

Application Engineering

Application Guidelines for Copeland™ Low Profile Tilted Fixed Speed Scroll Compressors ZSH*, YSH*, ZFH* & YFH*

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Safety

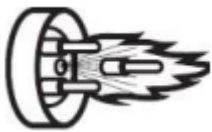
Important Safety Information

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](https://www.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

This application bulletin provides instructions on how to apply the ZSH*, YSH*, ZFH* & YFH* Copeland™ scroll compressors in a safe and reliable manner.

See Table 1 for a summary of mechanical specifications.

The instructions listed on this document are critical for the proper and safe operation of the compressors. Copeland will not guarantee the performance and reliability of the product if it is misused in regard of these guidelines.

YFH/YSH*KAU compressors are released only for R290 stationary applications with refrigerant charges below 150 grams (5.3 oz.).

General Instructions



During service make sure that:

- the area is well ventilated;
- the materials and equipment used are suitable for use under explosive conditions;
- only non-sparking tools are used;
- antistatic gloves and clothes are used;
- build-up of electrostatic charges is avoided.
- In case of explosive atmosphere: Immediately stop the compressor and/or de-energize the power supply of the compressor and any other electrical component/equipment
- no unshielded flame is allowed.

Furthermore, before opening the refrigeration system or working on it with an unshielded flame:

- continuously check if the ambient atmosphere is non-explosive and ensure proper ventilation of the room before creating any naked flame; no naked flame is allowed in an explosive atmosphere;
- if the atmosphere reaches a dangerous concentration of flammable gas, avoid any ignition source, and ventilate the room further;



If an explosive atmosphere is detected, immediately stop the compressor, and ventilate the room. No open flame is allowed.

Nomenclature

The refrigeration scrolls model numbers include the nominal capacity at standard 60HZ ARI rating conditions for low temperature (-25/105 °F) and medium temperature (20/120°F). For additional information on this product, please refer to the Online Product Information accessible on www.copeland.com.

Z S H 09K A E - TF5 - BOM

1	2	3	4	5	6	7	8
1	Z = A1 Scroll, Y= A1 / A2L / A3 Scroll						
2	S = Extended Medium Temperature F = Low Temperature						
3	H = Horizontal						
4	09K = Nominal Capacity [Btu/h] @60Hz (A1/A2L) or @ 50hz (A3), both at ARI conditions using multiplier "K" for 1000						
5	Model Variation						
6	E = Poe Oil w/A1/A2L, or U= Poe Oil w/A3						
7	Motor Version						
8	Bill of Material						

Compressor Data

Compressor mechanical, electrical and performance data are available online in Online Product Information at www.copeland.com/OPI. From this site, compressor drawings (PDF format) can be downloaded. Other drawing formats can be obtained by contacting your Application Engineer

Operating Envelope

The ZSH/ ZFH*KAE refrigeration scroll compressor models can be used with a variety of A1 refrigerants (see **Table 1**). The YSH/ YFH*KAE refrigeration scroll compressor models can be used with a variety of A1, A2L refrigerant (see **Table 1**). The YSH/ YFH*KAU refrigeration

scroll compressor can be used with a variety of A3 refrigerant (see **Table 1**).

The ZSH* and YSH* models are intended for extended medium and high temperature refrigeration type duty while the ZFH* & YFH* are intended for low temperature refrigeration type duty. The models and operating envelopes are depicted in **Figures 4 to 9**.

Application Considerations

Approved Refrigerants and Oils

The compressor is supplied with an initial oil charge polyolester (POE) oil. See the compressor nameplate for the original oil charge amount. Refer to **Table 7** for approved refrigerants and oils. Polyol ester lubricants must be provided if the scroll compressor is to be used with HFC refrigerants. See [Form 93-11](#) for a complete list of all Copeland approved lubricants



POE oil 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, and spills should be cleaned up quickly with paper towels, soap, and water.

Accumulators

Due to the scrolls' inherent ability 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 compressor is used.

Excessive liquid flood back or repeated flooded starts will dilute the oil in the compressor causing inadequate

lubrication and bearing wear. Proper system design will minimize liquid flood back, thereby ensuring maximum compressor life.

Superheat Requirements

In order to assure that liquid refrigerant does not return to the compressor during the running cycle, attention must be given to maintaining proper superheat at the compressor suction inlet. Copeland recommends a minimum of 20°F (11K) superheat, measured on the suction line 6 inches (152mm) from the suction valve, to prevent liquid refrigerant flood back.

Another method to determine if liquid refrigerant is returning to the compressor is to accurately measure the temperature difference between the compressor oil crankcase and the suction line. During continuous operation we recommend that this difference be a minimum of 50°F (27K). This "crankcase differential temperature" requirement supersedes the minimum suction superheat requirement in the last paragraph. To measure oil temperature through the compressor shell, place a thermocouple on the bottom center (not the side) of the compressor shell and insulate from the ambient.

During rapid system changes, such as defrost or ice harvest cycles, this temperature difference may drop rapidly for a short period of time. When the crankcase temperature difference falls below the recommended 50°F (27K), our recommendation is the duration should not exceed a maximum (continuous) time period of two minutes and should not go lower than a 25°F (14K) difference.

Contact your Application Engineer regarding any exceptions to the above requirements.

Crankcase Heaters

Crankcase heaters are required when the system charge exceeds charge limit shown on **Table 2**.

The listed crankcase heaters on **Table 4** are intended for use only when there is limited access. The heaters are not equipped for use with electrical conduit. Where applicable,

electrical safety codes require lead protection, a crankcase heater terminal box should be used.

The crankcase heater for these compressors is to cover the bottom half of the compressor. See Figure 10 for more details.

If there are any questions concerning their application, contact your Application Engineer.

ZFH & YFH Low Temperature Liquid Injection

The low temperature models are provided with an injection port that can be used for liquid injection.

Liquid Injection is required when using the ZFH scrolls for liquid injection operation, a discharge temperature control (DTC) valve must be applied.

The purpose of the DTC valve is to maintain safe internal operating temperatures.

DTC Valve Specifications

The following components are not required, but they are recommended for liquid injection.

- Sight Glass - A sight glass can be installed before the DTC valve to allow for visual inspection for the presence of liquid refrigerant.
- Filter/Drier - A filter/drier can be installed upstream of the injection circuit to avoid the possibility of the DTC screen blockage due to contaminants.

Installation of DTC Valve

The valve bulb must be installed in the top cap thermal well to adequately control scroll temperatures. **It is strongly recommended that the DTC valve be brazed directly into the injection fitting on the compressor. If limited height does not allow for direct connection to the compressor and must be remotely mounted see Section 2.8 for further details.**

The capillary tube connecting the valve to the bulb should be positioned such that it does not contact the compressor

during operation. Do not bend the capillary tube within 1" (25.4mm) of the valve.

