copeland	Customer
ZRT 98 - ZRT 162	8 - 13,5	Tandem	x	x
ZZ 18 - ZZ 38	15 - 30	Tandem	x	x
ZRY 48 - ZRY 57	39 - 45	Trio		x
ZRT 500/600	40 - 50	Tandem		x

2 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 ZZ18M3-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, “M” by 10,000. 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 Designations and Bills of Materials

ZRT 144 K C E -TWD-522
1 2 3 4 5 6 7

ZZ 38 M 3 E -TWD-870
1 2 3 4 5 6 7

ZRY 57 M 3 E -TWD-XXX
1 2 3 4 5 6 7

1 - compressor family: Z = Scroll
2 - Design: RT, Z = Tandem design, RY = Trio design
3 - nominal capacity [BTU/h] @ 60 Hz and ARI conditions (*see below) using multipliers "K" for 1000 and "M" for 10 000
4 - model variation
5 - oil type: E=POE oil, no value = mineral oil
6 - motor versions:

Motor version	50 Hz	60 Hz	Models
TWD	400 V	460 V	ZZ,ZRT 250-300, ZRY
TW7	-	380 V	ZZ,ZRT 250-300, ZRY
TWR	220-240 V	-	ZZ,ZRT 250-300, ZRY
TW7	-	380 V	ZZ,ZRT 250-300, ZRY
TWE	500 V	575 V	ZZ,ZRT 250-300, ZRY
TFD	400 V	460 V	ZRT 98…ZRT 162
TF5	200-230 V	-	ZRT 98…ZRT 162

7 – ***Bill of Materials (BOM's):***

BOM	Model	Module	Connection	Scope of Delivery
870	ZZ18…ZZ38	120/240V AC	Rotalock valves	Tandem assembly
871	ZZ18…ZZ38	120/240V AC	Rotalock adaptors	Tandem assembly
540	ZR90…ZR19	24 V AC	Rotalock	Tandem/Trio single
570	ZR90…ZR19	120/240V AC	Rotalock	Tandem/Trio single
572	ZR90…ZR19	120/240V AC	Brazing	Tandem/Trio single
568	ZR90…ZR19	24 V AC	Brazing	Tandem/Trio single
422	ZR49…ZR81	NA	Brazing	Tandem single
522	ZRT98…ZRT162	NA	Brazed tubes	Tandem assembly
522	ZR250/ZR300	120/240V AC	Brazing	Single (Tandem/Trio suitable)
524	ZR250/ZR300	24 V AC	Brazing	Single (Tandem/Trio suitable)
523	ZR250/ZR300	120/240V AC	Rotalock	Single (Tandem/Trio suitable)
525	ZR250/ZR300	24 V AC	Rotalock	Single (Tandem/Trio suitable)

****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		

3 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.

4 Oil and Gas Equalization

When all compressors are operating in a Tandem or Trio design **(ZRT 98 K3…ZRT 162 KC, ZZ 18 M3…ZZ 38 M3, ZRY 48 M3/ZRY 57 M3)**, the flow of return gas and oil enters the header and divides with flow to the operating compressor(s). The oil sumps of the compressors are equipped with an adaptor where an oil equalization line can be 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.
The description of the oil and gas equalization for the models **ZRT 500 KC** and **ZRT 600 KC** you can find in **section 18.**

5 Service

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.

6 TANDEM Compressors

Tandem compressors consist of two compressors, which can be equal or different models within the ZR 49 K3, ZR 61 K3, ZR 72 KC, ZR 81 KC, ZR 90 K3...ZR 300 KC and offer advantages over single compressors with equivalent capacity:

- efficient capacity control - through cycling one compressor (modulation),
- 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 compressor fails, reduced replacement cost - If one compressor fails, it is less costly to replace than a single larger compressor.
  These models are provided either preassembled by Copeland (see following table) or can be built on site using proper kits to connect the two compressors (only ZZ, ZRT 500 and ZRT 600).

ZRT 98 K3* = ZR 49 K3* + ZR 49 K3*
ZRT 122 K3* = ZR 61 K3* + ZR 61 K3*
ZRT 144 KC* = ZR 72 KC* + ZR 72 KC*
ZRT 162 KC* = ZR 81 KC* + ZR 81 KC*

ZZ 18 M3* = ZR 90 K3* + ZR 90 K3*
ZZ 22 M3* = ZR 11 M3* + ZR 11 M3*
ZZ 24 M3* = ZR 12 M3* + ZR 12 M3*
ZZ 28 M3* = ZR 12 M3* + ZR 16 M3*
ZZ 31 M3* = ZR 19 M3* + ZR 12 M3*
ZZ 32 M3* = ZR 16 M3* + ZR 16 M3*
ZZ 38 M3* = ZR 19 M3* + ZR 19 M3*

ZRT 500 KC* = ZR 250 KC* + ZR 250 KC*
ZRT 600 KC* = ZR 300 KC* + ZR 300 KC*

7 Compressors Used

The two compressors that make up the tandem are the same as standard single compressors with the following additions:

Gas Equalization Line	**7/8" Brazing Connection**	**1 ¾ " – 12 UNF Rotalock Connection**
Models	ZRT 98 K3*…ZRT 162 KC*	ZZ 18 M3*…ZZ 38 M3*
Oil Equalization Line	**3/4"-16 UNF Rotalock connection**	
Models	ZRT 98 K3*…ZRT 162 KC*; ZZ 18 M3*…ZZ 38 M3*	
Oil and Gas Equalization Line	**1" 3/8-Diameter Tube at Sight Glass Position**	
Models	ZRT 500 KC*/ZRT 600 KC*	

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 vapour through the shell of the idle compressor into the oil equalization line and into the shell of the running compressor. This flow can take oil from the idle compressor into the shell of the running compressor. The gas equalization line helps to balance the pressures between two shells and so maintain the same oil level in both compressors.
If the two equalizing connections are blanked off (compressor's bill of material 422 and 570), the compressor can be used in a single compressor installation just like a standard compressor.
These compressors are fitted with an oil sight glass as standard. The oil level should be checked after initial system startup and also periodically, when both compressors are off to ensure that the oil level is within the sight glass. Use the Schrader valve to adjust the oil level as needed, since the compressors are shipped with the oil level above the sight glass.

8 Qualified Refrigerants

TANDEM-Models	**R407C**	**R134a**	**R22**
ZRT 144 KC*…ZZ 38 M3*	**x**	**x**	**x**
ZRT 98 K3*…ZRT 600 KC*	**x**	-	**x**

The application envelopes of each refrigerant are shown in **Section 18**.

9 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.

10 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 or Mobil EAL Arctic 22 CC, if 3MAF is not available. In R22 applications Suniso 3GS is used. Suniso 3GS is compatible with Texaco WF 32 and Fuchs KM.

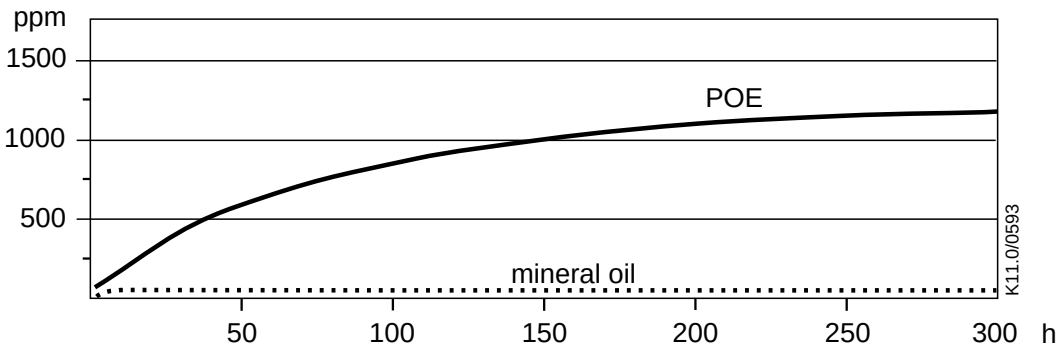


Fig. 1: Absorption of moisture in ester oil in comparison to mineral oil in [ppm] by weight at 25°C and 50% relative humidity. h = hours.

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.

11 Accumulators

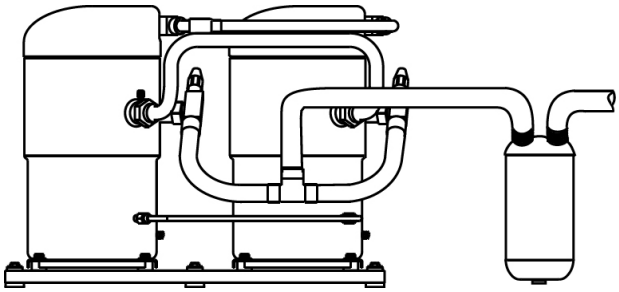


Fig. 2: Suction Accumulator

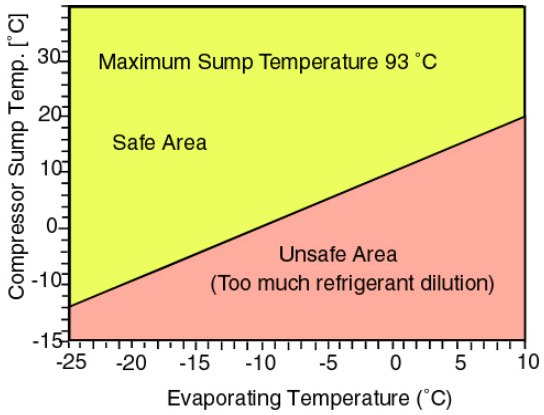


Fig. 3: Bottom Shell Temperature

Due to the Copeland Scroll's inherent ability to handle liquid refrigerant in flooded start and defrost cycle operation, an accumulator is not be 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 mm^2 is recommended. A large-area protective screen no finer than 30 x 30 mesh (0.6 mm^2 openings) is required to protect this small orifice from plugging with system debris. 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.

12 Screens

The use of screens finer than 30 x 30 mesh (0,6 mm^2 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.

