AE4-1318

# APPLICATION GUIDELINES FOR ZB*KC/ZB*KCE REFRIGERATION SCROLL COMPRESSORS 7 TO 15 HP

December, 2003

## Introduction

The Copeland Refrigeration Scroll ZB*KC/ZB*KCE product offering has expanded to include higher horsepower models. These new models include 7-15 Hp and produce between 50,000 Btu/H and 110,000 Btu/H at 20/120°F using 60 Hz electrical power. This bulletin covers the application parameters recommended for operating these compressors properly.

## Nomenclature

The ZB*KC/ZB*KCE refrigeration scroll model number includes two digits that indicate the amount of cooling capacity in thousands of Btu/H at the 60 Hz ARI rating point (20/120°F) in the third and fourth location. (e.g. ZB92KC produces approximately 92,000 Btu/H). For actual compressor performance information please visit "On-Line Product Information" at www.copeland-corp.com.

## Operating Envelope

The Copeland Refrigeration Scroll models can be used with a variety of refrigerants. **Table 1** shows these selection options.

The operating envelopes are depicted in **Figures1A, 1B, and 1C**.

**TABLE 1**

| Model | Refrigerant | Lubricant |
|---|---|---|
| ZB50KC/E | R22/R407C/R404A/R507/R134a | MO/POE |
| ZB58KC/E | R22/R407C/R404A/R507/R134a | MO/POE |
| ZB66KC/E | R22/R407C/R404A/R507/R134a | MO/POE |
| ZB76KC/E | R22/R407C/R404A/R507/R134a | MO/POE |
| ZB88KC | R22 | MO |
| ZB56KC/E | R22/R404A/R507/R134a | MO/POE |
| ZB75KC/E | R22/R404A/R507/R134a | MO/POE |
| ZB92KC/E | R22/R404A/R507/R134a | MO/POE |
| ZB11MC/E | R22/R404A/R507/R134a | MO/POE |

**FIGURE 1A**
**ZB*KCE APPLICATION ENVELOPE FOR R404A/R507 7-15HP**

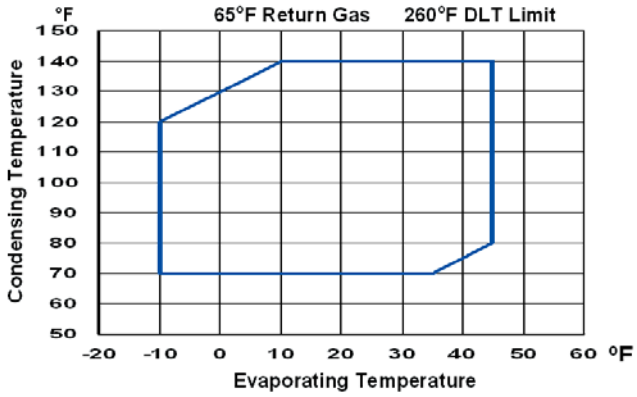



**FIGURE 1B**
**ZB*KC APPLICATION ENVELOPE FOR R22 7-15HP**

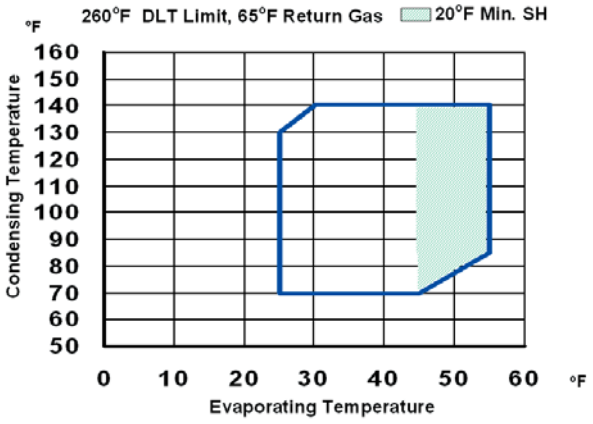
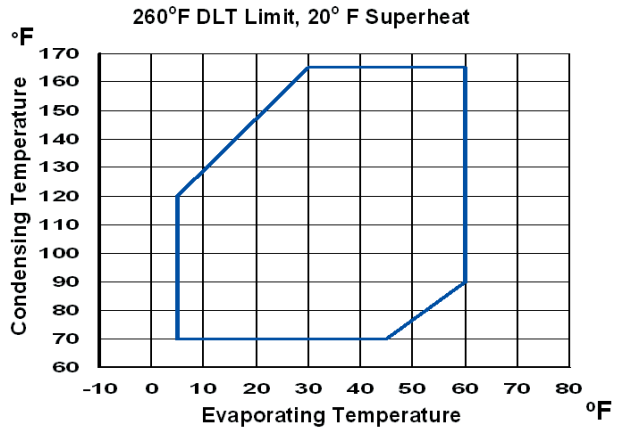


