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Warranty

Sundyne Corporation warrants to Buyer for a period of twelve (12) months from the date of being placed in service (but not to exceed eighteen (18) months after the date of shipment) that the equipment at the time of shipment will be free from defects of design, material and workmanship. If any defects or malperformance occur during the warranty period, Sundyne’s sole obligation shall be limited to alteration, repair or replacement at Sundyne’s expense, F.O.B. Factory, of parts or equipment, which upon return to Sundyne and upon Sundyne’s examination prove to be defective. Equipment and accessories not manufactured by Sundyne are warranted only to the extent of and by the original manufacturers’ warranty. Sundyne shall not be liable for damage or wear to equipment caused by abnormal conditions, vibration, failure to properly prime or to operate equipment without flow or caused by corrosives, abrasives or foreign objects. THE FOREGOING WARRANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES, WHETHER EXPRESSED OR IMPLIED INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE. In no event shall Sundyne be liable for consequential or incidental damages.
## Revisions

| March 2009 | Add seal configurations / misc. updates |
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INTRODUCTION

Sundyne Centrifugal Pumps

Sundyne API pumps provide high-energy performance and competitive efficiencies in a compact unit that is easy to maintain. Sundyne pumps are single stage that utilize an integral gearbox. Designed to increase the pressure of a continuous flow of fluid by applying centrifugal action, Sundyne pumps are most commonly used in HPI, CPI, and Boiler Feed applications. Commonly applied in refineries, petrochemical plants, and power generation plants, Sundyne pumps are used in high-head, low-to-medium flow processes.

This manual presents installation, servicing, troubleshooting, maintenance and spare parts information for the latest configuration of Sundyne centrifugal pumps.

Note: Parenthetical numbers included in the text correspond to item numbers on the illustrated figures. The correct spare part can be ordered for any generation pump by referencing the item and serial numbers.

Text Symbols

The following symbols may be found in the text of this manual.

They have the following meanings:

- **WARNING:** Text accompanied by this symbol indicates that failure to follow directions could result in bodily harm or death.

- **ELECTRICAL HAZARD:** Text accompanied by this symbol indicates that failure to follow directions could result in electrical damage to equipment or electrical shock.

- **RECOMMENDED:** Text accompanied by this symbol indicates recommended usage.

- **REMINDER:** Text accompanied by this symbol indicates a reminder to perform an action.

- **EQUIPMENT USE ALERT:** Text accompanied by this symbol indicates that failure to follow directions could result in damage to equipment.
Sundyne Corporation manufactures centrifugal pumps to exacting International Quality Management System Standards (ISO 9001) as certified and audited by Lloyd’s Register Quality Assurance Limited. Genuine parts and accessories are specifically designed and tested for use with these products to ensure continued product quality and performance. Sundyne cannot test all parts and accessories sourced from other vendors; incorrect design and/or fabrication of such parts and accessories may adversely affect the performance and safety features of these products. Failure to properly select, install or use authorized Sundyne pump parts and accessories is considered misuse and damage or failure caused by misuse is not covered by Sundyne’s warranty. Additionally, modification of Sundyne products or removal of original components may impair the safety of these products and their effective operation.

CAUTION

Sundyne pumps may handle hazardous, flammable, and/or toxic fluids. Proper personal protective equipment should be worn. Precautions must be taken to prevent physical injury. Pumpage must be handled and disposed of in accordance with applicable environmental regulations.

Note: Safety procedures must be applied prior to any installation, maintenance, or repair of a Sundyne pump. Failure to follow safety precautions may lead to injury!

Wearing Personal Protective Equipment

To ensure safety, protective equipment must be worn at all times when installing, performing maintenance, or repairing equipment. The following safety recommendations must be adhered to for optimum safety:

- Safety glasses, with the minimum requirement of side shields, must be worn at all times.
- Steel-toed shoes must be worn when lifting equipment greater than 15 pounds (7 kg) or if pallet jacks or forklifts are operated.

- Hearing protection is strongly recommended at all times when noise levels exceed 85 dB during an eight (8.0) hour period.

Note: Chemical resistant gloves must be used if chemicals are utilized (refer to Using Chemicals for additional information).

Note: A dust mask respirator must be worn if chemicals have warning labels regarding fumes, dust, or mists.

Using Forklifts

Any persons operating a forklift must have an active recognized operator license.

Note: Before initializing forklift operation, verify that the lift is in a safe operating position.

Ensuring Electrical Safety

All electrical sources must be powered-off before installation, service, or repair of equipment occurs.

Note: Sundyne recommends that a Lock-out/Tag-out program be followed prior to altering the equipment. Locks or tags must be provided to warn employees that equipment is temporarily unavailable.

Once all work has been completed, the person installing the lock or tag must remove it according to company procedure.

Testing Equipment

Prior to performing a test on newly installed, maintained, or repaired equipment; all personnel in the immediate area must be warned.

Note: Follow company procedures prior to equipment testing at all times.
Using Chemicals
Any chemicals to be used must be accompanied by a relevant material safety data sheet (MSDS), in accordance with government legislation. If applicable, use chemical proof gloves.

Note: An eye wash station (or equivalent) should be available in the event of injury. If any hazardous or flammable chemicals pass through the equipment, a complete decontamination of the equipment is required.

Preventative Machine Guards
Preventative guards must remain in place on all equipment.

Note: Only remove the guards while performing maintenance or repair.
Replace the guards immediately after working on the equipment and prior to start up.

Protection from Falling
Fall protection and associated preventative measures are required when working on equipment located six feet or higher from the ground.

Note: Follow company fall prevention procedures prior to working on equipment.

Pre-Commission Checklist

Familiarizing Yourself with the Pump
Before servicing and starting up the Sundyne pump, carefully review all information on the product, including:

- Specification sheets
- Outline drawings
- Performance curves
- Instruction and related manuals
- System P&ID/Process Flow Diagram (Clients equipment)
- Control system and operational philosophy/narrative (Client)

Familiarize yourself with the pump configuration before starting and operating the pump.

Driver Instructions
Carefully follow all installation and starting instructions provided by the driver manufacturer. This information is included in the final data package.

Verifying Auxiliaries
Before start up, verify that the following auxiliaries are met:

- Check the utility connections
- Verify that the auxiliary piping conforms to Sundyne standards, as indicated in the detailed specifications
- Verify all switch and instrument connections
- Verify that all switch and instrument settings are set to normal operating standards
- Calibrate all measurement equipment, such as flow meters, ampere meters, and pressure meters, etc.

EXPLOSION/FIRE HAZARD

Note: Never use an acetylene torch, open flame, or heat to attempt to remove parts that have seized together in Sundyne equipment. Any residual process gas or liquid that is flammable can result in an explosion or fire with potential for serious injury or death.
Installing a Seal Environmental Control System

- Install a system to control the seal environment. See outline drawing and seal housing port identification schematic found in the "Seal Environmental Control System" section of this manual.
- Verify that port 1 is properly drained.
- If required, install vent piping overhead to ensure that the environment operates under normal conditions. For more information, contact Sundyne Corporation.

Checking Driver Rotation

If the driver is coupled, un-couple; then verify that the direction of the driver rotates in the same direction as the arrow stamped or cast on the pump casing.

If the driver is splined, check the direction of the motor fan.