13 Crankcase Heaters

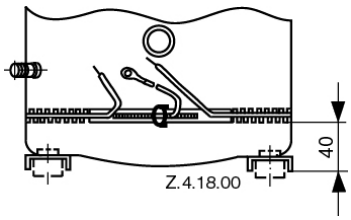


Fig. 4: Crankcase Heater Location

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 the 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:

Model	System Charge [kg]
ZRT 98 K3*…ZRT 162 KC*	5,5
ZZ 18 M3*…ZR 38 M3*	12,0
ZRT 500 KC*	13,5
ZRT 600 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**.

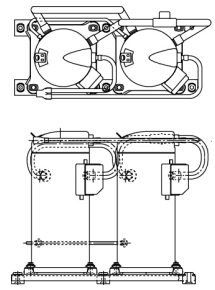
14 Minimum Run Time

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 to return 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.

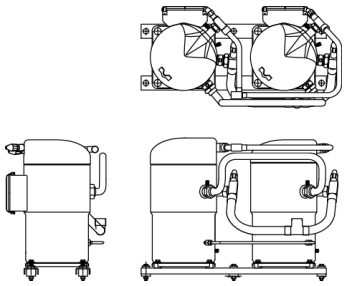
15 Design

The two compressors are rigidly mounted by means of steel grommets onto two rigid rails to form a tandem unit. The reason for the rigid mounting is to keep the stresses in the tubing between the two compressors at reasonable levels. The compressors should be mounted as close to each other as possible 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 two 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 compressors. This will ensure an even life for both compressors and will give optimum reliability for the unit. It will also prevent an undesirable situation where one compressor lies 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.

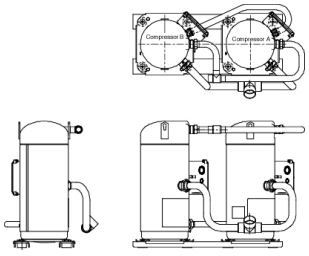
16 Piping



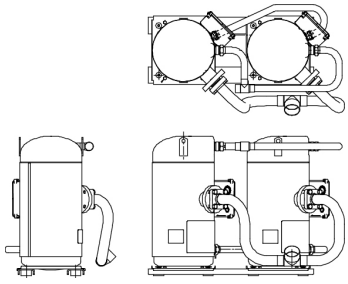
ZRT 98 to ZRT 162



ZZ18 to ZZ38



ZRT 500



ZRT 600

Fig. 5: Tandem Configurations

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 13** a suction accumulator should be provided to protect the compressors from liquid refrigerant floodback.

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.

