Carlyle Commercial Scroll Compressor

Commercial Models Application Guide

Carlyle™

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This application guide contains much of the same information as that in the standard scroll product guide, however special attention should be paid to Section 4, as the commercial line has unique requirements.

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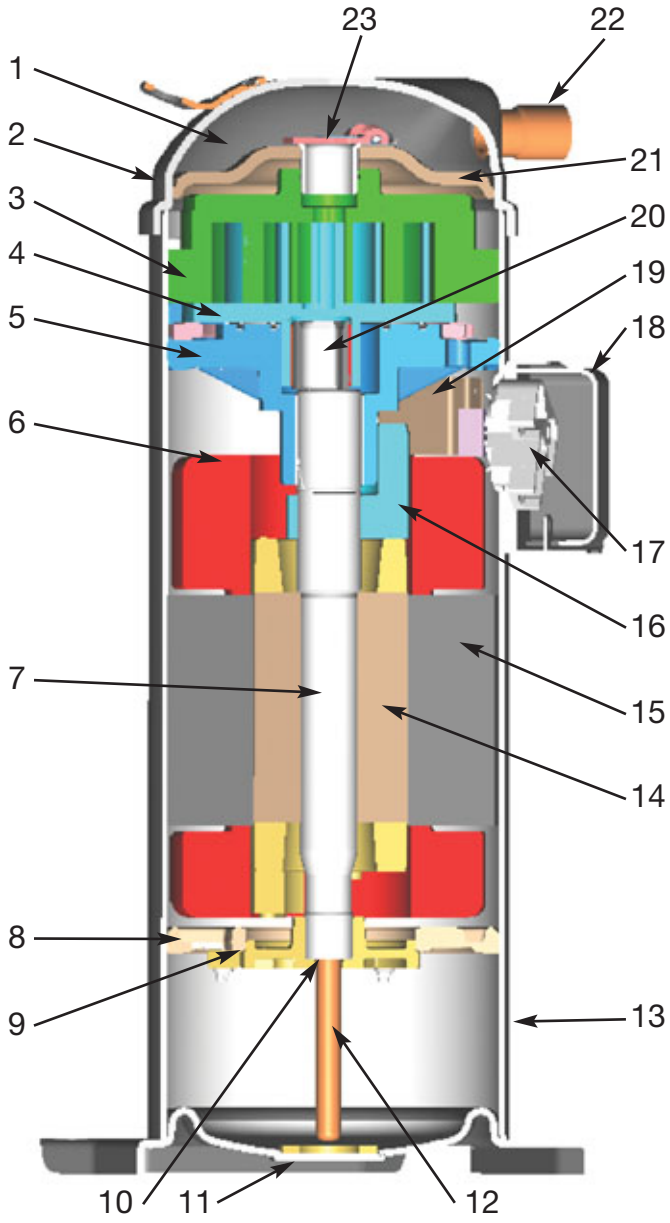


Figure 1-1
Scroll Compressor Components

A cutaway view of the scroll compressor with key components labeled is shown in Figure 1-1. The motor stator is rigidly attached to the shell. The rotor is shrunk onto the eccentric shaft. The shaft is supported by two bearings, one in the crankcase and the second below the motor.

2.0 Key Features of CARLYLE Scroll Compressors

General Compressor Specifications

2.1 Condensing & Evaporating Temperature Ranges

The operating envelope for **CARLYLE** commercial scroll compressors is shown in Table 2-1 where the condensing and evaporating temperatures represent the range for steady-state operation. Under transient conditions, such as start-up and defrost conditions (for heat pump applications), the compressor may operate outside this envelope for short periods.

Table 2-1 Operating Ranges

TEMPERATURE RANGE	°F	°C
Evaporating	-25 to 55	-31.7 to 12.8
Condensing	80 to 155	26.7 to 68.3
Maximum Discharge	280	137.8

2.2 Insulation Resistance/Dielectric Strength

The insulation resistance shall be greater than 1 mega-ohm when measured with a 500 volt-direct current mega-ohm tester.

Each compressor motor is tested at the factory with a high potential voltage (hi-pot) above the UL requirement of [(2 x Rated Voltage + 1000) X 1.25] for longer than the 1 second required. The leakage current must be less than 0.5 mA.

CARLYLE commercial scroll compressors are configured with the motor below the pump assembly located at the top of the shell. As a result, the motor is partially immersed in refrigerant and oil. The presence of refrigerant around the motor windings will result in lower resistance values and higher leakage current readings. These readings are not cause for concern and do not indicate a faulty compressor. It is recommended to operate the system for a brief period of time to redistribute the refrigerant throughout the system, and then retest the compressor for insulation resistance or current leakage.

2.3 Residual Moisture

Every compressor is dehydrated, evacuated, and charged with dry nitrogen at the factory prior to shipment. Maximum residual moisture level is 500 mg (0.0176 oz).