The DTC valve comes with an insulating cap. If this additional height from the cap is an issue, the valve cap could be replaced with high temperature insulation. This should be applied to insulate and protect the valves remote bulb assembly. This will reduce the total height requirement by 0.5" (12.7mm) The DTC valve kit part number is 998-0746-00 (liquid line 3/8" sweat tube, 250°F set point).

NOTICE

When brazing the DTC valve to the stub tube injection fitting of the compressor it is important to focus the heat at the connection joint of the tubing and not the compressor fitting. Using an excessive amount of solder material can also increase the risk of plugging the injection fitting which can lead to excess heat and unreliable operation.

Suggested Application Techniques for All Liquid Injection Applications

For the most efficient thermal sensing, spread a thin film of thermal grease around the DTC valve bulb/thermistors before installing into the top cap well. However, for proper functioning of the valve this is not required.

- For service purposes, a mechanical ball valve (not provided by Copeland) is also recommended in the liquid line. For the liquid injection system to be effective, a minimum of 5°F subcooled liquid at the DTC inlet is required.

NOTICE

For system application, it is recommended to braze the DTC valve directly to the compressor. If the valve must be located away from the injection port, the below needs to be done and will need to be done by OEM (Original Equipment Manufacturer).

For remote mounting of DTC Valve:

- If remote mounted, it is strongly recommended that the valve be located near the compressor so the valve cap tube that connects to the DTC bulb is not fully stretched when bulb is installed in compressor top cap.
- If remote mounted The line between the valve and compressor injection port must be insulated to avoid heat transfer from the ambient.
- The DTC Valve must also be located at a lower height than the injection port to avoid liquid staying in the line when the compressor is not running.
- The valve must be verified by the OEM that it is mounted securely, and it is recommended that vibration testing be done to help avoid the injection line fracturing during operation and startups.

NOTE: To ensure adequate temperature control, take care to not damage the DTC valve bulb/thermistor when installing. Damage of DTC valve bulb/thermistor could result in improper injection.

Discharge Line Thermostat

Figure 4 to Figure 9 shows the operating maps based on refrigerant. Operation beyond these limits can cause high compression ratios or excessive internal compressor temperatures. This will result in overheating the scroll members, causing excessive wear resulting in premature compressor failure.

If the system is designed where operation within these guidelines cannot be guaranteed, then a discharge line thermostat is required in the compressor control circuit.

When installed approximately 6 inches from the discharge tube outlet, the thermostats have a cut-out setting that will ensure the external discharge line temperature does not exceed the 260°F limit for medium temperature application and should not exceed 240°F for low temperature application. If a rotalock service valve is installed on the discharge port connection, the thermostat should be located approximately 5 inches from the valve braze connection.

Kits have been set up to include the thermostat, retainer, and installation instructions. These thermostats must be used with ½ 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 an alarm circuit capability. **See Table 5** for a list of discharge line thermostat kit numbers.

NOTICE

For use with R290 make sure to select a discharge line thermostat that complies with the ATEX requirements. Other discharge thermostat devices might not comply with the ATEX requirements and could be a potential ignition source, and therefore they could only be installed in a non-explosive atmosphere.

To be ATEX compliant, the cable ends of the thermostat must be connected with suitable cable glands and electrical enclosure to achieve a minimum protection degree of IP54 according to UL471 SB5 (IEC60079-15, clause 6.3).

When connecting the cable ends, a creepage distance of minimum 0.16 inches (4 mm) and a clearance distance of 0.1 inches (2.5 mm) between the conductive parts at different potentials must be maintained.

Maximal Voltage and Amps values for the thermostat and a protection against electrical shock must be respected during the installation.

Additionally, the ATEX compliance requires a protection of the thermostat body against mechanical damage, according to UL471 SB5 (IEC 60079-0, clause 26.4.2, table 13). There is no need for an additional housing around the thermostat body. Protection against mechanical damage to the thermostat can be achieved with an overall cover or box placed around the compressor or refrigerant system.

Low Pressure Protection



Operation under ambient pressure! During operation under ambient pressure an explosive mixture can form inside the system. Make sure that the pressure never falls below atmospheric pressure.



Loss of system charge! Loss of lubrication! Bearing malfunction and compressor breakdown! A low-pressure limiter protection must be installed and set above the atmospheric pressure. Do not bridge or bypass the low-pressure limiter. Do not operate under atmospheric pressure.

In some instances, systems must operate at low evaporating pressure because of the low ambient temperatures, sometimes combined with a high level of relative humidity. Proper evaporator sizing and adequate defrost strategy control will prevent the system from operating outside the operating envelope published by Copeland, whatever the climatic conditions and the capacity demand.

However, in some extreme cases – such as loss of system charge, extreme heat transfer restriction at the evaporator, any defect or blocked flow control component (expansion valve, screens, etc.) – the evaporating conditions may be such that the compressor will operate outside the published operating envelope limits. These conditions may result in compressor failure.

Therefore, Copeland requires that all compressors without exception be fitted with a low-pressure protection in the suction line. The mandatory inclusion of a low-pressure switch will stop the compressor operating outside the published envelope limits or below atmospheric pressure.

Pump Down Recommendations

These compressors have an internal spring-loaded low leak discharge check valve suitable for pump down application. This valve prevents system pressures from equalizing and pump down can be achieved. However, during laboratory testing, we have observed a potential short cycling condition on these models. This phenomenon can be attributed to several factors:

1. Location of low-pressure control sensor. If it is located right at the suction inlet of the compressor, it will be more sensitive to pressure spikes.
2. Actual low-pressure setting. Refer to our recommended setting in **Table 10**. If the differential

pressure setting is too close, this will increase the possibility of short cycling.

3. The type of low-pressure control can have an effect on cycling. The encapsulated non-adjustable type is more susceptible to causing excessive cycling due to tolerances.
4. If short cycling cannot be avoided, using a 3- minute time delay will limit the cycling of the compressor to an acceptable level.

IPR Valve

Refrigeration scroll compressors (HP range) have internal pressure relief valves which open at a discharge to suction differential pressure of 375 to 450 psi for ZSH/YSH models and 550-625 for ZFH/YFH models. This action will trip the motor protector and remove the motor from the line.

Motor Protection

Conventional inherent internal line break motor protection is provided.

Contaminant Control

Copeland™ scroll compressors leave the factory with a miniscule number of contaminants. Manufacturing processes have been designed to minimize the introduction of solid or liquid contaminants.

