



***Scroll compressors for
air-conditioning
ZR 18 K4* ... ZR 81 KC****

Application Guidelines



EMERSON
Climate Technologies



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1 Introduction

The Compliant Scroll compressor has been under development at Copeland since 1979 and is the most efficient and durable compressor Copeland has ever developed for air conditioning, refrigeration and heat pump applications. It offers very low vibration and sound levels and is tolerant to stresses caused by liquid slugging, flooded starts, and debris commonly found in refrigeration systems. Available product range in this family is from 1,5 to 6 HP. For detailed information, please, refer to the Copeland Selection Software accessible from the Copeland website at www.ecopeland.com or printed performance brochures. These guidelines are not meant to replace the system expertise available from system manufacturers.

2 Nomenclature

The model numbers of Copeland Scroll compressors have been designed to include a coded nominal capacity at ARI A/C operating conditions in BTU/h at 60 Hz with R 22. For example, model ZR 28 K3 has a capacity of approximately 28000 BTU/h at 60 Hz, using "K" as multiplier 1000. Index "3" denotes the version of the scroll set. The "C" in this position refers to a scroll set with slightly higher built in compression ratio. If the letter "E" follows the index, the compressor is charged with Ester oil. Use factor 0.244 for approximate capacity in Watt at 50 Hz.

Model Designation

<u>Z</u>	<u>R</u>	<u>28</u>	<u>K</u>	<u>3</u>	<u>E</u>	-	<u>P</u>	<u>F</u>	<u>J</u>	-	<u>5</u>	<u>2</u>	<u>2</u>
1	2	3	4	5			6				7		

1 - compressor family: Z = Scroll

2 - high/medium range

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 - POE oil

6 - motor version

7 - bill of material number

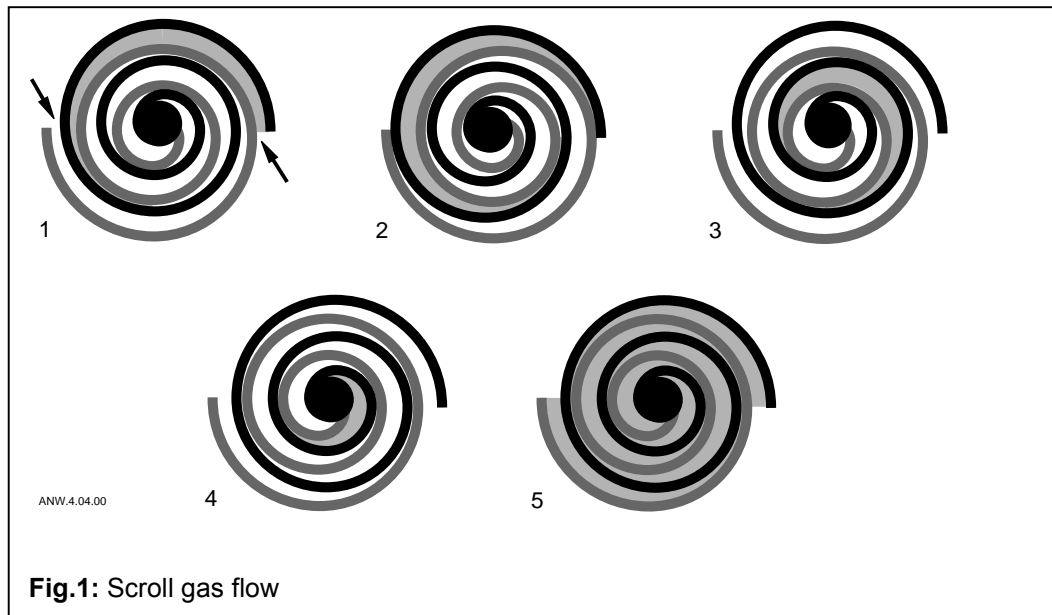
522: brazing stub tubes (ZR 22 K*...ZR 81 K*)

523: Rotalock threaded stubs (ZR 48 K*...ZR 81 K*)

*ARI-Conditions:

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

3 How a Scroll Works



The scroll is a simple compression concept first patented in 1905. A scroll is an involute spiral which, when matched with a mating scroll form, generates a series of crescent-shaped gas pockets between the two members (see **Fig. 1**). During compression, one scroll remains stationary (fixed scroll) while the other form (orbiting scroll) is allowed to orbit (but not rotate) around the first form. As this motion occurs, the pockets between the two forms are slowly pushed to the center of the two scrolls while simultaneously being reduced in volume. When the pocket reaches the center of the scroll form, the gas, which is now at a high pressure, is discharged out of a port located at the center. During compression, several pockets are being compressed simultaneously, resulting in a very smooth process. Both the suction process (outer portion of the scroll members) and the discharge process (inner portion) are almost continuous.

1. Compression in the scroll is created by the interaction of an orbiting spiral and a stationary spiral. Gas enters the outer openings as one of the spirals orbits.
2. The open passages are sealed off as gas is drawn into the spirals.
3. As the spiral continues to orbit, the gas is compressed into two increasingly smaller pockets.
4. By the time the gas arrives at the center port, discharge pressure has been reached.
5. Actually, during operation, all six gas passages are in various stages of compression at all times, resulting in almost continuous suction and discharge.

4 Qualified Refrigerants

R 407C has been qualified as a replacement for R 22 for the compressor models ZR 18 K4E ... ZR81 KCE. R 134a is also qualified. The application envelopes of each refrigerant are shown in section 36.

5 Lubrication

The compressor is supplied with an initial oil charge. The standard oil charge for the use of refrigerants R 407C 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 R 22 applications "White Oil" is used. White Oil is compatible with Suniso 3GS, Texaco WF 32 and Fuchs KM. These oils may be used if an addition is required in the field. The recharge values can be taken from Copeland's brochure. Although there is no flexible mounting of the internal compressor parts, the number of start/stop cycles should be limited to 10 per hour. A high cycling rate will pump oil into the system and may lead to lubrication failure. Oil leaves the compressor at start-up

