

Application Engineering

1.5 to 2 Ton ZP*KA R-410A Copeland Scroll Compressors for Air Conditioning

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Safety

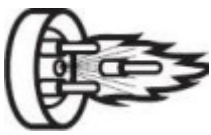
Important Safety Information

Those involved in the design, manufacture, and installation of a system, system purchasers, and service personnel may need to be aware of hazards and precautions discussed in this section and throughout this document. OEMs integrating the compressor into a system should ensure that their own employees follow this bulletin and provide any necessary safety information to those involved in manufacturing, installing, purchasing, and servicing the system.

Responsibilities, Qualifications and Training

- OEMs are responsible for system design, selection of appropriate components, integration of this component into the system, and testing the system. OEMs must ensure that staff involved in these activities are competent and qualified.
- OEMs are also responsible for ensuring that all product, service, and cautionary labels remain visible or are appropriately added in a conspicuous location on the system to ensure they are clear to any personnel involved in the installation, commissioning, troubleshooting or maintenance of this equipment.
- Only qualified and authorized HVAC or refrigeration personnel are permitted to install, commission, troubleshoot and maintain this equipment. Electrical connections must be made by qualified electrical personnel.
- Observe all applicable standards and codes for installing, servicing, and maintaining electrical and refrigeration equipment.

Terminal Venting and Other Pressurized System Hazards



If a compressor's electrical terminal pin loses its seal, pressurized oil, refrigerant, and debris may spray out. This is called "terminal venting".

The ejected debris, oil, and refrigerant can injure people or damage property. The oil and refrigerant spray can be ignited by electrical arcing at the terminal or any nearby ignition source, producing flames that may project a significant distance from the compressor. The distance depends on the pressure and the amount of refrigerant and oil mixture in the system. The flames can cause serious or fatal burns and ignite nearby materials.

Each compressor has a terminal cover or molded plug that covers electrical connections. The cover or plug helps to protect against electric shock and the risks of terminal venting. If terminal venting occurs, the cover or plug helps contain the spray of refrigerant and oil and reduces the risk of ignition. If ignition occurs, the plug or cover helps contain the flames. However, neither the terminal cover nor the molded plug can completely eliminate the risk of venting, ignition, or electric shock.

See [copeland.com/terminal-venting](https://www.copeland.com/terminal-venting) for more details about terminal venting. Additionally, a compressor's refrigerant lines keep refrigerant and oil under pressure. When removing or recharging refrigerant from this component during service, this can pose a pressurized fluid hazard.

Flammable Refrigerant Hazards



If flammable refrigerant is released from a system, an explosive concentration can be present in the air near the system. If there is an ignition source nearby, a release of flammable refrigerant can result in a fire or explosion. While systems using flammable refrigerant are designed to mitigate the risk of ignition if the refrigerant is released, fire and explosion can still occur.

See copeland.com/flammable-refrigerants for more information on flammable refrigerant safety.

Electrical Hazards



Until a system is de-energized, and capacitors have been discharged, the system presents a risk of electric shock.

Hot Surface and Fire Hazards



While the system is energized, and for some time after it is deenergized, the compressor may be hot. Touching the compressor before it has cooled can result in severe burns. When brazing system components during service, the flames can cause severe burns and ignite nearby combustible materials.

Lifting Hazards



Certain system components may be very heavy. Improperly lifting system components or the compressor can result in serious personal injury. Use proper lifting techniques when moving.

POE Oil Hazards

This equipment contains polyol ester (POE) oils. Certain polymers (e.g., PVC/CPVC and polycarbonate) can be harmed if they come into contact with POE oils. If POE oil contacts bare skin, it may cause an allergic skin reaction.

Precautions

- Always wear personal protective equipment (gloves, eye protection, etc.).
- Keep a fire extinguisher at the jobsite at all times.
- Keep clear of the compressor when power is applied.
- **IMMEDIATELY GET AWAY if you hear unusual sounds in the compressor. They can indicate that terminal pin ejection may be imminent. This may sound like electrical arcing (sizzling, sputtering or popping). However, terminal venting may still occur even if you do not hear any unusual sounds.**

