Application Guidelines for Copeland™ Semi-Hermetic Compressors for Transcritical and Subcritical CO2 Applications

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Revision Tracking R6

Pg. 3– Pg. 4 – High Pressure sign added.
Pg. 6– Oil Management Control OMC-CO2 replaced to third party sensor in section "Oil Level Control".
Pg. 14 – 4MTLS20M and 4MTLS22M Operating Envelope added.
Pg. 15 – 4MSLS Operating Envelope added.
Pg. 27 – Relief Pressure Valves Rating includes new models.
Pg. 27 – Table 5: “4MSLS Model Selection” added.
Pg. 29 – Table related to obsolete P/N 998-0244-00 was deleted.
Safety Instructions

Copeland™ compressors are manufactured according to the latest U.S. and European Safety Standards. Particular emphasis has been placed on the user's safety. Safety icons are explained below and safety instructions applicable to the products in this bulletin are grouped on Page 3. These instructions should be retained throughout the lifetime of the compressor. You are strongly advised to follow these safety instructions.

Safety Icon Explanation

![DANGER](image) DANGER indicates a hazardous situation which, if not avoided, will result in death or serious injury.

![WARNING](image) WARNING indicates a hazardous situation which, if not avoided, could result in death or serious injury.

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

![NOTICE](image) NOTICE is used to address practices not related to personal injury.

![CAUTION](image) CAUTION, without the safety alert symbol, is used to address practices not related to personal injury.

![FLAMMABLE](image) FLAMMABLE

![PRESSURE](image) PRESSURE indicates a dangerous proximity to high pressure section of the system.
Instructions Pertaining to Risk of Electrical Shock, Fire, or Injury to Persons

**ELECTRICAL SHOCK HAZARD**
- Disconnect and lock out power before servicing.
- Discharge all capacitors before servicing.
- Use compressor with grounded system only.
- Molded electrical plug must be used when required.
- Refer to original equipment wiring diagrams.
- Electrical connections must be made by qualified electrical personnel.

**PRESSURIZED SYSTEM HAZARD**
- System contains refrigerant and oil under pressure.
- Remove refrigerant from both the high and low compressor side before removing 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.
- Use only approved refrigerants and refrigeration oils.
- Personal safety equipment must be used.
- Failure to follow these warnings could result in serious personal injury.

**BURN HAZARD**
- Do not touch the compressor until it has cooled down.
- Ensure that materials and wiring do not touch high temperature areas of the compressor.
- Use caution when brazing system components.
- Personal safety equipment must be used.
- Failure to follow these warnings could result in serious personal injury or property damage.

**COMPRESSOR HANDLING**
- Use the appropriate lifting devices to move compressors.
- Personal safety equipment must be used.
- Failure to follow these warnings could result in personal injury or property damage.

**Safety Statements**
- Refrigerant compressors must be employed only for their intended use.
- Only qualified and authorized HVAC or refrigeration personnel are permitted to install commission and maintain this equipment.
- Electrical connections must be made by qualified electrical personnel.
- All valid standards and codes for installing, servicing, and maintaining electrical and refrigeration equipment must be observed.
INTRODUCTION
This manual covers semi-hermetic Copeland™ CO₂ compressors. The 4MTLS Transcritical compressor models range from 5 HP to 30 HP and Subcritical 4MSLS compressor models range from 8 HP to 15HP. The performance listed in Table 3 and Table 4 at the end of this document correspond to 60 Hz operation.

The line-up of four-cylinder compressors are an ideal solution for transcritical medium temperature and low temperature subcritical operation used in booster system applications.

NOTE: The compressor is only one component which must be combined with many others to build a functional and efficient refrigeration system. Therefore, the information in this bulletin relates to all 4M*LS compressors for CO₂ medium temperature applications and subcritical low temperatures with standard equipment and accessories only.

This bulletin is intended to enable users to ensure the safe installation, starting, operation and maintenance of semi-hermetic compressors. It is not intended to replace the system expertise available from system manufacturers.

Nomenclature
The model designation contains the following technical information:

The Copeland 4MTLS compressor model numbers include the nominal capacity @ 60 Hertz, at 14°F/1305 psia/32°F/95°F (evaporating temperature/discharge pressure/return gas temperature/gas cooler exit temperature) with R-744 refrigerant.

Application Range
Qualified Refrigerants and Oils
Copeland 4MTLS are only applicable for transcritical CO₂ (R-744) applications, see Table 3 for list of available models. Copeland 4MSLS are only applicable for subcritical CO₂ (R-744) applications, see Table 4 for list of available models.

The approved oil is a polyolester (POE) lubricant, Emkarate RL68HB. Oil charge and recharge values are located in Emerson's Online Product Information at Emerson.com/OPI. For other oil types, contact Emerson.

Recommended quality for carbon dioxide purity grade is 4.0 [(≥ 99.99 %) H₂O≤10ppm, O₂≤10ppm, N₂≤50ppm] or higher.

4  MT  LS  82K  E  -  FSD  -  C00
1  2  3  4  5  6  7
1  4 = Number of Cylinders
2  MT = Transcritical Application
   MS = Subcritical Application
3  LS = Model Variation
4  82K = Nominal Capacity
   K= kBtu/hr, M= MBtu/hr
5  E = Oil Type (POE)
   L = Less Oil
6  FSC = 208-230 Volt Motor Version
   FSD = 460 Volt Motor Version
   TSE = 575 Volt Motor Version
7  C00 = Product Variation

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Application Limits

**CAUTION**

*Oil dilution! Bearing malfunction!* A minimum superheat of 9°F (5K) at the compressor inlet is required at all operating conditions to avoid oil dilution with CO₂ (R-744). 18°F (10K) superheat is recommended.

The compressor superheat should be controlled at a balanced level to not only avoid oil dilution in the compressor but also maintain a compressor head discharge temperature below 310 °F (154°C), especially at high compression ratios (high condensing and low evaporating temperatures). See Figure 3, Figure 4, Figure 6 and Figure 7 for compressor operating envelopes.