2.4 Oil Charge Levels

The compressors are charged with oil at the factory to the levels shown in Table 2-2. Alkylbenzene oil is used for R-22 models. The oil type is either Sontex SA32 with 1.5% Syn-O-Ad or Zerol 150 with 1.5% Syn-O-Ad. R-407C models use POE oil, HATCO FRL 32ST, ISO viscosity grade 32. If additional oil charge is added for in-service conditions, use only the oils noted above.

Table 2-2 Oil Charge Levels

Model	Oil Charge ml (fl. oz.)	Recharge ml (fl. oz.)
SR_78	2129 (72)	1952 (66)
SR_81	2366 (80)	2188 (74)
SR_94 SR_109 SR_120	2662 (90)	2484 (84)

2.5 Starting Voltage

At a temperature of 20°C (68°F) or above, the compressor will start at 90% of the lowest nameplate voltage when measured near to the compressor with the compressor energized. Voltage should NOT be measured directly at the compressor terminals under energized conditions with the terminal cover removed. Prior to energizing, verify that leads and terminal connectors are in proper working condition. The closest point of safe terminal voltage measurement is typically at the load side of the contactor.

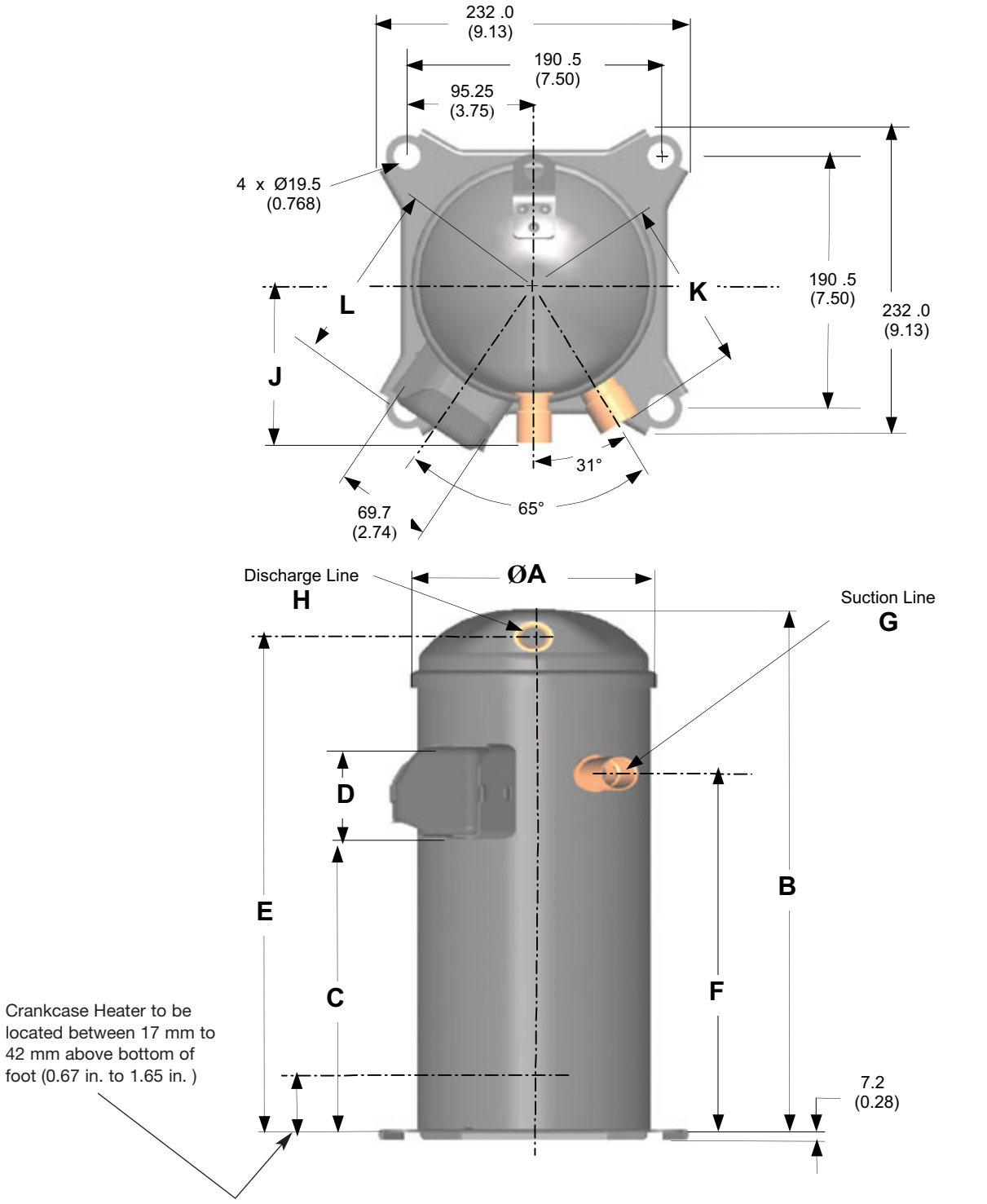
2.6 Internal Motor Protection

CARLYLE commercial scroll compressors are protected by internal line breaks mounted on the motor windings. These protectors are automatic reset devices containing a snap action bimetal switch.