NOTICE

Dehydration and purge processes ensure minimal moisture levels in the compressor and continuous auditing of lubricant moisture levels assure that moisture isn't inadvertently introduced into the compressor. It is recommended to perform triple evacuation, evacuating twice to 1500 microns, and the last time to 500 microns, or to the limit of the vacuum pump's ability. Due to the inherent properties on POE oil, moisture levels should be maintained below 50 ppm for optimal performance. A filter-drier is required 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.

Refrigerant Piping

Particular attention must be given to the system refrigerant pipe size with the variable speed scrolls. ASHRAE guidelines for pipe sizing should be followed to ensure that refrigerant velocities are high enough at low speeds to ensure oil return to the compressor. At the same time, high refrigerant velocities at high-speed operation can result in excessive pressure drop and loss of system efficiency. A careful evaluation and compromise in pipe sizing will likely have to be settled upon. A compressor sample with a sight-tube for monitoring the oil level should be used during system development to ensure an adequate oil level is maintained at operating conditions and speeds.

Compressor Mounting

The compressors are designed to be mounted on vibration absorber grommets. The grommets dampen the start-up surge of the compressor and minimize sound and vibration transmission to the compressor base during operation. The metal sleeve inside is a guide designed to hold the grommet in place. It is not designed as a load-bearing member, and application of excessive torque to the bolts can crush the sleeve. The mounting torque should be 12-14 Nm (106-124 lb-in). It is critically important that the grommet is not compressed.

Wrong or inconsistent durometer of the mounting grommets can result in sound and vibration complaints.

The compressor is built in such that it has a range of $\pm 2^\circ$ tilt variance from its inherent tilted design. To maintain proper and reliable operation the compressor must be securely mounted to a flat, horizontal surface. This will allow for the proper oil flow in the shell of the compressor to maintain the supply of oil to the utilized oil pump.

For additional information on grommet durometer please consult with Application Engineering.

Starting Characteristics

Single-phase scroll compressors are designed with permanent split capacitor (PSC) type motors. However, if low voltage conditions exist at start up, protector trips can result. Therefore, start assist devices (start capacitors and relays) are available to maximize starting characteristics under abnormal conditions.

NOTICE

The single phase (PFV) motors for the low profile scroll compressors are required to use the start devices (start capacitor and relay) that can be found on the Copeland's OPI site for each specific compressor model.

Connection Fittings

Scroll compressors are provided only with sweat connections. (Consult your representative for details). See section on New Installation for suggestions on how to properly braze these fittings.

Three Phase Rotation Direction

Scroll compressors are directional dependent: i.e., they will compress in one rotational direction only. On single phase compressors, this is not an issue since they will only start and run in the proper direction (except as described in the Labeled Brief Power Interruptions).

Three-phase scrolls, however, will rotate in either direction depending on the power of the phasing. So, 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 Original Equipment Manufacturer.

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.

Although operation of scroll in reverse direction for brief periods of time is not harmful, continued operation could result in failure.

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 fuse terminals will maintain the proper rotation.

Brief Power Interruptions

Brief power interruptions (less than ½ second) may result in powered reverse rotation of single-phase refrigeration scroll compressors. High-pressure discharge gas expands backward through the scrolls at power interruption causing the scroll to orbit in the reverse direction. If power is reapplied while this reversal is occurring, the compressor may continue to run noisily in the reverse direction for several minutes until the compressor internal protector trips. This has no negative effect on durability. When the protector resets, the compressor will start and run normally. Copeland strongly encourages the use of a timer which can sense brief power interruptions and lock the compressor out of operation for two minutes. No time delay is required on three phase models to prevent reverse rotation due to power interruptions.

Off-Cycle Migration Control

Off-cycle migration control is important for long term compressor reliability and to minimize nuisance complaints associated with flooded start conditions. Off cycle migration control is recommended when the system charge exceeds the charge limits listed in **Table 2**.

A pump down cycle to control refrigerant migration may have to be used in conjunction with the crankcase heating function when the compressor is located outside without any housing so that cold air blowing over the compressor makes the crankcase heating function ineffective.

If a pump down cycle is used, a separate external check valve must be added.

These compressors have an internal discharge check valve, but it is only 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 causing the scroll compressor to recycle more frequently. The low-pressure control differential must be reviewed since a relatively large volume of gas will re-expand from the high side of the compressor into the low side after shutdown.

Minimum Runtime

Copeland recommends a maximum of 10 starts per hour. 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 start-up. To establish the minimum run time, a sample compressor equipped with a sight tube can be ordered from Copeland. Install it in a system with the longest connecting lines that are approved for the system. The minimum on time becomes the time required for oil lost during compressor start-up to return to the compressor sump and restore a minimal oil level that will ensure oil pick-up through the crankshaft. 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.

Rack Applications

These compressors are not approved for rack or parallel applications because the compressors do not have sight glasses and cannot be equipped with oil equalization devices.

Application Test

New system designs should be evaluated throughout the entire expected operating range of the unit to ensure the system will perform reliably throughout the life of the product. Test data, taken throughout the operating range

of the unit, should be closely scrutinized to help identify gross errors in system design that may produce conditions that could lead to compressor failure.

General Application Tests

System faults, such as low or loss of indoor airflow, loss of outdoor airflow, and low/overcharge conditions should all be evaluated to ensure the compressor and service technician are protected against any adverse condition.

NOTICE

The tests outlined above are for common applications of compressors in this family. Please consult with Application Engineering on applications outside of those outlined above for the appropriate application tests.

Assembly Line Procedures



During service make sure that:

- The area is well ventilated.
- The materials and equipment used are suitable for use under explosive conditions.
- Only non-sparking tools are used.
- Antistatic gloves and clothes are used.
- Build-up of electrostatic charges is avoided.
- In case of explosive atmosphere: Immediately stop the compressor and/or de-energize the power supply of the compressor and any other electrical component/equipment
- No unshielded flame is allowed. Furthermore, before opening the refrigeration system or working on it with an unshielded flame:
- Continuously check if the ambient atmosphere is nonexplosive and ensure proper ventilation of the room before creating any naked flame; no naked flame is allowed in an explosive atmosphere.
- If the atmosphere reaches a dangerous concentration of flammable gas, avoid any ignition source, and ventilate the room further.



If an explosive atmosphere is detected, immediately stop the compressor, and ventilate the room. No open flame is allowed.



Electrical shock hazard! Serious personal injuries and/or system breakdown! Allow drive components to electrically discharge for a minimum of two minutes before servicing. Use compressor with grounded system only. Refer to original equipment wiring diagrams. Electrical connections must be made by qualified electrical personnel.



System breakdown! Personal injuries! Only approved refrigerants and refrigeration oils must be used.

Installing the Compressor



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

The compressor should be kept horizontal during handling.

