AE4-1335

ZR54KS to ZR61KS 4.0 to 5.0 TON COPELAND SCROLL™ COMPRESSORS

January 2006

Introduction

The ZR*KS Copeland Scroll compressors are designed for use in high efficiency air conditioning and heat pump systems. They range in size from 45,000 Btu/hr to 61,000 Btu/hr (13.2 - 17.8 kW). Typical model numbers are ZR54KS-TF5 and ZR61KS-TFD.

This bulletin describes the operating characteristics, design features, and application requirements for these models. Operating principles of the Copeland Scroll are described in **Figure 6** at the end of this Application Engineering Bulletin.

The ZRKS models include the features described below:

IPR Valve-Internal Pressure Relief Valve: Three phase ZR*KS compressors contain an internal pressure relief valve that is located between the high side and the low side of the compressor. It is designed to open when the discharge-to-suction differential pressure exceeds 375 to 450 psid (26 - 32 kg/cm2). When the valve opens, hot discharge gas is routed back into the area of the motor protector to cause a trip. During developmental blocked fan testing, it is sometimes noted that the valve opens, but the compressor does not shut off while the discharge pressure continues to climb. This condition is normally caused by refrigerant flood back and may be corrected by using a more restrictive expansion device or reducing the refrigerant charge.

Internal Temperature Protection: The Therm-O-Disc® or TOD is a temperature-sensitive snap disc device located on the muffler plate between the high and low pressure sides of the compressor. It is designed to open and route excessively hot discharge gas back to the motor protector. During a situation such as loss of charge, the compressor will be protected for some time while it trips the protector. However, as refrigerant leaks out, the mass flow and the amperage draw are reduced and the scrolls will start to overheat. Normally, during air conditioning operation the problem is detected because of rising indoor temperatures before damage is done. This may not be the case during heat pump operation since backup heat may make up the deficit. A low pressure control is recommended for loss of charge protection in heat pumps for the highest level of system protection. A cut out setting no lower than 25 psig (2 kg/cm2) for air conditioning and 7 psig (0.5 kg/cm2) for heat pumps is recommended. The low pressure cut-out, if installed in the suction line to the compressor, can provide additional protection against a TXV failed in the closed position, outdoor fan failure in heating, a closed liquid line or suction line service valve, or a blocked liquid line screen, filter, orifice, or TXV. All of these can starve the compressor for refrigerant and result in compressor failure. The low pressure cut-out should have a manual reset feature for the highest level of system protection. If a compressor is allowed to cycle after a fault is detected, there is a high probability that the compressor will be damaged and the system contaminated with debris from the failed compressor and decomposed oil. If current monitoring to the compressor is available, the system controller can take advantage of the compressor TOD and internal protector operation. The controller can lock out the compressor if current draw is not coincident with the contactor energizing, implying that the compressor has shut off on its internal protector. This will prevent unnecessary compressor cycling on a fault condition until corrective action can be taken.

Quiet Shut Down: All scrolls in this size range have one of several types of "quiet" shutdown solutions. All of these quiet shut down solutions allow the scroll compressor to restart immediately even if the system is not equalized. No time delay is required for any of these compressors to restart. Development testing should include a review of the shutdown sound for acceptability in a particular system.

Discharge Check Valve: A low mass, disc-type check valve in the discharge fitting of the compressor prevents the high side, high pressure discharge gas from flowing rapidly back through the compressor. This check valve was not designed to be used with recycling pump down because it is not entirely leak-proof.

Motor Protector: Conventional internal line break motor protection is provided. The protector opens the center of the Y connection on three-phase motors. The protector provides primary single-phase protection and reacts to current and motor winding temperature.

Application Considerations

The Copeland Scroll compressor has a number of application characteristics that are different from those of the traditional reciprocating or rotary compressor. These are described below.

Accumulators

The use of accumulators is very dependent on the application. The Copeland Scroll's inherent ability to handle liquid refrigerant during occasional operating flood back situations makes the use of an accumulator unnecessary in designs such as air conditioning condensing units. Heat pumps with orifice or capillary tube refrigerant control can allow large volumes of liquid refrigerant to flood back to the compressor during normal steady operation. If flood back is excessive, it can dilute the oil to such an extent that bearings are inadequately lubricated, and wear will occur. In such a case, an accumulator must be used to reduce flood back to a safe level that the compressor can handle. To test for flood back conditions and determine if an accumulator design is adequate, please see the section entitled **Excessive Liquid Flood Back Tests** at the end of this bulletin. The accumulator oil return orifice should be from .040 to .060 inches (1 - 1.5 mm) in diameter depending on compressor size and compressor flood back results. A large-area protective screen no finer than 30 x 30 mesh (0.6 mm openings) is required to protect this small orifice from plugging. Tests have shown that a small screen with a fine mesh can easily become plugged causing oil starvation to the compressor bearings.