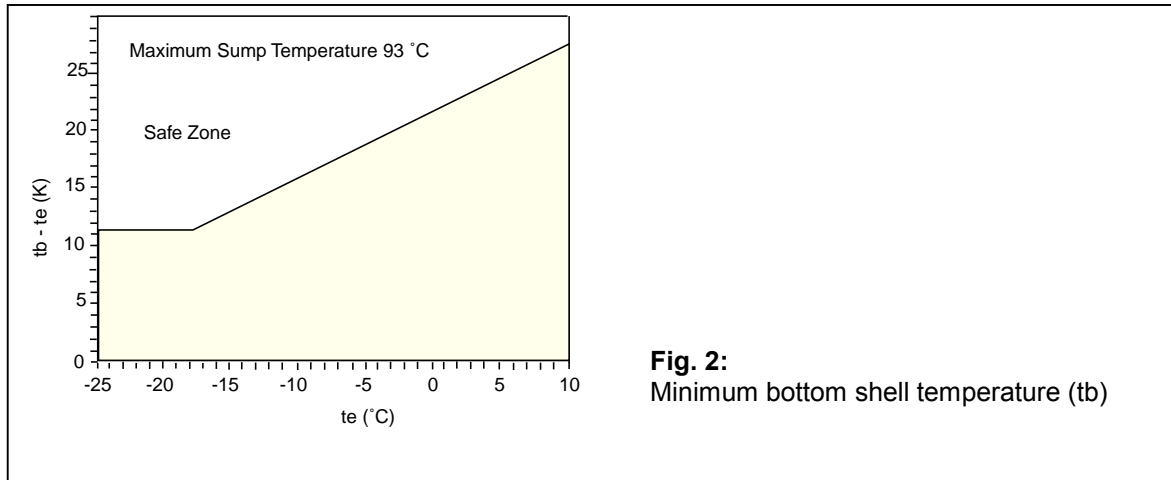


Fig. 2:
Minimum bottom shell temperature (tb)

regardless of the low oil carry over of the Scroll. The short running time is insufficient to return the oil to the compressor and possibly results in a lack of lubricant.

It must be considered that the entire system will be coated with oil to some extent. Oil viscosity changes with temperature. System gas velocity changes depending on temperature and load. In low load conditions gas velocity may not be high enough to return oil to the compressor. System piping should be designed to return oil under all operating conditions.

For proper lubrication the minimum differential between bottom shell (tb) and evaporating (te) temperatures should be carefully observed as laid out in **Fig.2**.

On the other hand, the maximum bottom shell temperature should never exceed 93°C, measured close to the bottom center of the compressor.

One disadvantage of POE is that it is far more hygroscopic than mineral oil (**Fig.3**). 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.

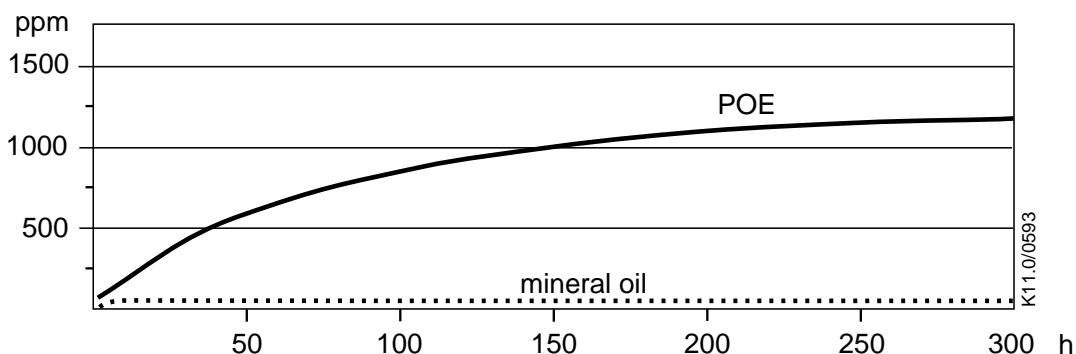


Fig. 3: Absorption of moisture in ester oil in comparison to mineral oil in [ppm] by weight at 25°C and 50% relative humidity. h = hours.

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.

6 Accumulators

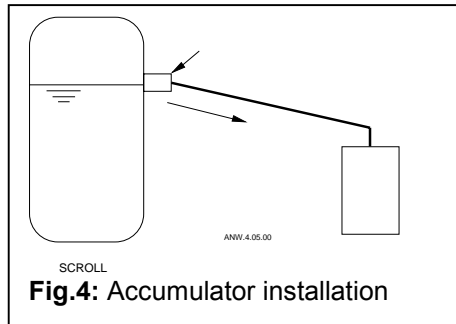


Fig.4: Accumulator installation

Durability is ensured by the Compliant Scroll's inherent ability to handle liquid refrigerant in flooded start and defrost cycle operation, and an accumulator is normally not required. However, large volumes of liquid refrigerant which repeatedly flood back to the compressor during normal off cycles or excessive liquid refrigerant floodback during steady operation can dilute the oil in any compressor to the point where bearings become inadequately lubricated and wear may occur. Use the diagram in **Fig.16** to determine if your system charge is such that a test is necessary to see if repeated floodback can occur. Recommended tests are described in section 23.

7 Crankcase Heaters

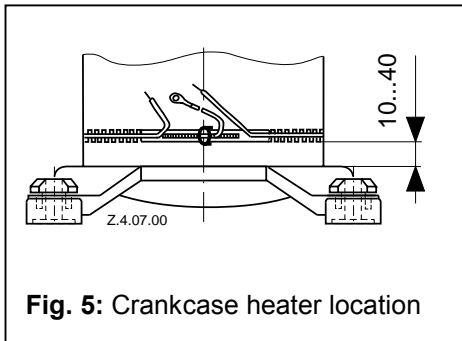


Fig. 5: Crankcase heater location

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

- 2,7 kg for ZR18 K4
- 4,5 kg for ZR 22 K3 ... ZR 81 KC

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.4**.

Please also see section 23. For correct mounting location of such a heater please see **Fig.5**.

8 Pump down

For the models ZR18K4...ZR81KC pump down is not recommended. The Scroll discharge check valve is designed to stop extended reverse rotation and prevent high-pressure gas from leaking rapidly into the low side after shut off. The check valve will in some cases leak more than reciprocating compressor discharge reeds normally used with automatic pump down causing the compressor to cycle more frequently. If pump down is used a separate external check valve must be added. For large compressors, like ZR 90 and bigger, pump down may be used, but a separate discharge check valve here is not needed, since those models are equipped with a low leak check valve. The low-pressure control differential has to be reviewed since a relatively large volume of gas will re-expand from the discharge plenum of the compressor into the low side on shut down.

9 Reversing Valves

Since Compliant Scroll compressors have very high volumetric efficiencies, their displacements are lower than for comparable capacity reciprocating compressors. As a result, Copeland recommends that the capacity rating on reversing valves be no more than approximately 1.5 times the nominal capacity of the compressor with which it will be used in order to ensure proper operation of the reversing valve under all operating conditions. The reversing valve solenoid should be wired so that the valve does not reverse when the system is shut-off by the operating thermostat in the heating or cooling mode. If the valve is allowed to reverse at system shut-off, suction and discharge pressures are reversed to the compressor. This results in system pressures equalizing through the compressor, which



can cause the compressor to slowly rotate until the pressures equalize. This does not affect compressor durability but can cause unexpected sound after the compressor is turned off.