**FIGURE 1C**
**ZB*KCE APPLICATION ENVELOPE FOR R134A**
**7-15HP**




## Compressor Lubrication

The compressors can be used with different lubricants depending upon the refrigerant used. See Application Engineering Bulletin 17-1248 for a complete list of all Copeland approved lubricants.

## Accumulators

Due to the inherent ability of scroll compressors to handle liquid refrigerant in flooded start and defrost cycle operation conditions, accumulators may not be required. An accumulator is required on single compressor systems when the charge limitations exceed those values listed in **Table 2**. On systems with defrost schemes or transient operations that allow prolonged uncontrolled liquid return to the compressor, an accumulator is required unless a suction header of sufficient volume to prevent liquid migration to the compressors is used. Excessive liquid floodback or repeated flooded starts will dilute the oil in the compressor causing inadequate lubrication and bearing wear. Proper system design will minimize liquid floodback, thereby ensuring maximum compressor life.

**TABLE 2**
**CHARGE LIMITS**

| Model Family | Charg. Lmts. |
|---|---|
| ZB50, 58, 66, 76, 88 KC/E | 16 lbs |
| ZB56,75,92KC/E & ZB11MC/E | 17 lbs |

If an accumulator must be used, an oil return orifice size in the range of 0.040 - 0.075 inches (1 - 1.9 mm) is recommended. 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 with system debris. Tests have shown that a small screen with a fine mesh can easily become plugged causing oil starvation to the compressor bearings.

## Screens

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

## Crankcase Heater

Crankcase heaters are required on systems when the system charge exceeds the recommended charge limit. See **Table 2**.

**TABLE 3**
**CRANKCASE HEATERS**

| Model | Part No. | Volts | Watts | Leads |
|---|---|---|---|---|
| ZB50, ZB58, | 018-0047-00 | 120 | 90 | 48" |
| ZB66, ZB76, | 018-0047-01 | 240 | 90 | 48" |
| ZB88 | 018-0047-02 | 480 | 90 | 48" |
| | 018-0047-03 | 575 | 90 | 48" |
| | 018-0036-00 | 240 | 70 | 26" |
| | 018-0036-01 | 120 | 70 | 26" |
| ZB56, | 018-0036-02 | 480 | 70 | 26" |
| ZB75, ZB92, | 018-0036-03 | 575 | 60 | 26" |
| ZB11M | 018-0036-04 | 240 | 70 | 34" |
| | 018-0036-05 | 480 | 70 | 34" |
| | 018-0036-06 | 575 | 60 | 34" |

The listed crankcase heaters **(Table 3)** are intended for use only when there is limited access. The heaters are not equipped for use with electrical conduit. Where applicable, electric safety codes require heater lead protection, a crankcase heater terminal box should be used. Recommended crankcase heater terminal cover and box numbers are listed in **Table 3A**. If there are any questions concerning the application, contact the Copeland Application Engineering department.