Screens

Screens with a mesh size finer than 30 x 30 (0.6mm openings) should not be used anywhere in the system with these compressors. Field experience has shown that finer mesh screens used to protect thermal expansion valves, capillary tubes, or accumulators can become temporarily or permanently plugged with normal system debris and block the flow of either oil or refrigerant to the compressor. Such blockage can result in compressor failure.

Crankcase Heat - Three-Phase

A crankcase heater is required for three-phase compressors when the system charge exceeds the compressor charge limit listed in **Table 4** and an accumulator cannot be piped to provide free liquid drainage during the off cycle (See **Figure 2** and **Table 5**).

Pump Down Cycle

A pump down cycle for control of refrigerant migration is not recommended for scroll compressors of this size. **If a pump down cycle is used, a separate external check valve must be added.** 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 pump down, causing the scroll compressor to cycle more frequently. Repeated short-cycling of this nature can result in a low oil situation and consequent damage to the compressor. The low-pressure control differential has to be reviewed since a relatively large volume of gas will re-expand from the high side of the compressor into the low side on shut down.

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 scroll compressors start unloaded, even if the system has unbalanced pressures. The most critical consideration is the **minimum run time required to return oil to the compressor after startup.** This is most easily determined using a sample compressor equipped with a sight glass (available from Copeland) and configured with the longest connecting lines that are approved for the system. The minimum on time becomes the time required for oil lost on compressor start-up to return to the compressor sump and restore a normal level in the sight glass. Cycling the compressor for a shorter period than this, for instance to maintain very tight temperature control, will result in progressive loss of oil and damage to the compressor. See Application Engineering Bulletin 17-1262 for more information on preventing compressor short cycling.

Reversing Valves

Since Copeland Scroll compressors have very high volumetric efficiency, their displacements are lower than those of comparable capacity reciprocating compressors. As a result, Copeland recommends that the capacity rating on reversing valves be no more than 2 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 shutoff, suction and discharge pressures are reversed to the compressor. This results in pressures equalizing through the compressor which can cause the compressor to slowly rotate until the pressures equalize. This condition does not affect compressor durability but can cause unexpected sound after the compressor is turned off.

Low Ambient Cut-Out

A low ambient cut-out is not required to limit air-to-air heat pump operation. Air-to-water heat pumps must be reviewed since this configuration could possibly run outside of the approved operating envelope (**Figure 4**) causing overheating or excessive wear.

Oil Type

The ZR*KS compressors are originally charged with white mineral oil. A standard 3GS oil may be used if the addition of oil in the field is required. See the compressor nameplate for original oil charge. See Application Engineering bulletin 17-1248 for more information about oil types Copeland uses. A complete recharge should be four fluid ounces (118 ml) less than the nameplate value for ZR*KS compressors.

Discharge Mufflers

Flow through Copeland Scroll Compressors is semi-continuous with relatively low pulsation. External mufflers, where they are normally applied to piston compressors today, may not be required for Copeland Scroll. Because of variability between systems, however, individual system tests should be performed to verify acceptability of sound performance. When no testing is performed, mufflers are recommended in heat pumps. A hollow shell muffler such as the Alco APD-1 or APD-054 will work quite well. The muffler should be located a minimum of six inches (15 cm) to a maximum of 18 inches (46 cm) from the compressor for most effective operation. The further the muffler is placed from the compressor within this range, the more effective it may be. If adequate attenuation is not achieved, use a muffler with a larger cross-sectional area to inlet-area ratio. The ratio should be a minimum of 20 to 1 with a 30 to 1 ratio recommended. The muffler should be from four to six inches (10-15 cm) long.

Air Conditioning System Suction Line Noise and Vibration

Copeland Scroll compressors inherently have low sound and vibration characteristics. However, the sound and vibration characteristics differ in some respects from those of reciprocating compressors. In rare instances, these could result in unexpected sound complaints.

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 in an internally suspended compressor. These frequencies, which are present in all compressors, may result in a low level "beat" frequency that may 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.

The most important frequencies to avoid are line and twice-line frequencies for single-phase compressors and line frequency for three phase compressors. This is easily done by using one of the common combinations of design configurations described in **Table 3**. The scroll compressor makes both a rocking and a torsional motion, and enough flexibility must be provided in the line to prevent vibration transmission into any lines attached to the unit. In a split system the most important goal is to ensure minimal vibration in all directions at the service valve to avoid transmitting vibrations to the structure to which the lines are fastened.

A second difference of the Copeland Scroll is that under some conditions the normal rotational starting motion of the compressor can transmit an "impact" noise along the suction line. This may be particularly pronounced in three-phase models due to their inherently higher starting torque. This phenomenon, like the one described previously, also results from the lack of internal suspension, and can be easily avoided by using standard suction line isolation techniques as described in **Table 3**.