Design Features

Compressor Construction

All compressors are equipped with reed-style valve plates which cannot be dismantled. To maintain the high capacity of these compressors, the correct valve plate-to-body gasket must always be selected in case of exchange.

Each cylinder head has a plugged 1/8" - 27 NPTF tapped hole for connecting high-pressure switches. High-pressure switches must be calibrated and tested before putting the compressor into service. They must stop the compressor if 1755 PSIG (121 bar) is exceeded.

**NOTE:** Copeland™ 4M*LS compressors come equipped with an external high side safety valve that opens at 1960 psi (135 bar). Refer to Safety Valves section.

Compressor Cooling

All 4M*LS CO₂ compressors are suction gas-cooled. With suction gas-cooled compressors, the motor is cooled by refrigerant gas that flows through the motor. Depending on operating conditions, the maximum allowed suction gas superheat shall not exceed the values shown in the envelopes.

Oil Lubrication

40K to 15M capacity rated CO₂ compressors employ an oil impeller system to ensure lubrication at constant and variable speed conditions.

Oil Level

All 4MTLS CO₂ compressors are equipped with three sight glasses, two of them on the sides of the compressor and one on the front. See Figure 8.

The optimum oil level should be checked by operating the compressor until the system is stable and then checking the sight glass reading with the appropriate diagram.

Oil level on the side sight glasses should be a minimum 1/4 and maximum 3/4 of the sight glass. The level can also be checked within 10 seconds of compressor shutdown. See Figure 9.

The sight glass in the front of the compressor serves as an oil level check only. The oil level during operation should be at least 3/4 of the sight glass at all times. If the oil level is less than this on the front of the compressor, check the oil levels on the side sight glasses. Oil level controls cannot be mounted to this sight glass.

Sensors can be installed in the sight glass port on the side of the compressor. The sight glass is 1-1/8" – 18 UNEF with a tightening torque specification of 37-44 lb-ft.

Oil Level Control

40K to 15M capacity rated CO₂ do not have an oil pump, so an oil pressure safety control cannot be used to protect the compressor against lubrication problems for these compressors.

![Figure 1 - Oil Management Control OMC-CO2](image-url)
An OMC CO2 electronic oil level management system should be used that is suitable for both high and low pressure oil management systems. See Figure 1 for reference to this electronic device. See Table 8 for technical information about OMC-CO2

**INSTALLATION**

**WARNING**

*High pressure! Injury to skin and eyes possible! Be careful when opening connections on a pressurized item.*

**Compressor Handling**

**Delivery**

Please check whether the delivery is correct and complete; deficiencies should be reported immediately in writing.

**Standard Delivery:**
- Suction and discharge shut-off valves
- Oil charge, oil sight glass
- Mounting kit (rubber)
- CoreSense Protection module
- Electrical terminals
- Safety pressure relief valve on discharge
- Holding charge up to a gauge pressure of 2.5 bar (36.25 PSIG) (dry air)

**Transport and Storage**

**WARNING**

*Risk of collapse! Personal injuries! Move compressors only with appropriate mechanical or handling equipment according to weight. Keep in the upright position. Do not stack pallets on top of each other. Keep the packaging dry at all times. See Figure 10.*

Compressors are individually packed and may be delivered on pallets depending on quantity and size.

**Positioning and Securing**

**NOTICE**

*Handling damage! Compressor malfunction!*

Only use the lifting eyes whenever the compressor requires positioning. Using discharge or suction connections for lifting may cause damage or leaks. If possible, the compressor should be kept horizontal during handling. For safety reasons two lifting eyes should be fitted before moving a compressor (½" - 13 UNC). Refer to Figure 11.

**Installation Location**

Ensure the compressors are installed on a solid level base.

Temperature around the compressor should not exceed 150°F in order to avoid suction gas temperature increase and malfunctioning of electronics.

**Mounting Parts**

To minimize vibration and start/stop impulses, flexible mounting should be used. For this purpose, one set of rubber grommets for each of the 4MTLS models is delivered with each 4M*LS compressor. This Kit can be used for single and parallel operation. See Figure 12.

When 4M*LS compressors are mounted in racks, rubber mounting parts should be used. Solid mounting is acceptable to limit piping movement.

A compressor may be rigidly mounted (i.e., without rubber mounting or springs). In this case more shock and vibration loading will be transmitted to the frame. Use only the compressor mounting feet for fixation and avoid direct contact of other parts of the compressor housing with bordering components or base frame. If the installation requires a very high level of vibration absorption, additional vibration absorbers – available on the market - can be fitted between the rails and the foundation.

**Pressure Safety Controls**

**Safety Valves**

**WARNING**

*In the event that a safety valve activates, it is recommended to replace the valve to avoid nuisance trips. Always check the system for CO₂ loss after activation of the external pressure safety valve.*

**Safety Relief Valves/Standstill Pressures**

The compressor employs a factory installed pressure safety relief valve on the discharge side of the compressor. The valve setting provides that if the standstill pressures of 1960 psi (135 bar) are exceeded, the safety valve opens and vents CO₂ to ambient to prevent further pressure increase.
Emerson also offers a 1305 psi (90 bar) low pressure safety relief valve that may be employed in the field on the suction or low-pressure side of the compressor. This low-pressure valve is not required by UL and is not intended to replace the high-pressure valve but rather serve as a means of added compressor protection. Typically, system controls will serve as a means of protecting the suction or low-pressure side. With this valve employed, standstill pressures are 1305 psi (90 bar) low side and 1960 psi (135 bar) high side. See Table 5.

**NOTE:** The 1960 psi (135 bar) valve is M24 - LH thread and the 1305 psi (90 bar) valve is M24 - RH thread to prevent improper usage.

**Maximum Operating Pressures**

Maximum operating pressures are defined by the operating envelope, as seen in Figure 3, Figure 4, Figure 6 and Figure 7. It is recommended to connect the pressure cut-out devices directly to the compressor housing. For a high-pressure cut-out switch, connection port 4 may be used. For low-pressure cut-out connection, port 6 is recommended. See Figure 14 to locate high pressure and low-pressure connection positions as well as the port identity on the compressor.