**TABLE 3A**
**CONDUIT READY HEATER BOX KITS**

| Model Number | Kit Number |
|---|---|
| ZB50, ZB58, ZB66 ZB76, ZB88 | 998-7029-00 |
| ZB56, ZB75 ZB92, ZB11M | 998-7015-00 |

## Discharge Line Thermostat

The thermostats have a cut out setting that will insure discharge line temperatures remain below the 260°F maximum limit. It should be installed approximately 7 inches from the discharge tube outlet. If a service valve is installed at the discharge tube, the thermostat should be located 5 inches from the valve braze.

Kits have been set up to include the thermostat, retainer, and installation instructions. These thermostats must be used with 7/8" O.D. discharge lines to ensure proper thermal transfer and temperature control. They work with either 120 or 240-volt control circuits, and are available with or without conduit ready connections. See **Table 4** for a list of discharge line thermostat kit numbers.

**TABLE 4**

| Model | Discharge T-Stat | T-Stat Kit Number | Conduit Ready |
|---|---|---|---|
| ZB50<br>ZB58<br>ZB76<br>ZB88 | Thermostat Required | 998-0540-03<br>998-7022-05 | No<br>Yes |
| ZB56<br>ZB75<br>ZB92<br>ZB11M | Internal Discharge Temperature Protection Provided No thermostat required | | |

## Pressure Controls

Both high and low pressure controls are required and the following are the minimum and maximum set points. Refer to **Table 5** for proper settings.

**TABLE 5**
**PRESSURE CONTROL SETTINGS**

| Model | Control Type | R404A/R507 | R134a | R22 |
|---|---|---|---|---|
| ZB50, ZB58, ZB66, ZB76 | Low<br>High | 17 psig min.<br>454 psig max. | 4 psig min.<br>263 psig max | 37 psig min.<br>381 psig max |
| ZB88 | Low<br>High | N/A<br>N/A | N/A<br>N/A | 37 psig min.<br>381 psig max |
| ZB56, ZB75, ZB92, ZB11M | Low<br>High | 17 psig min.<br>454 psig max. | 4 psig min.<br>263 psig max | 37 psig min.<br>381 psig max |

## IPR Valve

The 7.5 through 15 horsepower refrigeration scroll compressors DO NOT have an internal high pressure relief valve. To provide safe operation, a high pressure control set no higher than 445 psig must be used in all applications (reference **Table 5**).

## Motor Protection

The larger horsepower refrigeration scroll compressors have either line break protection or the use of sensors with an electronic module. The type of protection is obtained from the protector code in the model number. **Table 6** lists the various models protector number and the type of protection.

**TABLE 6**
**MOTOR PROTECTION**

| | |
|---|---|
| Models with Line Break Protection ZB50, ZB58, ZB66, ZB76, ZB88 (note: electric code = TF*) | No Module |
| Models with Electronic Module ZB56, ZB75, ZB92, ZB11M (note: electric code = TW*) | P/N: 071-0547-01 |

For the electronic motor protection there are five PTC (positive temperature coefficient) internal thermisters connected in series that react with avalanche resistance in the event of high temperatures. Four of the thermisters are used to sense motor temperatures and the fifth is used as a discharge temperature sensor. The thermister circuit is connected to the protector module terminals S1 and S2.

When any thermister reaches a limiting value, the module interrupts the control circuit and shuts off the compressor. After the thermister has cooled sufficiently, the resistance will decrease, thus allowing the module to reset. However, the module has a 30-minute time delay before reset after a thermister trip.

For all other compressors, conventional internal line break motor protection is provided.

**Programmable Logic Controller Requirements**

If the INT69SCY (071-0547-00) module is applied in conjunction with a Programmable Logic Controller, it is important that a minimum load is carried through the M1-M2 control circuit contacts.

The minimum required current through the module relay contacts needs to be **greater than 100 milliamps but not to exceed 5 amps**. If this minimum current is not maintained, this has a detrimental effect upon the long-term contact resistance of the relay and may result in false compressor trips.