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

Electrical Connection
The orientation of the electrical connections on the Copeland Scroll compressors is shown in **Figure 3** and is also shown on the wiring diagram on the top of the terminal box cover.

Deep Vacuum Operation
Scrolls incorporate internal low vacuum protection and will stop pumping (unload) when the pressure ratio exceeds approximately 10:1. There is an audible increase in sound when the scrolls start unloading.

Copeland Scroll compressors (as with any refrigerant compressor) **should never be used to evacuate a refrigeration or air conditioning system.** The scroll compressor can be used to pump down refrigerant in a unit as long as the pressures remain within the operating envelope shown in **Figure 4**. Prolonged operation at low suction pressures will result in overheating of the scrolls and permanent damage to the scroll tips, drive bearings and internal seal. (See Application Engineering Bulletin 24-1105 for proper system evacuation procedures.)

Shell Temperature
Certain types of system failures, such as condenser or evaporator fan blockage or loss of charge, may cause the top shell and discharge line to briefly but repeatedly reach temperatures above 350ºF (177ºC) 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 in contact with these potentially hot areas.

Suction and Discharge Fittings
Copeland Scroll compressors have copper plated steel suction and discharge fittings. These fittings are far more rugged and less prone to leaks than copper fittings 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. See **Figure 5** for assembly line and field brazing procedures.

Three Phase Scroll Compressors
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 the section "Brief Power Interruptions"). Three phase compressors will rotate in either direction depending upon phasing of the power. Since there is a 50-50 chance of connecting power in such a way as to cause rotation in the reverse direction, i**t is important to include notices and instructions in appropriate locations on the equipment to ensure that 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 will result in substantially-reduced current draw compared to normal values.

There is no negative impact on durability caused by operating three phase Copeland Scroll compressors in the reversed direction for a short period of time, but oil may be lost. Oil loss can be prevented during reverse rotation if the tubing is routed at least six inches (15 cm) above the compressor. After several minutes of reverse operation, the compressor's internal protector will trip. If allowed to repeatedly restart and run in reverse without correcting the situation, the compressor will be permanently damaged because of oil loss to the system.

All three-phase scroll 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 identified compressor electrical (Fusite) terminals will maintain proper rotation direction. See **Figure 3**.

Brief Power Interruptions
Because three-phase models have high enough torque to prevent reverse rotation after power interruptions, no time delay is necessary.

Assembly Line Procedures

Installing the Compressor
Copeland Scroll compressors leave the factory dehydrated with a positive pressure dry air charge. Plugs should not be removed from the compressor until the compressor has had sufficient time to warm up if stored outside and is ready for assembly to the unit. It is suggested that the larger suction plug be removed first to relieve the internal pressure. Removing the smaller discharge plug could result in a spray of oil out of this fitting since some oil will accumulate in the head of the compressor after Copeland test-runs the compressor. The inside of both fittings should be wiped with a lint-free wipe to remove residual oil prior to brazing. A compressor containing mineral oil should never be left open longer than 15 minutes.

Assembly Line Brazing Procedure
Figure 5 discusses the proper procedures for brazing the suction and discharge lines to a scroll compressor. **It is important to flow nitrogen through the system while brazing all joints during the system assembly process.** Nitrogen displaces the air and prevents the formation of copper oxides in the system. If allowed to form, the copper oxide flakes can later be swept through the system and block screens such as those protecting capillary tubes, thermal expansion valves, and accumulator oil return holes. The resulting blockage of oil or refrigerant may do damage resulting in compressor failure.

Pressure Testing
The test pressure used on the assembly line to meet the burst pressure requirements **must not** be higher than **400 psig (28 kg/cm2)**. Higher pressure may result in permanent deformation of the compressor shell.

Assembly Line System Charging Procedure
Systems should be charged with liquid on the high side to the extent possible. The majority of the charge should be pumped into the high side of the system to prevent low volt start difficulties, Hipot failures, and bearing washout during first-time start on the assembly line. If additional charge is needed, it should be added as liquid to the low side of the system with the compressor operating. Pre-charging on the high side and adding liquid on the low side of the system are both meant to protect the compressor from operating with abnormally low suction pressures during charging. **Do not operate compressor without enough system charge to maintain at least 7 psig (0.5kg/cm2) suction pressure. Do not operate with a restricted suction. Do not operate with the low pressure cut-out disabled.** Allowing pressure to drop below 7 psig (0.5 kg/cm2) for more than a few seconds may overheat scrolls and cause early drive bearing damage. Do not use compressor to test opening set point of a high pressure cutout. Bearings are susceptible to damage before they have had several hours of normal running for proper break in.

