Copeland

Application Engineering Bulletin

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APPLICATION GUIDELINES FOR "GLACIER" K3 REFRIGERATION SCROLL COMPRESSORS

Introduction

The "Glacier" K3 refrigeration scroll represents the industry's first application of scroll technology for refrigeration. This bulletin describes unique guidelines which must be followed to ensure proper, safe and durable service.

Operating Envelope

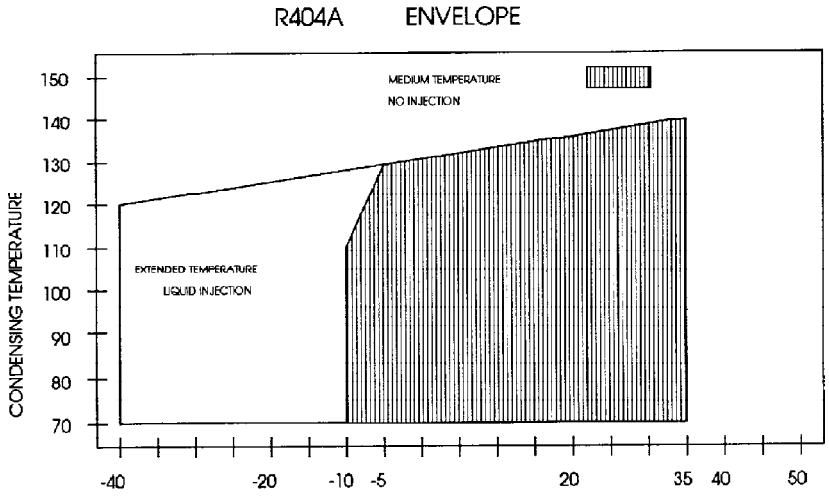
Glacier is currently released for R-404A refrigerant systems only. Because this refrigerant is an HFC, Copeland approved polyol ester lubricant - MOBIL EAL Arctic 22 CC, must be used with this compressor.

See Figure 1 for the application envelope limitations.

Accumulators

Due to the Compliant Scroll's inherent ability to handle liquid refrigerant in flooded start and defrost cycle operation conditions, accumulators may not be required. On systems with extremely large refrigerant charges or defrost schemes that allow prolonged uncontrolled liquid return to the compressor, an accumulator would be recommended.

Excessive liquid flood back or repeated flooded starts will dilute the oil in any compressor causing inadequate lubrication and bearing wear. Proper system design will ensure maximum compressor life.



CONDITIONS: 0º F SUBCOOLING, AIR OVER
95º F AMBIENT, 65º F RETURN GAS

Figure 1

Crankcase Heat - Single Phase

No crankcase heat is required for single phase compressors.

Crankcase Heat - Three Phase - Outdoor Only

A crankcase heater is required for three phase compressors when the system charge exceeds 10 lbs. and no accumulator is used. A crankcase heater or pumpdown cycle is also required if the charge exceeds 10 lbs. and piping does not provide liquid drainage into an accumulator during the off cycle (See Figure 2).

Crankcase Heater Numbers
80 Watt Wrap Around

Copeland Part No.	Voltage	Springfield Wire No.
018-0042-02	240V	SW 2994-3
018-0042-05	480V	SW 2994-6
018-0042-08	577V	SW 2994-9

Discharge Line Thermostat

A discharge line thermostat is required in the compressor control circuit. This thermostat has a cut-out setting of 200°F to 210°F with 50°F closing differential and should be installed approximately 7 inches from discharge tube outlet.

If a service valve is installed at the discharge tube, the thermostat should be located 5 inches from the valve braze. Copeland recommends TOD thermostat part number 37TJ31X1976E.

Pressure Controls

Both high and low pressure controls are required and the following values are recommended:

Low - Greater than 15 psia
High - Less than 415 psia

Liquid Injection

For low temperature applications liquid injection is required. The compressor is supplied with a 1/4" diameter injection tube. A standard on-off solenoid should be wired to open when the compressor is running and close when (A) compressor shuts off (B) during a hot gas defrost (C) during a pump down cycle. In the event the internal motor protector trips, power to the injection solenoids must be dropped. Typically this is accomplished by the use of a current sensing relay. The liquid line leading to the on-off solenoid should pass through a filter dryer to avoid clogging the injection port.

The solenoid valve orifice diameter should be at least .056 inches.

Motor Protection

Conventional inherent internal line break motor protection is provided.