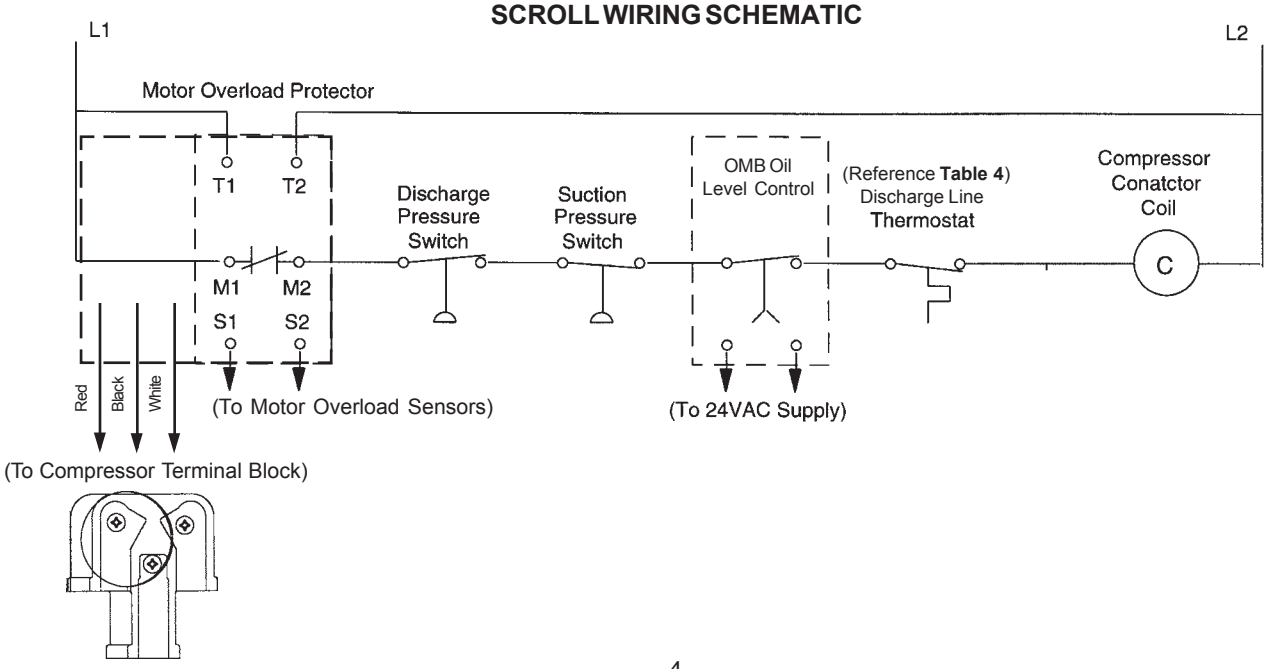
PLC operated control circuits may not always provide this minimum current. In these cases modifications to the PLC control circuit are required. Consult your application engineering department for details.

**Phase Protection**

The INT69-SCY module provides phase protection for the compressor. The module senses the correct phase sequence, phase loss and voltage sag for each leg (L1, L2 and L3) of the incoming power supplied to the compressor. At installation the three phases of the power supply must be wired in the correct 120° phase sequence. This will ensure the compressor will start and operate in the correct clockwise direction.

The INT69-SCY module trips (M1-M2 contacts open) when the module senses a phase loss. There is a 5 minute time delay before the module attempts a restart. If all three phases are present, then the module will reset (M1-M2 contacts will close) and

**FIGURE 2**
**SCROLL WIRING SCHEMATIC**



the compressor will start and run. If not, the module will attempt a restart after another 5 minute time delay. After 10 failed attempts to restart, the module will lock-out (M1-M2 contacts will remain open) and can only be reset by removing the power from T1-T2 for a minimum of 5 seconds.

The INT69SCY is intended to protect the compressor. The L1/L2/L3 and S1/S2 leads are pre-wired on the compressor and are engineered to work in conjunction with the motor protector module. The module leads should not be moved or extended because of the possibility of inducing electronic noise into the INT69SCY, which could cause false trips of the module.

### Module and Sensor Functional Check

The following field troubleshooting procedure can be used to evaluate the solid state control circuit: Refer to **Table 7** for a technical data summary.