"Hipot" (AC High Potential) Testing
Copeland Scroll compressors are configured with the motor down and the pumping components at the top of the shell. As a result, the motor will 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-hermetic compressors which can have horizontal motors partially submerged in oil and refrigerant. When Copeland Scroll compressors are Hipot tested with liquid refrigerant in the shell, they can show higher levels of leakage current than compressors with the motor on top. This phenomenon can occur with any compressor when the motor is immersed in refrigerant. The level of current leakage does 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 Hipot tested again. See AE Bulletin 4-1294 for Megohm testing recommendations. Under no circumstances should the Hipot test be performed while the compressor is under a vacuum.

Unbrazing System Components

Caution! Before opening a system it is important to remove all refrigerant from both the high and low side. If the refrigerant charge is removed from a scroll-equipped unit by bleeding one side only, it is very possible that either the high or low side of the system remains pressurized. If a brazing torch is then used to disconnect tubing, the pressurized refrigerant and oil mixture could ignite when it escapes and contacts the brazing flame. **It is important to check both the high pressure and low pressure side with manifold gauges before unbrazing.** Instructions should be provided in appropriate product literature and assembly (line repair) areas. If compressor removal is required, the compressor should be cut out of the system rather than unbrazed. See **Figure 5** for proper compressor removal procedure.

Copeland Scroll Functional Check

A functional compressor test during which the suction service valve is closed to check how low the compressor will pull suction pressure is not a good indication of how well a compressor is performing. **Such a test will permanently damage a scroll compressor in a few seconds.** The following diagnostic procedure should be used to evaluate whether a Copeland Scroll compressor is functioning properly:

1. Proper voltage to the unit should be verified.

2. Check that the compressor is correctly wired.

3. Determine if the internal motor overload protector has opened or if an internal motor short or ground fault has developed. If the protector has opened, the compressor must be allowed to cool sufficiently to allow it to reset.

4. Proper indoor and outdoor fan/blower operation should be verified.

5. 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.

6. **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 the compressor was not wired to run in reverse. 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.

7. To test if the compressor is pumping properly, the compressor current draw must be compared to published compressor performance curves using the operating pressures and voltage of the system. If the measured average current deviates more than ±15% from published values, a faulty compressor may be indicated. A current imbalance exceeding 15% of the average on the three phases of a three-phase compressor should be investigated further. A more comprehensive troubleshooting sequence for compressors and systems can be found in Section H of the **Copeland Electrical Handbook.**

8. **Before replacing or returning a compressor:** Be certain that the compressor is actually defective. As a minimum, recheck a compressor returned from the field in the shop or depot for Hipot, winding resistance, and ability to start before returning to Copeland. More than one-third of compressors returned to Copeland for warranty analysis are determined to have nothing wrong. They were misdiagnosed in the field as being defective. Replacing working compressors unnecessarily costs everyone.

Compressor Replacement after Motor Burn

In the case of a motor burn, the majority of contaminated oil will be removed with the compressor. The rest of the oil is cleaned through use of suction and liquid line filter dryers. A 100% activated alumina suction filter drier is recommended but must be removed after 72 hours. See Application Engineering bulletin 24-1105 for clean up procedures and AE bulletin 11-1297 for liquid line filter-drier recommendations. **It is highly recommended that the suction accumulator be replaced if the system contains one.** This is because the accumulator oil return orifice or screen may be plugged with debris or may become plugged shortly after a compressor failure. This will result in starvation of oil to the replacement compressor and a second failure.

Start-up of a New or Replacement Compressor

It is good service practice, when charging a system with a scroll compressor, to add liquid refrigerant into the high side only. It is not good for any compressor to have liquid refrigerant dumped from a refrigerant cylinder into the crankcase of the stationary compressor. If additional charge needs to be added, charge liquid into the low side of the system with the compressor operating. **Do not start the compressor while the system is in a deep vacuum.** Internal arcing may occur when a scroll compressor is started in a vacuum. **Do not operate compressor without enough system charge to maintain at least 7 psig (0.5 kg/cm2) suction pressure. Do not operate with a restricted suction. Do not operate with the low pressure cut-out disabled**. Allowing suction pressure to drop below 7 psig (0.5 kg/cm2) for more than a few seconds may overheat scrolls and cause early drive bearing damage. Never install a system in the field and leave it unattended with no charge, a holding charge, or with the service valves closed without securely locking out the system. This will prevent unauthorized personnel from accidentally operating the system for comfort cooling and potentially ruining the compressor by operating with no refrigerant flow.

Excessive Liquid Floodback Tests

The following tests are for those system configurations and charge levels identified in **Table 1** that need special testing to verify exemption from need of an accumulator. **Figure 1** should be used to determine the effectiveness of an accumulator. The compressor sump temperature during any test where the return gas superheat is near zero must always meet the guidelines of **Figure 1**.