Internal protectors respond to over current and high temperature. They are designed to interrupt motor current under a variety of fault conditions. In three-phase compressors these devices also provide protection during primary and secondary single-phase conditions.

2.7 Dimensions

An outline drawing depicting overall dimensions of the compressors is shown in Figure 2-1. For more detailed information refer to the specific product specification document for your model.



MODEL	A	B	C	D	E	F	G	H	J	K	L
SR78 TO SR81	184.1 (7.25)	511.3 (20.13)	286.4 (11.28)	93.0 (3.66)	484.3 (19.07)	350.2 (13.79)	28.83 / 28.65 (1.125) I.D. x 16.7 (0.65) DEEP	22.48 / 22.31 (0.88) I.D. x 22.3 (0.88) DEEP	119.5 (4.70)	124.6 (4.91)	133.1 (5.24)
SR94 TO SR120		517.6 (20.38)			490.6 (19.31)						

Figure 2-1 Compressor Outline Dimensions

Note: All dimensions are in millimeters. ( ) Denotes inches.

3.0 System Design Considerations

3.1 General

The successful application of scroll compressors is dependent on a good match between the system design and the compressor. A poorly matched system will result in the compressor running beyond the limitations specified in this manual. This may result in poor performance and/or reduced reliability.

3.2 Sound Levels

3.2.1 At Start-Up

During the start-up transient it is natural for the compressor sound levels to be slightly higher. Scroll compressor models exhibit very little start-up transient sound. If the compressor is mis-wired in 3-phase models, the compressor will run in the reverse direction. The reverse rotation is characterized by an objectionable sound from the compressor. This can be corrected by disconnecting power and switching any two power leads at the unit contactor. NEVER switch leads directly at the compressor.

3.2.2 Normal Running

Scroll compressors are designed with optimized discharge ports and wrap geometry to control the sound levels of each compressor. Properly designed shock loops for suction and discharge connecting tubes will enhance the sound level benefit of the scroll, as well as reduce vibration and premature tube breakage. (Tube design and testing information is available from the Application Engineering Department).

The use of a sound shield is not required, but is acceptable if an application requires it.

3.3 Voltage Range

Running voltage measured at the compressor between terminals should be within ± 10% of the nominal rated voltage of the compressor to ensure continued operation.

For three-phase applications the voltage measured at the compressor terminals for any phase should be within ± 2% of the average for all phases.

Warning: For safety reasons, these voltage measurements should be at the unit contactor, not at the compressor terminals. Always keep the terminal cover in place when the compressor is energized.

3.4 Refrigerant

The **CARLYLE** commercial scroll compressor was designed to operate with Refrigerant-22 (using Alkylbenzene oil) and R-407C (using polyolester oil) (see product bulletin).

3.5 Evaporating Temperature Range

The minimum continuous saturated suction temperature is -31.7°C (-25°F), which corresponds to a pressure of 50.9 kPa (7.39 psig) for R-22 and 25.5 kPa (3.7 psig) for R-407C. The maximum continuous saturated suction temperature is 12.8°C (55°F), which corresponds to a pressure of 638.4 kPa (92.56 psig) for R-22 and 590.5 kPa (85.6 psig) for R-407C. During transient conditions such as start-up and defrost cycles (for heat pump applications) the compressor may operate beyond these limits for brief periods of time.

3.6 Condensing Temperature Range

The minimum continuous saturated discharge temperature is 26.7°C (80°F), which corresponds to a pressure of 989.4 kPa (143.6 psig) for R-22 and 950.4 kPa (137.8 psig) for R-407C. The maximum continuous saturated discharge temperature is 68.3°C (155°F), which corresponds to a pressure of 2791.1 kPa (405.1 psig) for R-22 and 2922.7 kPa (423.8 psig) for R-407C. During transient conditions such as start-up and defrost cycles (for heat pump applications), the compressor may operate beyond these limits for brief periods of time.

3.7 Maximum Discharge Gas Temperature

Discharge gas temperature should be measured with an isolated thermocouple attached to the discharge line 15.3 cm (6 inches) from the shell of the compressor. Maximum discharge gas temperature must not exceed 137.8°C (280°F) when the compressor is running within the approved operating envelope.

3.8 Maximum Suction Gas Temperature

Maximum suction gas temperature under steady-state operating conditions is 41°C (105°F).

3.9 Maximum Length and Elevation of Piping

In split system type applications, the maximum length of piping between the indoor and outdoor sections is not to exceed 15.25 m (50 feet). The maximum elevation difference between the indoor and outdoor section cannot exceed 7.62 m (25 feet). System manufacturers should specify precautions for any applications that exceed these limits to ensure compressor reliability.