### Module Voltage Supply Troubleshooting

- Verify that all wire connectors are maintaining a good mechanical connection. Replace any connectors that are loose.
- Measure the voltage across T1-T2 to ensure proper supply voltage.
- Determine the control voltage by using a voltmeter and then measure the voltage across the M1-M2 contacts:
  a) If the measured voltage is equal to the control volts then the M1-M2 contacts are open.
  b) If the measurement is less than 1 volt and the compressor is not running, then the problem is external to the INT69-SCY module.
  c) If the voltage is greater than 1 volt but less than the control voltage, the module is faulty and should be replaced.

### Sensor Troubleshooting

- Remove the leads from S1-S2, and then by using an ohmmeter measure the resistance of the incoming leads.
  **CAUTION: Use an Ohmmeter with a maximum of 9 VDC for checking – do not attempt to check continuity through the sensors with any other type of instrument. Any external voltage or current may cause damage requiring compressor replacement.**

**TABLE 7**

| Copeland P/N | 071-0520-07 | 071-0520-05 | 071-0547-01 |
|---|---|---|---|
| Manufacture P/N | T.I. 30AA201E | Kriwan 69SC-DV | Kriwan 69SCY |
| **T1-T2 Module Power** | | | |
| Voltage Supply | 120V & 240V | 120V & 240V | 120V & 240V |
| Frequency | 50Hz 60 Hz | 50Hz 60 Hz | 50Hz 60 Hz |
| **M1-M2 Module Output Contacts** | | | |
| Maximum Voltage | N/A | 250VAC | 250VAC |
| Maximum Current | 5 Amps | 5 Amps | 5 Amps |
| Minimum Current | 100 milliamps | 100 milliamps | 100 milliamps |
| Relay Output | 2.5 A, 600 V | 5 A, 300 VA | 5 A, 300 VA |
| Power Output | < 5.5 VA | < 3 VA | < 3 VA |
| **S1-S2 Thermal Protection** | | | |
| Trip Out Resistance | N/A | 4500Ω ± 20% | 4500Ω ± 20% |
| Reset Resistance | N/A | 2750Ω ± 20% | 2750Ω ± 20% |
| Reset Time | 30 min ± 5 min. | 30 min ± 5 min. | 30 min ± 5 min. |
| Manual Reset | T1-T2 interrupt for minimum of 5 sec | T1-T2 interrupt for minimum of 5 sec | T1-T2 interrupt for minimum of 5 sec |
| **L1-L2-L3 Phase Monitoring** | | | |
| Phase Sensor | Non Phase Sensing | Non Phase Sensing | 3 |
| Phase Monitoring Circuit Rating | Non Phase Sensing | Non Phase Sensing | 3 AC 50/60Hz 120V to 632V |
| Trip Delay | Non Phase Sensing | Non Phase Sensing | 5 min delay before restart attempt |
| Lockout | Non Phase Sensing | Non Phase Sensing | After 10 module trips |
| Reset for Lockout | Non Phase Sensing | Non Phase Sensing | T1-T2 interrupt for minimum of 5 sec |

a) During normal operation, this resistance value should read less than 4500 ohms ±20%.
b) If the M1-M2 contacts are open, the measured S1-S2 value is above 2750 ohms ±20% and the compressor has been tripped less then 30 minutes then the module is functioning properly.

- If the S1-S2 wire leads read less than 2750 ohms ±20% and the M1-M2 contacts are open, reset the module by removing the power to T1-T2 for a minimum of 5 seconds.
- Replace all wire leads and use a voltmeter to verify the M1-M2 contacts are closed.
- If the M1-M2 contacts remain open and S1-S2 are less than 2500 ohms, remove leads from the M1-M2 contacts and jumper together; **CAUTION: Compressor should start at this time. HOWEVER DO NOT LEAVE JUMPER IN PLACE FOR NORMAL SYSTEM OPERATIONS. THE JUMPER IS USED FOR DIAGNOSTIC PURPOSES ONLY.**
- Go to Compressor Supply Voltage Troubleshooting.