Piping Connections

Verify that the following bolted or threaded connections are tight:

- Pump flange bolts
- Seal environment piping and port connections
- Cooling water connections to heat exchanger (if applicable)
- Gearbox oil drain plug
- Pump case drain plug
- Port 1 must be open to drain
- Is a check valve in the discharge line?
- Note: A start-up bypass line upstream of the check valve is recommended whenever feasible.
Start-Up Procedures

Review start-up checklist.

Pressurizing the Fluid Loop
Pressurize the double seal buffer loop or external seal flush, if applicable, prior to admitting fluid into the pump casing.

Servicing the Gearbox
Fill the gearbox with lube oil up to a quarter inch (¼) or 6 mm from the top of the oil level sight glass.

Note: Prior to using lube oil, verify that it conforms to acceptable lube oil specification standards. Refer to the SPECIFICATIONS section in this manual for more information.

Under normal operation, the lube oil level will be about a quarter inch lower than when off. Some foaming may occur at the top of the site glass during operation.

Auxiliary Lube Pump
If your pump includes an auxiliary lubrication pump, unlock the electrical circuit and move it to the "hand" position. Check for oil leaks and recheck the oil level.

Setting the Valves
To set the pump to the designated operating point, start the pump with the suction valve in the open position while throttling the discharge valve.

Control Checklist

Verifying Operating Conditions
Verify the following parameters against the specifications on the specification sheet:

- Suction pressure
- Suction temperature
- Discharge pressure
- Total head
- Flow rate
- Power consumption
- Specific gravity
- Viscosity
- Net Positive Suction Head (NPSH)

The status of these conditions will significantly alter performance of the pump if they are not in accordance with the specification sheet.

Check with your Sundyne representative if the operation conditions of your pump must run under different parameters than indicated by the specifications on the specification sheet.

Adjusting the Cooling Flow
If your model pump includes an installed heat exchanger for the gearbox, adjust the cooling flow to keep the temperature of the gearbox sump at 140°-160°F (60°-71°C). Maximum recommended temperature is 180°F (82°C).
Installation and Start-Up Checklist

Note: Lock out all switch gears, including main driver, auxiliary lubrication system and instrumentation before working on this equipment.

This checklist is NOT intended to be inclusive. You must read and follow: instruction manuals, outline drawings, specification sheets and curves for this equipment during installation, commissioning, and operation. Please call with any questions or comments. Be sure to have the unit serial number that is imprinted on the gearbox nameplate, and request “Sundyne Field Service”.

- Is all the information underlined above readily available?
- Are the following bolted/threaded connections tight?
  - Pump flange bolts?
  - Seal environment piping and port connections?
  - Cooling water connections to heat exchanger(s)(if applicable)?
  - Gearbox oil drain plug?
  - Pump case drain plug?
- There are two types of connections between the motor and gearbox; a splined shaft or a coupling. For splined connections, the splined shaft must be lubricated with the supplied spline grease and the two o-rings installed prior to mounting the motor. It is recommended that the input shaft be rotated by hand prior to mounting the motor. If the unit has a coupling, be sure the coupling gap is correct and bolting between coupling halves is tight. This instruction manual contains coupling set-up information. It is not necessary to align the coupling for run-out or flatness as this is controlled by the rabbet fits on the gearbox and coupling adaptor.
- Is a check valve installed in the discharge line?
- Is Port 1 open to atmosphere or piped to safety drain or flare or vent header? (Back pressure must not exceed 5 psig).

Note: A drip leg must be used if the Port 1 connection rises from the seal housing.

- Are all other seal system ports identified and connected according to the outline drawings?
- Is gearbox filled to within ¼” (6.35mm) of the top of the sight glass with the approved oil and the breather fitting installed? Oil capacity is 7 quarts (6.6 liters). Is the needle valve on the gearbox pressure gauge open? Removal of the vent plug below the fill/vent fitting will speed filling.
- Has the oil filter, heat exchanger, and related piping been filled with oil (primed)?
- Do process conditions, suction pressure, suction temperature, discharge header pressure, and specific gravity agree with specification sheet information? DO NOT test the pump on water unless it is designed for water. Check with your representative or Sundyne Corporation if you must test on a different fluid than shown on the specification sheet.
- If you have auxiliary lubrication pump, unlock the electrical circuit and start it in the “hand” position. Check for oil leaks and recheck the oil level. If the process suction pressure exceeds 460 psig (32.3 kg/cm² g), the auxiliary lube pump should be running prior to and anytime the suction is pressurized.
- Prior to starting the unit, have you opened the suction valve fully and discharge throttled to allow design flow, typically 40-50% open? Check the control valve to be sure it is functional. Inspect the case drain, ports, and flanges for leaks. Has the pump been vented through Port 6? Open both supply and return valves supplying cooling water to the gearbox heat exchanger. Check suction pressure to be sure it agrees with the specification sheet.
Unlock the main driver circuit and bump the motor. Rotation is CCW as viewed from the top end of the motor. Is rotation correct? Once rotation is verified, run motor for 1 second on, 20 seconds off. Do this several times until gearbox oil pressure gauge shows pressure, then start the main driver. Oil pressure will be between 15-60 psig (1.1-4.2 kg/cm²g) depending on the type of bearings in the gearbox. After priming the lube oil pump, bumping the motor is not required.

If pressure control is being used, throttle the discharge valve immediately after start-up. Does the discharge pressure agree with the specification sheet? If flow control is being used, adjust the valve until flow agrees with the design value listed on the specification sheet.

Once the gearbox oil temperature has stabilized, adjust cooling water supply until the oil temperature is 140-160°F (60-71°C) on units equipped with heat exchangers. Maximum recommended temperature is 180°F (82°C).

Listen for any unusual noises or pressure fluctuations.

Note: If you have any questions or concerns about these procedures or the information supplied, please call your representative or Sundyne Corporation.
INSTALLATION

Inspection

Immediately inspect your Sundyne product upon receipt of the equipment. Check for any damage, which may have occurred during shipment. Notify the carrier and Sundyne immediately if damage is evident.

Note: The input shaft on the pump may not turn freely due to seal drag and speed increasing gear meshes. If the input shaft does turn freely, and if rotation is "not smooth," damage may have occurred during shipping.

Storing Your Pump Short-Term

If your Sundyne pump is not to be installed immediately, protect it from exposure to moisture and dust. Do not remove the factory installed shipping covers for casing flanges and seal ports. Ensure that the shipping covers be kept securely in place.

Note: Observe the storage instructions provided by the driver manufacturer.

Storing Your Pump Long-Term

In addition to the precautions in the short-term section above, additional precautions are required for long-term storage.

If your Sundyne pump will not be operated for a period of time exceeding six months from the date of shipment, long-term storage conditions must be met to ensure minimum corrosion damage to the gearbox and fluid-end components.

Note: Sundyne does not accept liability for equipment damaged during the storage period. Sundyne does not guarantee the quality of equipment during and after the storage period.

To ensure the original quality of the Sundyne pump after storage, all components must be inspected by an authorized Sundyne service engineer. Components that are not manufactured by Sundyne (except mechanical seals) must be inspected by its own manufacturer.

Note: Any inspection fees are the sole responsibility of the purchaser.

Factors which affect the quality of a Sundyne pump, when stored, are:

- Humidity
- Temperature
- Surrounding chemicals

Long-term storage methods must prevent damaging conditions from making contact with the internal components of the equipment. When the equipment is stored in strong chemical environments or near salt water, protection must occur immediately upon receipt of the equipment.