- Never reset a breaker or replace a blown fuse without performing appropriate electrical testing
 - **A tripped breaker or blown fuse may indicate an electrical fault in the compressor. Energizing a compressor with an electrical fault can cause terminal venting. Perform checks to rule out an electrical fault.**
- Disconnect power and use lock-out/tag-out procedures before servicing.
 - Before removing the terminal cover or molded plug, check that ALL electrical power is disconnected from the unit. Make sure that all power legs are open. (Note: The system may have more than one power supply.)
 - Discharge capacitors for a minimum of two minutes
 - Always use control of hazardous energy (lock-out/tag-out) procedures to ensure that power is not reconnected while the unit is being serviced.
- Allow time for the compressor to cool before servicing.
 - Ensure that materials and wiring do not touch high temperature areas of the compressor.
- Keep all non-essential personnel away from the compressor during service.
- For A3 refrigerants (R290) remove refrigerant from both the high and low sides of the compressor. Use a recovery machine and cylinder designed for flammable refrigerants. Do not use standard recovery machines because they contain sources of ignition such as switches, high- and low-pressure controls and relays. Only vent the R290 refrigerant into the atmosphere if the system is in a well-ventilated area.
- Never use a torch to remove the compressor. Only tubing cutters should be used for both A2L and A3 refrigerants.
- Use an appropriate lifting device to install or remove the compressor.
- Never install a system and leave it unattended when it has no charge, a holding charge, or with the service valves closed without electrically locking out the system.
- Always wear appropriate safety glasses and gloves when brazing or unbrazing system components.
- Charge the system with only approved refrigerants and refrigeration oils.
- Keep POE oils away from certain polymers (e.g., PVC/CPVC and polycarbonate) and any other surface or material that might be harmed by POE oils. Proper protective equipment (gloves, eye protection, etc.) must be used when handling POE lubricant. Handle POE oil with care. Refer to the Safety Data Sheet (SDS) for further details.
- Before energizing the system:
 1. Securely fasten the protective terminal cover or molded plug to the compressor, and
 2. Check that the compressor is properly grounded per the applicable system and compressor requirements.

Signal Word Definitions

The signal word explained below are used throughout the document to indicate safety messages.



DANGER indicates a hazardous situation which, if not avoided, will result in death or serious injury.



WARNING indicates a hazardous situation which, if not avoided, could result in death or serious injury.



CAUTION, used with the safety alert symbol, indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

Introduction

The ZP*KA family of compressors is designed for small tonnage air conditioning applications. The ZP*KA compressors have optimized compression, bearing, and motor components for competitive cost and performance advantages for small tonnage cooling applications. This bulletin describes the operating characteristics, design features, and application requirements for the ZP*KA Copeland Scroll compressor family.

For additional information, please refer to our Online Product Information, accessible from the Copeland website at www.Copeland.com. Operating principles of the Copeland Scroll compressor are described in Figure 1. The ZP*KA family includes the features outlined in the matrix below.

Nomenclature

The model numbers of Copeland Scroll compressors include the approximate nominal 60 Hz capacity at standard operating conditions. An example would be the ZP20KAE-PFV, which has approximately 20,000 Btu/hr (5.7kW) cooling capacity at the AHRI high temperature air conditioning rating point when operated at 60 Hz.

APPLICATION CONSIDERATIONS

The following application guidelines should be considered in the design of a system using ZP*KA scroll compressors. Some of this information is recommended, whereas other guidelines must be followed. The Application Engineering department will always welcome suggestions that will help improve these types of documents.

Internal Pressure Relief (IPR) Valve

The internal pressure relief valve is located between the high and low side of the compressor. It is designed to open when the discharge-to-suction pressure differential exceeds 575 to 625 psid (38-43 bar). When the valve opens, hot discharge gas is routed back into the area of the motor protector to cause a trip. During fan failure

testing, system behavior and operating pressures will depend on the type of refrigerant metering device. Fixed orifice devices may flood the compressor with refrigerant, and thermostatic expansion devices will attempt to control superheat and result in higher compressor top cap temperatures. Fan failure testing or loss of air flow in both cooling and heating should be evaluated by the system designer to assure that the compressor and system are protected from abnormally high pressures.

Discharge Temperature Protection



Compressor top cap temperatures can be very hot. Care must be taken to ensure that wiring or other materials which could be damaged by these temperatures do not come into contact with these potentially hot areas.

The Therm-O-Disc™ or TOD is a temperature-sensitive snap disc device located on the muffler plate. It is designed to open and route excessively hot discharge gas back to the motor protector when the internal discharge gas exceeds 290°F (144°C). 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. If a compressor is allowed to continue 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 of 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.

Model	Motor Frame Size	Application		IPR	TOD	Quiet shutdown	Discharge Check valve	Motor Protector	Electrical Connections
		AC	HP						
ZP14- 20KA	53	Yes	No	Yes	Yes	Yes	Yes	Yes	Molded Plug

Table 1

* Approximate Shell Diameter (e.g. 53 = 5.5")

Low Pressure Control

Air-conditioning units can be protected against high discharge temperatures through a low pressure control in the suction line. Testing has shown that a cut out setting of not lower than 55 psig (3.8 bar) will adequately protect the compressor against overheating from the aforementioned loss of charge, blower failure in a TXV system, etc. A higher level of protection is achieved if the low pressure control is set to cut out around 95 psig (6.7 bar) to prevent evaporator coil icing. The cut in setting can be as high as 180 psig (12.5 bar) to prevent rapid recycling in case of refrigerant loss.