10 Discharge Temperature Protection

Internal discharge temperatures reached under some extreme operating conditions (such as loss of charge or extremely high compression ratio caused by failure of evaporator fan) can cause compressor damage. In order to guarantee positive compressor protection a discharge gas temperature protection is provided internally. A thermodisc is positioned adjacent to the discharge port. When the thermodisc opens a small gas by pass occurs which trips the motor protector. The internal thermodisc opens at 146°C +/-4°C and closes at 91°C +/-7°C.

11 Standard Motor Protection

Conventional inherent internal line break motor protection is provided with models ZR 18 K*...ZR 81 KC.

12 Mufflers

Flow through Compliant Scroll compressors is continuous and has relatively low pulsations. External mufflers, often applied to piston compressors today, may not be required for Compliant Scrolls. Because of variability between systems, however, individual system tests should be performed to verify acceptability of sound performance. Please also see section 36.

13 Low Ambient Cut-Out

A low ambient cut-out is not required to limit heat pump operation.

14 Pressure Controls

A high pressure cut-out may be required according to individual national regulations and is strongly recommended with three-phase compressors due to their capabilities of pumping to high pressures once the discharge is obstructed. There is an internal pressure relief valve in the ZR 18 K4 ... 81 KC models, which opens at a differential pressure of 28 bar ±3 bar between high and low pressure sides. For the low-pressure side a minimum working pressure setting of 0.3 bar is recommended. There is no such valve installed in the early models ZR 23 K1 ... ZR 28 K1.

15 Shut-Off

Since the Compliant Scroll compressor is also an excellent gas expander, the compressor may run backwards for a very brief period at shut-off as the internal pressures equalize, and a typical sound is generated. A check valve in the discharge connection of the compressor prevents the compressor from running backwards for more than a second or two. This momentary reversal of direction of the scrolls has no effect on compressor durability and is entirely normal.

All ZR models, described here, have an internal device that reduces, but does not eliminate the shut-off sound.

16 Starting

During the very brief start-up, a short metallic sound is audible, resulting from initial contacting of the spirals and is normal.

No start assist devices are required for single-phase compressors, even if a system utilizes non-bleed expansion valves. Due to the design of the Compliant 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 startup, low-voltage starting characteristics are excellent for Compliant Scroll compressors.

17 Deep-Vacuum Operation

The danger of pulling deep vacuums is avoided due to an internal low vacuum protection which prevents the scrolls pumping (unloads) when the pressure ratio exceeds approximately 10:1. In order to avoid nuisance trips, it is recommended to set the low-pressure control as described in section 14 above.

18 Brief Power Interruptions

With single-phase Compliant Scroll compressors built before May 1995 (serial no. 95E..), brief power interruptions of less than 1/2 second may result in powered reverse rotation. This occurs as a result of the high-pressure discharge gas expanding backwards through the scrolls at power interruption, causing the scroll to orbit in the reverse direction. When power is reapplied while reverse rotation is occurring, the compressor may continue to run in the reverse direction for several minutes until the compressor's internal protector trips. This has no effect on durability. When the protector resets the compressor will start and run normally.

To avoid the loss of cooling resulting from powered reverse rotation Copeland strongly encourages the use of an electronic control which can sense brief power interruptions and will lock the compressor out of operation for five minutes. This control could be incorporated with the other system controls (such as defrost or thermostat), or be a stand-alone control. Functional specifications for this control are the following:

Timer opens: 1 electrical cycle (0,02 sec at 50-Hz operation) after power is removed and closes: 5 minutes ($\pm 20\%$) delayed whether power is restored or not. No such device is required on three-phase models.

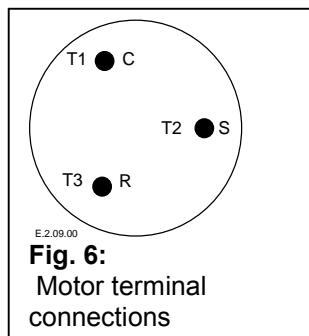
19 Electrical Installation

Independently from the internal motor protection, fuses F6...8 have to be installed before the compressor as shown in **Fig. 7** and **Fig.8**. Selection of fuses has to be carried out according to VDE 0635 or DIN 57635 or IEC 269-1 or EN60-269-1.

Motor insulation material class is "B" for models ZR 18 K4 ... ZR 81 KC according to VDE 0530 or DIN 57530.

The Fusite connections are marked as in **Fig.6**. Recommended wiring diagrams are shown in **Fig.7** and **Fig.8**.

20 Single-Phase Models



Single-phase compressors are connected to the common (C), start (S) and run (R) connections as usual.

21 Three-Phase Models

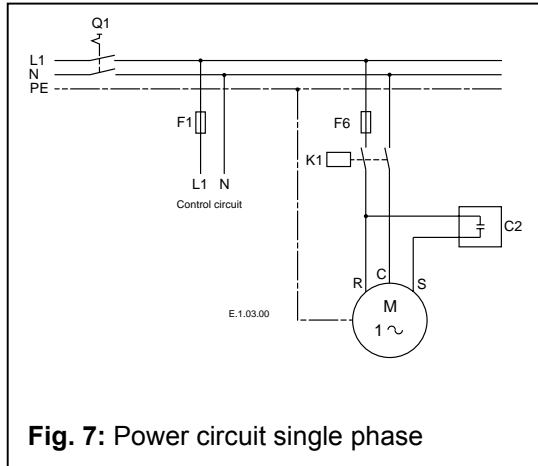


Fig. 7: Power circuit single phase

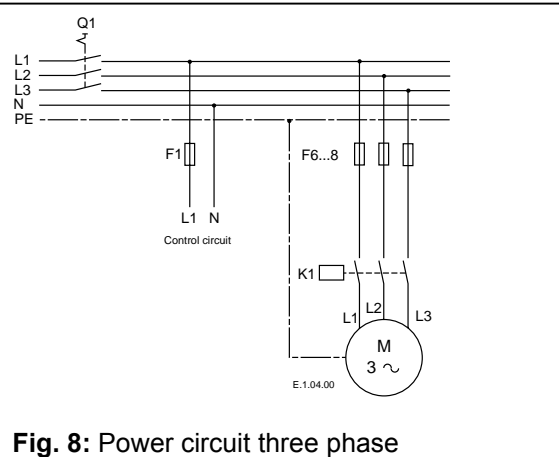


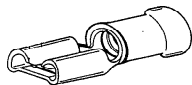
Fig. 8: Power circuit three phase

Scroll compressors, like several other types of compressors, will only compress in one rotational direction. Direction of rotation is not an issue with single-phase compressors since they will always start and run in the proper direction (except as described in section 18). However, three-phase compressors will rotate in either direction depending upon phasing of the power to L1, L2 and L3. 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 is achieved when the system is installed and operated. Verification of proper rotation direction is made by observing that suction pressure drops and discharge pressure rises when the compressor is energized. Reverse rotation results in a sound level above that with correct rotation direction, as well as substantially reduced current draw compared to tabulated values and after several minutes of operation the compressor's internal protector will trip.