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 with glue or solder to the center of the bottom shell and to the suction and discharge lines approximately 6 inches (15 cm from the shell). These thermocouples should be insulated from the ambient air with Permagum® or other thermal insulation to be able to record true shell and line temperatures. 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 70°F (21°C). and outdoor temperature extremes (0°F or -18°C or lower in heating) to produce floodback conditions. The compressor suction and discharge pressures and temperatures as well as the sump temperature 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 below -10°F (-23°C). The compressor sump temperature must remain above the sump temperature shown in **Figure 1**, or design changes must be made to reduce the amount of floodback. If an accumulator is used, an oil return orifice size of 0.040 - .060" (1 - 1.5 mm) is recommended. (See information on Accumulators in Application Considerations and also Copeland Application Engineering bulletin 11-1247). Increasing indoor coil volume, increasing outdoor air flow, reducing refrigerant charge, decreasing capillary or orifice diameter, and adding a charge compensator can also be used to reduce excessive continuous liquid refrigerant flood back.

To test for **repeated excessive liquid flood back** during normal system off-cycles, perform the **"Field Application Test"**. 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 several feet above the outdoor unit with twenty-five feet (8 meters) 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 **Table 2**. 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 the results with Copeland Application Engineering to determine if an accumulator is required for the application. The criteria for pass/fail is whether the liquid level reaches the height of the scroll compressor suction fitting on the side of the shell. Liquid levels higher than the suction fitting will allow compressor oil floating on top of the refrigerant to be ingested by the scrolls and pumped out of the compressor.

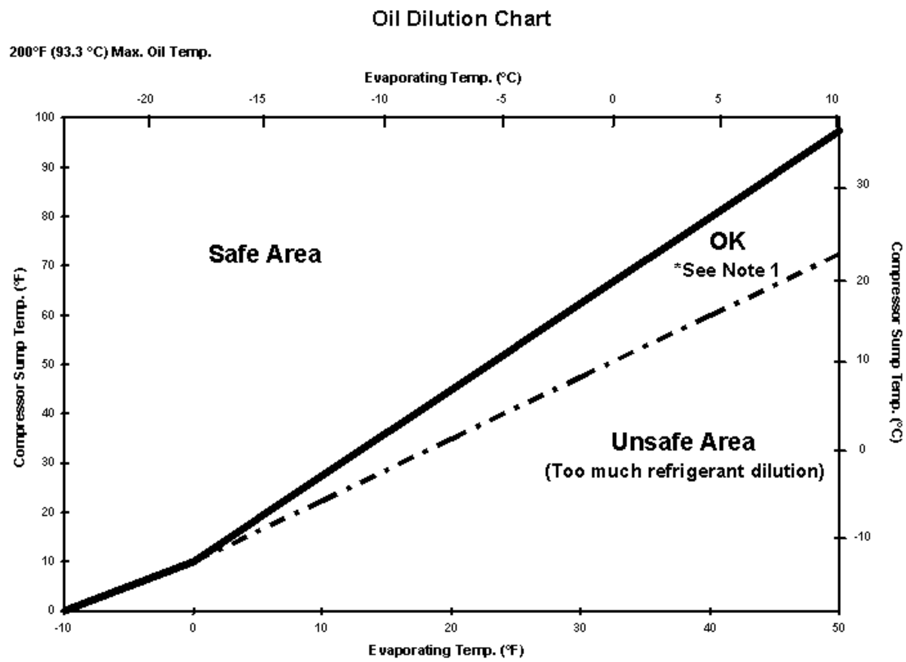


Figure 1

Note 1: Operation in this refrigerant dilution area is safe in air-to-air heat pump heating mode. For other applications, such as AC only, review expansion device to raise superheat. A cold sump may result in high refrigerant migration after shut down.

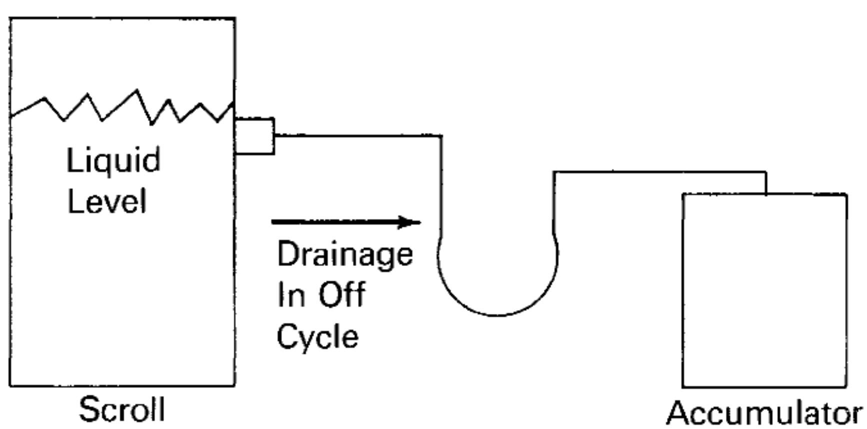


Figure 2

To prevent flooded start damage 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. When the above configuration is not possible and the unit charge is over the charge limit shown in Table 5, a crankcase heater is required.