3.10 Maximum Refrigerant Charge Without Suction Accumulators

Maximum refrigerant nameplate charge for the SR78/81/94/109/120 frame size is 7.3 kg (16 lb). Refer to Section 6.0 for outlining the suction accumulator requirements when maximum charge levels are exceeded.

3.11 Maximum Operating Angle of Inclination

The inclination from the vertical plane shall not exceed 7 degrees.

3.12 Maximum Operating Condition

The maximum load condition for long term operation is 638.5 kPa (92.6 psig) suction pressure and 2792 kPa (405 psig) discharge pressure for R-22, and 90% rated voltage. Pressures for R-407C are 590.5 kPa (85.6 psig) suction and 2922.7 kPa (423.8 psig) discharge.

3.13 Residual Moisture

Residual moisture content of the system with refrigerant charge should be less than 100 PPM by weight.

3.14 Residual Contaminants

Residual solid contaminants in the system should not exceed 28 mg per 1.0 kW of nominal system capacity. The compacted volume of solid contaminants should not exceed 0.07 cc per 1.0 kW of nominal system capacity.

3.15 Operation

CARLYLE commercial scroll compressors should never be used to evacuate an air conditioning or refrigeration system. This is because of the high volumetric efficiency, which can cause extremely low vacuums when the suction side of the compressor is closed or restricted. The low vacuum pressures may cause internal arcing at the electrical terminal. This could result in a failure of the hermetic terminal and ultimately a vented pin.

3.16 High-Pressure Ratio

Scroll compressors are fixed pressure-ratio machines and therefore operate more efficiently near the designed pressure-ratio. In the extreme case, do not exceed 7.5:1 pressure ratio (discharge pressure to suction pressure in psia) for extended periods.

4.0 System Requirements / Controls

**** Failure to follow System requirements could void the warranty***

4.1 General

The 6.5 through 10 ton commercial scrolls, while based on the SR platform, have several unique design changes and requirements.

4.2 High Pressure Control

The commercial product line is not equipped with internal pressure relief, therefore a high pressure switch is required, set no higher than 2932 kPa ± 35 kPa (425 psig ± 5 psig) for both R-22 and R-407C.

4.3 Crankcase Heat

To prevent excessive refrigerant migration during off cycles, a 70 watt (minimum) crankcase heater is required for this product line. For initial installation of pre-charged systems and any extended power interruptions, the heater should be energized for 24 hours prior to compressor startup.

The following 'bellyband' style heaters are approved for the **CARLYLE** commercial scrolls.

RCD Part No.	Watts	Lead Length	Volts
HT32BH857	70	68"	240
HT32BH858	70	68"	480

4.4 Filter/Drier

A properly sized filter/drier is required for all commercial scroll applications. Filter/driers are to be located in the liquid line.

4.5 Reverse Rotation Protection

Three phase, mis-wire protection is required for all applications. The selected phase sensing device should lockout the compressor from operation in reverse.

4.6 Loss of Charge / Indoor Fan Failure Protection

The commercial scroll does not have internal thermal protection. Therefore, all applications require loss of charge and indoor fan failure protection.

4.6.1 Air Conditioning Protection

A/C protection consists of a low pressure switch in the low pressure side of the system set at 172 kPa (25 psig) nominal for R-22 and R-407C.

4.6.2 Heat Pump Protection

Heat pump protection consists of a discharge line thermostat set no higher than 138°C (280°F). The thermostat must be a manual lockout type device (or electrical lockout circuit) and be located within 152 mm (6 inches) of the compressor discharge connection. The discharge line thermostat must be insulated to insure proper sensing and operation.

4.7 Mounting Hardware

CARLYLE recommends the use of a neoprene grommet with a durometer range of 34-45. Mounting hardware: bolts, nuts, washers, and sleeve should be low carbon steel that is treated to withstand at least 100 hours of salt spray testing.

7SC5828B	Neoprene grommet
6SC5829B	Sleeve washers, and screw assembly

5.0 System Assembly and Process Considerations

5.1 Compressor Holding Charge

Each compressor is shipped with a dry nitrogen nominal holding charge between 71 kPa and 101 kPa (10.3 psig and 14.7 psig) and is sealed with elastomer plugs. The plugs should be removed with care to avoid the loss of oil when the holding charge is released.

5.2 Tube Brazing Procedure

During brazing of the unit piping to the compressor, a nitrogen purge must be used. Do not bend the discharge or suction lines or force the unit piping into the compressor connections since this will increase stresses and potential for failure. For brazing procedures and recommended material, see Figure 5-1 and the procedures listed below.