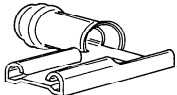
All three-phase compressors are wired identically internally. As a result, once the correct phasing is determined for a specific system or installation, connecting properly phased power leads to the same terminals should maintain proper rotation direction.

22 Cable Connectors

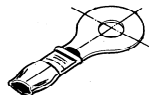
Model	PFJ	TF5	TFC	TFD
ZR 18	A/B	A/B	-	A/B
ZR 22	A/B	A/B	-	A/B
ZR 28	A/B	A/B	-	A/B
ZR 34	A/B	A/B	-	A/B
ZR 40	A/B	A/B	-	A/B
ZR 48	A/B	A/B	-	A/B
ZR 61	-	C/D	-	C/D
ZR 72	-	C/D	-	C/D
ZR 81	-	C/D	-	C/D



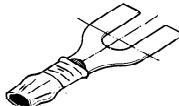
A Straight receptacle



B Flag receptacle



C Ring Tongue



D Spade

Fig. 9: Cable connectors

The above table lists recommended types of cable connectors to be used for the various electric terminals of the compressors and the motor protection module. "A" and "B" must fit 1/4" or 6.3 mm tab sizes. "C" and "D" are to be selected for #10 studs or diameters of 5mm respectively.



Cable sizes are to be selected according to DIN ISO 0100, IEC 364 or national regulations.

Compressor and System Tests

23 Compressor Functional Check

Since Compliant Scroll compressors do not have internal suction valves or dynamic discharge valves which can be damaged it is not necessary to perform functional compressor tests where the compressor is turned on with the suction service valve closed to check how low the compressor will pull suction pressure. Rather, the following diagnostic procedure should be used to evaluate whether the Compliant Scroll compressor is functioning properly.

1. Proper voltage to the unit should be verified.
2. The normal checks of motor winding continuity and short to ground should be made to determine if the internal overload motor protector of a ZR 18 K4 ... ZR 81 KC model has opened or if an internal short to ground has developed. If the protector has opened, the compressor must be allowed to cool sufficiently to allow it to reset.
. The normal checks of motor winding continuity and short to ground should be made to determine if the internal overload motor protector has opened or if an internal short to ground has developed. If the protector has opened, the compressor must be allowed to cool sufficiently to allow it to reset.
3. Proper indoor and outdoor fan/blower operation should be verified.
4. With service gauges connected to suction and discharge pressure fittings, turn on the compressor. If suction pressure falls below normal levels the system is either low on charge or there is a flow blockage in the system.

5.a) Single-phase compressors

If suction pressure does not drop and discharge pressure does not rise to normal levels, either the reversing valve (if so equipped) or the compressor is faulty. Use normal diagnostic procedures to check operation of the reversing valve.

b) Three-phase compressors

If suction pressure does not drop and discharge pressure does not rise to normal levels, reverse any two of the compressor power leads and reapply power to make sure compressor was not wired to run in reverse direction. If pressures still do not move to normal values, either the reversing valve (if so equipped) or the compressor is faulty. Reconnect the compressor leads as originally configured and use normal diagnostic procedures to check operation of the reversing valve.

6. If the reversing valve (if so equipped) checks out satisfactorily, then the compressor current draw must be compared to published compressor performance data at the compressor operating conditions (pressures and voltages) and significant deviations (more than $\pm 15\%$) from published values may indicate a faulty compressor.

24 Excessive Liquid Floodback

The following tests are for those system configurations and charge levels identified in **Fig.16**, which need special testing to verify exemption from the need of an accumulator.

25 Continuous Floodback

To test for excessive continuous liquid refrigerant floodback, it is necessary to operate the system in a test room at conditions where steady state floodback may occur (low ambient heating operation). Thermocouples should be attached to the suction and discharge lines of the compressor (approximately 150 mm from the shell) and insulated. If the system is designed to be field charged it



should be overcharged by 15 % in this test to simulate overcharging commonly found in field installations.

The system should be operated at an indoor temperature of 20°C and outdoor temperature extremes (-18°C or lower in heating mode) which produce floodback conditions. The compressor suction and discharge pressures and temperatures should be recorded. The system should be allowed to frost up for several hours (disabling the defrost control and spraying water on the outdoor coil may be necessary) to cause the saturated suction temperature to fall to -30°C or below. The compressor sump temperature must remain above the saturated suction temperature as determined from **Fig.2** or design changes must be made to reduce the amount of floodback. If an accumulator is used an oil return orifice size of 1,4 mm is recommended.

26 Repeated Floodback

To test for repeated excessive liquid floodback during normal system off-cycles perform the “Field Application Test” below. Obtain a sample compressor with a side sight tube to measure liquid level in the compressor. Set the system up in a configuration with the indoor unit elevated approximately 1 m above the outdoor unit with approximately 7 m of connecting tubing with no traps between the indoor and outdoor units. If the system is designed to be field charged, the system should be overcharged by 15% in this test to simulate overcharging commonly found in field installations. Operate the system in the cooling mode at the outdoor ambient, on/off cycle times and number of cycles specified in the table below. Record the height of the liquid in the compressor at the start of each on cycle, any protector trips, or any compressor stalls during each test. Review all test results with Copeland Application Engineering to determine if an accumulator is required for the application.

27 Field Application Test:

Outdoor ambient (°C):	29	35	40
System on-time (minutes):	7	14	54
System off-time (minutes):	13	8	6
Number of on/off cycles:	5	5	4

To prevent flooded start damage on three phase Scroll compressors due to off cycle migration, the accumulator may be configured on some systems to allow free drainage from the compressor to the accumulator during the off cycle.

Please see **Fig.2**. When this configuration is not possible, a crankcase heater is required.

27 High Potential Testing

Copeland subjects all motor compressors to a high voltage test after final assembly. This is carried out according to VDE 0530 part 1.

Since high voltage tests lead to premature aging of the winding insulation we do not recommend additional tests of that nature. They may also be carried out with new machines only.