Copeland™ scroll compressors leave the factory dehydrated, with a dry air holding charge. If compressors are stored in a cold ambient (i.e. outside during the winter), the suction and discharge plugs should not be removed until the compressor has had enough time to warm up to the plant ambient temperature. The suggested warm up time is one hour per 4°F (2°C) difference between outdoor and indoor temperature. 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 head 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

WARNING

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.

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, expansion valves, and accumulator oil return holes. Any blockage of oil or refrigerant may damage the compressor resulting in failure.

Pressure Testing

WARNING

Never pressurize the compressor to more than 341psig (23.5 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 line to meet the U.L. burst pressure requirement must not be higher than 341 psig (23.5 bar). Higher pressure may result in permanent deformation of the compressor shell and possible misalignment or bottom cover distortion.

For each compressor model the Maximum Allowable Pressure can be referenced on the compressor label.

Assembly Line System Charging Procedure

Systems should be charged with liquid on the high side to the extent possible. Most 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 the minimum operating conditions defined by the envelope. 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 pressure to drop below the envelope limit 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 test when compressor is in a vacuum.

Copeland subjects all Scroll compressors to a high voltage test after final assembly.

Since high-voltage tests lead to premature aging of the winding insulation, further additional tests of that nature are not recommended. However, if it must be done for any reason, a lower voltage must be used. Disconnect all

electronic devices, e.g., motor protection module, fan speed control prior to testing.



High potential testing on R290 compressor! Special attention should be paid when performing high potential testing.



Conductor cables! Electrical shock! Shut off power supply before high-potential testing.



Internal arcing! Motor destruction! Do not carry out high-voltage or insulation tests if the compressor housing is under vacuum.

Copeland subjects all Scroll compressors to a high voltage test after final assembly. Each motor phase winding is tested according to EN60335-2-34, IEC 60335-2-34, and UL 60335-2-34 at a differential voltage of 1000V plus twice the nominal voltage.

Since high-voltage tests lead to premature ageing of the winding insulation, further additional tests of this nature are not recommended. However, if it must be done for any reason, a lower voltage must be used. Disconnect all electronic devices, e.g., motor protection module, fan speed control, etc. prior to testing.



The high-potential and/or Megohm resistance testing must not be done with the compressor charged with R-290. These tests can induce an electrical arc and cause a potential fire/explosion hazard.

For the same reason, compressors removed from an R290 system will need to have the oil drained and a nitrogen purge introduced to flush any remaining refrigerant from the compressor prior to high-potential testing and Megohm resistance reading.

Unbrazing System Components



Before attempting to braze, 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.

Assembly of Molded Plug Cable

- The 529-0654-00 is the required molded plug with clip and lanyard for all refrigerant options.
- Shut off power supply.
- Check, that the circle fence is clean and dry, before connecting the molded plug power cable.
- Install the molded plug connector properly to the motor terminals. Push the molded plug connector smoothly as far as possible towards the terminals. Don't use any tool to knock on the molded plug connector, because this could damage the glass inserts of the Fusite terminal pins.
- Secure the connection with the retainer. Refer to **Figure 1 and 2** for more details.



Figure 1 Power Cable Molded Plug

Part number 529-0654-00

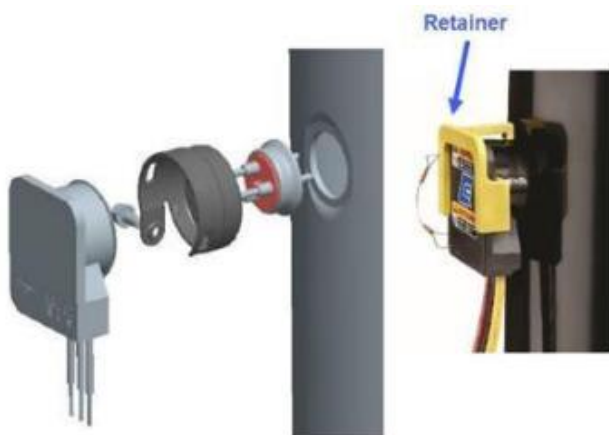


Figure 2 Principle of Connecting the Molded Plug Power Cable to the Connection Pins

Removing the Molded Plug Power Cable

- Shut off power supply.
- Remove the retainer from the connection.
- Remove the molded plug connector from the connection pins.

Service Procedures

Copeland Scroll Functional Check

Refrigeration 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 Copeland™ 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. Check for:
 - A. Single-Phase Compressor

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

- B. Three-Phase Compressor

If the suction pressure does not drop and the discharge pressure does not rise, reverse any two of the compressor power leads and reapply power to make sure the compressor was not wired to run in the reverse direction.

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

Note that these ZSH, ZFH, YSH, YFH three-phase models use uniquely designed motors that do not have equal resistances on all three windings. Resistance

may differ from leg-to-leg. Refer to related data in Online Product Information (OPI) for published resistance specifications for a specific model. Carefully compare measured motor resistance values to published values before replacing the compressor as being defective.

Resistance values and other technical data can be found at www.copeland.com/OPI or from Copeland Mobile App.

New Installation

- The copper-coated steel suction, discharge, and injection tubes on scroll compressors can be brazed in approximately the same manner as any copper tube.
- Recommended brazing material – Any Silfos material is recommended, preferably with a minimum of 5% silver. However, 0% silver is acceptable.
- Use of a dry nitrogen purge to eliminate possibility of carbon buildup on internal tube surfaces is recommended.
- Be sure process tube fitting I.D. and process tube O.D. are clean prior to assembly.
- Apply heat in Area 1. As tube approaches brazing temperature, move torch flame to Area 2. (See Scroll Tube Brazing Figure 3 below.)
- 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 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:

- Recover 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.
- Reinsert tubing fitting.
- Heat tube uniformly in Area 1, moving slowly to Area 2. When joint reaches brazing temperature, apply brazing material. (See Figure 3)
- Heat joint uniformly around the circumference to flow braze material completely around the joint.
- Slowly move torch in Area 3 to draw braze material into the joint. Do not overheat joint.

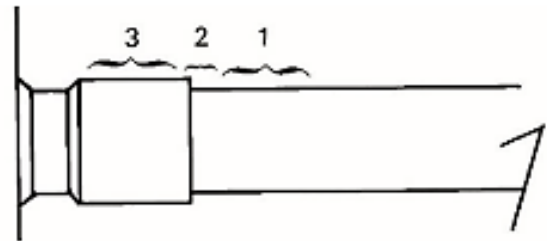


Figure 3 Scroll Tube Brazing

For general Copeland Scroll compressor please log in to Online Product Information at www.copeland.com/OPI, refer to the Application Engineering bulletins listed below, or contact your Application Engineer.