**Shut Off Valve Design**

4M*LS compressors are factory equipped with both suction and discharge shut-off valves. The standard shut-off valves are flange valves with one flare connection port (lockable) for service. The service connection port is a 7/16” – 20 UNF with a blind cap SAE ¼” (material of blind cap is stainless steel 1.4301). Valve connection methods may be brazing, butt welding, or fillet welding – see Table 7 for connection sizes.

Torque values for the bolts, spindle cap, blind cap and gland seal may be found in Appendix 1. The spindle is front seated (closed to piping system) when the compressor is delivered.

Valve material is fine grained mild steel (EN 10025) with Fe/Cu5Sn5 plating material. For brazing connections where dissimilar or ferric metals are joined, a silver alloy rod with a minimum of 34% silver should be used, either flux coated or with a separate flux. For welding operations with stainless steel tubing, the welding consumable must be selected for dissimilar materials (SS to mild steel).

Optional discharge valves with compression fittings are available through Emerson and installed in the field. See Table 7 for offering.

**Screens**

**Screen blocking! Compressor breakdown!** Use screens with at least 0.6 mm openings.

The use of screens finer than 30 x 30 mesh (0.6 mm openings) anywhere in the system should be avoided 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.

In the event of a released charge through the suction safety relief valve (if installed, not mandatory), ensure that the suction screen does not need to be replaced. If a replacement is required, refer to Emerson.com/OPI

**ELECTRICAL CONNECTION**

**General Recommendations**

The compressor terminal box has a wiring diagram on the inside of its cover. Before connecting the compressor, ensure the supply voltage, the phases and the frequency match the nameplate data.

**Electrical Installation**

**Three Phase Motors**

All compressors can be started Direct-On-Line.

**NOTE:** Pay special attention to the position of the voltage terminals. Refer to Figure 15 and Figure 17.

**Part-Winding Motor (YY/Y) – Code A**

Part winding PWS motors contain two separate windings which are internally connected in star and operated in parallel. You cannot change the voltage by changing the electrical connections, the motor is only suitable for one voltage.
For 4MTLS40K to 64K, the first part winding, the 1/2 winding on terminals 1-2-3, can be used for part winding start. After a time-delay of 1 ± 0.1 seconds the second part winding (1/2) must be brought on line.

For 4MTLS82K to 22M, the first part winding, the 2/3 winding on terminals 1-2-3, can be used for part winding start. After a time-delay of 1 ± 0.1 seconds the second part winding (1/3) must be brought on line.

For 4MSLS65K to 13M, the first part winding, the 2/3 winding on terminals 1-2-3, can be used for part winding start. After a time-delay of 1 ± 0.1 seconds the second part winding (1/3) must be brought on line.

**Wiring Diagrams**

The position of the jumpers in the terminal box and the recommended wiring diagrams are shown in Figure 15 and Figure 17.

**Terminal Box Isolator**

4MTLS40K to 15M FSD (460v), 4MTLS40K to 15M TSE (575v), 4MTLS40K to 64K FSC (208/230v) and 4MSLS65K to 13M compressor models are equipped with two isolators. One is for across the line start and one is for part winding start applicators. Refer to Figure 19.

4TMLS82K to 15M FSC (208/230v) and 4MTLS20M to 4MTLS22M compressor models do not include isolators. Refer to Figure 21.

**NOTE:** It is recommended to use these isolators on above mentioned models including the terminal isolators in order to keep the terminals isolated.

**Breaker**

Independently from the internal motor protection, fuses must be installed before the compressor. The selection of fuses has to be carried out according to VDE 0635, DIN 57635, IEC 269-1 or EN 60-269-1.

**CoreSense Protection**

CoreSense Protection provides motor protection for 4M*LS compressors. The CoreSense Protection Module (CPM) will communicate a motor protection trip when the resistance caused by an increasing motor temperature has risen above 4.5 K Ohms. The compressor will restart once the resistance drops below 2.5 K Ohms and five minutes has elapsed.

CoreSense Protection for Copeland Discus 4M*LS compressors can also provide valuable discharge temperature protection. By installing the temperature probe into the head of the Discus 4M*LS compressor and connecting to the CPM, CoreSense will protect the compressor from high discharge temperature conditions.

If the temperature sensor detects a head temperature greater than 310°F, CoreSense will trip the compressor off until the temperature cools down to an acceptable level (about 267°F) and a two minute off time has been achieved.

A high discharge temperature lockout can also be enabled through the E2. Please refer to AE8-1367 for more information about the CoreSense Protection and E2 setup screens. The module is capable of communication via MODBUS protocol.

Because there is no oil pump, the low oil pressure protection feature is disabled on the 4M*LS compressors.

The CoreSense Protection module comes factory installed on each 4M*LS compressor. For electrical connections to the module, refer to AE8-1367.

**NOTE:** CoreSense Protection on 4M*LS compressors disables switch 6. Only switches 1 to 5 may be used for node address (32 combinations).

**Crankcase Heaters**

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**Crankcase Heaters**

**NOTICE**

*Oil dilution! Bearing malfunction! Turn the crankcase heater on 12 hours before starting the compressor.*

Two voltages (115V and 208V) for the 100 watt heater are available for use on the 4M*LS compressors. Please refer to Figure 24 at the end of this bulletin.

**STARTUP AND OPERATION**

**WARNING**

*Diesel effect! Compressor destruction! The mixture of air and oil at high temperature can lead to an explosion. Avoid operating with air.*
Leak Test
The suction shut-off valve and discharge shut-off valve on the compressor must remain closed during pressure testing to prevent air and moisture from entering the compressor. The test pressure (dry nitrogen) must not exceed 870 psi (60 bar) provided no other system component’s pressure is lower, in this case the lower pressure is the test pressure. Systems should be checked once per year (or as required). Check local legislation for requirements.