If it has to be done for any reason disconnect all electronic devices (e.g. motor protection module, fan speed control, etc.) prior to testing. The test voltage of 1000 V plus twice the nominal voltage is applied for 1 - 4 seconds between motor winding (each one of the phases) and the compressor shell: The maximum leak current limit is approximately 10 mA. Repeated tests have to be performed at lower voltages.

Caution: Do not carry out high voltage or insulation tests if the compressor housing is under vacuum. Compliant Scroll compressors are configured with the motor down and the pumping components at the top of the shell. As a result, the motor can be immersed in refrigerant to a greater extent than hermetic reciprocating compressors when liquid refrigerant is present in the shell. In this respect, the scroll is more like semi-hermetics (which have horizontal motors partially submerged in oil and refrigerant). When Compliant Scroll compressors are high potential tested with liquid refrigerant in the shell they can show higher levels of leakage current than compressors with the motor on top because of the higher electrical conductivity of liquid refrigerant than refrigerant vapour and oil. However, this phenomenon can occur with any compressor when the motor is immersed in refrigerant. The levels of

current leakage do not present any safety issue. To lower the current leakage reading the system should be operated for a brief period of time to redistribute the refrigerant to a more normal configuration and the system high potential tested again.

28 Installation

Four vibration absorber grommets are supplied with each compressor (see **Fig.10**). They dampen the start-up surge of the compressor and prevent sounds and vibrations from being transmitted to the compressor base during operation to a large extent. The metal sleeve inside is intended as a guide to hold the grommet in place. It is not designed as a load-bearing member, and excessive torquing can crush the sleeve. Its inner diameter is approximately 8.5 mm to fit e.g. an M8 screw. The mounting torque should be 13 ± 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 (see **Fig. 10**).

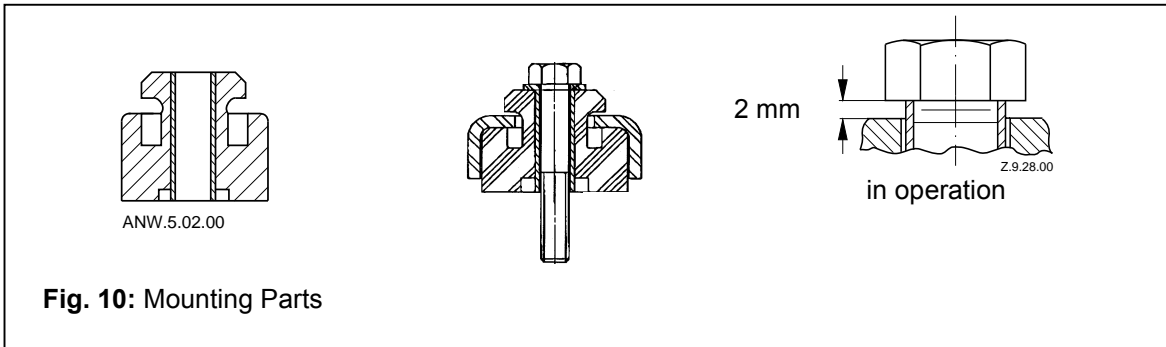


Fig. 10: Mounting Parts

29 Service

Compliant Scroll compressors have copper plated steel suction and discharge tubes. These tubes are far more robust and less prone to leaks than copper tubes 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. For brazing of the tubes see **Fig.11** and the following procedures.

Since the discharge spud contains a check valve, care must be taken not to overheat it as well as to prevent brazing material from flowing into it.

30 New Installations

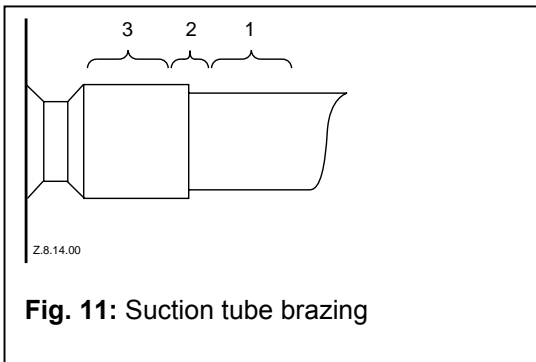


Fig. 11: Suction tube brazing

- 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
- 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.

31 Field Service

To disconnect:

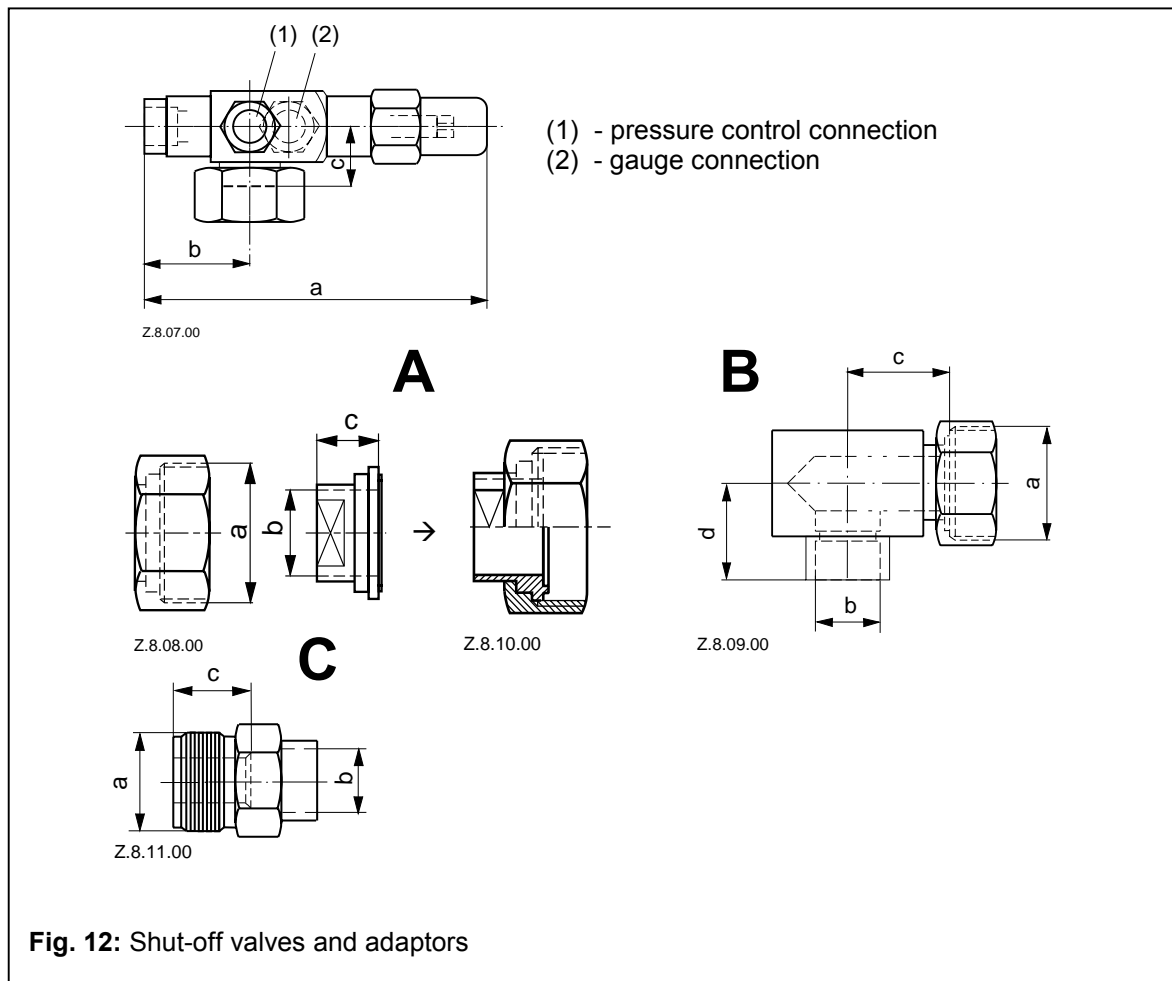
- Heat joint areas 2 and 3 slowly and uniformly until the braze material softens and the tube can be pulled out of the fitting.