Recommended Long-Term Storage Procedures

Sundyne recommends that you do the following to prevent damage to your pump during long-term storage:
1. Store your pump only in an indoor, climate controlled building. These conditions will maintain constant temperature and humidity.

2. Perform inert gas purging of component internals.

3. Ensure oil flooding of gearbox internals.

4. Use desiccant bags.

**Note:** Because long-term storage of equipment is of a highly critical nature, it is recommended that Sundyne be contacted to provide more details on the above procedures.

---

### Suction and Discharge Piping

Please adhere to the following best practices for installing and maintaining suction and discharge piping:

1. Install a suction strainer (12 mesh - .062" or 1.66mm opening) and clean the suction line prior to starting the pump. This procedure will protect the impeller from damage by mill scale, welding slag, or other foreign particles during initial startup.

**Note:** Sundyne Recommends installation of a differential pressure instrument across strainer to indicate strainer condition.

2. When installing piping to the pump, ensure that all piping is supported independently from the pump.

3. All piping must always line up with the pump flanges.

**Note:** Never use force to position piping into place at the flanged suction and discharge connection locations. Failure to have piping properly aligned may impose excessive strains on the unit.

4. Sundyne recommends using a straight pipe assembly of at least three times the length of the pipe diameter.

**Note:** Carefully select the size of pipe and fittings to be installed so that friction losses will remain low.

5. Never use a suction pipe that is smaller in diameter than the pump suction inlet.

6. Sundyne recommends installation of a discharge check valve to prevent reverse rotation.

7. Use block valves (both suction and discharge) when isolating the pump during shutdown. This practice will minimize process leakage and prevent possible reverse rotation from pump back-flow.

8. It is recommended that suction and discharge pressure gauges be installed on any pump that is not flow controlled. If no flow measuring device is installed there is no way to determine accurately where on its curve the pump is operating.
Seal Environmental Control System

A seal environmental control system may be required depending upon the pump seal arrangement and application. Always maintain the pump seal environment as detailed on the specification sheet that accompanies each unit.

**Note:** For most applications, a standard control system can be obtained from the factory.

Ensure that the specified seal environmental control system is properly installed and that the ports are open (or plugged) as indicated in Figure 1.

**Note:** Port 1 must always be open so that it is free to drain.

![Impeller and Driver Shaft Rotation](image)

**Figure 1. Seal Housing Port Identification**

<table>
<thead>
<tr>
<th>Port</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Seal Drain, Gearbox Oil (ALWAYS OPEN)</td>
</tr>
<tr>
<td>2</td>
<td>Seal Drain (Single Seal) or Buffer Fluid Out (Self Circulating) or Plug (Tandem Seal when Specified)</td>
</tr>
<tr>
<td>3</td>
<td>Cooling In (Normally Plugged)</td>
</tr>
<tr>
<td>4</td>
<td>Cooling Out (Normally Plugged)</td>
</tr>
<tr>
<td>5</td>
<td>Seal Flush</td>
</tr>
<tr>
<td>6</td>
<td>Seal Flush</td>
</tr>
<tr>
<td>7</td>
<td>Seal Drain (Single Seal) or Buffer Fluid In (Self Circulating) or Plug (Tandem Seal when Specified)</td>
</tr>
</tbody>
</table>

Liquid Buffer System

For double liquid seals and tandem liquid seals, a liquid buffer system is used. Introduce the buffer liquid into port 7, which will flow through the seal cavity, and out from port 2.

Buffer flow should be 0.5 to 3 gpm (2 to 12 liters/min) with an inlet temperature of 60° to 120°F (16° to 49°C), and inlet pressure as indicated on the pump specification sheet. The liquid must be clean to 5 microns.

Mounting Vertical Units Without Stands

For all vertical units without stands, a mounting base is recommended. The pump should be mounted on a rigid foundation, secured in position by one-inch diameter bolts. The bolts should be installed in the foundation as shown on the installation drawing. The length of the bolts should be sufficient to extend at least ½-inch above the nut.
Mounting Vertical Units with Stands (LMV)

Grouting of the base plate is required for all vertical stand units. The top of the stand (driver mounting surface) should be leveled by shimming under the base prior to grouting the channels that are to be filled with grout through the access holes. The nuts on the foundation bolts should not be tightened until the grout has set for at least 48 hours.

Base Mounted (BMP) Units

Grouting of the base plate is required on all BMP units. The base plate should be leveled prior to grouting. After grout has been applied, it must be allowed to set for at least 48 hours before tightening foundation bolts.

Driver and Coupling

Drivers are normally shipped separately from the gearbox and pump. When a splined interconnecting shaft is supplied, this shaft must be lubricated at each end with one tube (5cc) of anti-fretting compound (Sundyne Part Number MP01AA10).

Also available are solid shaft drivers coupled to the gearbox with a flexible coupling. Drivers are to be installed and maintained in accordance with the manufacturer's instructions.
Flexible Coupling for LMV Units Without a Vertical Stand

**Note:** Lock out the driver starting switch before working on the coupling.

When installing flexible couplings, use those supplied by Sundyne to ensure tolerance of parallel and angular misalignment, and axial end float. Use flexible disc couplings or gear type couplings if not using those supplied by Sundyne. Coupling installation for turbine drivers is identical to that for motors.

The gearbox coupling hub is normally mounted at the factory. The driver coupling hub is mounted on all motors and turbines shipped directly from Sundyne.

**Driver Coupling is Not Mounted**

If your product is received without the driver coupling hub mounted, use the following procedure when installing Falk or Thomas couplings:

1. Measure the distance from the top surface of the gearbox hub, to the datum face of the driver adapter. This measurement is referred to as dimension "X".

2. Determine the end gap (the distance between each coupling hub) for the size of coupling provided. Refer to the Coupling Specifications tables in the Specifications section of this manual for specific measurements.

3. Subtract the end gap value from dimension X to determine the distance from the driver datum face to the coupling hub face. This value is referred to as dimension "Y".

4. Scribe the shaft to show dimension Y.

5. Ensure that the coupling hub bore, keyways, and shaft are clean and free from burrs. Also determine that the key fits in the keyways.

6. Heat the hub in an oil bath or oven to approximately 250°F (121°C), or more if necessary, so that the hub will slide onto the motor shaft.

7. Position the hub at the scribed line on the shaft.

8. Tighten the hub key set screw.

**Note:** Before the hub is installed onto the flexible disk couplings, verify that the coupling bolts and washers can be assembled (Figure 4) from the motor side of the hub when installed. If these pieces do not assemble, insert short bolts with bevel washers into the hub flange before fitting them onto the shaft.
LUBE SYSTEM

The internal lube oil system engineered for Sundyne pumps consist of four major components. They are:
- Gearbox sump
- Main lube pump
- Oil heat exchanger
- Oil filter

The lube pump intakes oil from the sump and passes it internally to an externally mounted manifold. The oil is then passed through the heat exchanger, the filter, and back into the gearbox. Once the oil is passed through the bearings, it then drains back into the sump.