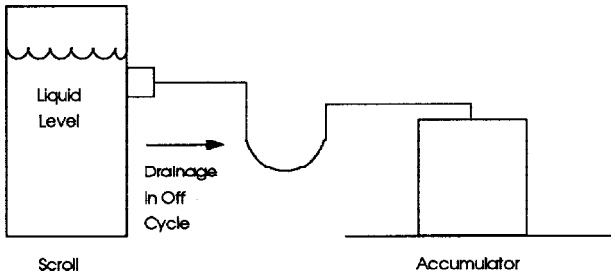


Figure 2

Oil Type

Polyol ester lubricant must be used in Copeland Glacier scroll compressors. MOBIL EAL Arctic 22 CC is approved for Copeland compressors. See Table 1 for field oil recharge values. Glacier models equipped with a sight glass and oil drain/fill Schraeder valve should be recharged to the glass mid-point.

Oil Management

Glaciers may be used on multiple compressor parallel rack applications. This requires the use of an oil management system to maintain proper oil level in each compressor crankcase. There are several manufacturers of conventional oil control systems that have successfully been applied to glacier compressors. The sight glass connections supplied on ZF and ZS models can accommodate the mounting of these oil control devices.

Discharge Mufflers

Flow through Glacier scroll compressors is continuous with relatively low pulsation's. External mufflers applied to piston compressors may not be required on Glacier Scroll. Because of system variability individual system tests should be performed to verify acceptable sound levels.

Compressor Mounting

Compressors may be mounted either with grommets or solid mounted. However, consideration should be given for sound attenuation and tubing reliability. Unlike a hermetic reciprocating compressor, the scroll motor is pressed into the shell and not internally sprung. Some tubing geometry or "shock loop" may be required to reduce start-up vibration transferred from the compressor to external tubing.

Starting Characteristics

No start assist devices are required, even in systems utilizing non-bleed expansion valves. Due to in-

herent scroll design, internal compression components always start unloaded even if system pressures are not balanced. Since internal compressor pressures are always balanced at startup, scrolls exhibit excellent low voltage starting characteristics.

Fusite

Fusite pin orientation for single phase and three phase Glacier scroll compressors are shown in Figure 3 and inside the terminal box. Screw terminals are also available as an option.

Deep Vacuum Operation

If the suction side of the compressor is closed or severely restricted, arcing damage to the Fusite pins may result. Glacier models require a low pressure control for deep vacuum protection.

Scroll compressors (as with any refrigerant compressor) should never be used to evacuate a refrigeration or air conditioning system. (See Application Engineering Bulletin AE24-1105 for proper system evacuation procedures.)

Nomenclature

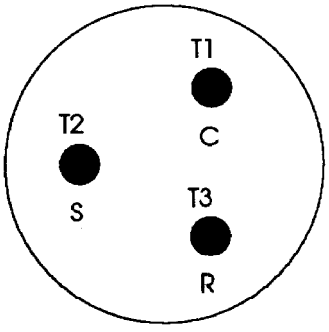
The Glacier scroll model numbers include the nominal capacity at standard operating conditions. Please refer to the product literature for model number details.

Shell Temperature

System component failure, may cause the top shell and discharge line to briefly reach temperatures above 350°F as the compressor cycles on its internal protection devices. Wiring or other materials which could be damaged by these temperatures should not come in contact with the shell.

IPR Valve

Refrigeration scroll compressors have internal pressure relief valves which open at a discharge to suction differential pressure of 375 to 450 psi.



Motor Terminal (Fusite) Connections For Single Phase And Three Phase Scrolls

Figure 3

Shutoff Sound

Since the scroll compressor is an excellent gas expander, it may run backwards for a brief period at shutoff as the internal pressures equalize. A low mass disc type check valve in the compressor discharge tube prevents it from running backwards for more than a second or two. This momentary reversal of scroll direction has no effect on compressor durability. Development testing should include a review of the shutoff sound for acceptability in a particular system.

Suction Tubes

Scroll compressors have copper plated steel suction tubes. These tubes are more rugged 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. See Figure 4 for assembly line and field brazing procedures suggestions.

Three Phase Scroll Compressors

Scroll compressors are directional dependent, i.e., they will only compress in one rotational direction. Single phase compressors 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 on power phasing. Since there is a 50-50 chance of connecting power causing reverse rotation, it is important to include notices and instructions in appropriate locations on the equipment to ensure proper rotational direction is achieved when the system is installed and operated. Verification of proper rotational direction is made by observing that suction pressure drops and discharge pressure rises when the compressor is energized. Reverse rotation also results in an elevated sound level over correct rotation, as well as substantially reduced current draw compared to tabulated values.