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. For brazing of the tubes see **Fig.11** and the following procedures.

Since the discharge stub contains a check valve, care must be taken not to overheat it as well as to prevent brazing material to flow into it.

32 Shut-off Valves and Adaptors



The Scroll compressors are delivered with brazing connections (ZR 18 K4 ... ZR 81 KC) or threads for Rotalock valves (ZR 48 K*...ZR 81 K*).

Rotalock type shut-off valves can also fit compressors with braze connections (by the mean of Rotalock adaptors "C"). Rotalock-shut-off valves are available for the suction as well as the discharge side (see **Fig.12** & spare parts list "ZR").

Using adaptor "A" and "B" in either straight or angled form provides a way to convert a Rotalock into a brazing connection (see **Fig.12** & spare parts list "ZR").

33 Shell Temperature

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

34 System Charging Procedure

Rapid charging on only the suction side of a single-phase 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 spirals happen to be in a sealed position, rapid pressurization of the low side without opposing high side pressure can cause the spirals to seal axially. As a result, until the pressures eventually equalize, the spirals can be held tightly together, preventing rotation. The best way to avoid this situation is to charge on both the high and the low side simultaneously at a rate which does not result in axial loading of the spirals. The maximum charging rate can be determined through simple tests.

35 Unbrazing System Components

If the refrigerant charge is removed from a scroll equipped unit by bleeding the high side only, it is sometimes 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 applied to the low side while the low side shell and suction line contains pressure, the pressurized refrigerant and oil mixtures could ignite when it escapes and contacts the brazing flame. To prevent this occurrence, it is important to check both the high and the low side with gauges before unbrazing, or in the case of repairing a unit on an assembly line, bleed refrigerant from both the low and the high side. Instructions should be provided in appropriate product literature and assembly (line repair) areas.

36 Suction Line Noise and Vibration

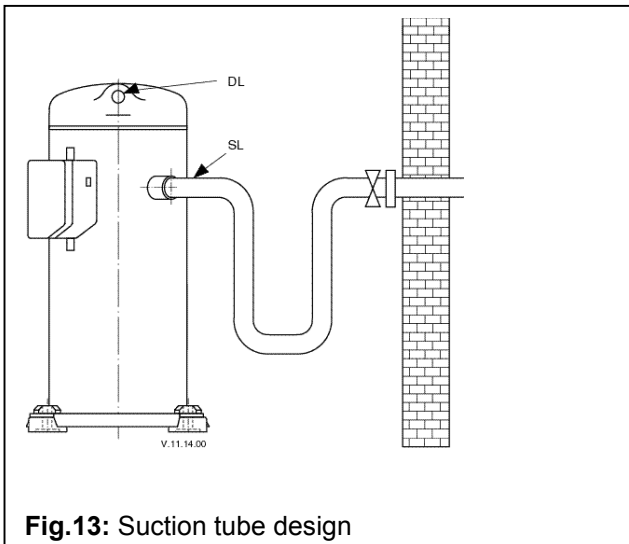


Fig.13: Suction tube design

Copeland Compliant Scroll compressors inherently have low sound and vibration characteristics. However, in some respects, the sound and vibration characteristics differ from reciprocating compressors and, in rare instances, could result in unexpected sound complaints with plain air conditioning systems. One difference is that the vibration characteristic of the Scroll compressor, although low, includes two very close frequencies, one of which is normally isolated from the shell by the suspension of an internally suspended compressor. These frequencies, which are present in all compressors, may result in a low level “beat” frequency that can be detected as noise coming along the suction line into a house under some conditions. Elimination of the “beat” can be achieved by attenuating either of the

contributing frequencies. This is easily done by using one of the common combinations of design configuration described below.

A second difference of the Compliant Scroll compressor is that under some conditions the normal starting motion of the compressor can transmit an “impact” noise along the suction line. This phenomenon, like the one described above, also results from the lack of internal suspension, and can be easily avoided by using standard line isolation techniques as described below.

Recommended configuration (Fig.13):