17 Operating Envelopes

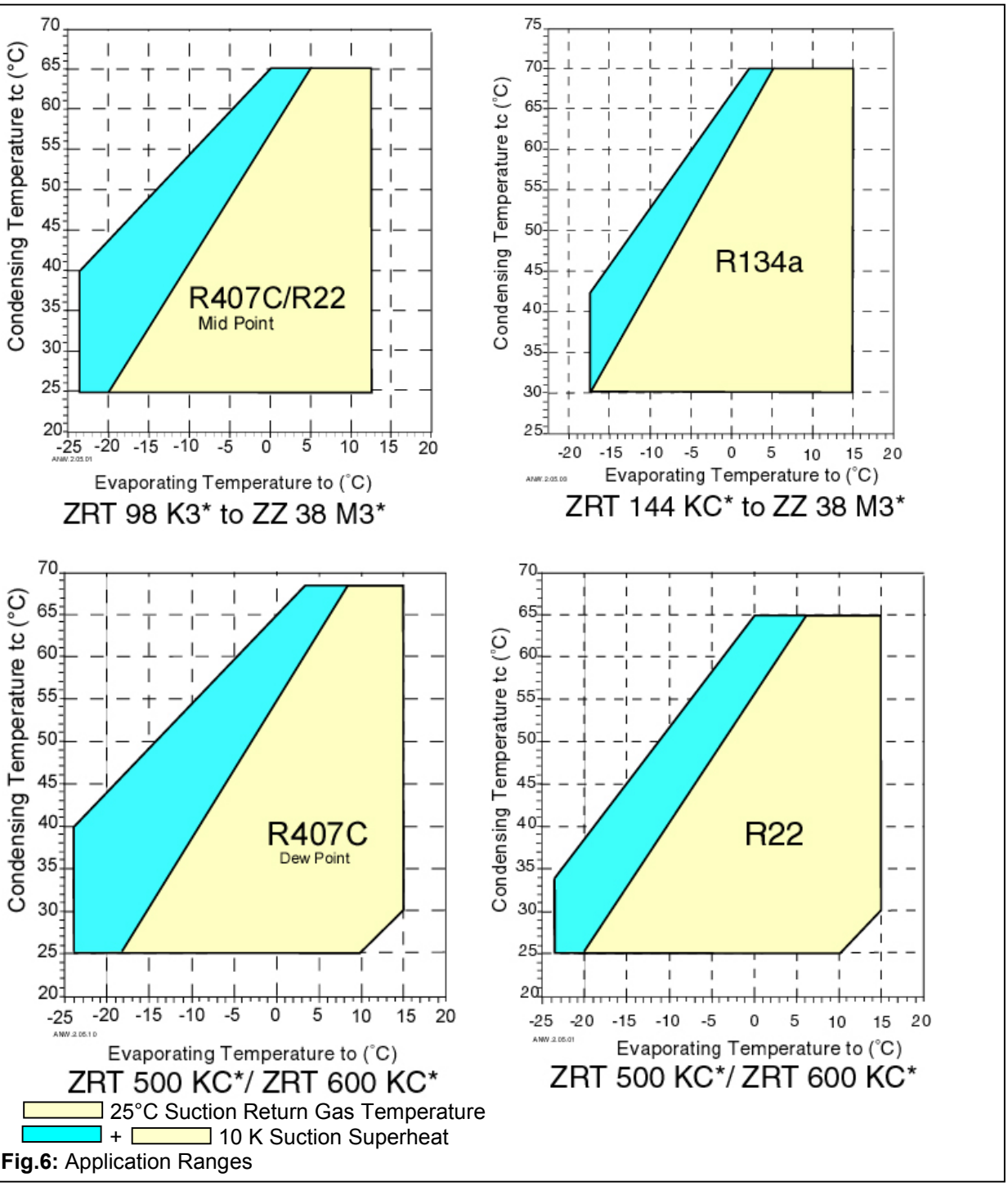


Fig.6: Application Ranges

18 Assembling of ZZ 18 M3*…ZZ 38 M3* (15 to 30 HP) Tandem compressors (BOM 870/871)

Connection	Position	Torque [Nm]
M10	A	45 - 55
Rotalock 3/4"	B	40 - 50
Rotalock 1"1/4	D [1]	100 - 110
Rotalock 1"3/4	C / D [1]	170 - 180
Rotalock 2"1/4	C [1]	190 – 200
Flange w. M16 bolts	NI	102 - 113
Sight Glass	NI	25 - 25.5
Mounting Bolts 5/16", M 10	A	27 max.

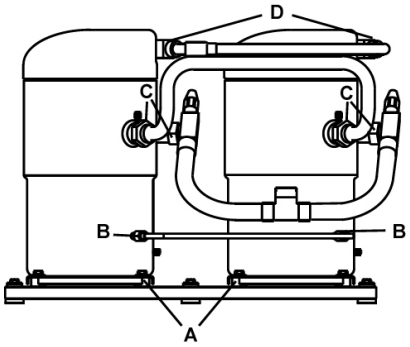


Fig.7: Tightening Positions

Fig.8: Gas Equalization Line

1 Mount both compressors on the rails according to torque for M10 (**see Fig. 7**).

2 Remove rubber plugs from suction and discharge connections ; remove nuts from gas equalization connection.

3 Position gas equalization line (with Teflon gasket) and tighten according to torque (**see Fig. 8**).

4 Position the suction line (with teflon gasket) without tightening.

5 Position the discharge line (with teflon gasket) without tightening.

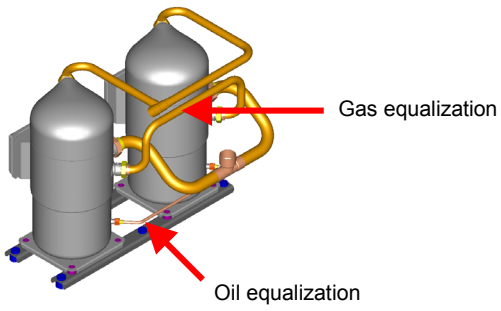
6 Tighten the suction and discharge Rotalock according to the torque (**see Fig. 7**).

7 Tilt the two compressors backward (see **Fig.9**).

8 Remove both nuts from oil equalization connection. Position adaptors and oil equalization line with teflon gasket (**see Fig. 9, 10**). Tighten according to torque (**see Fig. 7**).

9 Only ZZ38 : Position two brackets between discharge and gas equalization lines

[1]Rotalock size depends on tandem displacement



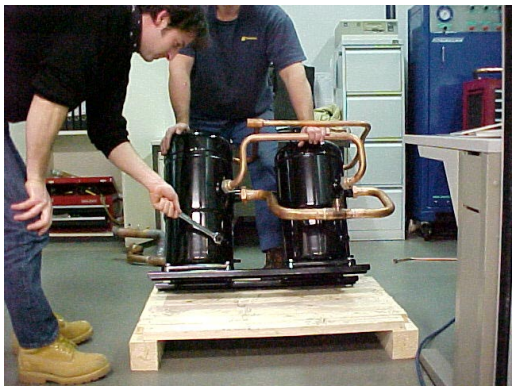


Fig. 9 : Mounting of the Oil Line Adaptors

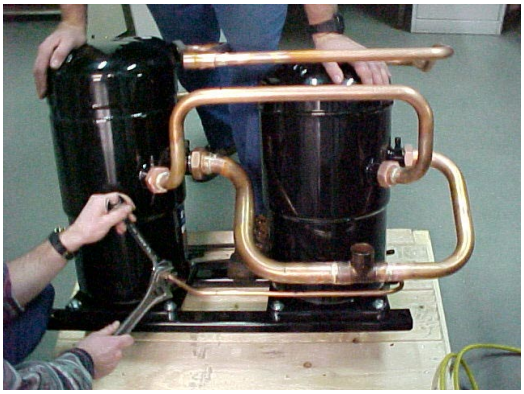


Fig. 10 Mounting of the Oil Equalization Line

19 Assembling of the Tandem-Models ZRT 500 KC* and ZRT 600 KC* (40 & 50 HP)

The ZRT 500 (40 HP) and ZRT 600 (50 HP) tandem design incorporates a special “2-phase” tube which connects the compressors via the sight glass fittings by a 1” 3/8-diameter tube (**see Fig. 11**). This design allows both proper crankcase pressure and oil level balance between the two compressors. The assembling of the oil/gas equalization line is similar to the mounting of the 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.