Durability is not effected by reversed rotation. After several minutes of operation the compressor’s internal protector will trip.

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

Brief Power Interruptions

Brief power interruptions (less than 1/2 second) may result in powered reverse rotation of single phase Glacier scroll compressors. High pressure discharge gas expands backwards through the scrolls at power interruption, causing the scroll to orbit in the reverse direction. When the power is applied while reverse

rotation is occurring, the compressor may continue to run noisily 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 noise and loss of space temperature from single phase powered reverse rotation, Copeland strongly encourages use of an electronic control which can sense brief power interruptions and lock the compressor out of operation for two minutes. This control could be incorporated in other system controls (such as defrost or thermostat), or be a stand alone control. Functional specifications for this control as well as suggested wiring diagram are shown in Figure 5.

No time delay is required on three phase models to prevent reverse rotation due to power interruptions.

Assembly Line System Charging Procedure

Rapid charging only on the suction side of a scroll system or condensing unit can occasionally result in a temporary no-start condition for the compressor. If the flanks of the compressor happen to be in a sealed position, rapid pressurization of the low side without opposing high side pressure can cause the scrolls to seal axially. Until the pressures eventually equalize, the Scrolls can be held tightly together, preventing rotation. The best way to avoid this situation is to charge on both the high and low side simultaneously at a rate which does not result in axial loading of the Scrolls. The maximum charging rate can be determined through simple tests.

Unbrazing System Components

If the refrigerant charge is removed from a scroll 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 then applied to the low side, the pressurized refrigerant and oil mixture could ignite when it escapes and contacts the brazing flame. It is important to check both the high and low side with manifold gauges before unbrazing, or in the case of assembly line repair, remove refrigerant from both the high and low side. Instructions should be provided in appropriate product literature and assembly (line repair) areas.

HiPot Testing

Compliant Scroll compressors are configured with the motor in the bottom of the shell. Unlike other hermetic compressors, the scroll motor can be immersed in refrigerant when liquid is present in the shell. In this respect, the scroll is more like semi-hermetic compressors which have horizontal motors partially submerged in oil and refrigerant. HiPot tested with liquid refrigerant in the shell can show higher levels of current leakage due to higher electrical conductivity of liquid refrigerant verses refrigerant vapor and oil. This phenomenon can occur with any compressor when the motor is immersed in refrigerant and does not present any safety issue. To lower the current leakage reading operate the system for a brief period of time, redistributing the refrigerant to a more normal configuration, and test again.

Compliant Scroll Functional Check

Glacier scroll compressors do not have internal suction valves. It is not necessary to perform functional compressor tests to check how low the compressor will pull suction pressure. This type of test may damage a Scroll compressor. The following diagnostic procedure should be used to evaluate whether a Compliant Scroll compressor is functioning properly.

1. Verify proper unit voltage.

2. Normal motor winding continuity and short to ground checks will determine if the inherent overload motor protector has opened or if an internal short to ground has developed. If the protector has opened, the compressor must cool sufficiently to reset.

3. 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.

4. **Single Phase Compressors**

   If suction pressure does not drop and discharge pressure does not rise to normal levels the compressor is faulty.

   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 the compressor is faulty.

5. The compressor current draw must be compared to published compressor performance curves at the compressor operating conditions (pressures and voltages). Significant deviations (±15%) from published values may indicate a faulty compressor.

Lubricant
Table 1
Field Recharge Values EAL ARCTIC 22 CC

Compressor Model Number	Oil Recharge (Fl. Ounces)	Factory Oil Charge
ZS30K* -PFV	48	52
ZF13K* -TF5	48	52
ZF13K* -TFD	48	52
ZB30K* -TFE	48	52
ZS38K* -PFV	60	64
ZF15K* -TF5	60	64
ZF15K* -TFD	60	64
ZB38K* -TFE	60	64

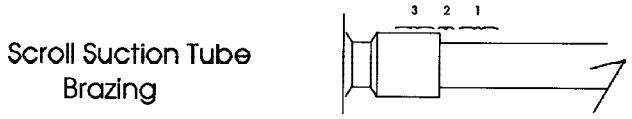


Figure 4

New Installation

- The copper-coated steel suction tube on scroll compressors can be brazed in approximately the same manner as any copper tube.
- Recommended brazing material: Any silfos material is recommended, preferable 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.
- 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 tub 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: Heat joint Areas 2 and 3 slowly and uniformly until braze material softens and tube can be pulled out of suction fitting.
- To reconnect:
- Recommended brazing materials: Silfos with minimum 5% silver or silver braze material with flux.
- Reinsert tube into fitting.
- Heat tube uniformly in Area 1, moving slowly to Area 2. When joint reaches brazing temperature, apply brazing material.
- Heat joint uniformly around the circumference to flow braze material completely around the joint.
- Slowly move torch into Area 3 to draw braze material into the joint.
- Do not overheat joint.