Gearbox Heat Exchanger

The standard heat exchanger is a shell and tube water-cooled type. For optimum performance, the following conditions must be met.
- Cool water must be provided to the tube side at a maximum pressure of 150 psig (11 kg/cm²)(103.5 Kpag).
- Coolant flow must be controlled to maintain a gearbox sump temperature between 140°F and 160°F (60° to 71°C). Maximum recommended temperature is 180°F (82°C).

The optional air-cooled heat exchanger should be controlled to maintain the same gearbox sump temperatures as above.

Mount the heat exchanger lower than the oil filter to prevent air pockets in the lube oil lines at start up. Air pockets can cause oil starvation at the bearings.

Note: The heat exchanger installation is a Sundyne assembly and should not be rearranged. The heat exchanger is NEVER mounted higher than the filter.

Oil Manifolds

There are two standard oil manifold configurations, MA01AA78 for units without heat exchangers and MA01AA79 for units with heat exchangers. For units purchased prior to 1991, the standard manifold is MA01AA01.

Figure 5. Heat Exchanger Manifolds
MA01AA78 (left), MA01AA79 (center), MA01AA01 (right).
The MA01AA01 model requires a ¼" socket-head pipe plug in the filter manifold when using the gearbox heat exchanger. The plug must be removed when the heat exchanger is not being used.

**Remote Heat Exchanger**

All air-cooled heat exchangers as well as some large water-cooled heat exchangers must be mounted away from the gearbox.

*Note:* Interconnecting piping is the purchaser’s responsibility unless the piping is included with packaged units.

All connecting piping, including fittings, must not exceed 20’ (6m). The minimum requirement of all piping is 5/8” (16mm) inner diameter (I.D.) tubing or piping. If pipe lengths exceed 20’ (6m), then the pipe diameter must be increased accordingly.

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**Gearbox Sump**

The gearbox sump holds approximately seven U.S. quarts (6.6 liters) of oil, not including the oil contained within the auxiliary piping and heat exchanger. The oil level must always be maintained as recommended by Sundyne.

*Note:* Sundyne recommends that the oil level must be within ¼” of top of the round sight glass when the machine is static (refer to the mark labeled "MAX"). When the pump is in operation, the level will be approximately ¼” below the MAX level, with bubbles filling the rest of the glass. Do not overfill the gearbox. Overfilling will cause overheating/excessive foaming.

**Gearbox Sump Heater (optional)**

When gearbox oil temperature falls below –20°F (-29°C) it becomes too viscous for proper lube pump operation. A sump heater is required when these conditions may exist. Two types of sump heaters are recommended for these conditions—electric or steam.

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**SundGard® Oil Filter**

The specially designed oil filter is rated for 3 microns at a beta ratio of 200.

*Note:* Oil filters other than Sundgard®-OEM filters will void the Sundyne warranty.

The gearbox oil and filter should be changed every six months. Refer to the Lube Oil Specifications in the Specification section of this manual for more information.
Main Lube Pump and Lube Oil Priming Kit

**Note:** Use the auxiliary lube oil priming pump to circulate oil around the heater when the main drive motor is not running.

The main lube pump is a positive displacement gear type pump directly driven by the input shaft. A pre-lube system is required on some pumps. The kit consists of:

- Motor driven positive displacement pump
- Check valve
- Gages
- Necessary piping

To start the pump, allow the pre-lube pump to run for approximately 30 seconds. There should be a minimum indication of 7 psig (0.5kg/cm²) maintained for 30 seconds before starting the main driver. If the oil piping has been drained, allow several minutes of operation to bleed trapped air from the system.

**Note:** Only allow shut down of pre-lube pump after main driver is at full operating speed.

---

Oil Pressure

During normal operation the gearbox internal lube pump will maintain oil pressure between 15 and 60 psig (1.0 and 4.2kg/cm²). This oil pressure can vary depending on the bearing configuration and characteristics of the oil being used.

**Note:** Never operate the gearbox with oil pressure less than 10 psig (0.7 kg/cm²)
Start-Up Procedures

Perform the following tasks to start the Sundyne pump.

1. Run-in of pump: If the pump is to be run under conditions which are considerably different from those conditions listed on the spec sheet (such as a change in specific gravity, suction pressure, flow rate, etc.) the factory should be consulted to ensure that the run-in conditions are compatible with the pump.

2. Check to ensure that the driver has been serviced per instructions provided by the driver manufacturer.

3. Auxiliaries - Check utility connections; verify that auxiliary piping is per Sundyne drawings; verify switch and instrument connections and set points; calibrate flow instruments and other transmitters.

4. Flushing screens should be installed in all field assembled piping connections.

5. Check the pump specification sheet and outline drawings for seal environment requirements. Be sure seal housing port piping is properly connected. If double seals are used, buffer fluid must be pressurized before suction pressure is applied to the pump. Port 1 must be open. Maximum allowable back pressure on Port 1 is 5 psig (0.35 kg/cm²).

6. Fill the gearbox with oil.

Remove the gearbox fill-vent plug and the filter-breather cap from the fill opening on the gearbox. Fill gearbox within ½ inch (6.4 mm) from top of oil level sight glass with lube oil which conforms to the specification in Table 9. Where applicable, operate auxiliary lube pump to fill heat exchanger and filter. Add oil as necessary through fill fitting until oil level stabilizes in sight glass. The gearbox alone requires approximately 7 quarts (6.6 liters). Replace the filter breather cap on the fill-opening fitting and replace the fill-vent plug. If an auxiliary lube pump is not used, remove the plug on top of the oil filter (item 924g) manifold and fill the oil filter and the heat exchanger with oil (Figure 6).

7. Prime the lube oil system

The following actions must occur at the time of initial pump installation and following every re-installation after maintenance that required the draining/removal of the gearbox lubricating fluid.

Verify that gearbox lube oil pressure will be achieved by priming the lube oil system and expelling all of the air that is potentially trapped. Priming can be achieved by either operating the (optional) auxiliary lube oil priming pump or by jogging the main driver connected to the gearbox (oil pressure should be observed by the second or third jog - each of 2-3 seconds duration).

---

**Note:** Jogging is required for initial installation or following re-installation after maintenance and re-filling of gear oil lubricant. Units remaining idle should be jogged once a month to prevent the bearings from brinelling and to prevent internal rusting.

Jogging is also used to verify proper direction of rotation for the main driver. Jogging is a prudent, conservative activity that can be quite useful to ensure long service life of the Sundyne high-speed products by providing a fluid film of lubricant on the surfaces of bearings and gears.

After priming the lube oil system, check the oil level in the gearbox sump, and add oil as necessary.

---

**Note:** Never start the pump against a closed discharge valve. Always check to ensure that the discharge valve is partially open.

After priming the lube oil system as defined above, the pump can now be routinely started without the need of jogging. This would include switching of main/stand-by units, start-up of idle reserve units, start-up
of emergency units, etc. Non-operating units should be started/used every 9-12 months on an alternating basis.

8. If an auxiliary lube system is installed, it should be used in the following manner.
   a) At the initial startup or after changing the lube oil, run the pump for several minutes to work any trapped air out of the piping. Adjust the relief valve on the auxiliary pump to provide 25 psi (1.76 kg/cm²) oil pressure to the system.
   b) The auxiliary system is intended to provide oil before starting the main driver. It should run for a minimum of 5 seconds at minimum pressure before the main driver is started. Pressure switches and time delays can be used if automatic start sequences are desired.

   c) After the start of the main driver, oil pressure will be supplied by the main lube pump inside the gearbox. An increase in oil pressure should be observed. Shut down the auxiliary pump within two minutes of the main driver start.