High Pressure Control

If a high pressure control is used with these compressors the recommended maximum cut out setting is 650 psig (45 bar). The high pressure control should have a manual reset feature for the highest level of system protection. It is not recommended to use the compressor to test the high

pressure switch function during the assembly line test.

Shut Down Device

ZP*KA compressors employ a unitary shutdown device to manage the flow of top-cap discharge gas back through the scrolls after shutdown. This allows the scroll compressor to restart immediately even if the system is not equalized, eliminating the need for a time delay. Development testing should include a review of the shutdown sound for acceptability in a particular system.

Brief Power Interruptions

Brief power interruptions (less than 2 seconds) may result in powered reverse rotation of single-phase Copeland

Scroll compressors. This occurs because high-pressure discharge gas expands backward through the scrolls during 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 some time before the compressor's internal overload trips. This will not cause any damage to the compressor, and when the internal overload resets, the compressor will start and run normally.

To avoid disruption of operation, an electronic control that can sense brief power interruptions may be used to lock out the compressor for a short time. This control could be incorporated in other system controls (such as defrost control board or the system thermostat), or can be a stand-alone control.

A start kit (specified start capacitor and relay) is another effective means of mitigating a powered reverse condition that is caused by a brief power interruption.

Discharge Check Valve

A low mass, disk-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 after shutdown. This check valve was not designed to be used with recycling pump down because it is not entirely leak-proof.

Motor Overload Protection

Conventional internal line break motor overload protection is provided. The overload protector opens the common connection of the single-phase motor. The motor protector reacts to current, motor winding temperature, and hot gas from the TOD and IPR valve. Overload reset times vary depending on how hot the compressor is prior to trip and the ambient temperature.

Operating Envelope

Figure 2 illustrates the operating envelope for the ZP*KA scroll family. **Please note the evaporating temperature range; the ZP*KA scrolls are not designed nor qualified for heat pump applications.**

The operating envelope represents 100% duty cycle of the compressor with 20F° (11K) superheated suction gas and a voltage range of 197 to 253 volts. Operating outside of these limits may result in internal overload trips and reduced duty cycle.

Power Supply

The ZP*KA compressors are available as 208/230-1- 60 only. The paragraphs below describe the minimum starting and running voltages.

ZP*KA compressors are designed to start with a minimum voltage of 187. The 187 minimum voltage is the measured voltage while the compressor is trying to start, not the line voltage when the compressor is deenergized. To correctly measure the minimum starting voltage that the power supply is capable of delivering during a locked rotor starting condition, remove the start wire from the run capacitor and measure the common to run voltage while the compressor is trying to start. If the measured voltage is less than 187 volts the power supply must be investigated (undersized wires, failing contactor, loose wire connections, undersized utility transformers, etc.).

ZP*KA compressors are designed to run with a voltage range of 197 to 253 volts. Operating outside of this range may result in overload trips or compressor failure.

Accumulators

Current industry design practices for small tonnage residential cooling applications typically don't require an accumulator. However, some applications may benefit or even require an accumulator if the metering device is not capable of controlling an acceptable level of superheat. Applications with fixed orifice metering devices that are required to operate across a wide range of outdoor temperature may have significant flooding when the outdoor ambient is high. Applications with long, inter-connecting piping with several floors of elevation difference may require an accumulator. The Field Application Test in the Application Tests section should be run for applications such as those mentioned to determine the need for an accumulator.

Screens

Screens finer than 30x30 mesh (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

A crankcase heater is recommended when the system charge is over the charge limit shown in **Table 5**. A crankcase heater is required for systems containing more than 120% of the compressor refrigerant charge limit listed in **Table 5**. This includes long line length systems where the extra charge will increase the standard factory charge above the 120% limit.

Experience has shown that compressors may fill with liquid refrigerant under certain circumstances and system configurations, notably after long off cycles when the compressor has cooled. This may cause excessive start-up clearing noise; or the compressor may start and trip the internal overload protector several times before running. The addition of a crankcase heater will reduce customer noise and dimming light complaints since the compressor

will no longer have to clear out liquid during starting. **Table 4** lists the crankcase heaters recommended for the various models and voltages. **WARNING! Crankcase heaters must be properly grounded.** To properly install the crankcase heater, the heater should be installed as low on the compressor shell as possible, either above or below the lower bearing pin welds that protrude from the compressor shell. Ideally the heater would come together for clamping with the vertical shell seam weld coming up through the area where the crankcase heater is clamped together. See **Figure 4** for details. Tighten the clamp screw carefully ensuring that the heater is uniformly tensioned along its entire length and that the circumference of the heater element is in complete contact with the compressor shell. It's important that the clamp screw is torqued to the range of 20-25 in-lb (2.3-2.8 N m) to ensure adequate contact and to prevent heater burnout. Never apply power to heater in free air or before heater is installed on compressor to prevent overheating and burnout.