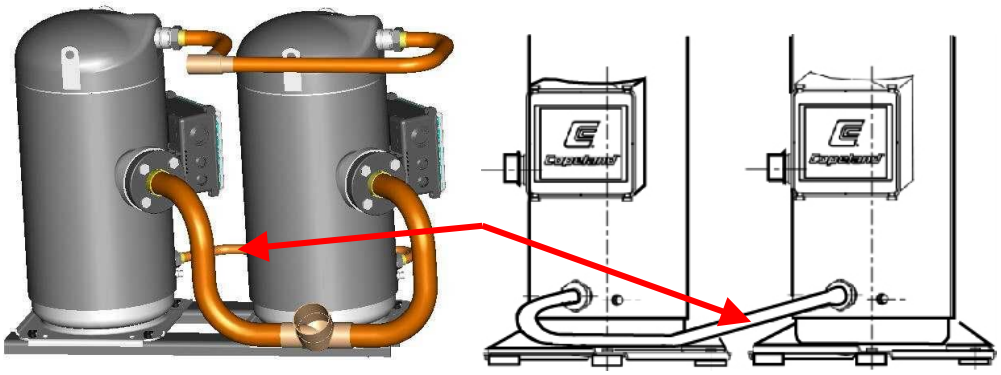


Fig.: 11 Two-Phase Gas & Oil Equalization Line

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 tandem tubing. 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 & 25 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, which reduces cost (**see Fig. 12**).

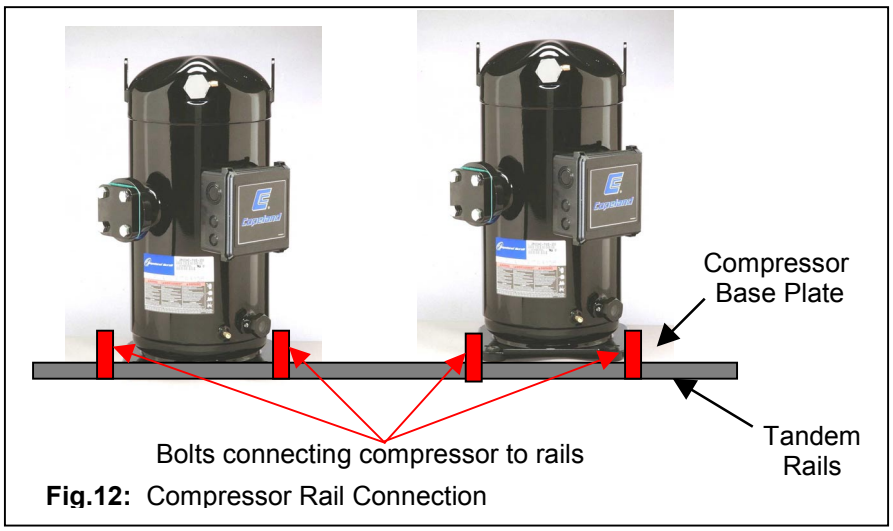


Fig.12: Compressor Rail Connection

Rubber grommets are used to connect the tandem assembly to the system base to isolate the system from any vibration (**see Fig.13 & 14**).