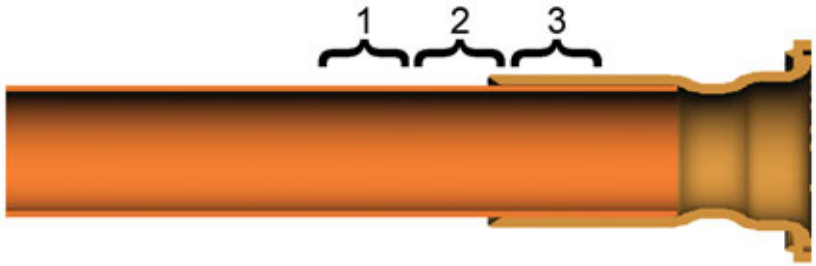


Figure 5-1

1. Recommended brazing material: A copper-phosphorus brazing material is recommended for copper suction and discharge fittings. Sil-fos and other silver braze materials are acceptable as well.

2. Clean the compressor tubing and system piping prior to assembly. Do not remove copper plating.

3. A double-tipped torch is recommended during brazing.

a.) Apply heat to Area 1, moving the torch up and down and rotating around the tube in order to heat the tube evenly. It will become a dull orange color.

b.) Move the torch to Area 2 until it reaches a dull orange color. Move the torch up and down and rotate it around tube in order to heat the tube evenly.

c.) Add braze material to the joint while moving the torch around joint to flow braze material evenly around the circumference.

d.) After braze material flows around the joint, move torch to Area 3. This will draw the braze material into the joint. The time spent heating Area 3 should be minimal, in order to keep excess braze material from entering the compressor.

5.3 System Evacuation

The system must be evacuated to a vacuum level of at least 200 microns of mercury to remove residual moisture.

5.4 System Charging

It is recommended that system charging be done using the weighed charge method, by adding refrigerant to the high side of the system. Charging the high and low sides of a system with gas simultaneously and at controlled rate is also an acceptable method. Do not exceed the recommended unit charge and never charge liquid to the low side.

5.5 Wiring Connections

The **CARLYLE** commercial scroll compressors will only compress gas in the counter-clockwise direction when viewed from the top. Three-phase motors will start and run in either direction depending on the phase angles of the supplied power. This requires care during installations to ensure the compressor is operating in the proper direction. Verification of proper rotation is done by observing suction and discharge pressures when the compressor is energized. A decrease in discharge pressure and an increase in suction pressure indicate reverse rotation. After several minutes of operation the compressor line break will de-energize the compressor. In order to correct this, disconnect power and switch any two power leads at the unit contactor. Never switch leads directly at the compressor.

Internal wiring of the **CARLYLE** commercial three-phase scroll compressor is consistent with the direction or rotation. As a result, once the correct phasing is determined for a specific system or installation, connecting properly phased power leads to the same terminals should maintain proper rotation direction. A phase monitor must be applied to ensure correct rotation when power is initiated. Figure 5-2A shows the electrical terminal labeling for reference when wiring the compressor. For three phase applications the terminals are labeled T1, T2 and T3. Each compressor is labeled with both sets of labels as shown in Figure 5-2. Compressors are available with ring terminals, shown in Figure 5-3.

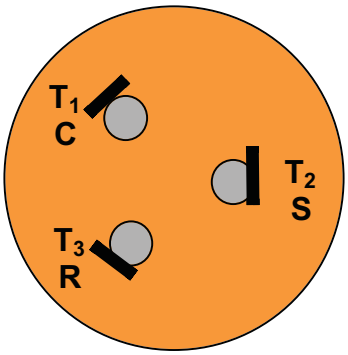


Figure 5-2

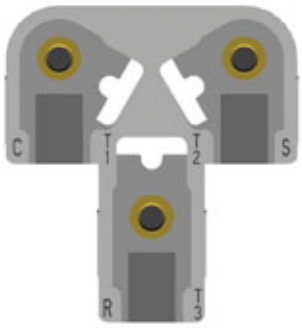


Figure 5-3

6.0 Service Considerations

6.1 System Evacuation

When evacuating a system in the field, it is extremely important to use a vacuum manifold set with at least 2 vacuum lines connected to the system. One line must be connected to the high side of the system and one line must be connected to the low side of the system. This procedure is necessary to ensure that the system is completely evacuated, since the scroll sets can seal under some non-energized conditions and in turn isolate the high and low sides from each other. If this situation occurs and only a single evacuation line is used it is possible to unknowingly leave some charge in the system. This could create a hazard if the system tubing is unbrazed with a refrigerant charge still present in the system. Whenever the compressor is replaced, the filter drier should be replaced at the same time. Please be sure to follow all government regulations regarding refrigerant reclamation and storage.

6.2 Unbrazing System Components

The preferred method of replacing a compressor is to cut the connecting lines using a tubing cutter, however unbrazing is acceptable using the following precautions. Before unbrazing any system component, it is extremely important to check both the high and low sides of the system with manifold gauges to ensure that all refrigerant has been reclaimed. **A refrigerant and oil mixture can ignite if it comes in contact with a flame.** This hazard dictates the caution that must be taken when unbrazing system components.