Pump Down Cycle

A pump down cycle for control of refrigerant migration is not recommended for scroll compressors of this size. Crankcase heat should be used to minimize off-cycle migration (see the section on crankcase heat).

Oil Type

Polyol ester (POE) oil is used in these compressors. See the compressor nameplate for the original oil charge. A complete recharge should be approximately four fluid ounces (118 ml) less than the nameplate value. If additional oil is needed in the field, Copeland Ultra 32-3MAF, Lubrizol Emkarate RL32-3MAF, Parker Emkarate RL32-3MAF/(Virginia) LE32-3MAF, or Nu Calgon 4314-66 (Emkarate RL32-3MAF) should be used. Copeland Ultra22 CC, Hatcol EAL22CC, and Mobil EAL Arctic 22 CC are acceptable alternatives.

CAUTION! POE must be handled carefully and the proper protective equipment (gloves, eye protection, etc.) must be used when handling POE lubricant. POE must not come into contact with any surface or material that might be harmed by POE, including

without limitation, certain polymers (e.g. PVC/CPVC and polycarbonate).

Contaminant Control

It is generally accepted that system moisture levels should be maintained below 50 ppm. **A filter-drier is required on all R-410A and POE lubricant systems to prevent solid particulate contamination, oil dielectric strength degradation, ice formation, oil hydrolysis, and metal corrosion.** It is the system designer's responsibility to make sure the filter-drier is adequately sized to accommodate the contaminants from system manufacturing processes that leave solid or liquid contaminants in the evaporator coil, condenser coil, and interconnecting tubing plus any contaminants introduced during the field installation process. Molecular sieve and activated alumina are two filter-drier materials designed to remove moisture and mitigate acid formation. A 100% molecular sieve filter can be used for maximum moisture

capacity. A more conservative mix, such as 75% molecular sieve and 25% activated alumina, should be used for service applications.

Noise & Vibration Control

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 characteristics of the scroll compressor, although low, include 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 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 50 and 60 Hz power supply 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

configuration described in **Table 3**. The scroll compressor makes both a rocking and 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.

Mounting Parts

Table 4 lists the recommended mounting parts kits to be used with the ZP*KA compressors. Many OEM customers buy the mounting parts directly from the supplier, but Copeland's grommet design and durometer recommendation should be followed for best vibration reduction through the mounting feet. Please see **AE4-1111** for grommet mounting suggestions and supplier addresses.

Single Phase Starting Characteristics

Start assist devices are usually not required, even if a system utilizes non-bleed expansion valves. Due to the inherent design of the Copeland Scroll compressor, 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 Copeland Scroll compressors. If starting components are required to address a poor power supply, please refer to **Table 4** for the recommended part numbers and component values.

PTC Start Components

For less severe voltage drops or as a start boost, solid state Positive Temperature Coefficient (PTC) devices rated from 10 to 25 ohms may be used to facilitate starting for any of these compressors.

Electrical Connections



Molded electrical plug (Copeland p/n 529-0060- 04 or OEM equivalent) must be used in all applications.

The ZP*KA electrical connections require a molded plug. Flag (1/4" push-on) type electrical connections are not available. When installing the molded plug by hand, the plug should be lined up squarely with the pins and fence and seated firmly using the palm of your hand. In high volume production settings, a pneumatic install tool will help ensure consistent installation. Contact the molded plug supplier for drawings/designs of tools used to install the plug. **Hammers or other blunt instruments should not be used to install the plug.**

Deep Vacuum Operation

ZP*KA Copeland Scroll compressors incorporate internal low vacuum protection and will stop pumping (unload) when the pressure ratio exceeds approximately 7:1. There is an audible increase in sound when the scrolls start unloading.

CAUTION 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 2**. Prolonged operation at low suction pressures will result in overheating of the scrolls and permanent damage to the scroll tips, drive bearing and internal seal. See **AE24-1105** for proper system evacuation procedures.

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 recommendations.

System Tubing Stress

System tubing should be designed to keep tubing stresses below 9.5 ksi (62 MPa), the endurance limit of copper tubing. Start, stop and running (resonance) cases should be evaluated.

APPLICATION TESTS

Application Test Summary

Copeland devotes a significant effort to ensure Copeland Scroll compressors are reliable and have a long service life when applied in the manner outlined in this bulletin. However, the system designer, installer, and servicer all have a part to play in ensuring reliability.