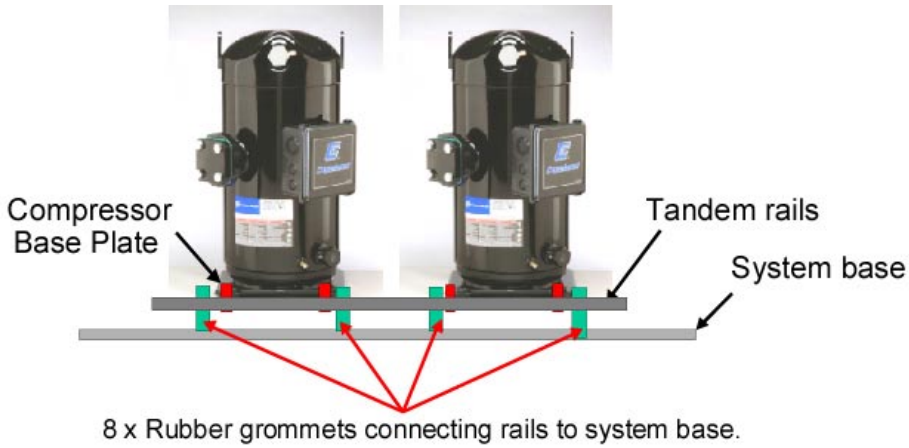


Fig. 13: Mounting of the Tandem Unit to the Ground

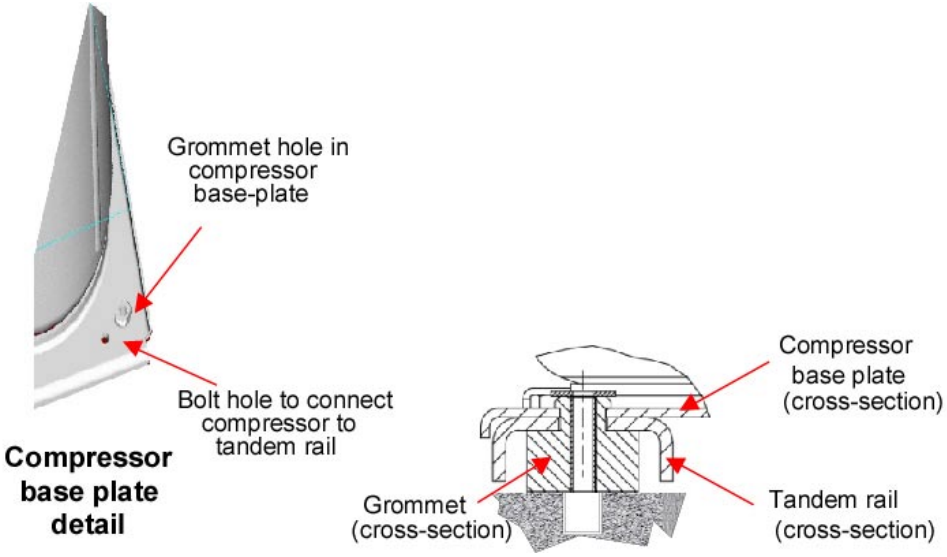


Fig. 14: Mounting of the Rubber Grommets

Transportation

Fig. 15: Lifting

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.

20 Introduction Trio arrangements

The following part of this guideline reviews the design of using Copeland scrolls in a trio arrangement. It will be the customers responsibility to test their particular trio design and ensures it works within their system specifications.
Copeland provides application guidelines and design of trio units and does not provide fully assembled trios. This design has been fully tested for use with 3 x 13 HP (ZR16M) and 3 x 15 HP (ZR19M) compressors only. No other arrangements have been approved.

21 Specifications

Displacements	39 Hp : ZRY 48M (3 x ZR16M) 45 Hp : ZRY 57M (3 x ZR19M)
Voltages	Same as single compressor
Motor Protection & IP rating	Same as single compressor.
Refrigerants	R22 & R407C, *not released for R134a.*
Operating Map	Same as single compressor.
Oil Charge	12.3 Liter.

Cooling Capacity and Input Power

	Cooling Capacity	**Input Power**
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 + 6 dBA
2 Compressors running	Single + 3 dBA
1 Compressor running	Single

At ARI for R22 and R407C, 50 Hz and 60 Hz

22 Layout

The overall compressors and tubing layout must be as indicated in Figure 16. The suction T fitting can also be placed between compressor A & B and in any orientation.

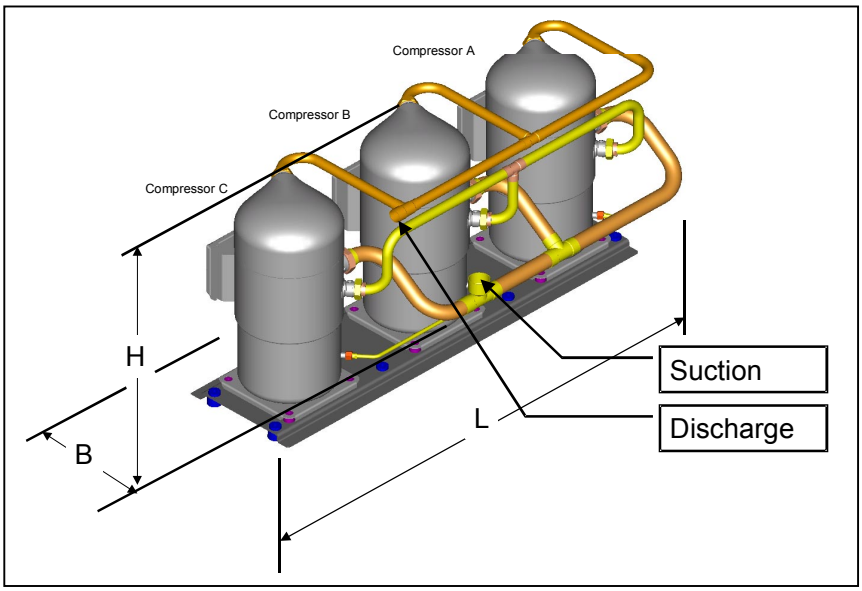


Fig. 16 : Trio assembly layout.

A design with symmetrical suction tubing and gas & oil equalization is necessary to ensure low tube 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) 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.

A complete drawing package is available for the Copeland Trio design. Details of Copeland Trio dimensions are given in the following table.