<p>AE4-1380</p>	<p>Guide for the Use of R-290 Refrigerant in Copeland™ Refrigeration Compressors</p>
<p>Form 93-11</p>	<p>Refrigerants and lubricants approved for use in Copeland™ compressors</p>

Figures & Tables

Table 1 Approved Refrigerants/Lubricants

Model	HP	Refrigerant	Lubricant
YFH03KAE	1	R404A/R407A/R448A/R449A/R507/R454A/R454C/R455A	POE
YFH04KAE	1.3	R404A/R407A/R448A/R449A/R507/R454A/R454C/R455A	POE
YFH05KAE	1.5	R404A/R407A/R448A/R449A/R507/R454A/R454C/R455A	POE
YFH07KAE	2	R404A/R407A/R448A/R449A/R507/R454A/R454C/R455A	POE
YFH08KAE	3	R404A/R407A/R448A/R449A/R507/R454A/R454C/R455A	POE
YFH03KAU	1	R290	POE
YFH04KAU	1.3	R290	POE
YFH05KAU	1.5	R290	POE
YFH07KAU	2	R290	POE
YFH08KAU	3	R290	POE
YSH07KAE	1	R134a/R22/R404A/R407A/R407C/R448A/R449A/R507/R454A/R454C/R455A	POE
YSH09KAE	1.3	R134a/R22/R404A/R407A/R407C/R448A/R449A/R507/R454A/R454C/R455A	POE
YSH12KAE	1.9	R134a/R22/R404A/R407A/R407C/R448A/R449A/R507/R454A/R454C/R455A	POE
YSH16KAE	2.5	R134a/R22/R404A/R407A/R407C/R448A/R449A/R507/R454A/R454C/R455A	POE
YSH19KAE	3	R134a/R22/R404A/R407A/R407C/R448A/R449A/R507/R454A/R454C/R455A	POE
YSH06KAU	1	R290	POE
YSH08KAU	1.3	R290	POE
YSH11KAU	1.9	R290	POE
YSH15KAU	2.5	R290	POE
YSH18KAU	3	R290	POE
ZFH03KAE	1	R404A/R407A/R448A/R449A/R507	POE
ZFH04KAE	1.3	R404A/R407A/R448A/R449A/R507	POE
ZFH05KAE	1.5	R404A/R407A/R448A/R449A/R507	POE
ZFH07KAE	2	R404A/R407A/R448A/R449A/R507	POE
ZFH09KAE	3	R404A/R407A/R448A/R449A/R507	POE
ZSH07KAE	1	R134a/R22/R404A/R407A/R407C/R448A/R449A/R507	POE
ZSH09KAE	1.3	R134a/R22/R404A/R407A/R407C/R448A/R449A/R507	POE
ZSH13KAE	1.9	R134a/R22/R404A/R407A/R407C/R448A/R449A/R507	POE
ZSH19KAE	2.5	R134a/R22/R404A/R407A/R407C/R448A/R449A/R507	POE
ZSH20KAE	3	R134a/R22/R404A/R407A/R407C/R448A/R449A/R507	POE

See Copeland [Form 93-11](#) for a complete list of all Copeland approved lubricants.

Table 2 Charge Limits

Model	A1 Charge Limit	A2L Charge Limit	A3 Charge Limit
YFH*KA	8 lbs.	8 lbs.	.33 lbs.
YSH*KA	8 lbs.	8 lbs.	.33 lbs.
ZFH*KAE	8 lbs.	N/A	N/A
ZSH*KAE	8 lbs.	N/A	N/A

For charge limits for YS / YF compressors using A2L refrigerants see UL/CSA 60335-2-89 All systems must be listed to UL/CSA 60335-2-89 – Charge limits consistent with UL/CSA 60335-2-89

Table 3 Crankcase Heater

Model	Part Number	Volts	Watts	Length (in)
YFH*KA, YSH*KA, ZFH*KAE & ZSH*KAE	018-0094-00	240	40	21
	018-0094-01	120	40	21
	018-0094-03	480	40	21

Table 4 Conduit Ready Heater Terminal Box Kits

Models	Kit Number
YFH*KA, YSH*KA, ZFH*KAE & ZSH*KAE	998-0358-00

Table 5 Discharge Thermostat Line Kits

Kit Number	Conduit Lead Connector	Alarm Contact
998-0540-00	NO	NO
998-0548-00	NO	YES
998-7022-02	YES	NO

Table 6 DTC Valve Kit

Kit Number	Connection	Setpoint
998-0746-00	3/8" SWEAT	250 °F

Table 7 Recommended Oil Charge by Model Family

Model	Initial	Recharge
YFH*KA, YSH*KA, ZFH*KAE & ZSH*KAE	25 oz	19 oz

Table 8 Rotalock Fitting Adapters

Models	Suction Tube	Discharge Tube
YFH*KA, YSH*KA, ZFH*KAE & ZSH*KAE	998-0034-01	998-0034-15

Table 9 Voltage Ranges (Typical)

Voltage	60 Hertz Rating			50 Hertz Rating			
	Code	Rating	Min.	Max.	Rating	Min.	Max.
	C	208/230-3	187	253	200-3	180	220
	D	460-3	414	506	280/420-3	342	462
	E	575-3	518	633	500-3	450	550
	V	208/230-1	197	253	200-1	180	220
	5	200/230-3	180	253	200/220-3	180	242
	7	380-3	342	418	X	X	X
	J	265-1	239	292	220/240-1	198	264
	R	X	X	X	220/240-3	180	264

Table 10 Approved Mounting Kits

Kit Number	Grommet Number	Grommet Durometer
527-0044-15	027-0262-00	30-35
527-0157-00	027-0186-02	60-70

Table 11 Pressure Control Settings

Model	Pressure Control	R-134A	R-22	R-290	R-404A / R-507	R-407A / R448A / R449A	R-407C	R-454A / R454C / R455A
YFH*KAE	Low	N/A	N/A	N/A	0 PSIG	2 in Hg	N/A	3 in Hg
	High	N/A	N/A	N/A	455 PSIG	428 PSIG	N/A	406 PSIG
YSH*KAE	Low	4 PSIG	17 PSIG	N/A	8 PSIG	6 PSIG	1 in Hg	3 PSIG
	High	340 PSIG	425 PSIG	N/A	450 PSIG	428 PSIG	425 PSIG	406 PSIG
YFH*KAU	Low	N/A	N/A	0 PSIG	N/A	N/A	N/A	N/A
	High	N/A	N/A	330 PSIG	N/A	N/A	N/A	N/A
YSH*KAU	Low	N/A	N/A	4 PSIG	N/A	N/A	N/A	N/A
	High	N/A	N/A	330 PSIG	N/A	N/A	N/A	N/A
ZFH*KAE	Low	N/A	N/A	N/A	0 PSIG	2 in Hg	N/A	N/A
	High	N/A	N/A	N/A	455 PSIG	428 PSIG	N/A	N/A
ZSH*KAE	Low	4 PSIG	17 PSIG	N/A	8 PSIG	6 PSIG	1 in Hg	N/A
	High	340 PSIG	425 PSIG	N/A	450 PSIG	428 PSIG	425 PSIG	N/A