System Evacuation
Before commissioning the system, remove the holding charge and then evacuate with a vacuum pump. Proper evacuation reduces residual moisture to 50 ppm. The installation of adequately sized access valves at the furthest point from the compressor in the suction and liquid lines is advisable. To achieve undisturbed operation, close the compressor valves and evacuate the system. Pressure must be measured using a vacuum pressure gauge on the access valves and not on the vacuum pump; this serves to avoid incorrect measurements resulting from the pressure gradient along the connecting lines to the pump. Then the compressor must be evacuated.

Due to the factory holding charge of dry air the compressor is under pressure of about 14.5 to 36 psi (1 to 2.5 bar), this is to indicate that the compressor does not leak.

When plugs are removed from the compressor in order to connect a pressure gauge or to fill in oil, the plug may pop out under pressure and oil residue can spurt out.

Preliminary Checks – Pre-starting
Discuss details of the installation with the installer. If possible, obtain drawings, wiring diagrams, etc. It is ideal to use a check-list but always check the following:
- Visual check of the electrics, wiring, fuses etc.
- Visual check of the system for leaks, loose fittings
- Compressor oil level ¼ - ¾ sight glass (see Figure 9)
- Calibration of high and low-pressure switches and any pressure actuated valves
- Check setting and operation of all safety features and protection devices
- All valves in the correct running position
- Pressure and compound gauges fitted
- Check that compressor is pre-charged with refrigerant
- Ensure compressor electrical isolator is correct

Charging Procedure

**CAUTION**
**Low suction pressure operation! Compressor damage!** Do not operate with a restricted suction. Do not operate with the low-pressure cut-out jumpered.

**Low moisture content! Corrosive impact on refrigeration systems!** Use only highly dried CO₂.

Do not operate compressor without enough system charge to maintain at least 73 PSIG (5 bar) suction pressure. Allowing a pressure to drop below 73 psig (5 bar) for more than a few seconds might cause CO₂ solidification (dry ice) and block valves or pipes.

Charge the system with vapor CO₂ up to a minimum of 145 PSIG (10 bar) to prevent forming of dry ice. Then continue with charging liquid CO₂. The system should be charged through the liquid-receiver shut-off valve or through a valve in the liquid line.

The use of a filter drier in the charging line is highly recommended. Because there may be several valves in the system, it is recommended to charge on both the high and low sides simultaneously to ensure sufficient pressure is present in the compressor before it runs.

The majority of the charge should be placed in the high side of the system to prevent bearing washout during first-time start.

Initial Start-Up

**CAUTION**
**Oil dilution! Bearing malfunction!** It is important to ensure that new compressors are not subject to flooded start. For initial start-up, turn the crankcase heater on 12 hours prior to starting the compressor. During normal...
operation, when the compressor is off the crankcase heater should be on.

With the exception of rubber coated metallic gaskets. All gaskets should be oiled before fitting. O-rings should also be oiled. A compressor should never be operated beyond its approved application range.

To avoid motor damage, the compressor must not be started or high potential tested under vacuum.

Minimum Run Time

Emerson Climate Technologies recommends a maximum of 10 starts per hour. The most critical consideration is the minimum run time required to return oil to the compressor after start-up.

Recommended Inverter Range

4M*LS compressors can be applied with a variable frequency drive. The approved operating range is 25 to 60Hz.

Running the CO₂ compressor with an inverter is a reliable application. Resonances might occur in the lower frequency ranges. This phenomenon largely depends on the operating conditions and system design.

The following hardware variables have a significant impact on possible resonances:

- Mounting parts: The rubber mounting parts supplied with the 4M*LS compressor are suitable for the whole frequency range.
- Piping design: It is recommended to take special care for the discharge line. A discharge pipe parallel to the compressor axis normally gives a positive effect to reduce resonances at low frequency
- Base frame design: The framework structure should be stiff enough so that the resonant frequency is above 70 HZ. A design with natural frequencies below the 25 HZ speed may lead to high vibrations during start-up.

MAINTENANCE AND REPAIR

Exchanging the Refrigerant

4M*LS compressors are only released for usage with CO₂ (R-744) as a refrigerant.

For service kit part numbers, refer to the Online Product Information at Emerson.com/OPI or contact your Emerson sales representative.

Replacing a Compressor

CAUTION

Inadequate lubrication! Bearing destruction! Exchange the accumulator after replacing a compressor with a burned-out motor. The accumulator oil return orifice or screen may be plugged with debris or may become plugged. This will result in starvation of oil to the new compressor and a second failure.

In the case of a motor burnout, the majority of contaminated oil will be removed with the compressor. The rest of the oil is cleaned through the use of suction and liquid line filter driers. A 100 % activated alumina suction line filter drier is recommended but must be removed after 72 hours. When a compressor is exchanged in the field, it is possible that a major portion of the oil may still be in the system.

Lubrication and Oil Removal

WARNING

Chemical reaction! Compressor destruction! Do not mix up ester oils with mineral oil and/or alkyl benzene.

WARNING

Handle carefully!

POE may cause an allergic skin reaction and 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). Refer to the Safety Data Sheet (SDS) for further details.

Compressors that are not shipped “less oil” are supplied with an initial oil charge. The standard oil charge for use with refrigerants R744 is a polyolester (POE) lubricant Emkarate RL 68 HB.

POE is far more hygroscopic than mineral oil (see Figure 23). Only brief exposure to ambient air is needed for POE to absorb sufficient moisture to make it unacceptable for use in a refrigeration system. Since
POE holds moisture more readily than mineral oil; it is more difficult to remove it through the use of vacuum. Compressors supplied by Emerson Climate Technologies contain oil with low moisture content, and it may rise during the system assembling process. Therefore, it is recommended that a properly sized filter-drier is installed in all POE systems. This will maintain the moisture level in the oil to less than 50 ppm. If oil is charged into a system, it is recommended to use POE with a moisture content no higher than 50 ppm.