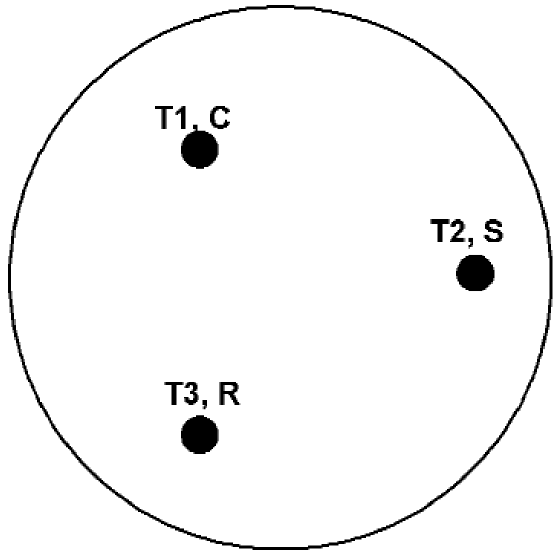


Figure 3

Motor Terminal (Fusite) Connections

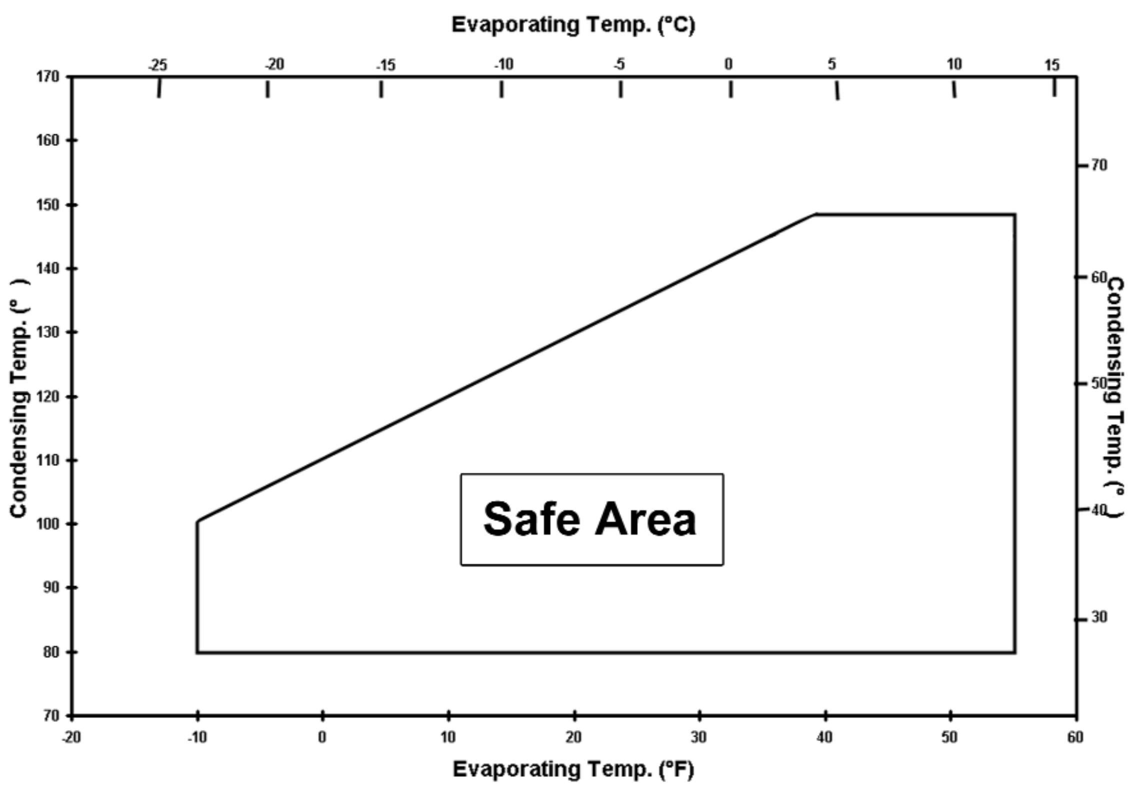


Figure 4

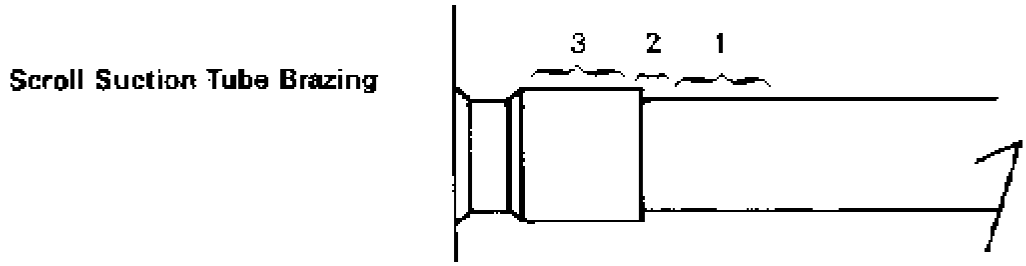


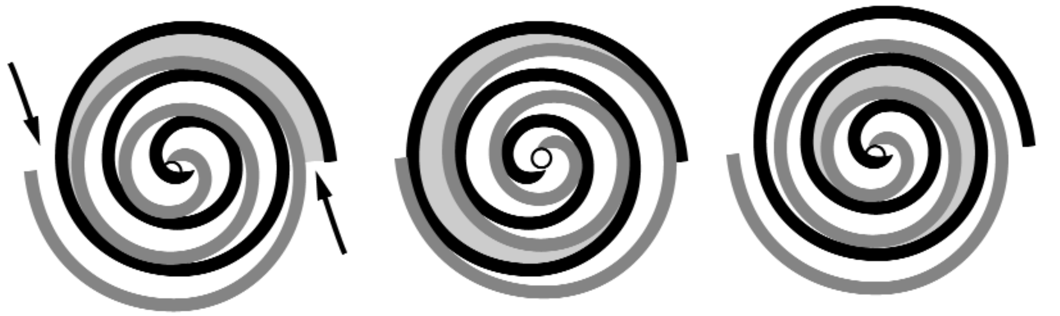
Figure 5

New Installations

- The copper-coated steel suction tube 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 suction tube fitting I.D. and suction tube O.D. are clean prior to assembly. If oil film is present wipe with denatured alcohol, Dichloro-Trifluoroethane or other suitable solvent.
- Using a double-tipped torch apply heat in Area 1. As tube approaches brazing temperature, move torch flame to Area 2.
- Heat Area 2 until braze temperature is attained, moving torch up and down and rotating around tube as necessary to heat tube evenly. Add braze material to the joint while moving torch around joint to flow braze material around circumference.
- After braze material flows around joint, move 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.

Field Service

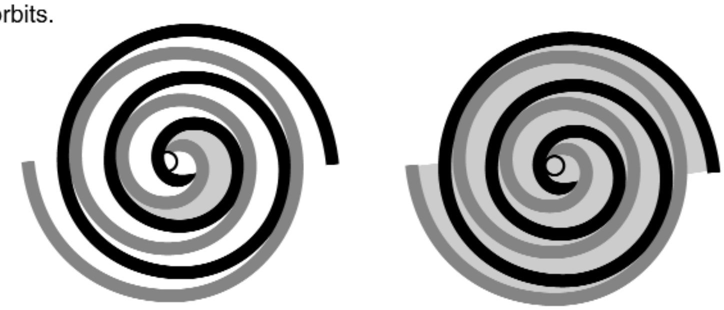
- To disconnect: Reclaim refrigerant from both the high and low side of the system. Cut tubing near compressor.
- To reconnect:
    - Recommended brazing materials: Silfos with minimum 5% silver or silver braze material with flux.
    - Insert tubing stubs into fitting and connect to the system with tubing connectors.
    - Follow **New Installation** brazing instructions.



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.

The open passages are sealed off as gas is drawn into the spiral.

As the spiral continues to orbit, the gas is compressed into two increasingly smaller pockets.



By the time the gas arrives at the center port, discharge pressure has been reached.

Actually, during operation, all six gas passages are in various stages of compression at all times, resulting in nearly continuous suction and discharge.

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 as shown above, generates a series of crescent-shaped gas pockets between the two members. 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 simultaneouly, resulting in a very smooth process. Both the suction process (outer portion of the scroll members) and the discharge process (inner portion) are continuous.