Trio Dimensions	Length **L**	Width **B**	Height **H**	Suction Line Fitting		Discharge line Fitting	
	mm	**mm**	**mm**	**Inch**	**mm**	**Inch**	**mm**
ZRY48M Rotalock	1396	510	552	2.1/8	54	1.1/8	28
ZRY48M Braze	1391	510	552	2.1/8	54	1.1/8	28
ZRY57M Rotalock	1408	509	598	2.3/8	60	1.3/8	35
ZRY57M Braze	1372	503	598	2.3/8	60	1.3/8	35

Copeland Trio design dimensions

23 Single Compressor Bill of Material

In order to ensure optimum performance and reliability of a trio assembly, a design with gas and oil equalization lines must be used. Suitable compressors are available (so called "tandem ready") which includes these additional gas and oil equalization fittings. Refer to the table below for the bill of material designation and for the specification of the connection of these compressors.

BOM Number	**Control Module**	**Oil Equalization Fitting**	**Gas Equalization Fitting**	**Suction Fitting**	**Discharge Fitting**
540	24V AC	Rotalock ¾″ -16 UNF	Rotalock 1.¾″-12 UNF	ZR16M Rotalock 1.¾″-12 UNF	ZR16M Rotalock 1.¼″-12 UNF
570	120/240V AC			ZR19M Rotalock 2.¼″-12 UNF	ZR19M Rotalock 1.¾″-12 UNF
542	24V AC	Rotalock ¾″ -16 UNF	Braze 1.⅜″	ZR16M Braze 1.⅜″	ZR16M Braze ⅞″
572	120/240V AC			ZR19M Braze 1.⅝″	ZR19M Braze 1.⅛″

Bill of material for single compressors to be used in a Trio assembly

24 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.

25 Tubing Details

Drawings are available with all details of the Trio design approved by Copeland. It is the responsibility of the OEM to manufacture the tubing in accordance to the general layout and appropriate refrigeration practice.

The following specifications must be followed to ensure a reliable Trio:

Gas equalization line

1.1/8” (28 mm) copper tube connecting the compressor stubs with rotalock adapter fittings.
1.3/8” (35mm) copper tube connecting the compressor stubs with braze fittings.

Discharge line

1.1/8” (28 mm) copper tube for ZRY 57M
7/8” (22 mm) copper tube for ZRY48M

Oil equalization line

3/8” (10mm) copper tube connected to the oil equalization stub with rotalock adapter fitting (3/4”-16 UNF). The tube must be positioned in a horizontal plane.

Suction line

The suction line contains section of tubing with different diameters. Please refer to the drawing package for details.

26 Kits For Trio Assembly

Rotalock Assembly Kits

Kits are available to support the Trio assembly by Customers. These kits include all necessary mounting parts and adapters to assemble a rotalock Trio design, tubing and rails are not included:

ZRY57M (rotalock version) : Kit Number 8 537 473
ZRY48M (rotalock version) : Kit Number 8 537 462

The parts included in these kits can also be ordered individually, refer to the table below for part numbers and quantities.

Description	ZRY57M	Quantity	ZRY48M	Quantity
Suction and Discharge rotalock adapter kit	8514176	3	8510641	3
Oil and Gas Equalization rotalock adapter kit	8536209	3	8536209	3
Steel spacer (compressor to rails) mounting kit	8522911	3	8522911	3
Rubber grommets (rails to ground) mounting kit	8537199	1	8537199	1

Rotalock adapters and mounting parts.

Brazed Assembly Kits

In order to assemble a braze Trio version, only the kits number 8522911 and number 8537199 are necessary (metal spacers and grommets), which can be ordered individually.

27 Rails and Lifting

Rails

The use of an intermediate base or rails between the compressor and the base of the unit is recommended. Refer to drawing 074-0939-00 for a typical rail design.

Lifting

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. Details of the clamps are shown in Figures 17-18-19.

The clamps can be positioned around the compressor below the suction tube, and tighten with M10 bolts. Typically the compressor clamps can be made from 25 mm metal strips (Figure 18) and clamp supports from 20 mm angle (Figure 19). The clamps can be assembled and disassembled as required.