A test plan to evaluate the effects that system design and installation variables will have on the operation of the compressor is warranted for new unit designs or designs that have undergone significant changes. Some of the variables to consider for evaluation include:

- Operating Temperature Range of the Unit
- Charge Tolerance
- Long Line Applications
- Air Flow
- Cyclic Operation

The Field Application Test described below has historically been prescribed to evaluate the effects that overcharge, ambient temperature, and cyclic operation have on the compressor. Application Engineering is always available to review and assist with the evaluation of results from such application tests.

Field Application Test

To test for repeated, excessive liquid flood back during normal system off-cycles, perform the **Field Application Test** that is outlined in **Table 2**. Obtain a sample compressor with a sight-tube to measure the liquid level in the compressor when it is off.

Note: The sight-tube is not a good liquid level indicator when the compressor is running because the top of the sight-tube is at a lower pressure than the bottom causing a higher apparent oil level.

Set the system up in a configuration with the indoor unit elevated several feet above the outdoor unit with a minimum of 25 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 field overcharging. 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 compressor overload trips, or any compressor abnormal starting sounds during each test. Review the results with Application Engineering to determine if an accumulator or other means of off cycle migration control are required. **This test does not eliminate the requirement for a crankcase heater if the system charge level exceeds the values in Table 5.** The criteria for pass/fail is whether the liquid level reaches the level of the compressor suction tube connection. Liquid levels higher than this can allow refrigerant/oil to be ingested by the scrolls and pumped out of the compressor after start-up.

ASSEMBLY LINE PROCEDURES

Installing the Compressor



Use care and the appropriate material handling equipment when lifting and moving compressors. Personal safety equipment must be used.

Copeland Scroll compressors leave the factory dehydrated and with a positive dry air charge. 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 accumulates in the top-cap of the compressor after Copeland's run test. The inside of both fittings should be wiped with a lint free cloth to remove residual oil prior to brazing. A compressor containing POE oil should never be left open longer than 20 minutes.

Assembly Line Brazing Procedure



Personal safety equipment must be used during brazing operation. Heat shields should be used to prevent overheating or burning nearby temperature sensitive parts. Fire extinguishing equipment should be accessible in the event of a fire.

Figure 5 discusses the proper procedures for brazing the suction and discharge lines to a scroll compressor. **NOTICE** 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. Any blockage of oil or refrigerant may damage the compressor resulting in failure.

Pressure Testing



Never pressurize the compressor to more than 475 psig (32.8 bar) for leak checking purposes. Never pressurize the compressor from a nitrogen cylinder or other pressure source without an appropriately sized pressure regulating and relief valve.

The pressure used on the assembly line to meet the UL pressure test requirement must not be higher than 475 psig (33 Bar). Higher pressure may result in permanent deformation of the compressor shell and possible misalignment or bottom cover distortion.

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 in the high side of the system to prevent low voltage starting difficulties, hipot failures, and bearing washout during the 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. **NOTICE Do not operate the compressor without enough system charge to maintain at least 55 psig (3.8 bar) suction pressure. Do not operate the compressor with the low pressure cut-out disabled. Do not operate with a restricted suction or liquid line.** Depending on the discharge pressure,

allowing the suction pressure to drop below 55 psig (3.8 bar) for more than a few seconds may overheat the scrolls and cause early drive bearing damage. **NOTICE Do not use the compressor to test the 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



Use caution with high voltage and never hipot when compressor is in a vacuum.

Copeland 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-hermetic compressors that 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. U.L. sets the requirement for dielectric strength testing and they should be consulted for the appropriate voltage and leakage values. **Under no circumstances should the hipot test be performed while the compressor is under a vacuum.**

Final Run Test

Customers that use a nitrogen final run test must be careful to not overheat the compressor. Nitrogen is not a good medium for removing heat from the compressor, and the scroll tips can be easily damaged with high compression ratios and/or long test times. Copeland Scroll compressors are designed for use with refrigerant, and testing with nitrogen may result in a situation where the compressor does not develop a pressure differential (no pump condition). When testing with nitrogen, the compressor must be allowed to cool for several minutes between tests.

Unbrazing System Components



Before attempting to braze on any system components, it is important to recover all refrigerant from both the high and low side of the system.

If the refrigerant charge is removed from a scroll-equipped unit by recovering 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. 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.

SERVICE PROCEDURES

Copeland Scroll Compressor Functional Check

A functional compressor test during which the unit suction base valve is closed to check how low the compressor will pull the suction pressure is not a good indication of how well a compressor is performing. **Such a test will 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. Determine if the internal motor overload has opened or if an internal motor short or ground fault has developed. If the internal overload has opened, the compressor must be allowed to cool sufficiently to allow it to reset.
3. Check that the compressor is correctly wired.
4. Proper indoor and outdoor blower/fan 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. 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 +/-20% from published values, a faulty compressor may be indicated.