Figure 6

Operating Principle of Scroll

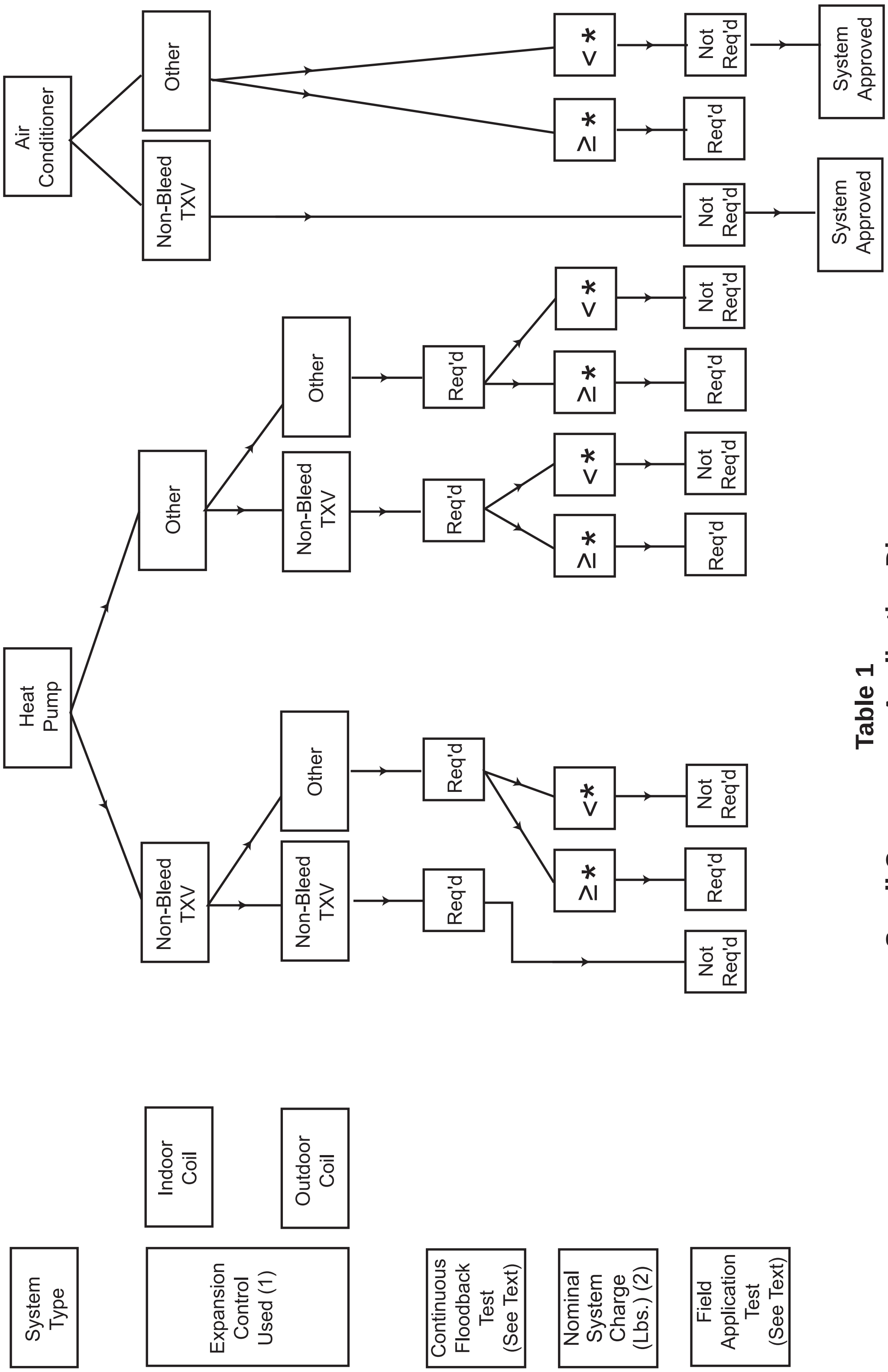


Table 1
Scroll Compressor Application Diagram

(1) "Other" includes bleed-type TXVs, capillary tubes, and fixed orifices.
(2) "Nominal System Charge" is defined as the design charge for a system.

Note: See text for crankcase heater requirements.

*120% Times Compressor refrigerant charge limit in Table 5.

Table 1
Scroll Compressor Application Diagram

Outdoor Ambient	85°F (29°C)	95°F (35°C)	105°F (40°C)
System On-Time (Minutes)	7	14	54
System Off-Time (Minutes)	13	8	6
Number of On/Off Cycles	5	5	4

Table 2
Field Application Test

Operate the system as it would be operated in an actual field installation, cycling the unit on and off for the times indicated at each ambient.

Recommended Configuration	
Component	**Description**
Tubing Configuration	Shock loop
Service Valve	"Angled valve" fastened to unit
Suction muffler	Not required
Alternate Configuration	
Component	**Description**
Tubing Configuration	Shock loop
Service Valve	"Straight through" valve not fastened to unit
Suction muffler	May be required (Acts as dampening mass)

Table 3

Compressor Refrigerant Charge Limits					
Model	**Frame Size***	**Charge Limit**		**120% x Limit ****	
		Pounds	kg	Pounds	kg
ZR54KS-ZR61KS	63	10	4.5	12.0	5.5

*Approximate Shell Diameter (e.g. 63 = 6.5 Inches)
** Includes Charge Allowance for system

Table 4

Crankcase Heaters						
Copeland Model	**Frame Size***	**Copeland Part #**	**Volts**	**Watts**	**Tutco Part #**	**Leads**
ZR54KS-ZR61KS	63	018-0057-00	240	70	02-6332-00	21"
		018-0057-01	480	70	02-6332-03	21”

*Approximate Shell Diameter (e.g. 70 = 7.3 Inches)

Table 5