**Compressor Voltage Supply Troubleshooting**

- Remove phase sensing leads from the module from L1/L2/L3.
- Use a voltmeter to measure the incoming 3 phase voltage on L1/L2/L3. **WARNING: L1/L2/L3 could be at a potential up to 600VAC**.
- Ensure proper voltage on each phase.
- Remove power to the module for a minimum of 5 seconds to reset and replace all wire leads. Re-energize the module. If the M1-M2 contacts are open with proper voltage to T1-T2, L1/L2/L3 and proper resistance to S1-S2 then the module is faulty and should be replaced.

**Oil Type**

Polyol ester lubricant (POE) must be provided if the Copeland refrigeration scroll is used with HFC refrigerants.

Copeland refrigeration scrolls intended for use with R22 are supplied with mineral oil.

Reference **Table 7** for proper oil charge.

**TABLE 7**
**COMPRESSOR OIL CHARGE**

| Model | Initial | Recharge |
|---|---|---|
| ZB50 | 85 | 81 |
| ZB58 | 85 | 81 |
| ZB66 | 110 | 106 |
| ZB76 | 110 | 106 |
| ZB88 | 110 | 106 |
| ZB56 | 140 | 137 |
| ZB75 | 140 | 137 |
| ZB92 | 140 | 137 |
| ZB11M | 140 | 137 |

See Application Engineering Bulletin 17-1248 for a complete list of all Copeland approved lubricants.

**Oil Management for Rack Applications**

Copeland Refrigeration Scrolls 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. The sight glass connection supplied can accommodate the mounting of the oil control devices.

Unlike Semi-Hermetic compressors, Scrolls do not have an oil pump with accompanying oil pressure safety controls. Therefore, an external oil level control is required.

The OMB Oil Level Management Control combines the functions of level control and timed compressor shut-off should the level not come back to normal within a set period of time. This device has been found to provide excellent performance in field tests on Scroll compressors and is recommended for parallel system applications.

**Note: Due to issues that have been experienced with the Trax Oil level control, Copeland recommends that OEM's not use the Trax Oil on future new scroll compressor rack applications. We may consider denial of warranty for lubrication related failures when the Trax Oil control is used on new systems in the future.**

Immediately after system start-up the oil reservoir level will fluctuate until equilibrium is reached. It is

advisable to monitor the oil level during this time to assure sufficient oil is available. This will prevent unnecessary trips of the oil control system.

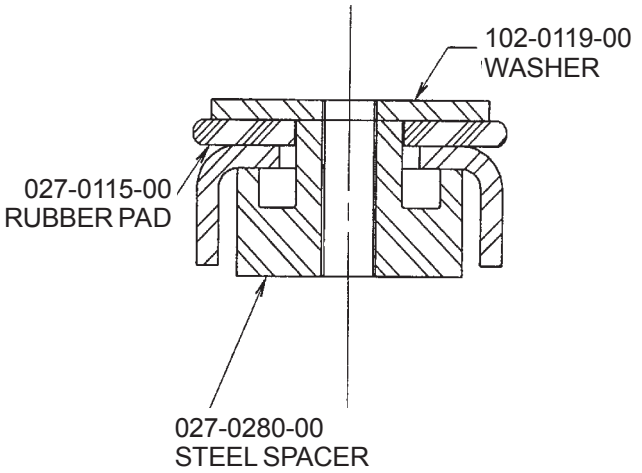
***Note: If oil management problems are occuring please refer to AE 17-1320 or contact the Copeland Application Engineering Department.***

*Note: ZB50, 58, 66, 76, 88 are not approved for rack applications due to compressor limitations*.

### Compressor Mounting

Compressor mounting must be selected based on application. Consideration must be given to sound reduction tubing reliability. Some tubing geometry

**FIGURE 3**
**7.5 - 15 HP RACK MOUNTING**




KIT #527-0158-00

or "shock loops" may be required to reduce vibration transferred from the compressor to external tubing.