Figure 4 ZSH*KAE Application Envelope for R134a YSH *KAE Application Envelope for R134a

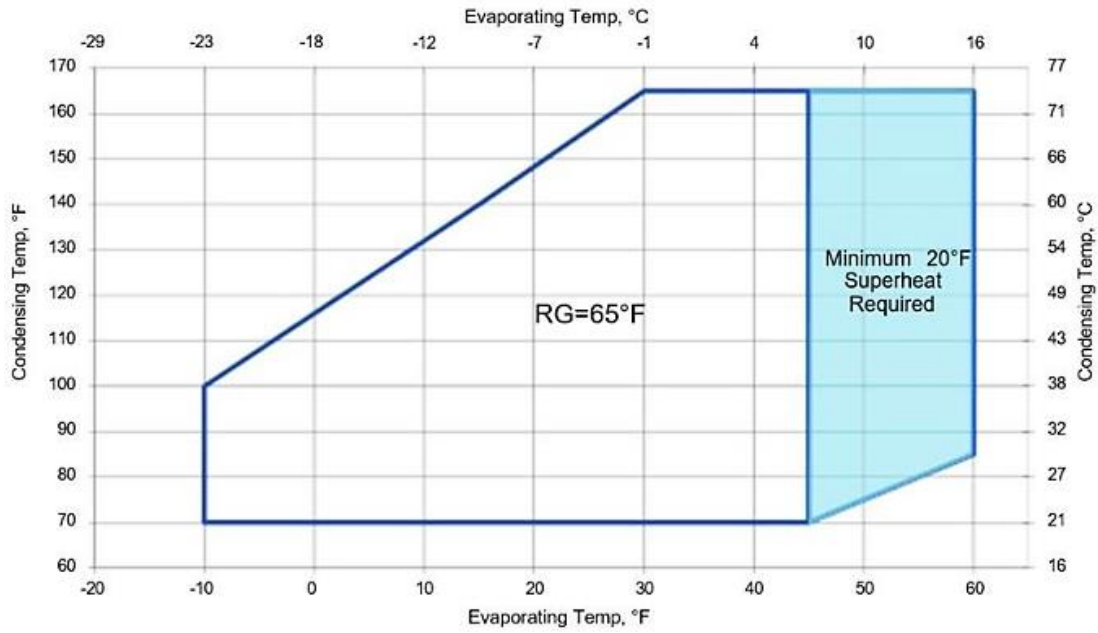


Figure 5 ZSH*KAE Application Envelope for R22 YSH *KAE Application Envelope for R22

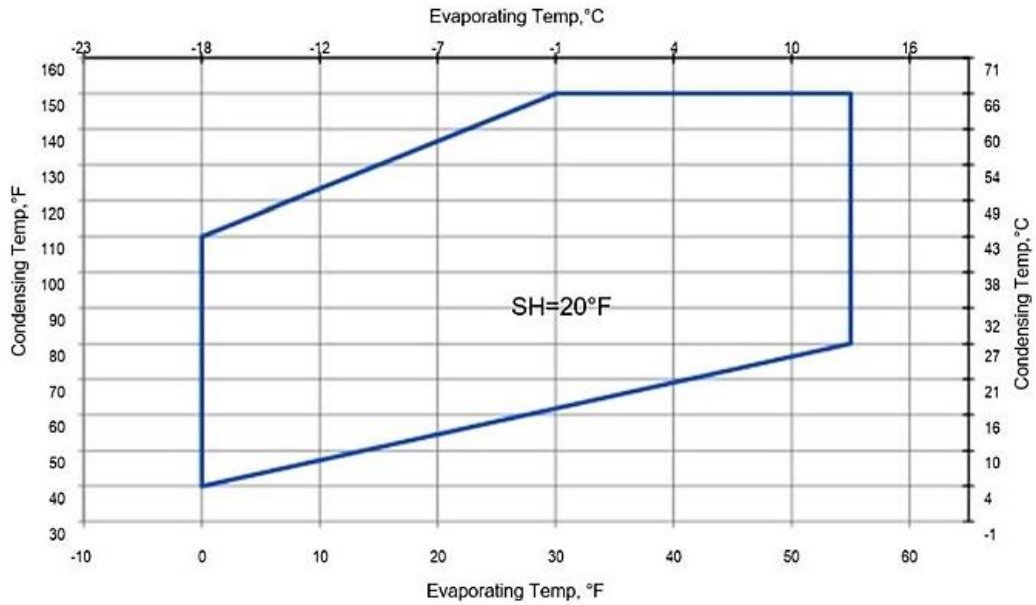


Figure 6 ZSH*KAE Application Envelope for R404A / R507 YSH*KAE Application Envelope for R404A / R507

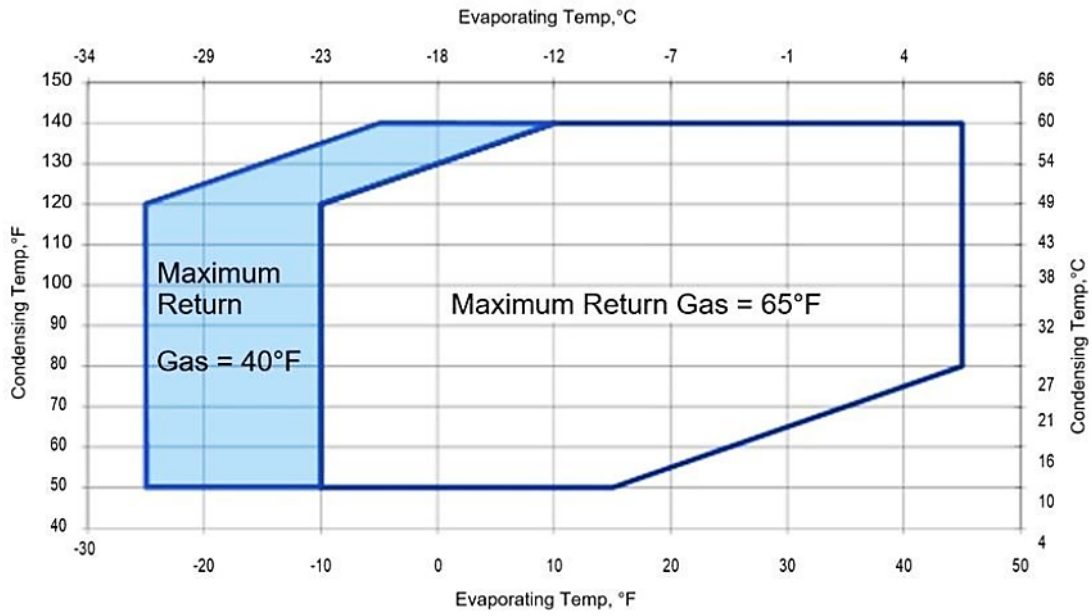


Figure 7 ZSH*KAE Application Envelope for R407A / R407C / R448A / R449A YSH*KAE Application Envelope for R407A / R407C / R448A / R449A / R454A / R454C / R455A