7. Before replacing or returning a compressor, be certain that the compressor is actually defective. As a minimum, recheck compressors returned from the field in the shop or depot by testing for a grounded, open or shorted winding and the ability to start. The orange tag in the service compressor box should be filled out and attached to the failed compressor to be returned. The information on this tag is captured in our warranty data base.

Compressor Replacement After a 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 with the use of suction and liquid line filter driers. A 100% activated alumina suction filter drier is recommended but must be removed after 72 hours. See **AE24-1105** for clean up procedures and **AE11-1297** for liquid line filter-drier recommendations. **NOTICE 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. The system contactor should be inspected for pitted/burnt contacts and replaced if necessary. It is highly recommended that the run capacitor be replaced when a single phase compressor is replaced.

Start-Up of a New or Replacement Compressor

It is good service practice, when charging a system with a scroll compressor, to charge liquid refrigerant into the high side only. It is not good practice to dump liquid refrigerant from a refrigerant cylinder into the crankcase of a stationary compressor. If additional charge is required, charge liquid into the low side of the system with the compressor operating. **CAUTION Do not start the compressor while the system is in a deep vacuum.** Internal arcing may occur when any type of compressor is started in a vacuum. **NOTICE Do not operate the compressor without enough system charge to maintain at least 55 psig (3.8 bar) suction pressure. Do**

not operate with a restricted suction or liquid line. Do not operate with the low pressure cut-out disabled. Allowing suction pressure to drop below 55 psig (3.8 bar) for more than a few seconds may overheat the 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 ruining the compressor by operating with no refrigerant flow.

Tables and Figures



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.