### Mounting for Rack Systems

Specially designed steel spacers and rubber isolator pads are available for Copeland Refrigeration Scroll 7.5-15 HP scroll rack applications. This mounting arrangement limits the compressors motion thereby minimizing potential problems of excessive tubing stress. Sufficient isolation is provided to prevent vibration from being transmitted to the mounting structure. This mounting arrangement is recommended for multiple compressor rack installations. See **Figure 3** for a detail for this mounting system.

**TABLE 8**

| Model | Rotalock Spud Connection | | Stub Connection | |
|---|---|---|---|---|
| | Suction | Discharge | Suction | Discharge |
| ZB50 | 1-3/4 - 12 | 1-1/4 - 12 | 1-1/8" | 7/8" |
| ZB58 | 1-3/4 - 12 | 1-1/4 - 12 | 1-1/8" | 7/8" |
| ZB66 | 1-3/4 - 12 | 1-1/4 - 12 | 1-3/8" | 7/8" |
| ZB76 | 1-3/4 - 12 | 1-1/4 - 12 | 1-3/8" | 7/8" |
| ZB88 | 1-3/4 - 12 | 1-1/4 - 12 | 1-3/8" | 7/8" |
| ZB56 | 1-3/4 - 12 | 1-1/4 - 12 | not offered | |
| ZB75 | 1-3/4 - 12 | 1-1/4 - 12 | not offered | |
| ZB92 | 1-3/4 - 12 | 1-1/4 - 12 | not offered | |
| ZB11M | 2-1/4 - 12 | 1-3/4 -12 | not offered | |

*Note: The use of standard soft grommets is not recommended for Copeland Refrigeration Scroll rack installations. These "softer" mounts allow for excessive movement that will result in tube breakage unless the entire system is properly designed.*

### Connection Fittings

There are various connection fittings available for Copeland Refrigeration Scroll compressors. The various options are shown in **Table 8**.

### Three Phase Scroll Compressors – Directional Dependents

Scroll compressors are directional dependent; i.e. they will compress in one rotational direction only. Three phase Scrolls will rotate in either direction depending on power phasing. Since there is a 50/50 chance of connected power being "backwards", contractors should be warned of this. Appropriate instructions or notices should be provided by the OEM. To eliminate the possibility of reverse rotation a Copeland Phase Control line monitor, P/N 085-0160-00, or other phase monitor is recommended.

Verification of proper rotation can be made by observing that the suction pressure drops and the discharge pressure rises when the compressor is energized. Additionally, if operated in reverse the compressor is noisier and its current draw is substantially reduced compared to tabulated values.

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

**Deep Vacuum Operation**

***WARNING: Do not run a Copeland Refrigeration Scroll compressor in a deep vacuum. Failure to heed this advice can result in arcing of the Fusite pins and permanent damage to the compressor.***

A low pressure control is required for protection against deep vacuum operation. See Pressure Control section for proper set points.

Scroll compressors (as with any refrigerant compressor) should never be used to evacuate a refrigeration or air conditioning system. See Application Engineering Bulleting AE 24-1105 for proper system evacuation procedures.

**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 as it escapes and contacts the brazing flame. It is important to check both the high and low sides with manifold gauges before unbrazing or in the case of assembly line repair, remove refrigerant from both the high and low sides. Instructions should be provided in appropriate product literature and assembly (line repair) areas.

**Hi-Pot Testing**

Compliant Scroll compressors are configured with the motor in the bottom of the shell. Unlike most other hermetic compressors, the Scroll motor can be immersed in refrigerant when liquid is present in the shell. Hi-Pot test with liquid refrigerant in the shell can show higher levels of current leakage due to higher electrical conductivity of liquid refrigerant vs. 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 in a more normal configuration and test again.

***Note: The solid state electronic module components and internal sensors are delicate and can be damaged by exposure to high voltage. Under no circumstances should a high potential test be made at the sensor terminals or sensor leads connected to the module. Damage to the sensors or module may result.***