6.3 Replacing Filter Drier

Reference manufacturer's sizing instructions.

6.4 Brazing Procedure

Please note Figure 6-1 and the procedure below for field servicing of system components.

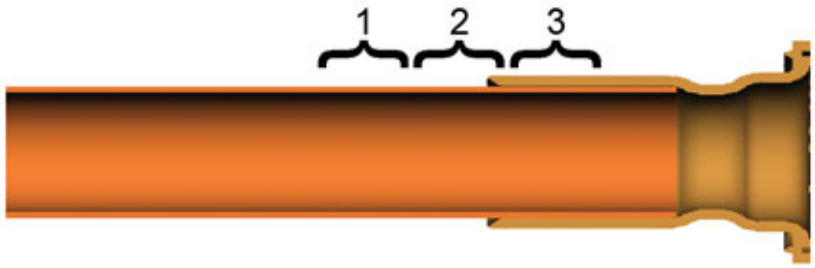


Figure 6-1

To Disconnect:

1. Disconnect power and remove wires from junction box.
2. Insure all pressure is out of the system (check high and low sides).
3. Heat Areas 2 and 3 slowly and uniformly until braze material softens and the tube can be pulled from the compressor fitting.

6.4 Brazing Procedures (Continued)

To Reconnect:

1. Recommended brazing material: See Section 5.2

2. Clean tube and fitting.

3. Reinsert tube into fitting.

4. Heat tube uniformly in Area 1, moving slowly to Area 2. When joint reaches brazing temperature (a dull orange color), apply the brazing material.

5. Heat joint uniformly around the circumference to flow the braze material completely around and into the joint.

6. Slowly move the torch into Area 3 to draw the braze material into the joint.

7. Do not overheat the joint. In some applications a cherry red color is indicative of overheating, which can weaken the joint and fittings.

6.5 CARLYLE Commercial Scroll Compressor Functional Check

In order to evaluate whether the **CARLYLE** commercial scroll compressor is functioning properly, the following procedures should be observed:

1. Voltage of the unit should be measured and verified as being correct.

2. An evaluation of the electrical system should be performed next. The status of the motor should be checked by using continuity and short to ground testing. The internal motor protector should be given time to reset if a continuity break is found in the motor windings.

3. Operation of indoor and outdoor fan/blower should be checked and verified as being correct.

4. Check charge levels by connecting service gauges to the suction and liquid service valves and then turning on the compressor. Correlate the operating pressures to the system manufacturer specifications for the existing conditions in which the unit is operating.

5. After checking the reversing valve and determining the operation is acceptable (heat pump only), verify that the compressor current is within the published compressor specifications at the proper operating conditions. If significant deviation from published specification occurs (+/- 15%), this may indicate a defective compressor.

6.6 Compressor Replacement – Motor Burn Out

If a motor burn out is present, follow the evacuation procedure in section 6.1. Remove and replace the liquid line filter drier, and install properly sized suction line filter drier (section 6.3). Be sure to use the proper clean out procedures (see section 6.6.1). The suction line filter drier should be checked within 48 hours to check the pressure drop across it. If a pressure drop exists that exceeds the filter drier recommendations, the liquid line and suction line filter driers must be replaced.

6.6.1 Clean Out Procedure

Recover refrigerant from the system using standard recovery procedures and equipment. Remove failed compressor. Install manufacture's recommended size filter-drier in the suction line, and an oversized filter drier in the liquid line. Evacuate system (section 6.1) before recharging with refrigerant through a filter drier. Monitor pressure drop across the filter driers as contaminants are filtered out for next four hours. If the maximum limit of pressure drop has been reached replace the filter drier and restart system.

7.0 Floodback Test Procedure

CARLYLE recommends the use of a thermostatic expansion valve for all air conditioning and heat pump system applications. The inherent benefit of TXVs is not only in modulating the system for varying load conditions, but protects the compressors from excessive floodback during adverse running conditions.

When the use of fixed orifice devices are designated in the system design, the following tests should be conducted.

ACCUMULATORS AND LIQUID FLOODBACK

Excessive liquid refrigerant floodback during steady state operation is a major system design consideration for all types of compressors. Oil dilution that occurs at excessive floodback can have a significant effect on bearing reliability. Suction accumulators may be required in some applications to prevent floodback.

The following test procedures are provided for determining the need for suction accumulators. Refer to Figure 7-1 and Figure 7-2 to determine when to apply the following test.

7.1 Excessive Liquid Floodback Test

7.1.1 Split Unit Cooling Mode

Set up a system with the smallest rated indoor section for the tested outdoor section. Charge the system with 120% system nameplate charge using 7.62 m (25 feet) of interconnecting tubing. The indoor and outdoor sections are to be operated with full airflow. Operate the compressor at nameplate voltage. Operate the system at 46.1°C (115°F) dry bulb outdoor and 19.4°C (67°F) dry bulb, 13.9°C (57°F) wet bulb indoor for a minimum of one hour. The sump superheat (compressor base temperature minus saturated suction temperature) must be in “ACCEPTABLE ZONE” as shown in Figure 7-3 or a suction accumulator is required.