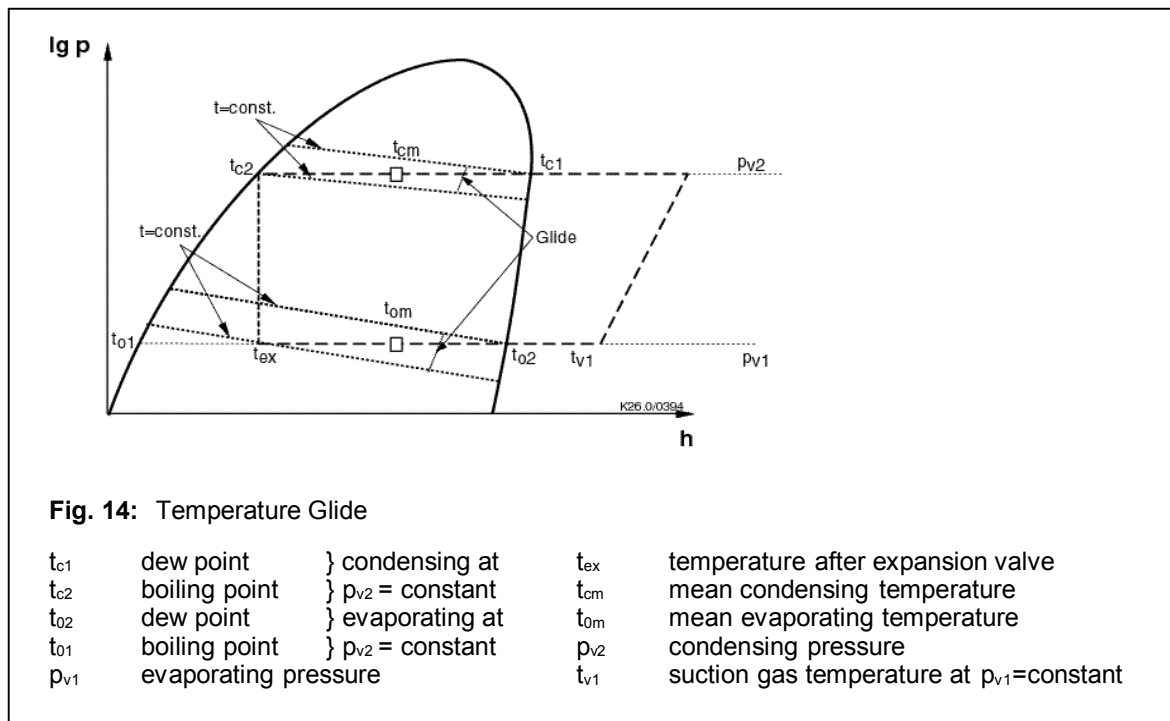
- Tubing configuration: small shock loop
- Service valve: “angled valve” fastened to unit/wall
- Suction muffler: not required

Alternative configuration:

- Tubing configuration: small shock loop
- Service valve: “straight-through” valve fastened to unit/wall
- Suction muffler: may be required

The sound phenomena described above are not usually associated with reversible air conditioning/heat pump systems because of the isolation and attenuation provided by the reversing valve and tubing bends.

37 R 407C Characteristics



Compressors designed for operation with HFC refrigerants are factory supplied with one of the approved oils and are suitably identified. They also can be used with HCFC R22. An “E” is added to the version figure, e.g. ZR 61 KC becomes ZR 61 KCE. Different from single component, azeotropic and near azeotropic refrigerants, the zeotropic R 407 blends are characterized by its relatively large temperature glide. Therefore, certain influences on system design, service and maintenance need to be considered. The composition of liquid and vapour of a zeotropic blend is different when both liquid and vapour are present. Therefore it is important that charging is carried out in the liquid phase only. Please also see the refrigerant manufacturer’s instructions. If a leak occurs there could be a change in composition of the refrigerant remaining in the system. Large changes in composition can result in decreasing superheat at the expansion valve leading to liquid returning to the compressor. Another characteristic of significant composition change can be the appearance of sudden “hunting” of the expansion valve. Tests by R 407C manufacturers have shown that satisfactory system operation can typically be restored simply by recharging with the original refrigerant. If it does not result in satisfactory system operation, it is recommended to analyse the refrigerant composition in the system prior to replacing the entire system charge. Working with zeotropic blends requires an understanding of the effect of temperature glide shown in Fig.14.



Evaporation at constant pressure takes place with the temperature of the refrigerant increasing from t_{ex} to t_{o2} and condensation takes place with a falling temperature from t_{c1} to t_{c2} . Thus the terms “evaporating temperature” and “condensing temperature” must be redefined. High glide causes considerable temperature differences within the heat exchangers. Similarly, clear definitions for “superheating” and “subcooling” are needed. Such new definitions are also necessary in order to ensure accurate comparisons of performance against other azeotropic or near azeotropic refrigerants. Evaporating temperature is defined as the mean temperature (t_{om}) between the dew-point temperature (t_{o2}) resulting from constant suction pressure (p_{v1}) and the temperature at which the refrigerant enters the evaporator (t_{ex}). Condensing temperature is defined as the mean temperature (t_{cm}) between the dew-point temperature (t_{c1}) resulting from constant discharge pressure (p_{v2}) and the boiling-point temperature (t_{c2}) of the refrigerant.

The superheating of the suction gas is then calculated as the difference in temperature at the compressor inlet (t_{v1}) and the dew-point temperature (t_{o2}) of the refrigerant at suction pressure (p_{v1}). It is essential that these definitions be followed when adjusting the superheat setting of expansion valves. Liquid subcooling is calculated as the difference between actual liquid temperature and the bubble point temperature (t_{c2}) of the refrigerant at discharge pressure (p_{v2}).

The definitions presented here are based on those specified by the Air- Conditioning and Refrigeration Institute (ARI) as part of their **Alternative Refrigerants Evaluation Program (AREP)**. These definitions are used to provide performance comparison with R 22. System designers normally use data based on the dew point temperatures as specified in EN 12900. With the Copeland Selection Software version 4 and above performance data sheets for both mid point and dew point definitions are available.

It is essential that the glide of R 407 refrigerant blends be given careful consideration when adjusting pressure controls. Furthermore, it is crucial to consider the effect of pressure losses on glide when sizing heat exchangers. Pressure losses effectively increase glide significantly in the system. Failure to consider this in heat energy balance calculations will likely result in undersizing heat exchangers and other system components. These effects are especially apparent when operating a system near the limits of its application range.