Figure 23 compares the hygroscopic characteristics of POE oil with mineral oil (moisture absorption in PPM at 25°C and 50% relative humidity).

If the moisture content of the oil in a refrigeration system reaches unacceptably high levels, corrosion and copper plating may occur. The system should be evacuated down to an absolute pressure of 225 microns or lower. If there is uncertainty as to the moisture content in the system, an oil sample should be taken and tested for moisture. Sight glass/moisture indicators currently available can be used with the HFC refrigerants and lubricants; however, the moisture indicator will just show the moisture content of the refrigerant. The actual moisture level of POE would be higher than the sight glass indicates. This is due to the high hygroscopicity of the POE oil. To determine the actual moisture content of the lubricant, samples have to be taken from the system and analyzed.

Oil Additives

Although Emerson Climate Technologies cannot comment on any specific product, from our own testing and past experience, we do not recommend the use of any additives to reduce compressor bearing losses or for any other purpose. Furthermore, the long term chemical stability of any additive in the presence of refrigerant, low and high temperatures, and materials commonly found in refrigeration systems is complex and difficult to evaluate without rigorously controlled chemical laboratory testing. The use of additives without adequate testing may result in malfunction or premature failure of components in the system and, in specific cases, in voiding the warranty on the component. Refer to AE17-1282 for additional information.

Unbrazing System Components

**WARNING**

*Explosive flame! Burning! Oil-refrigerant mixtures are highly flammable. Remove all refrigerant before opening the system. Avoid working with an unshielded flame in a refrigerant charged system.*

Before opening up a system it is important to remove all refrigerant from both the high and low sides of the system. If a brazing torch is then applied to the low side while the low side shell and suction line contain pressure, the pressurized refrigerant and oil mixture could ignite when it escapes and contacts the brazing flame. To prevent this occurrence, it is important to check both the high and low sides with manifold gauges before unbrazing. 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 system rather than unbrazed.

Dismantling and Disposal

Removing oil and refrigerant:

- Use the correct equipment and method of removal.
- Dispose of oil and refrigerant properly.
- Dispose of compressor properly.

General Guidelines and More Information

For general Copeland Discus compressor please log in to Online Product Information at Emerson.com/OPI or contact your Application Engineer.
Figure 2 - 4MTLS Name Plate

Figure 3 - CO2 Envelope, Compressors: 4MTLS40K, 4MTLS53K, 4MTLS64K
Figure 4 - CO2 Envelopes, Compressors: 4MTLS82K, 4MTLS11M

Figure 5 - CO2 Envelopes, Compressors: 4MTLS15M
Figure 6 - CO2 Envelope, Compressors: 4MTLS20M; 4MTLS22M

Figure 7 - CO2 Low Temp. Envelope, Compressors: 4MSLS65K, 4MSLS85K, 4MSLS13M
Figure 8 - **4M*LS Sight Glasses Location**

Figure 9 - **Sight Glass Oil Level**

Figure 10 - **Stacking Configuration**
Figure 11 - Lifting Eye Location

Figure 12 - Compressor Mounting Parts
Figure 13 - Safety Valve Location
Figure 14 - Pressure Connection Ports
<table>
<thead>
<tr>
<th>ID</th>
<th>Description</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>SL</td>
<td>Suction Service Valve</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4MTLS40K</td>
<td>5/8&quot; ID</td>
</tr>
<tr>
<td></td>
<td>4MTLS53K</td>
<td>22mm OD</td>
</tr>
<tr>
<td></td>
<td>4MTLS64K</td>
<td>7/8&quot; ID</td>
</tr>
<tr>
<td></td>
<td>4MTLS82K</td>
<td>30mm OD</td>
</tr>
<tr>
<td></td>
<td>4MTLS11M</td>
<td>1 3/8&quot; ID</td>
</tr>
<tr>
<td></td>
<td>4MTLS15M</td>
<td>42.40 mm OD</td>
</tr>
<tr>
<td></td>
<td>4MTLS20M</td>
<td>7/8&quot; ID</td>
</tr>
<tr>
<td></td>
<td>4MTLS22M</td>
<td>30mm OD</td>
</tr>
<tr>
<td>DL</td>
<td>Discharge Service Valve</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4MTLS40K</td>
<td>1/2&quot; ID</td>
</tr>
<tr>
<td></td>
<td>4MTLS53K</td>
<td>17.2mm OD</td>
</tr>
<tr>
<td></td>
<td>4MTLS64K</td>
<td>5/8&quot; ID</td>
</tr>
<tr>
<td></td>
<td>4MTLS82K</td>
<td>22mm OD</td>
</tr>
<tr>
<td></td>
<td>4MTLS11M</td>
<td>1 1/8&quot; ID</td>
</tr>
<tr>
<td></td>
<td>4MTLS15M</td>
<td>35.00 mm OD</td>
</tr>
<tr>
<td></td>
<td>4MTLS20M</td>
<td>5/8&quot; ID</td>
</tr>
<tr>
<td></td>
<td>4MTLS22M</td>
<td>22mm OD</td>
</tr>
<tr>
<td></td>
<td>4MSLS65K</td>
<td>7/8&quot; ID</td>
</tr>
<tr>
<td></td>
<td>4MSLS85K</td>
<td>30mm OD</td>
</tr>
<tr>
<td></td>
<td>4MSLS13M</td>
<td>5/8&quot; ID</td>
</tr>
<tr>
<td></td>
<td>4MSLS85K</td>
<td>22mm OD</td>
</tr>
<tr>
<td></td>
<td>4MSLS13M</td>
<td>22mm OD</td>
</tr>
<tr>
<td>1</td>
<td>Base Mountings</td>
<td>22mm OD</td>
</tr>
<tr>
<td>4</td>
<td>Plug High Pressure Connection</td>
<td>1/8&quot; 27 NPTF</td>
</tr>
<tr>
<td>5</td>
<td>Crankcase Heater</td>
<td>1/2&quot; 14 NPTF</td>
</tr>
<tr>
<td>6</td>
<td>Plug Low Pressure Connection/Oil Removal Plug</td>
<td>1/4&quot; 18 NPTF</td>
</tr>
<tr>
<td>8</td>
<td>Plug Low Pressure Connection</td>
<td>1/2&quot; 14 NPTF</td>
</tr>
</tbody>
</table>
Figure 15 - Wiring Diagram A