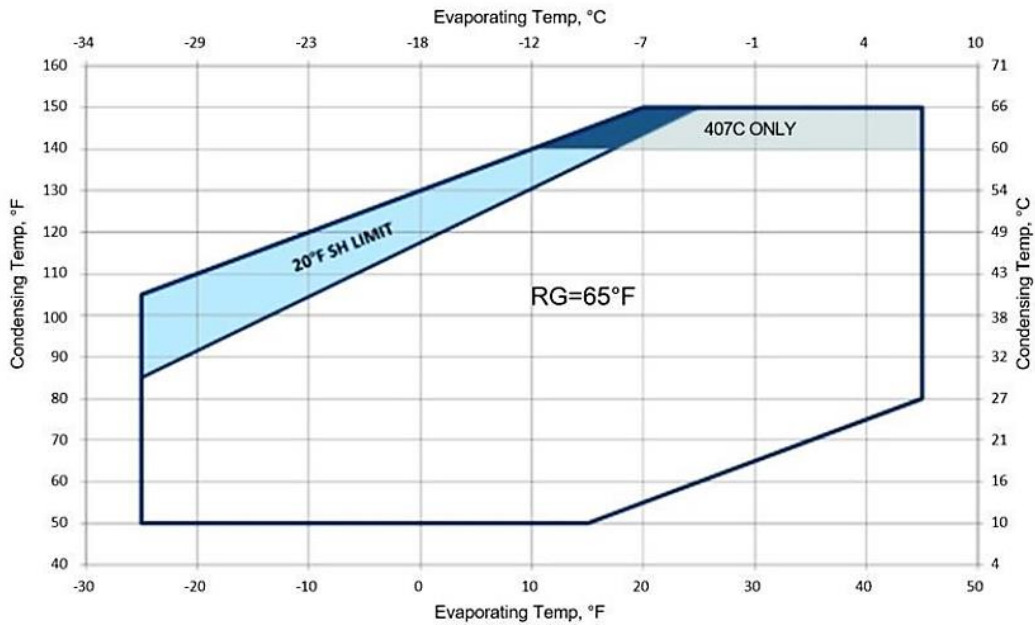


Figure 8 ZFH*KAE Application Envelope for R404A / R507 / R407A / R448A / R449A YFH*KAE Application Envelope for R404A / R507 / R407A / R448A / R449A / R454A / R454C / R455A