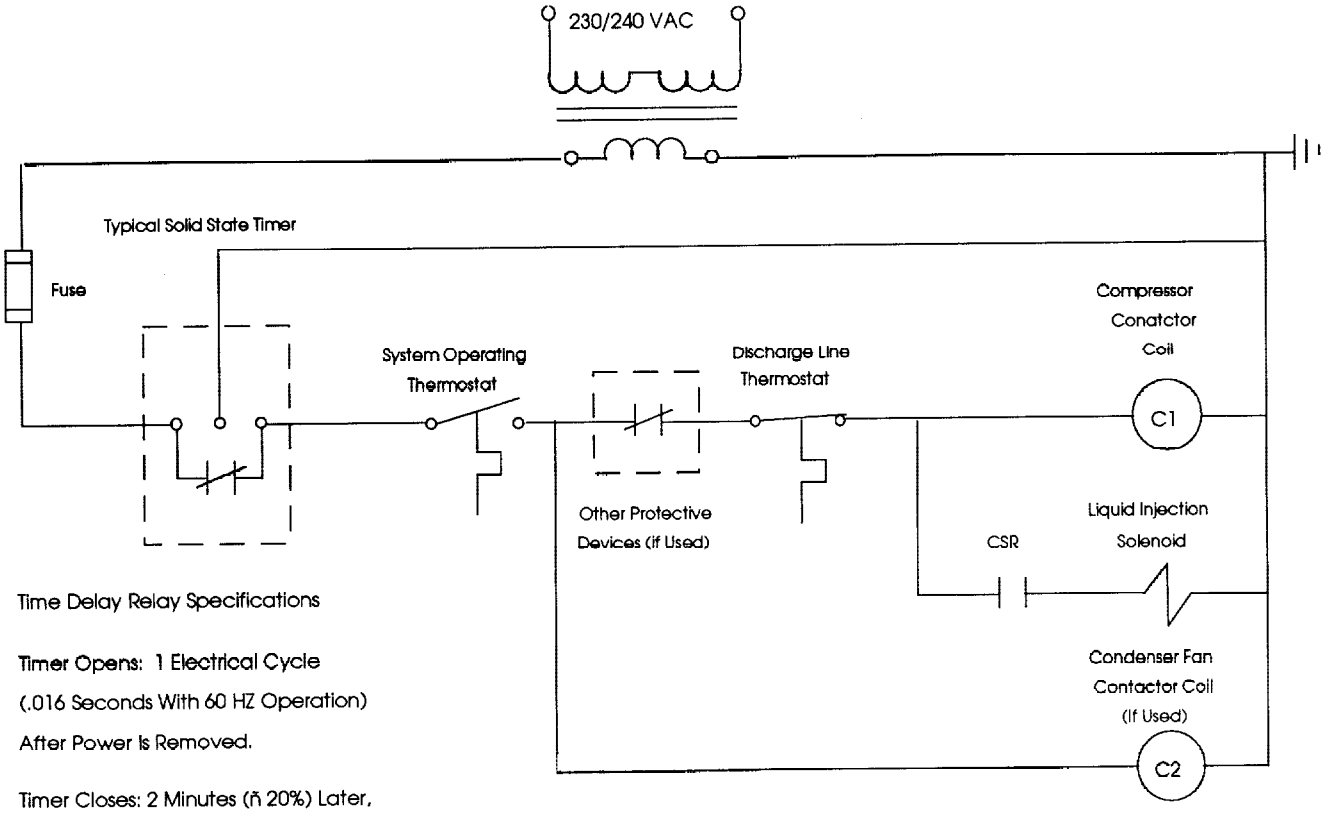

230/240 VAC
Typical Solid State Timer
Fuse
System Operating
Thermostat
Discharge Line
Thermostat
Compressor
Conatctor
Coil
C1
Other Protective
Devices (if Used)
CSR
Liquid Injection
Solenoid
Condenser Fan
Contactor Coil
(If Used)
C2
Time Delay Relay Specifications
Timer Opens: 1 Electrical Cycle
(.016 Seconds With 60 HZ Operation)
After Power Is Removed.
Timer Closes: 2 Minutes (ñ 20%) Later,
Whether Power is Restored Or Not.
CSR = Current sensing Relay
Contact

Figure 5