7.1.2 Split Unit Heating Mode

Repeat the test in paragraph 7.1.1 except with the system in heating mode and with the outdoor temperature at -17.8°C (0°F) dry bulb. The sump superheat must be in the “ACCEPTABLE ZONE” as shown in Figure 7-3 or a suction accumulator is required.

7.2 Accumulator Application

7.2.1 Contact CARLYLE Application Department for information on proper sizing of accumulators.

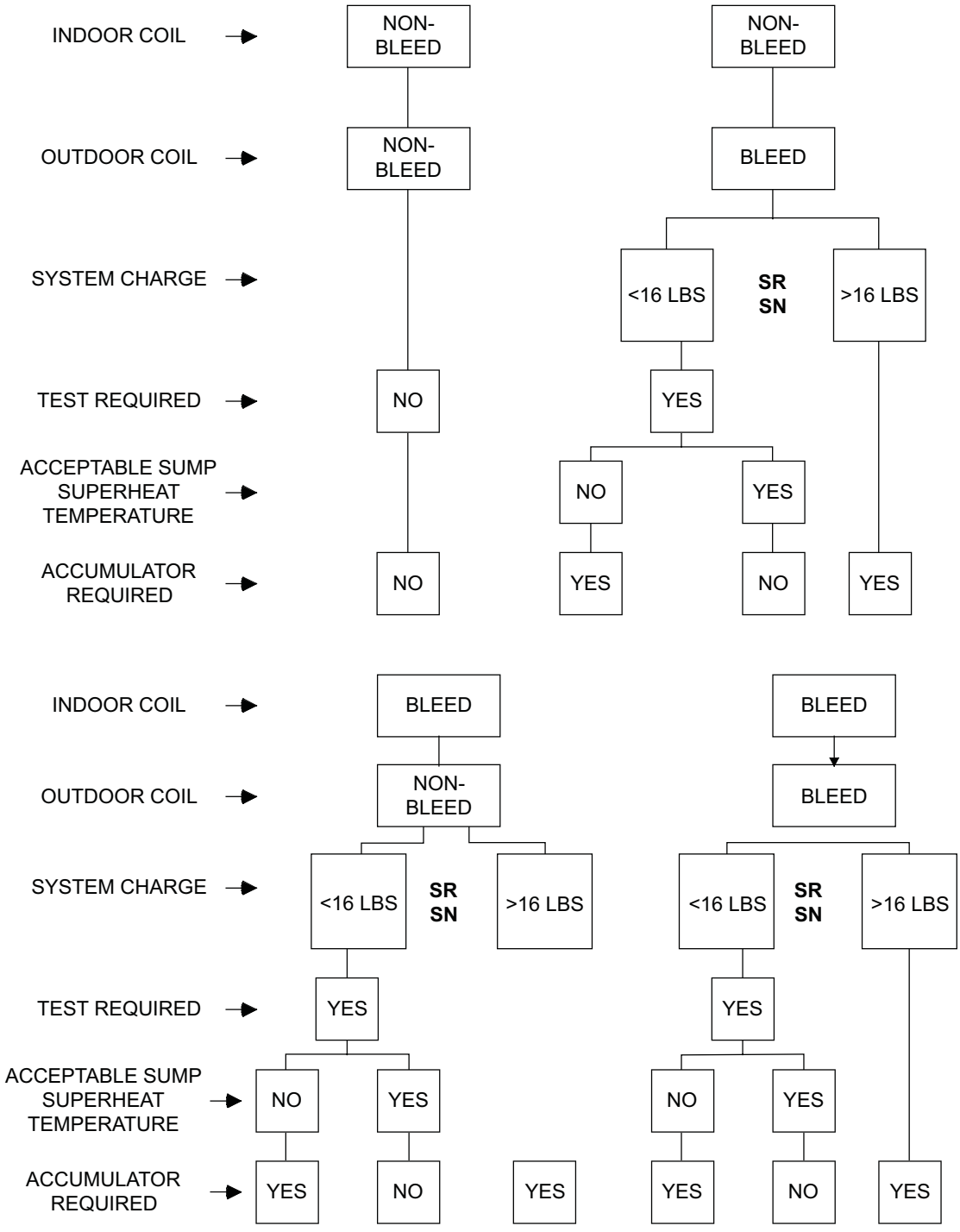


Figure 7-1 Heat Pump Floodback Test Procedure

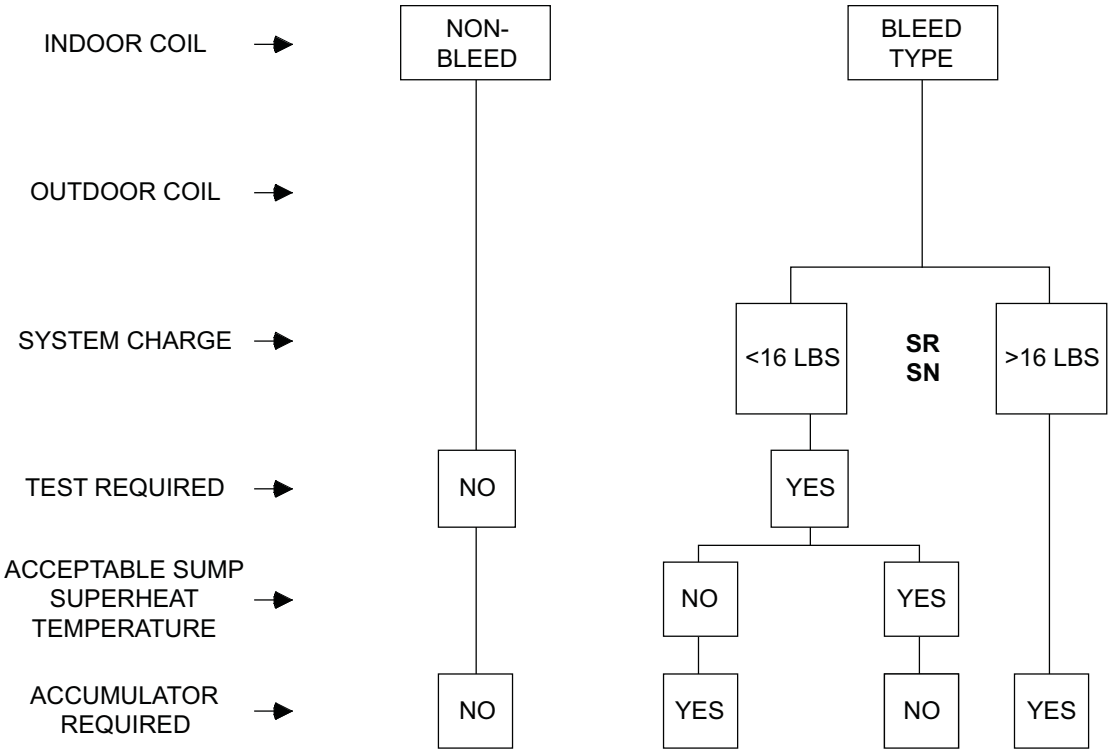


Figure 7-2: Air Conditioning Floodback Test Procedure

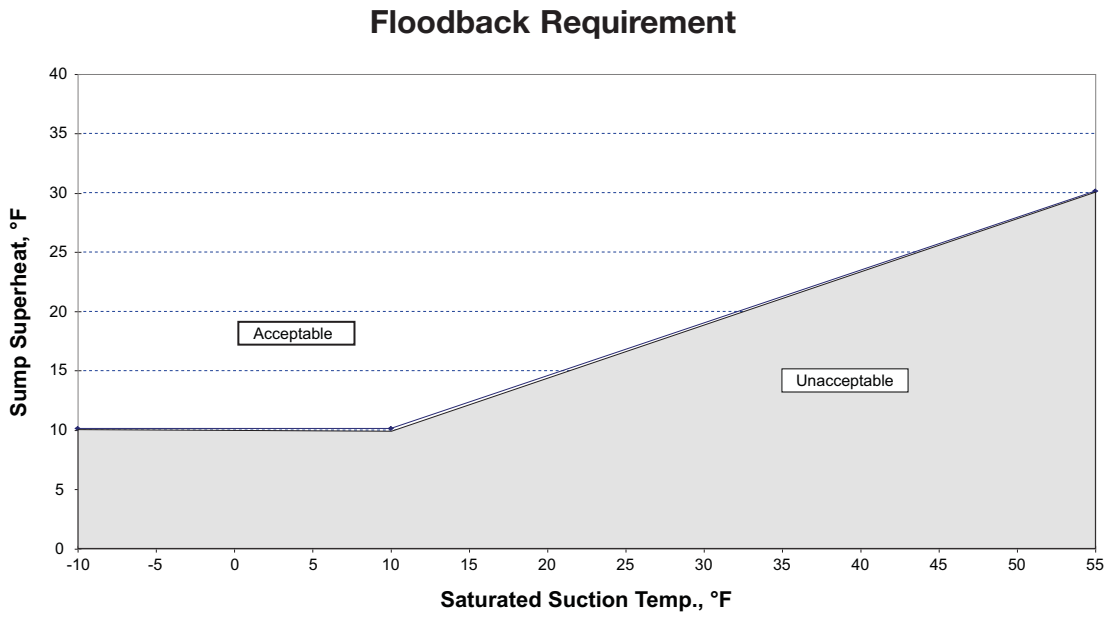


Figure 7-3

For more information about Carlyle's line of scroll compressors, contact:

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