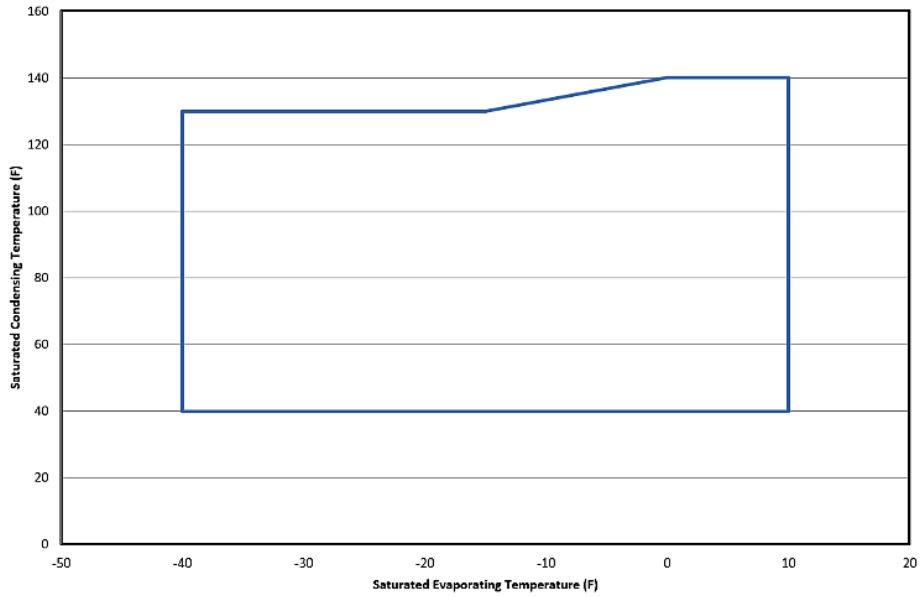


Figure 9 YSH*KAU Application Envelope for R290

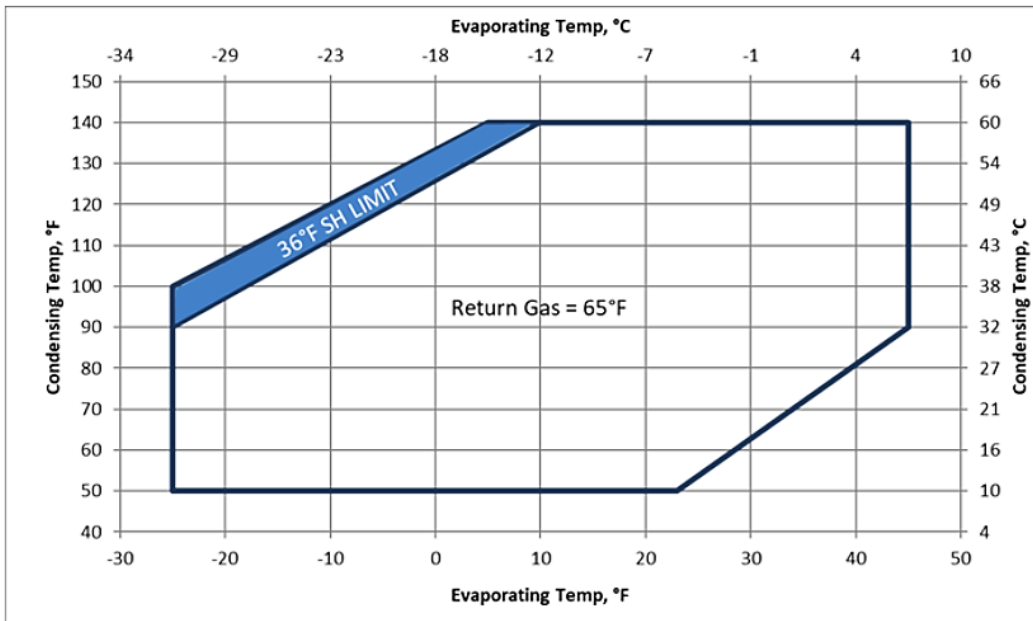


Figure 10 YFH*KAU Application Envelope for R290

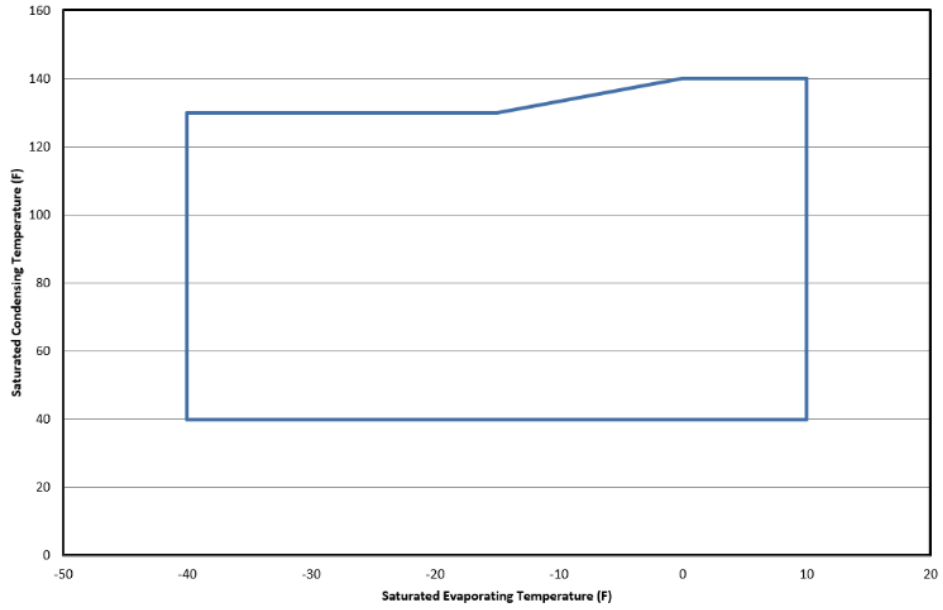


Figure 11 Crankcase Heater Position



Figure 12 Acceptable Oil Level



Figure 13 Small Refrigeration Scroll Condensing Unit Mounting

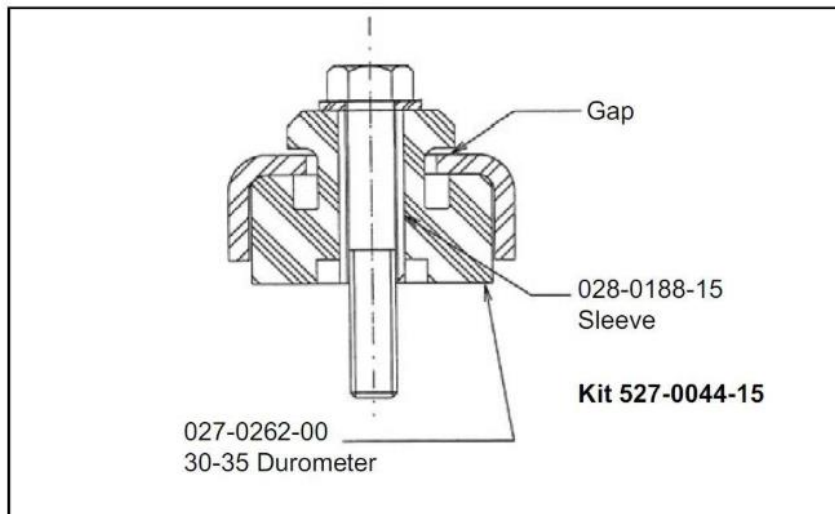


Figure 14 Motor Terminal (Fusite) Connections

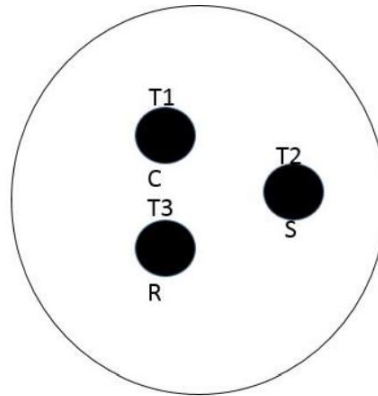
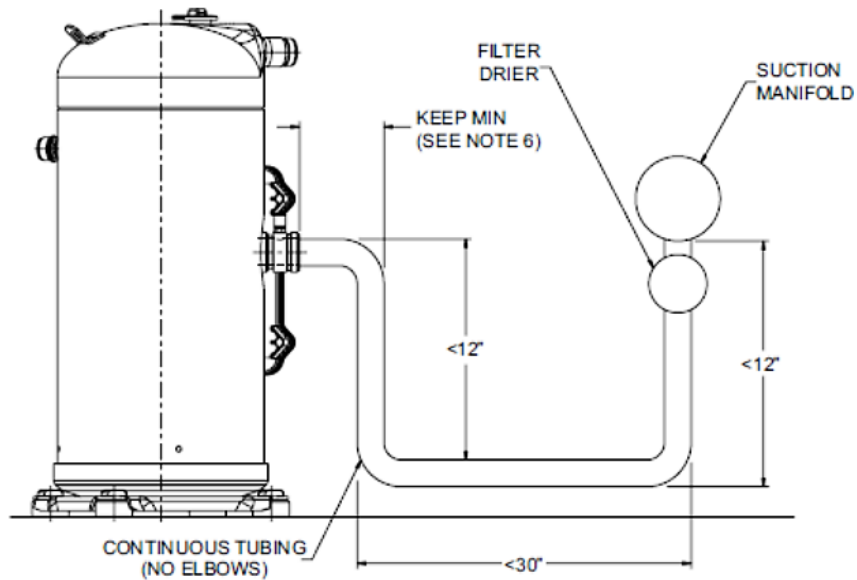


Figure 15 Typical Suction Tubing



NOTES:

1. The above tubing configurations are guidelines to minimize tube stress.
2. Follow similar guidelines for discharge tubing and oil return tubing as needed.
3. If a run of over 20" is required, intermediate clamps may be necessary.
4. Do not hang weights on tubing (e.g. filter drier on suction tubing) except after clamps or close to the header.
5. Tube runs of less than 8" are not recommended.
6. This dimension should be made as short as possible (e.g. 2" or less) but still insuring a proper braze joint.
7. The above tubing recommendations are based on runs with no elbow joints. The use of continuous tubing is preferred.

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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