9. Adjust the heat exchanger cooling flow to regulate the gearbox sump temperature between 140° and 160°F (60° and 71°C). Approximately one hour may be required to stabilize the temperature.

   Maximum recommended temperature is 180°F (82°C).

### Controlling the Pump During Startup

To ensure control of the pump during start up, follow the start up procedures for your desired configuration.

**Single Operation**
Start the pump with the suction valve open while throttling the discharge valve. This will ensure that the pump will reach the design flow operating point.

If the process fluid is near its vapor pressure, open the supply vessel seal cavity vent so that the pump can fill with liquid.

**Parallel Operation**
To prevent back-flow, place check valves in the discharge piping of each pump.

**Note:** Sundyne recommends installing separate bypass loops around each pump for additional operational flexibility.

1. Start the first unit as described in the Single Operation instructions.

2. Start the second unit with the bypass valve set to maintain the flow above minimum flow.

3. Open the discharge valve on the second unit so that the design flow of both units is maintained.

**Note:** Do not operate the pumps at their peak head capability.

Sundyne recommends that separate flow controls be used on each pump to provide a lower minimum flow range than is achieved by pressure control.
Operation of Sundyne Pumps

Under normal operation, several factors must be taken into consideration to ensure successful pump operation. Experienced pump operators will be aware of jeopardizing factors and their effects.

Suction Conditions
Improper flow of liquid into the impeller is the most common operational abuse of centrifugal pumps. Two conditions must exist to prevent turbulence at the eye of the impeller.

- Proper suction piping, see suction piping section.
- Liquid reaching the impeller eye must have enough vapor pressure to prevent the fluid from flashing to a gas in the impeller. If this condition occurs, it will cause cavitation, which can damage the impeller and inducer. When centrifugal pumps cavitate the noise sounds like the pump is “pumping gravel”. In high speed, single stage pumps, this sound may not be discernable. Cavitation can be prevented by maintaining suction pressure at a high enough level and suction temperatures low enough to maintain Net Positive Suction Head (NPSHa) available greater than Net Positive Suction Head (NPSHr) required by the pumps.

Minimum Flow Conditions
Vibration and noise will occur during operation of centrifugal pumps if either of two conditions exist:

- Internal flow separations
- Recirculation at low flow conditions

If the operator is noticing excessive noise or vibration, operation must be suspended until the cause is determined and corrected. Continued use may cause damage to the pump. Resonance in the discharge line can accentuate noise, vibration, and damage to the pump, primarily when a control valve is located an excessive distance downstream from the pump.

Entrained Gases
The head and capacity of centrifugal pumps will be reduced by gas that is drawn in with the liquid. Under normal operating conditions, centrifugal pumps can tolerate up to 2% of gas (by volume). Entrained gases can cause damage to mechanical seals with the exception of double seals. If you have entrained gas, contact Sundyne for further instruction.

System Head Curve
The point of intersection between the system curve and the pump characteristic curve determines the flow or operation for the centrifugal pump. For steady flow to occur, the system curve must intersect the pump characteristic curve at a significant angle. The following diagram gives examples of satisfactory and unsatisfactory angles of intersection.

Figure 8. Typical Operation
Note: The curve for pump A has a significant angle of intersection with system curves D and E. The system curve D could represent a system with the control valve wide open while curve E could represent the same system but with the throttle valve closed to reduce flow from flow 1 to flow 2. Pump curve B, on the other hand, will provide only flow 2, even with the control valve wide open (curve D). When the control valve is partially closed to create system curve E, the curve E and lower pump curve B are practically parallel. The lack of a significant angle of intersection means that the system is unstable, pump flow is likely to fluctuate erratically and not respond to control valve position.

Parallel Operation
Maximizing control is critical when operating centrifugal pumps in parallel. One pump can overpower the other in regards to head at a lower total flow. If a simple, unrestricted manifold connects two pumps at the discharge head, the discharge head of one pump is imposed on the other. All pumps will see the same discharge head at a given time. This is demonstrated on the following diagrams.

The characteristic curves of two pumps designated A and B are demonstrated in the Parallel Operation figure.

Since no two pumps will have exactly the same performance, it is assumed that pump A produces a slight amount more head than pump B. The pumps are arranged with a common manifold as shown in Parallel Units Common Valve figure.

The pressure in the manifold is set at P1; the flow through pump A indicated as A1 on the preceding curve. At the same time, the flow through pump B is indicated as B1. However, if the throttle valve is closed to cause the manifold pressure P to rise to P2, then flows through pump A and B are A2 and B2 respectively. If the throttle valve were closed even further, then pump B would cease to flow entirely. Since pump B would effectively be deadheaded, the fluid in it would heat up and boil. During internal boiling, it could encounter liquid slugging and probable damage to the pump. Proper selection of a control system can prevent this situation.
Disassembly of LMV-311

STEP 1
Remove attached hardware and lift the driver up off the gearbox. Remove the nuts from the pump casing studs. Lift the gearbox and seal housing up off of the pump casing.

*Note:* Ensure the impeller is protected from coming in contact with any objects that may cause damage.

STEP 2
Remove vent cap from gearbox.

STEP 3
Install the anti-rotation device to prevent impeller from spinning.

*Note:* Plate the gearbox on a suitable support with the impeller pointing upward.

*Note:* Tool number TO01AK02 for keyed input shaft and TO01AK03 for splined input shaft.
STEP 4
Remove inducer or impeller nut.

Note: Left hand thread.

STEP 5
Remove impeller using prying tools.

Note: The impeller is dynamically balanced and must be replaced or rebalanced if any signs of damage are visible.

STEP 6
Remove diffuser cover using prying tools.

Note: Groove on side of diffuser cover is for prying, and not for an o-ring.

Tandem seal arrangement is shown in the following disassembly steps.

STEP 7
Remove mechanical seal mating ring.
STEP 8
Remove lower mechanical seal.

Mating ring should slide right off.

Remove three hex head screws and washers.

STEP 9
Remove lower shaft sleeve and o-rings above and below shaft sleeve.

Use extraction tool to slide o-rings up the shaft.

Notice shaft sleeve next to impeller side o-ring.

Note: Tandem configuration shown.
STEP 10
Remove tandem-mating ring.

Use extraction tools to slide up, over shaft.

STEP 11
Remove four bolts holding seal housing.

STEP 12
Remove seal housing.

*Note:* Use “S” hooks or eyebolts and hoist when possible to avoid personal injury.

Lifting the seal housing using a hoist.
STEP 13
Turn seal housing over and remove upper seal from seal housing.

Remove three hex head screws and washers.

STEP 14
Remove the o-ring from the upper shaft sleeve.

Use extraction tool to remove o-ring.

STEP 15
Remove upper shaft sleeve.

STEP 16
Remove gearbox seal screws and gearbox seal.

Removing three hex head screws.

Note: The gearbox mechanical seal can be replaced or rebuilt.
STEP 17
Remove gearbox seal o-ring.
Use extraction tool to remove o-ring.

STEP 18
Remove gearbox seal mating ring.
Remove mating ring with extraction tools.