38 Application Envelopes

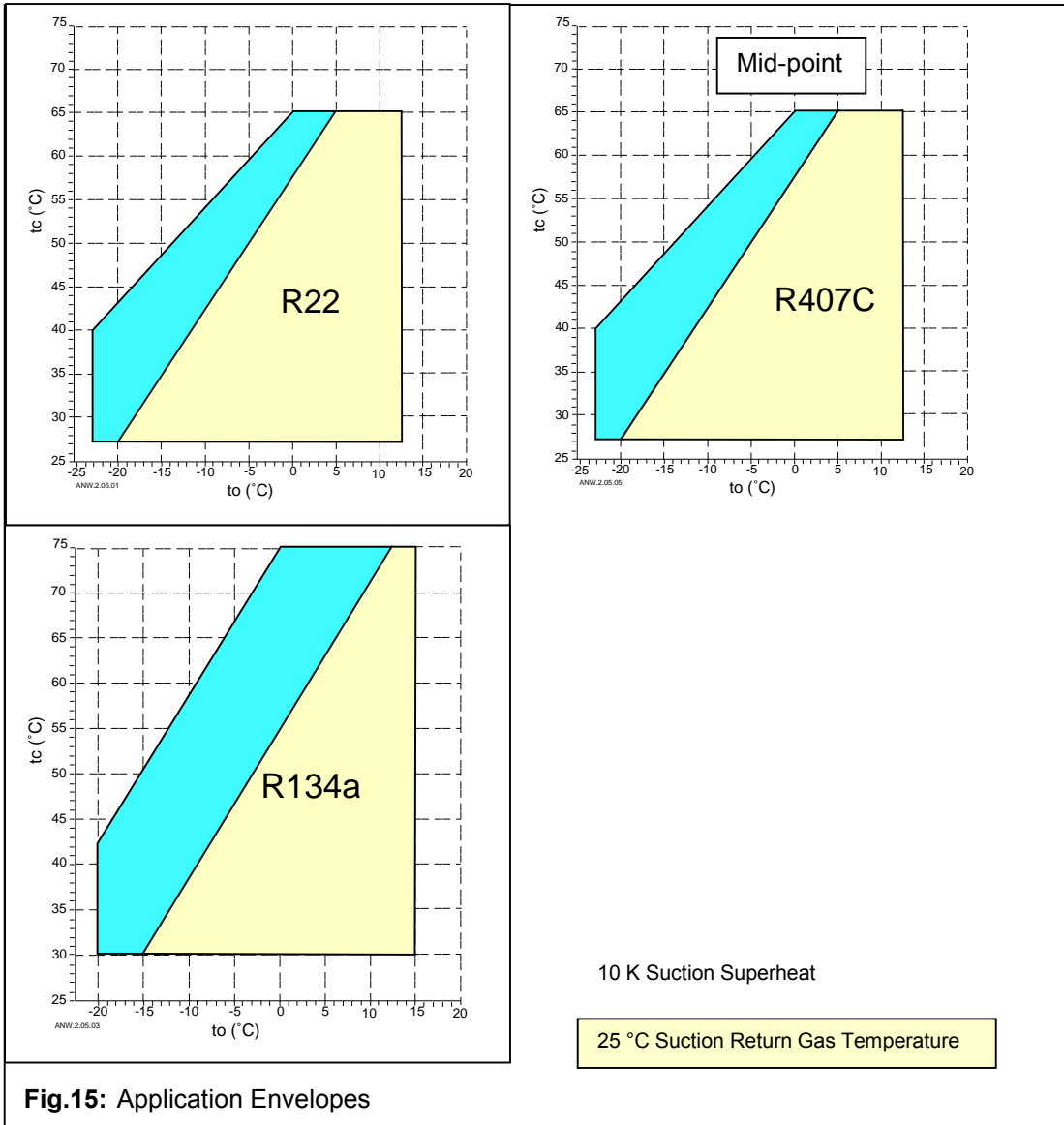


Fig.15: Application Envelopes

39 Application Diagram

Start at A/C or H/P depending on your application and follow the chart to see if you need additions or tests on your system.

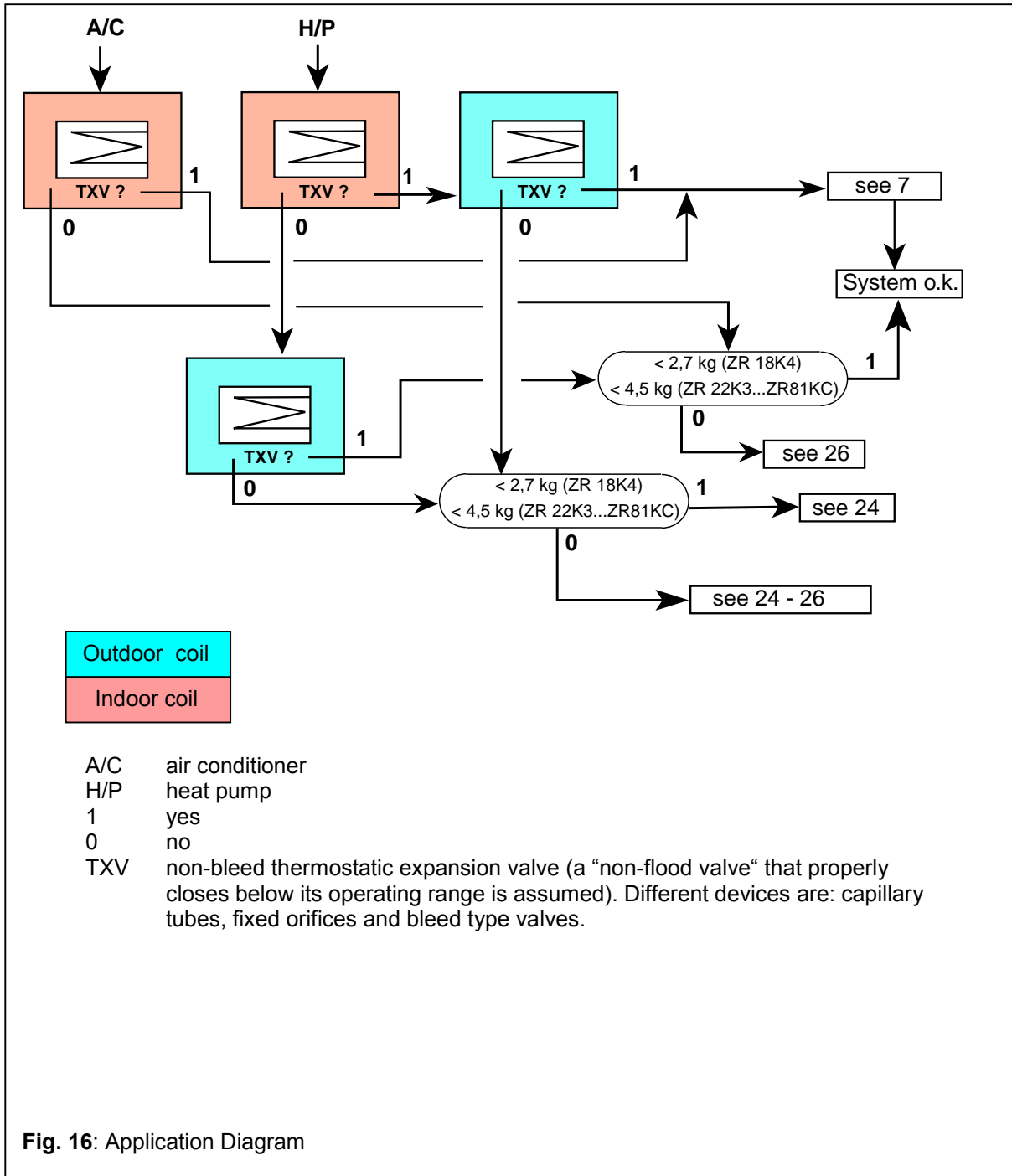


Fig. 16: Application Diagram

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