NOTE: Wiring diagram applies to the following models:

<table>
<thead>
<tr>
<th>4MTLS</th>
<th>40K</th>
<th>53K</th>
<th>64K</th>
<th>82K</th>
<th>11M</th>
<th>15M</th>
</tr>
</thead>
<tbody>
<tr>
<td>-FSC</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
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<tr>
<td>-FSD</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>-TSE</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4MSLS</th>
<th>65K</th>
<th>85K</th>
<th>13M</th>
</tr>
</thead>
<tbody>
<tr>
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<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>-TSE</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

Figure 16 - Applicable Models to 052-2753-00 schematic
NOTE: Wiring diagram applies to the following models:

<table>
<thead>
<tr>
<th>Model</th>
<th>4MTLS</th>
<th>40K</th>
<th>53K</th>
<th>64K</th>
<th>82K</th>
<th>11M</th>
<th>15M</th>
<th>20M</th>
<th>22M</th>
</tr>
</thead>
<tbody>
<tr>
<td>-FSC</td>
<td>X</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-TSE</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 18 - Applicable Models to 052-3148-00 schematic
Figure 19 - Terminal Box Isolator

NOTE: Terminal isolator applies to the following models:

<table>
<thead>
<tr>
<th>4MTLS</th>
<th>40K</th>
<th>53K</th>
<th>64K</th>
<th>82K</th>
<th>11M</th>
<th>15M</th>
</tr>
</thead>
<tbody>
<tr>
<td>-FSC</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>-FSD</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>-TSE</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4MSLS</th>
<th>65K</th>
<th>85K</th>
<th>13M</th>
</tr>
</thead>
<tbody>
<tr>
<td>-FSD</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>-TSE</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

Figure 20 - Applicable Models to Terminal Box Isolator
NOTE: Terminal plate applies to the following models:

<table>
<thead>
<tr>
<th>4MTLS</th>
<th>40K</th>
<th>53K</th>
<th>64K</th>
<th>82K</th>
<th>11M</th>
<th>15M</th>
<th>20M</th>
<th>22M</th>
</tr>
</thead>
<tbody>
<tr>
<td>-FSC</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>-FSD</td>
<td></td>
<td></td>
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<td></td>
<td>X</td>
</tr>
<tr>
<td>-TSE</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 21 - Ø 82K to 15M FSC Terminal Plate

Figure 22 - Applicable Models to FSC Terminal Plate

Figure 23 - Oil Dilution Graph

Absorption of moisture in ester oil in comparison to mineral oil in ppm by weight at 25°C 50% relative humidity.
Crankcase Heater Kit | Part Number
---|---
115V/100W | 918-0003-00
230V/100W | 918-0003-01

Kit contents:
1 crankcase heater
1 heat-conductive paste tube
1 mounting ring

1. Slide the mounting ring onto the heater.
2. Spread a thick layer of conductive paste around heater.
3. Remove the plug from compressor. Insert the heater in the hole.
4. Press the mounting ring into the hole.

Figure 24 - Crankcase Heaters
Figure 25 - Electronics Locations

Figure 26 - Wiring Diagram for CoreSense

Table 2 - Qualified Refrigerants and Oils

<table>
<thead>
<tr>
<th>Qualified Refrigerants</th>
<th>CO₂ (R-744)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copeland™ Standard Oil</td>
<td>Emkarate RL 68 HB</td>
</tr>
<tr>
<td>Servicing Oil</td>
<td>Emkarate RL 68 HB</td>
</tr>
</tbody>
</table>

NOTE: Refer to form 93-11 for the latest approved refrigerants for Copeland products.
### Table 3 - 4MTLS Model Selection

<table>
<thead>
<tr>
<th>Model</th>
<th>Displacement CFH (m3/h)</th>
<th>Capacity kBTU/hr (KW)</th>
<th>Max Oper. Pressure psig (bar)</th>
<th>Design Pressure psig (bar)</th>
<th>Burst Pressure psig (bar)</th>
<th>Net Weight lbs (kg)</th>
<th>Footprint in (mm)</th>
<th>Motors</th>
</tr>
</thead>
<tbody>
<tr>
<td>4MTLS40KE</td>
<td>197 (5.58)</td>
<td>38.3 (11.2)</td>
<td>1740/609 (120/42)</td>
<td>1960/1305 (135/90)</td>
<td>6090/4785 (420/330)</td>
<td>271 (123)</td>
<td>14.5 x 10 (368 x 256)</td>
<td>FSD</td>
</tr>
<tr>
<td>4MTLS53KE</td>
<td>261.8 (7.41)</td>
<td>51.6 (15.12)</td>
<td></td>
<td></td>
<td></td>
<td>273 (124)</td>
<td>10.079 x 14.488 (256 x 368)</td>
<td>TSE</td>
</tr>
<tr>
<td>4MTLS64KE</td>
<td>317.4 (8.99)</td>
<td>64 (18.76)</td>
<td></td>
<td></td>
<td></td>
<td>278 (126)</td>
<td></td>
<td>FSC</td>
</tr>
<tr>
<td>4MTLS82KE</td>
<td>406.5 (11.5)</td>
<td>83.9 (24.59)</td>
<td></td>
<td></td>
<td></td>
<td>375 (170)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4MTLS11ME</td>
<td>531.2 (15.04)</td>
<td>108 (32)</td>
<td></td>
<td></td>
<td></td>
<td>375 (170)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4MTLS15ME</td>
<td>765 (21.66)</td>
<td>158.5 (46.5)</td>
<td></td>
<td></td>
<td></td>
<td>386 (175)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4MTLS20ME</td>
<td>966.2 (27.36)</td>
<td>188 (55.1)</td>
<td></td>
<td></td>
<td></td>
<td>582 (264)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4MTLS22ME</td>
<td>1134 (32.11)</td>
<td>224 (65.65)</td>
<td>1505/609 (110/42)</td>
<td></td>
<td></td>
<td>595 (270)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Nomenclature based on rated capacity at 14°F evap, 95°F gas cooler, 18°F SH