STEP 19
Invert the gearbox and remove fill and vent fitting.
Use a pipe wrench to remove the ¾ inch pipe elbow first. Next, use the pipe wrench to loosen the pipe and remove from the gearbox.
Slide the fill and vent pipe out of gearbox.
STEP 20
Loosen and remove gearbox bolts, (7 total).

STEP 21
Loosen close tolerance alignment pin.

STEP 22
Drive close tolerance alignment pins out, (2 pins).

STEP 23
Remove upper gearbox housing.
A mallet can be used to tap around the edges of the housing to loosen the idler shaft and assist the housing in lifting off.

*Note:* Use hooks or eyebolts and a hoist when possible to avoid personal injury.
STEP 24
Remove idler shaft assembly.
Removing the idler shaft assembly disengages the upper idler and input shaft gears.

STEP 25
Remove input shaft assembly.

STEP 26
Remove the lube pump spring and the lube pump.

STEP 27
Inspect the condition of the lube pump anti-rotation pin.

STEP 28
Remove bearing plate.
STEP 29
Remove and inspect upper thrust washer.

Washer will slide off of the shaft.

STEP 30
Remove idler shaft assembly.

STEP 31
Remove high-speed shaft assembly.

STEP 32
Remove the lower thrust washer.

STEP 33
Remove and inspect upper journal bearing after removing from bearing plate.

Unscrew three hex head screws.

Use fingers to remove journal bearing.
Inspect the upper journal bearing for damage or signs of excessive wear.

**STEP 34**
Remove input shaft seal.

**STEP 35**
Remove the sump tube.

**STEP 36**
Remove lower journal bearing.

Repeat step 33 for removal of lower journal bearing.

**STEP 37**
Remove lower bearing shims.

**STEP 38**
Remove all the lube jets in lower and upper housing.

Use hex key to remove the lube jets.
STEP 39
Blow out lube passage.

Using air tool to blow out lube passages.

Blowing out lube passages.

STEP 40
Remove diffuser from the pump case.

Install three 5/16 eyebolts into the diffuser to use for hoisting the diffuser off of the pump case.

STEP 41
Lift the diffuser from the pump case.

Note: Use hoist when available to prevent personal injury.
Inspection, Cleaning and Repair

Inspecting All Bearings

Replace bearings if:
- They have been in operation for over three years
- If rotation is not smooth
- If outside of inside diameters are worn

**Note:** Only replace bearings with manufacturer’s approved replacement bearings. Non-approved bearings may jeopardize the mechanical integrity of the gearbox and pump.

**Note:** Refer to the Specifications section of the manual for all bearing and shaft clearances.

High-Speed Shaft

Inspect the High Speed Shaft at the thrust washer and journal bearing contact areas. Replace the shaft and gear assembly if:
- Outside diameter of shaft is less than 1.4960 inches
- If the shaft has bearing or washer materials on its surface
- Shows signs of overheating
- Shows wear to a depth greater than 0.001” (0.03mm)

Inspect upper and lower thrust washers or tilting pad bearing assembly. If metal is smeared into radial lube grooves of the washer face, install a new washer. If the tilting pads do not fit freely, or if they show signs of metal pick-up or overheating, install a new bearing assembly.

**Note:** The radial “free play” of the high speed shaft can be as high as 0.011 inch (0.28mm) due to the clearance in the bearings. It is not possible to check for shaft straightness while the gearbox is assembled. To check straightness, the shaft must be placed in V-blocks, on its bearing journals, and have runout measured at the impeller fit (0.0018 inch TIR max).

Gearbox Mechanical Seal

Carefully inspect the seals for abrasive particles, excessive seal face wear and any binding of the seal face washer.

Replace or rebuild a faulty mechanical seal. Seals may be rebuilt by replacing the seal face washer, wedge rings, o-ring, and springs. A seal repair kit is available.

Replace or lap the seal rotating face if the wear track is rough or worn to a depth greater than 2 helium light bands.

A combined total of 0.010 inch (0.25mm) maximum may be removed from the surfaces of the pump and gearbox seal rotating faces. Excess material removal will result in incorrect seal face loading causing increased seal leakage.

Remove any high spots on the end surfaces of the lower shaft sleeve and impeller hub to insure that the seal rotating face will not be distorted by clamping force of the impeller bolt.

Reassemble the seal, throttle bushing, if used seal housing, and impeller using an o-ring repair kit. All o-rings that were disturbed by disassembly should be replaced. During reassembly, carefully check the torque values listed in Table 12.

The impeller may rub on the diffuser cover plate (15) until o-rings (936D and 936E) are compressed by tightening hex nuts (914A). Check the gearbox input shaft for freedom of rotation after the pump is assembled and all bolts are tightened per Table 12.
Shaft Sleeve

Ensure that there are no high spots on the end surfaces of the shaft sleeve or the impeller hub. High spots will distort the seal rotating face due to the clamping force of the impeller bolt. Ensure that shaft sleeve end faces are parallel within 0.0003" (0.0076mm).

Bearing and Shaft Clearances

Figure 11. Bearing and Shaft Clearances
Reassembly of the LMV-311

STEP 1
Insert shim under lower journal bearing.

STEP 2
Insert 3 hex head screws.

Note: Torque to 40 in-lbs

Note: Using a torque wrench to tighten screws.

STEP 3
Install lower thrust washer if not already in place.

STEP 4
Install high-speed shaft assembly.

Note: Above picture has thrust washer already installed over journal bearing.
STEP 5
Re-install the sump tube into the bearing plate.

STEP 6
Re-install the upper journal bearing into the bearing plate.

**Note:** Torque screws to:

<table>
<thead>
<tr>
<th></th>
<th>Item 905M</th>
<th>English 40 in-lbs</th>
<th>Metric 4.5 N-m</th>
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</thead>
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<tr>
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</tbody>
</table>

STEP 7
Install new thrust washer.

Thrust washer is silver disc in center.

**Note:** A light coating of lubricant may be used to hold item 155B in place.

STEP 8
Install bearing plate without gasket using alignment pins.

Using alignment pin to install the bearing plate temporarily.

STEP 9
Clamp bearing plate to the lower gearbox housing.

Clamping the bearing plate to housing.

**Note:** “C” clamps can be utilized to perform this task.
STEP 10
Inspect endplay of the high-speed shaft.

Note: Endplay must fall within these tolerances, 0.015” +/- 0.002”

Measuring endplay of High Speed Shaft.

Note: For complete instructions for checking endplay refer to the “Procedure for Checking High Speed Shaft Endplay” later in this manual.

STEP 11
Remove bearing plate and install lower housing o-ring (936AG) and o-ring at oil passage (936N).

936AG

Lubricate the journal bearings, high-speed shaft, journal / thrust face with standard gearbox lubricant.

936N

STEP 12
Lubricate the lower idler bearing.

STEP 13
Install idler shaft assembly.

Note: The idler shaft assembly sits at a slight tilt to allow installation of the bearing plate.
STEP 14
Install the bearing plate.

STEP 15
Install lube pump.

STEP 16
Install lube pump spring.

The lube spring sits inside the lube pump.

STEP 17
Lubricate the lube pump.

STEP 18
Install input shaft assembly.

Note: Notice the input slots for the oil pump drive pins.

STEP 19
Push on input shaft to verify engagement of drive pins.
STEP 20
Set idler shaft assembly in place and engage input gears.

STEP 21
Lube input shaft bearings and upper idler bearings.
Install upper housing o-ring (936AG) and o-ring at oil passage (936T).