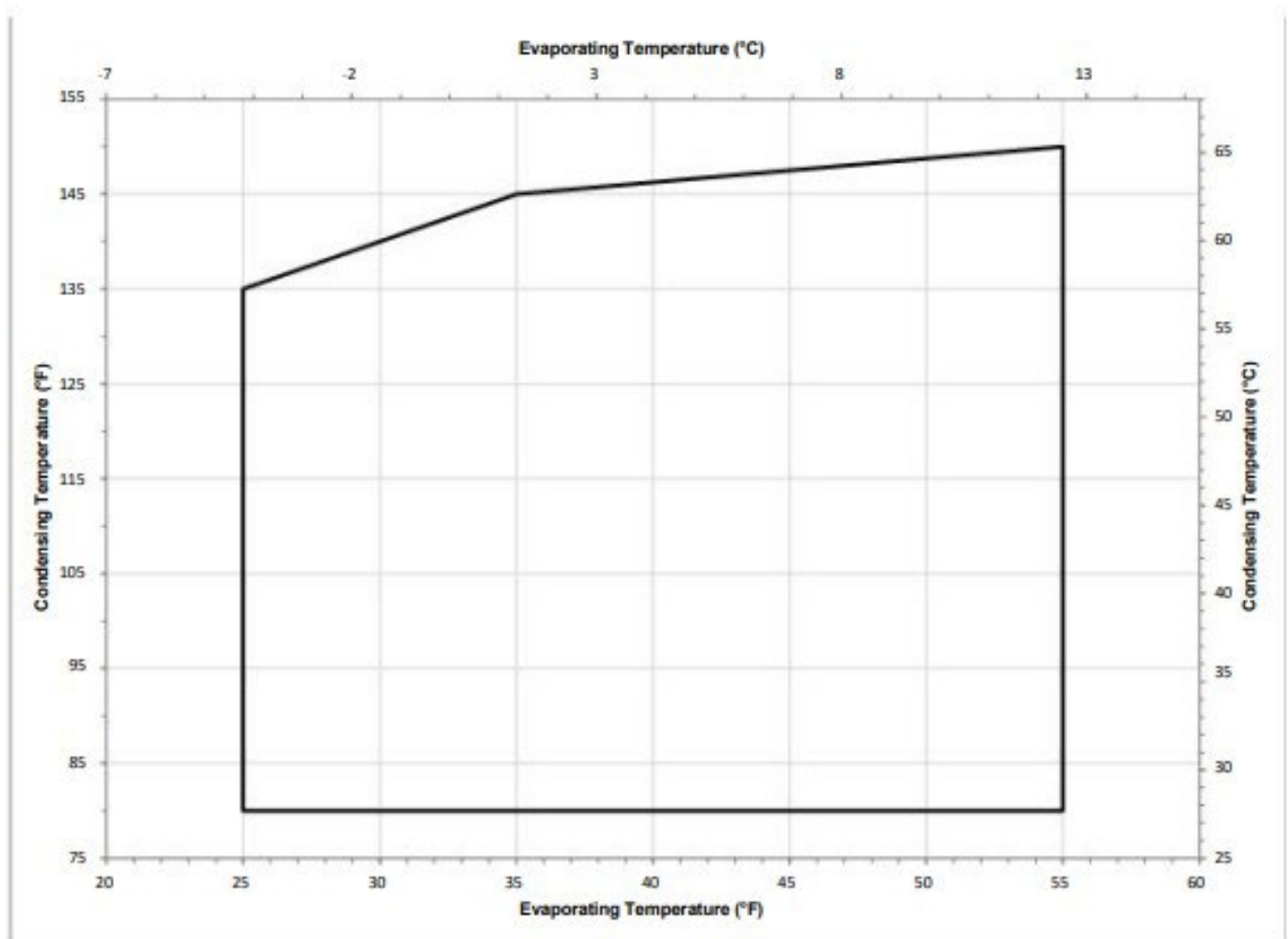


Actually, during operation, all six gas passages are in various stages of compression at all times, resulting in nearly continuous suction and discharge.

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 simultaneously, 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 1 - How a Scroll Works*Figure 2 - Operating Envelope*