### Table 4 - 4MSLS Model Selection

<table>
<thead>
<tr>
<th>Model</th>
<th>Displacement CFH (m3/h)</th>
<th>Capacity kBTU/hr (KW)</th>
<th>Max Oper. Pressure psig (bar)</th>
<th>Design Pressure psig (bar)</th>
<th>Burst Pressure psig (bar)</th>
<th>Net Weight lbs (kg)</th>
<th>Footprint in (mm)</th>
<th>Motors</th>
</tr>
</thead>
<tbody>
<tr>
<td>4MSLS65KE</td>
<td>406.5 (11.51)</td>
<td>64.9 (19)</td>
<td>1740/609 (120/42)</td>
<td>1960/1305 (135/90)</td>
<td>6090/4785 (420/330)</td>
<td>375 (170)</td>
<td>14.5 x 10 (368 x 256)</td>
<td>FSD</td>
</tr>
<tr>
<td>4MSLS85KE</td>
<td>531.2 (15.04)</td>
<td>88.0 (25.8)</td>
<td></td>
<td></td>
<td></td>
<td>375 (170)</td>
<td>10.0 x 14.5 (256 x 368)</td>
<td>TSE</td>
</tr>
<tr>
<td>4MSLS13ME</td>
<td>765 (21.66)</td>
<td>126.3 (37)</td>
<td></td>
<td></td>
<td></td>
<td>386 (175)</td>
<td></td>
<td>FSC</td>
</tr>
</tbody>
</table>

### Table 5 - Relief Pressure Valves Ratings

<table>
<thead>
<tr>
<th>Applications</th>
<th>Valve</th>
<th>Pressure Rating psig (bar)</th>
<th>Compressor Standstill Pressure psig (bar)</th>
<th>Note:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard – Supplied w/ Compressor: MT (Transcritical) and LT (Subcritical)</td>
<td>High-Pressure Side (HP)</td>
<td>1960 (135)</td>
<td>1960 (135)</td>
<td>HP valve protects whole compressor.</td>
</tr>
<tr>
<td>Optional – Field Installed: MT (Transcritical) and LT (Subcritical)</td>
<td>High-Pressure Side (HP)</td>
<td>1960 (135)</td>
<td>1305 (90)</td>
<td>HP valve protects HP side of compressor. LP valve protects LP side of compressor.</td>
</tr>
<tr>
<td></td>
<td>Low-Pressure Side (LP)</td>
<td>1305 (90)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table 6 - Relief Pressure Valves Part Numbers

<table>
<thead>
<tr>
<th>SAFETY PRV</th>
<th>4MTLS 40K to 15M / 4MSLS 65K to 13M</th>
<th>4MTLS 20M to 22M</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Side Pressure (135bar / 1960 psi)</td>
<td>510-0780-00</td>
<td>510-0814-00</td>
</tr>
<tr>
<td>Low-Side Pressure (90bar / 1305psi)</td>
<td>510-0784-04</td>
<td>510-0813-00</td>
</tr>
</tbody>
</table>
Table 7 - Connection Sizes

<table>
<thead>
<tr>
<th>Description</th>
<th>Part Number</th>
<th>Compressor</th>
<th>Flange Pitch (Mounting Footprint) (mm)</th>
<th>Brazing (Valve ID) d (in)</th>
<th>Butt Weld (Valve OD) D (in)</th>
<th>Conn. Wall Thickness z (in)</th>
<th>Weld Depth a (in)</th>
<th>Tube Ins. Depth h (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discharge Service</td>
<td>510-0809-00</td>
<td>4MTLS40K</td>
<td>45 x 45</td>
<td>1/2</td>
<td>0.677</td>
<td>0.087</td>
<td>0.122</td>
<td>0.433</td>
</tr>
<tr>
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<td></td>
<td>4MTLS53K</td>
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<td></td>
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<td>4MTLS64K</td>
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<td>Suction Service</td>
<td>510-0823-00</td>
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<td>45 x 45</td>
<td>5/8</td>
<td>0.866</td>
<td>0.116</td>
<td>0.164</td>
<td>0.433</td>
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<tr>
<td>Discharge Service</td>
<td>510-0842-00</td>
<td>4MTLS82K</td>
<td>52 x 52</td>
<td>5/8</td>
<td>0.866</td>
<td>0.116</td>
<td>0.164</td>
<td>0.433</td>
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<td>4MTLS11M</td>
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<td>Suction Service</td>
<td>510-0844-00</td>
<td>4MTLS15M</td>
<td>52 x 52</td>
<td>7/8</td>
<td>1.181</td>
<td>0.151</td>
<td>0.213</td>
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<td>4MSLS13M</td>
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</tr>
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<td>Discharge Service</td>
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<td>4MTLS20M</td>
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<td>1.378</td>
<td>0.124</td>
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<td>0.748</td>
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<td>4MTLS22M</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Suction Service</td>
<td>510-0847-00</td>
<td></td>
<td>70 x 70</td>
<td>1-3/8</td>
<td>1.670</td>
<td>0.142</td>
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<td>0.910</td>
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</tbody>
</table>

Additional Service Kit Offerings:

<table>
<thead>
<tr>
<th>Description</th>
<th>Part Number</th>
<th>Compressor</th>
<th>Flange Pitch (Mounting Footprint) (mm)</th>
<th>Brazing (Valve ID) d (in)</th>
<th>Butt Weld (Valve OD) D (in)</th>
<th>Conn. Wall Thickness z (in)</th>
<th>Weld Depth a (in)</th>
<th>Tube Ins. Depth h (in)</th>
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<tbody>
<tr>
<td>Swagelok Discharge Service</td>
<td>510-0865-00</td>
<td>4MTLS40K</td>
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<td>Swagelok Discharge Service</td>
<td>510-0867-00</td>
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### Table 8 - OMC CO2 Specifications