STEP 22
Install upper gearbox housing.

Note: Lower carefully in order to slide bearings into bearing liners.

Note: Use hoist when available to prevent personal injury.

STEP 23
Install close tolerance alignment pins.

Note: Install first pin as noted on the bearing plate.
STEP 24
Install new lip seal.

*Note:* Use lip seal installation tool #T-H006AA-47 to install lip seal.

Putting lip seal onto lip seal installation tool.

STEP 24 continued

Installing the lip seal.
STEP 24 (Alternate)
Apply Lubricant.

STEP 24 (Alternate part 2) continued
Install the cartridge seal.

STEP 24 (Alternate part 3) continued
Install input seal. Use a pipe to tap cartridge seal into place

STEP 25
Install remainder of gearbox hex head bolts.

STEP 26
Install fill and vent fitting.

Note: Use pipe dope on all pipe threads. Use pipe wrench to tighten fitting after sliding into place.

Note: Do not use Teflon tape on connections to gearbox as this may result in lubrication system malfunction.
STEP 27
Install shaft anti-rotation device to prevent the impeller from spinning.

*Note:* Tool number TO01AK02 for keyed input shaft and TO01AK03 for splined input shaft.

STEP 28
Turn gearbox over.
Gearbox Seal Assembly

STEP 1
Install gearbox-mating ring.

*Note:* Chamfer on mating ring should be toward gearbox.

STEP 2
Install gearbox seal o-ring (936P) onto gearbox seal.

STEP 3
Install gearbox seal. Install three gearbox seal hex head screws.

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<th>English 75-80 in-lb</th>
<th>Metric 8.5-9.0 N-m</th>
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</table>

*Note:* Torque screws to:
Steps for Single Seal Only

STEP 1
Install thermal barrier gasket.

STEP 2
Install o-ring (936K) followed by shaft sleeve.

STEP 3
Install o-ring (936J).

STEP 4
Install o-ring (936H) on throttle bushing.

STEP 5
Install throttle bushing on the seal housing and torque throttle bushing screws.

Note: Torque screws to:

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<tr>
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<td>905F</td>
<td>70-75 in-lbs</td>
<td>8-8.5 N-m</td>
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</table>
**STEP 6**

Install seal on housing on gearbox.

*Note:* Use “S” hooks or eyebolts and hoist when available to prevent personal injury.

**STEP 7**

Install and torque seal housing cap screws.

**STEP 8**

Install o-ring (936H) on mechanical seal.

**STEP 9**

Install mechanical seal and torque.

*Note:* Torque screws to:

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<th></th>
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</table>

**STEP 10**

Install seal mating ring.

**Skip to page 56 for Instructions on the Throat Bushing Option.**

**Continue on page 58**
Steps for Dual Pressurized (Double Seal) Only

STEP 1
Install the thermal barrier gasket.

STEP 2
Install o-ring (936K) followed by the shaft sleeve.

STEP 3
Install o-ring (936J).

STEP 4
Install o-ring (936H).
STEP 5
Install upper seal and torque.

Note: Torque screws to:

<table>
<thead>
<tr>
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<th>English (in-lb)</th>
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</table>

STEP 6
Use a hoist to lift seal housing.

STEP 7
Install seal housing cap screws and torque.

Note: Torque screws to:

<table>
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<tr>
<th>Standard</th>
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<td>905A</td>
<td>27-30 ft-lbs</td>
<td>37-40 N-m</td>
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</tbody>
</table>

STEP 8
Install mating ring.

CAUTION! Dropping or rough handling of mating rings may result in micro cracks resulting in seal failure.
STEP 9
Install o-ring (936J).

STEP 10
Install the seal spacer, chamfer toward seal.

STEP 11
Install o-ring (936H).

STEP 12
Install lower seal and torque.

**Continue on page 58**
Steps for Dual Unpressurized (Tandem) Seal Only

STEP 1
Install the thermal barrier gasket.

STEP 2
Install o-ring (936K) followed by the shaft sleeve.

STEP 3
Install o-ring (936J).

STEP 4
Install o-ring (936H).

STEP 5
Install upper seal and torque.

Note: Torque screws to:

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<th>Metric</th>
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Compliant
STEP 6
Use a hoist to lift seal housing.

STEP 7
Install seal housing cap screws and torque.

Note: Torque screws to:

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STEP 8
Install mating ring.

Note: Torque screws to:

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<td>905E</td>
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<td>8-8.5 N-m</td>
</tr>
</tbody>
</table>

STEP 9
Install o-ring (936J).

STEP 10
Install o-ring (936H).

STEP 11
Install seal and torque.

Note: Torque screws to:

<table>
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<tr>
<td>Sundyne Standard</td>
<td>905E</td>
<td>95-102 in-lbs</td>
<td>11-11.5 N-m</td>
</tr>
<tr>
<td>Nace Compliant</td>
<td>905E</td>
<td>70-75 in-lbs</td>
<td>8-8.5 N-m</td>
</tr>
</tbody>
</table>
STEP 12
Install shaft sleeve.

STEP 13
Install o-ring (936J).

STEP 14
Install mating ring.

**Skip to page 56 for Instructions on the Throat Bushing Option.**

**Continue on page 58**
Steps for Single Seal with Isolation Bushing Only

**STEP 1**
Install the thermal barrier gasket.

**STEP 2**
Install o-ring (936K) followed by the shaft sleeve.

**STEP 3**
Install o-ring (936J).

**STEP 4**
Install o-ring (936H).

**STEP 5**
Install the upper seal and torque.

<table>
<thead>
<tr>
<th>Note: Torque screws to:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sundyne Standard</strong></td>
</tr>
<tr>
<td>905E</td>
</tr>
<tr>
<td><strong>Nace Compliant</strong></td>
</tr>
<tr>
<td>905E</td>
</tr>
</tbody>
</table>
STEP 6
Use a hoist to lift the seal housing.

STEP 7
Install the seal housing cap screws and torque.

STEP 8
Install the mating ring.

STEP 9
Install o-ring (936J).

STEP 10
Install o-ring (936H).

Note: Torque screws to:

<table>
<thead>
<tr>
<th></th>
<th>Item</th>
<th>English</th>
<th>Metric</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sundyne Standard</td>
<td>905A</td>
<td>35-40 ft-lbs</td>
<td>47-54 N-m</td>
</tr>
<tr>
<td>Nace Compliant</td>
<td>905A</td>
<td>27-30 ft-lbs</td>
<td>37-40 N-m</td>
</tr>
</tbody>
</table>
STEP 11
Install the isolation bushing and torque.

**Note: Torque screws to:**

<table>
<thead>
<tr>
<th></th>
<th>Item</th>
<th>English</th>
<th>Metric</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sundyne Standard</td>
<td>905G</td>
<td>95-102 in-lbs.</td>
<td>11-1.5 N-m</td>
</tr>
<tr>
<td>Nace Compliant</td>
<td>905G</td>
<td>70-75 in-lbs</td>
<td>8-8.5 N-m</td>
</tr>
</tbody>
</table>

STEP 12
Install the shaft sleeve.