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

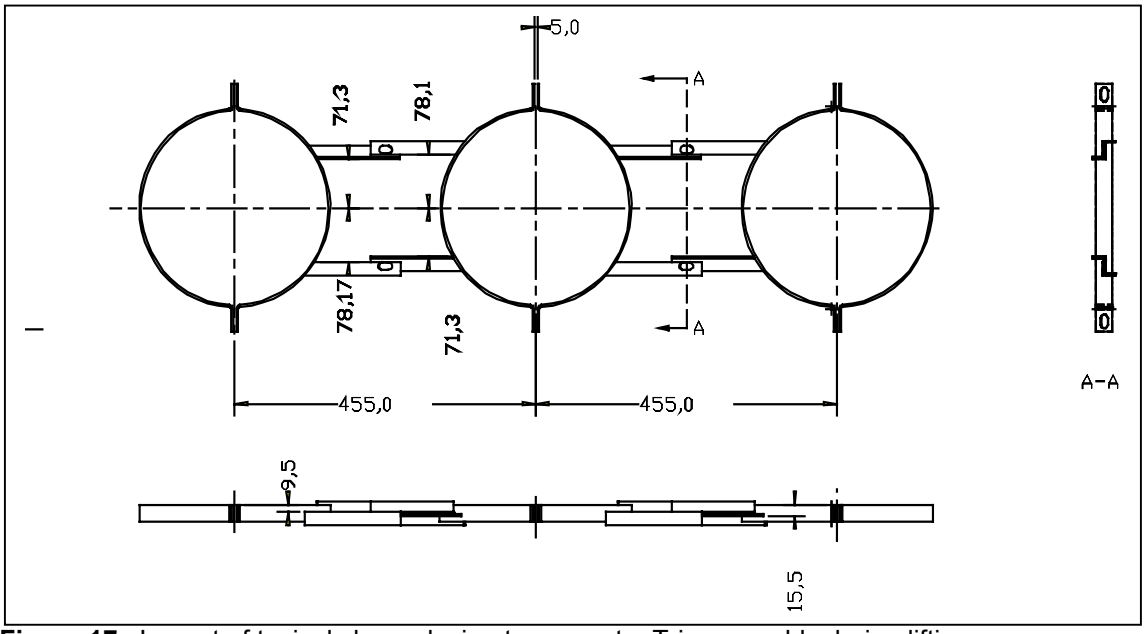
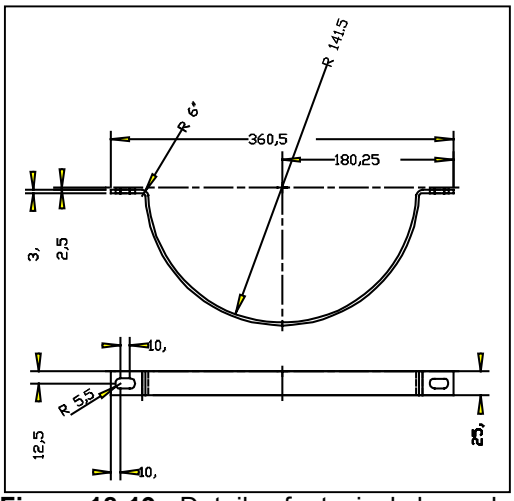


Figure 17 : Layout of typical clamp design to support a Trio assembly during lifting.



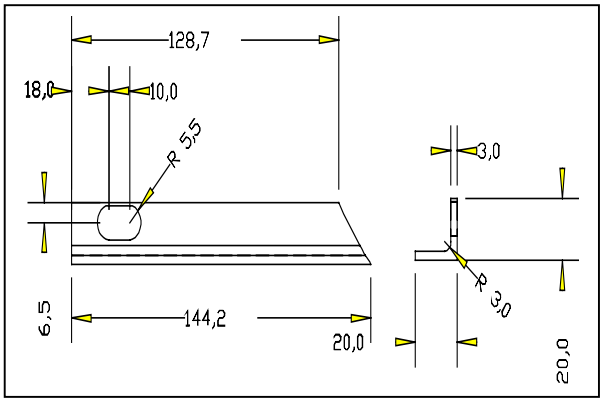


Figure 18-19 : Details of a typical clamp design.

28 Assembly Procedure

- Loosely mount the three compressors on the common base plate or rails, then tighten the mounting bolts to 1 to 5 Nm (10 to 45 inch-pounds).
- 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 nuts from the oil equalization ports at this point.

  Rotalock Adapter design

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

  - Gas equalization line.
  - Suction line.
  - Discharge line.

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

	(Nm)	(Inch-pounds)
Thread 1" ¼	100-110	885-975
Thread 1" ¾	170-180	1500-1590
Thread 2" ¼	190-200	1680-1770

  Brazing Fittings design

  Braze the tubes on the compressor with the following sequence.
  - Gas Equalization line.
  - Suction line.
  - Discharge line.

- Tilt the unit backward to keep the oil from flowing out through the oil equalization port. Remove the nuts from the oil equalization fittings. Assemble the oil equalization line (recommended torque 40 to 50 Nm, 355 to 440 inch-pounds)
- Tighten the connection of the compressor to the rails (M10 with solid steel metal spacers) to 40-50 Nm (355 to 440 inch-pounds).
- Use the soft mounting parts for the installation of the Trio assembly to the base of the system.

29 Crankcase Heater

No crankcase heater is required when the liquid system charge does no exceed 11.8 kg (26 LB).

30 Pumpdown System

A discharge check valve should be placed in the common discharge line when continuous pump down is used to control the refrigerant during shut down.

31 Drawing Package

A drawing package is available, which shows Copeland copper tube layout and mounting rails. The drawing package consists of the following drawings, which are available from your Copeland representative.

Model	Compr. Fittings	Trio Assembly	Suction Assembly	Discharge Assembly	Gas Equalization	Oil Equalization	Rails
ZRY48M	Rotalock	497-0318-00	528-1746-00	528-1742-00	528-1739-00	528-1745-00	074-939-00
	Brazed	497-0326-00	528-1747-00	528-1748-00	528-1741-00		
ZRY57M	Rotalock	497-0317-00	528-1738-00	528-1743-00	528-1739-00		
	Brazed	497-0319-00	528-1740-00	528-1744-00	528-1741-00		

Drawing numbers for Copeland Trio reference design