<table>
<thead>
<tr>
<th>SPECIFICATIONS</th>
<th>OMC CO2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Working Pressure (MWP)</td>
<td>1885 PSIG (130 Bar)</td>
</tr>
<tr>
<td>Solenoid min/max OPD</td>
<td>1/1450 PSIG</td>
</tr>
<tr>
<td>Supply Voltage</td>
<td>120 V or 220-240V, 50/60 Hz</td>
</tr>
<tr>
<td>Solenoid Coil</td>
<td>EMF</td>
</tr>
<tr>
<td>Current Consumption</td>
<td>0.15 Amp (120V), 0.07 Amp (220-240V)</td>
</tr>
<tr>
<td>Time Delay for Low Level Signal</td>
<td>10 seconds</td>
</tr>
<tr>
<td>Time Delay After Setpoint Recovery</td>
<td>5 seconds</td>
</tr>
<tr>
<td>Alarm Delay Time (Including Alarm Contact)</td>
<td>120 seconds</td>
</tr>
<tr>
<td>Alarm Switch</td>
<td>SPDT</td>
</tr>
<tr>
<td>Alarm Contact Rating</td>
<td>10A @ 120VAC 50/60Hz, 5A @ 250VAC 50/60 Hz, 3A@ 30 VDC</td>
</tr>
<tr>
<td>Refrigerant Temperature</td>
<td>-40° to 180°F (-40°C to 82.2°C) Maximum</td>
</tr>
<tr>
<td>Ambient Temperature - Storage</td>
<td>-40° to 120°F (-40°C to 48.9°C) Maximum</td>
</tr>
<tr>
<td>Ambient Temperature - Intermittent Duty</td>
<td>-40° to 120°F (-40°C to 48.9°C) Maximum</td>
</tr>
<tr>
<td>Oil Supply Fitting</td>
<td>1/4&quot; Male SAE (Brass)</td>
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</table>
Appendix 1 4M*LS Tightening Torques

<table>
<thead>
<tr>
<th>Component Description</th>
<th>Thread Type</th>
<th>Torque (lb-ft)</th>
<th>Torque (Nm)</th>
<th>Torque - Final Customer Installation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suction Service Valve Mounting</td>
<td>3/8&quot;-16 UNC</td>
<td>26-32</td>
<td>36-44</td>
<td></td>
</tr>
<tr>
<td>Suction Service Valve Pressure Tap</td>
<td>7/16&quot;-20 UNF</td>
<td>18-26</td>
<td>24-35</td>
<td></td>
</tr>
<tr>
<td>Suction Service Valve Cap</td>
<td>3/4&quot;-16 UNF-2A</td>
<td>4-Mar</td>
<td>5-Apr</td>
<td>30 - 37 lb-ft / 40 - 50 N-m</td>
</tr>
<tr>
<td>Discharge Service Valve Mounting</td>
<td>3/8&quot;-16 UNC</td>
<td>26-32</td>
<td>36-44</td>
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<tr>
<td>Discharge Service Valve Pressure Tap</td>
<td>7/16&quot;-20 UNF</td>
<td>18-26</td>
<td>24 -35</td>
<td>30 - 37 lb-ft / 40 - 50 N-m</td>
</tr>
<tr>
<td>Discharge Service Valve Cap</td>
<td>3/4&quot;-16 UNF-2A</td>
<td>4-Mar</td>
<td>5-Apr</td>
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<tr>
<td>Stator Cover Mounting</td>
<td>1/2&quot;-13 UNC</td>
<td>88-117</td>
<td>119-159</td>
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<tr>
<td>Housing Cover Mounting</td>
<td>1/2&quot;-13 UNC</td>
<td>88-117</td>
<td>119-159</td>
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<tr>
<td>Cylinder Head</td>
<td>1/2&quot;-13 UNC</td>
<td>75-102</td>
<td>102-138</td>
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<tr>
<td>Head Temperature Probe (CoreSense)</td>
<td>1/8&quot;-27 NPTF</td>
<td>25-26</td>
<td>35</td>
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<tr>
<td>Terminal Plate Mounting</td>
<td>3/8&quot;-16 UNC</td>
<td>26-32</td>
<td>36-44</td>
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<tr>
<td>Stator Mounting</td>
<td>M16</td>
<td>103-133</td>
<td>140-180</td>
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<tr>
<td>Oil Sight Glass</td>
<td>1-1/8&quot;-18 UNEF</td>
<td>37-44</td>
<td>50-60</td>
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</tr>
<tr>
<td>Oil Drain Plug</td>
<td>1/4&quot;-18 NPTF</td>
<td>22-30</td>
<td>30-40</td>
<td></td>
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<tr>
<td>Misc. Plugs</td>
<td>1/4-18 NPTF</td>
<td>22-30</td>
<td>30-40</td>
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<td>Oil Flinger Mounting</td>
<td>M10</td>
<td>13-16</td>
<td>18-22</td>
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<td>Safety Valves</td>
<td>M24x1.5 LH/RH</td>
<td>66-81</td>
<td>90-110</td>
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<td>Deflector mounting</td>
<td>M24x1.5 LH/RH</td>
<td>8-Jul</td>
<td>11-Sep</td>
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<td>Oil Sensor Probe</td>
<td>3/4&quot;-14 NPT</td>
<td>63-66</td>
<td>85-90</td>
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<tr>
<td>Oil Sensor Probe Adaptor</td>
<td>1 1/8&quot;-18 UNEF</td>
<td>66</td>
<td>90</td>
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</tbody>
</table>

**NOTE:** The ranges of torque values given in this specification are assembly torque. Torque after joint relaxation must be within 15 % of the minimum assembly torque unless re-torque is called for and must not be above 10 % of the maximum assembly torque.

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