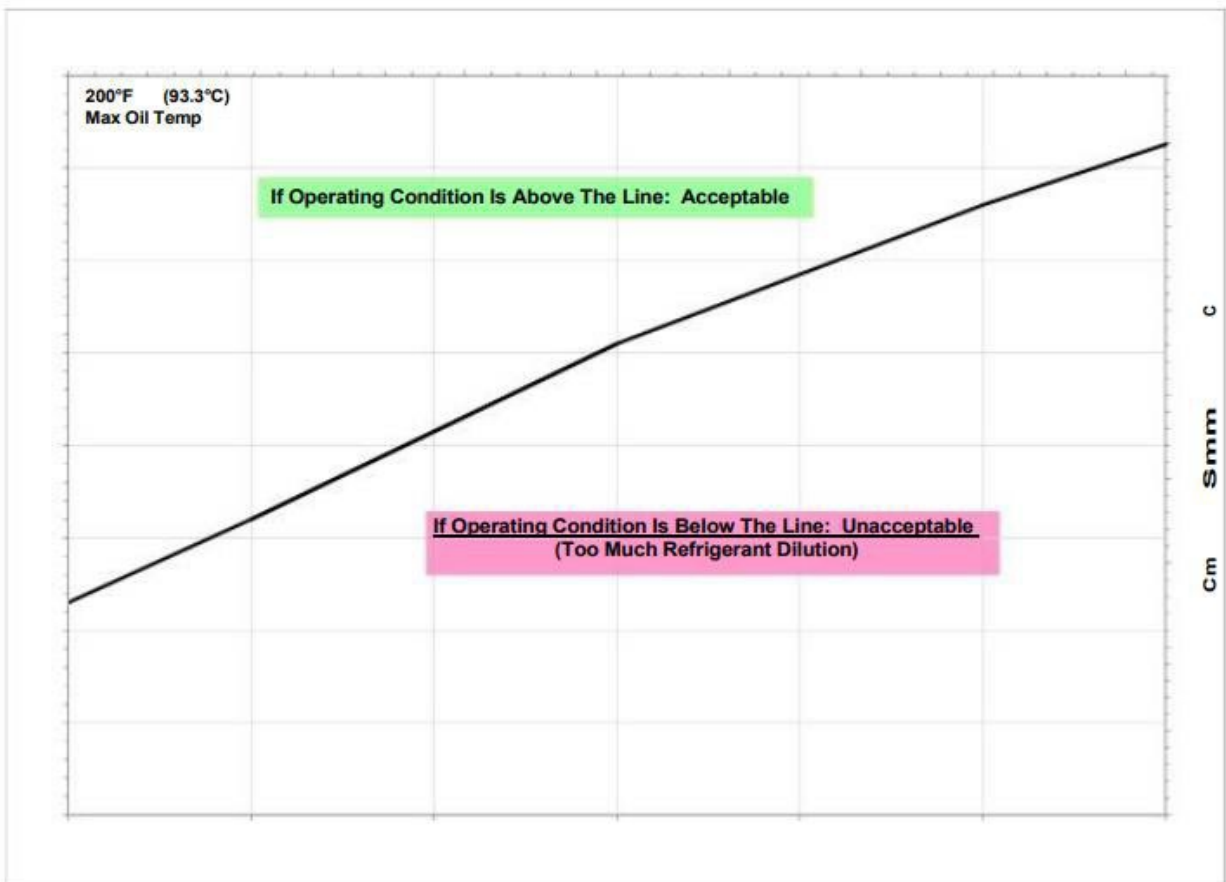


Figure 3 - Oil Dilution Chart

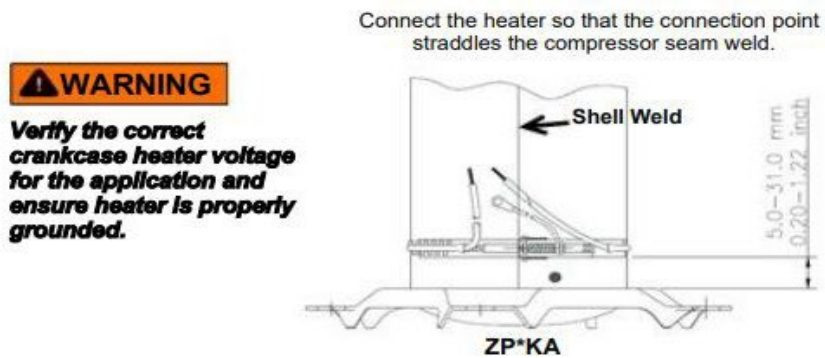


Figure 4 - Crankcase Heater

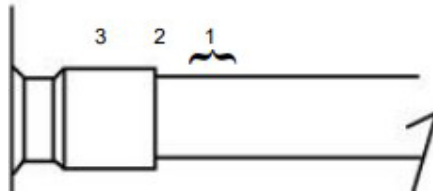


Figure 5 - Scroll Suction Tube Brazing

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, DichloroTrifluoroethane 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



Remove refrigerant charge from both the low and high side of the compressor before cutting the suction and discharge lines to remove the compressor. Verify the charge has been completely removed with manifold gauges.

- 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

Table 2 - Field Application Test

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 3 - Design Configurations

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
Mass / Suction muffler	May be required (Acts as dampening mass)

Table 4 - Compressor Accessories

Part Category	Part Description	Part Number	Models	Notes
Mounting	Compressor Mounting Kit	527-0044-15	ZP14-20KA	30-35 Durometer
Crankcase Heater	Crankcase Heater, 120V, 40W	018-0094-01	ZP14-20KA	21" Leads
	Crankcase Heater, 240V, 40W	018-0094-00	ZP14-20KA	21" Leads
Electrical	Grounding Screw	100-0605-00	ZP14-20KA	10-32 x 8mm Long, Taptite Screw
	Molded Plug	529-0370-00	ZP14-20KA	Universal Plug, 10 Gauge, 42" Leads
	Molded Plug Retainer Clip	032-0717-00	ZP14-20KA	Optional Part, Locks the Molded Plug To Fence
	Flexible Metal Conduit Retainer	032-7051-01	ZP14-20KA	Optional Part, Use with 032-0717-00
	Run Capacitor	014-0064-06	ZP14-16KAE-PFV	30 microFarad/370 Volts
	Run Capacitor	014-0064-07	ZP20KAE-PFV	35 microFarad/370 Volts
	Start Capacitor	014-0061-27	ZP14-20KA	88-106 microFarad/330 Volts
	Start Relay	040-0166-07	ZP14-20KA	140-150 Volts pick-up, 40-90 Volts drop-out, 290 coil Voltage
	SecureStart	943-0120-00	ZP14-20KA	
Diagnostics & Protection	CoreSense Diagnostics Module	971-0066-00	ZP14-20KA	2-Wire Module
	CoreSense Diagnostics Module	971-0067-00	ZP14-20KA	3-Wire Module
	Discharge Line Thermostat	998-7022-02	ZP14-20KA	Conduit Ready, fits 1/2" tube
Suction & Discharge	Discharge Rotalock O-Ring Seal	020-0028-00	ZP14-20KA	
	Suction Rotalock O-Ring Seal	020-0028-02	ZP14-20KA	

	Rotalock Service Valve, Disc 1/2"	998-0510-98	ZP14-20KA	
	Rotalock Service Valve, Suct 3/4"	998-0510-38	ZP14-20KA	
	1/2" Disc Stub Adapter to 1"-14 Rotalock	036-0538-00	ZP14-20KA	Requires 020-0028-00 Seal
	3/4" Suct Stub Adapter to 1-1/4"-12 Rotalock	998-0034-01	ZP14-20KA	

Table 5 - Compressor Refrigerant Charge Limits

Model	Frame Size	Charge Limit		120% x Limit**	
		Pounds	kg	Pounds	kg
ZP14-20KA	53	8	3.6	9.6	4.3

*Approximate Shell Diameter (e.g. 53 = 5.5 Inches)

**Charge Allowance For System

Revision Tracking R2

The document format has been updated to the new Copeland format

All occurrences of "Emerson" have been removed

A note regarding A3 and R290 venting has been updated.

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