**Continue on page 58**
Steps for Single Seal with Steam Bushing Only

**STEP 1**
Install o-ring (936K) followed by the shaft sleeve.

**STEP 2**
Install o-ring (936J).

**STEP 3**
Install o-ring (936H) on steam bushing.

**STEP 4**
Install steam bushing on the seal housing and torque steam bushing screws.

---

**Note: Torque screws to:**

<table>
<thead>
<tr>
<th></th>
<th>Item</th>
<th>English</th>
<th>Metric</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sundyne Standard</td>
<td>905F</td>
<td>95-102 in-lbs</td>
<td>11-11.5 N-m</td>
</tr>
<tr>
<td>Nace Compliant</td>
<td>905F</td>
<td>70-75 in-lbs</td>
<td>8-8.5 N-m</td>
</tr>
</tbody>
</table>
STEP 5
Use hoist to lift seal housing on gearbox.

**Note:** Use “S” hooks or eyebolts and hoist when available to prevent personal injury.

STEP 6
Install and torque seal housing cap screws.

**Note:** Torque screws to:

<table>
<thead>
<tr>
<th></th>
<th>Sundyne Standard</th>
<th>English</th>
<th>Metric</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item 905A</td>
<td></td>
<td>35-40 ft-lbs</td>
<td>47-54 N-m</td>
</tr>
</tbody>
</table>

**Note:** Torque screws to:

<table>
<thead>
<tr>
<th></th>
<th>Nace Compliant</th>
<th>English</th>
<th>Metric</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item 905A</td>
<td></td>
<td>27-30 ft-lbs</td>
<td>37-40 N-m</td>
</tr>
</tbody>
</table>

STEP 7
Install o-ring (936H) on mechanical seal.

STEP 8
Install mechanical seal and torque.

**Note:** Torque screws to:

<table>
<thead>
<tr>
<th></th>
<th>Sundyne Standard</th>
<th>English</th>
<th>Metric</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item 905E</td>
<td></td>
<td>95-102 In-lbs</td>
<td>11-11.5 N-m</td>
</tr>
</tbody>
</table>

**Note:** Torque screws to:

<table>
<thead>
<tr>
<th></th>
<th>Nace Compliant</th>
<th>English</th>
<th>Metric</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item 905E</td>
<td></td>
<td>70-75 in-lbs</td>
<td>8-8.5 N-m</td>
</tr>
</tbody>
</table>

**Skip to page 56 for Instructions on the Throat Bushing Option.**
STEP 9
Install seal mating ring.

**Continue on page 58**
Throat Bushing Option for Single Seal and Tandem Seal Only

STEP 1
Install o-ring (936G) on the mating ring.

STEP 2
Install seal mating ring.

STEP 3
Install o-ring (936S) on throat bushing and place into the diffuser cover plate.

STEP 4
Make sure the notch on the throat bushing lines up with the pin on the diffuser cover plate.

STEP 5
Install retaining ring.
STEP 6
Install o-ring (936E) on the diffuser plate.

STEP 7
Install o-ring (936D) on the diffuser plate.

STEP 8
Install the diffuser plate.

STEP 9
Install shaft sleeve SL01AA19.

**Skip to Impeller Installation
Step 4 on page 58**
Continuation for Single, Dual Pressurized (Double), Tandem, and Steam Bushing Assemblies (If Throat Bushing Does Not Apply)

STEP 1
Install o-ring (936E) on diffuser plate.

STEP 2
Install o-ring (936D) on diffuser plate.

STEP 3
Install the diffuser cover onto the gearbox.

Note: Rotate cover to engage alignment pin with hole in seal housing.

STEP 4
Install impeller o-ring (936G).
STEP 5
Install impeller.

STEP 6
Install tab washer.

STEP 7
Install o-ring (936F).

STEP 8
Install impeller bolt.

Note: Fully engage impeller bolt into the impeller nut or inducer before installing into the assembly.

STEP 9
Torque impeller bolt or inducer.

Note: Torque impeller bolt / inducer to:

<table>
<thead>
<tr>
<th></th>
<th>Item</th>
<th>English</th>
<th>Metric</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nace Compliant</td>
<td>3</td>
<td>36-40 ft-lbs</td>
<td>49-54 N-m</td>
</tr>
<tr>
<td>Sundyne Standard</td>
<td>3</td>
<td>36-40 ft-lbs</td>
<td>49-54 N-m</td>
</tr>
</tbody>
</table>
STEP 10  
Replace upper diffuser o-ring (936B).

STEP 11  
Install lower diffuser o-ring (936C).  
Note: Lower diffuser o-ring may require stretching before installation.

STEP 12  
Lower diffuser o-ring inside the pump case.

STEP 13  
Lower the diffuser back onto the pump case.

STEP 14  
Install seal housing and gearbox onto the pump case.
STEP 15

Install pump case nuts onto casing studs.

**Note:** Tighten casing nuts according to the Torque Specification Table.

**Note:** The impeller may rub on the diffuser cover plate until all the o-rings are compressed by the tightening of the hex nuts.

**Note:** When installing new anti-friction bearings, bearings should be pressed onto the shaft using a press which only contacts the inner race. Bearing damage will occur by pressing or pulling the outer race. No more than 0.001 inch (0.03mm) gap should exist between the bearings, spacers, gears, and shaft shoulders.
Procedure for Checking the High-Speed Shaft Endplay

The endplay of the shaft **MUST** be measured if any of the following parts have been replaced:

- High speed shaft assembly
- Thrust washer
- Output housing
- Journal bearing
- Bearing plate

Sundyne recommends checking endplay during any re-assembly.

To obtain correct shaft endplay shim spacers must be installed as required.

**Note:** All parts must be dry and free of oil.

**STEP 1**
Install the lower journal bearing (151A) into the gearbox output housing (101A). With no shim spacers installed, tighten screws (905M).

**STEP 2**
Install the upper journal bearing or bearing assembly (151B) into the bearing plate (102). With no shim spacers installed, tighten screws (905N).

**STEP 3**
If used, place both upper and lower thrust washers (155B and 155A) into the upper and lower journal bearings. Place the high-speed shaft assembly into the gearbox output housing.

**STEP 4**
Install the bearing plate (102) using two large-diameter alignment bolts (909C). Do not install the o-ring and gasket. Clamp the bearing plate to the output housing with two “C” clamps or bolts.

**STEP 5**
With the shaft in a vertical position, move the shaft up and down while measuring the total endplay with a dial indicator or depth micrometer. Shaft endplay must be 0.015 ± 0.002-inch (0.38 ± 0.05 mm). If endplay is not within this limit, calculate the shim thickness required to place the shaft within the proper clearance range. Select the required thickness shim using 158 series shim spacer sizes.

**STEP 6**
Remove the alignment bolts (909C) and bearing plate (102) with upper journal bearing (151B).

**STEP 7**
Remove the high-speed shaft, thrust washers (if used), and the lower journal bearing.

**STEP 8**
Install the required shim spacers in place on the gearbox output housing and replace the lower journal bearing. Install attaching bolts (905M) and tighten.

**STEP 9**
Repeat steps 3-5 to verify correct endplay. If within specifications, proceed to step 10. If outside of tolerances, recalculate shims required and repeat steps 3-9.

**STEP 10**
Install the lower thrust washer (155A-if used) with the flat side on the bearing surface and replace the high-speed shaft.

**STEP 11**
Install the upper thrust washer (155B-if used) with the flat side on the journal bearing’s surface. A light grease may be used to hold the thrust washer in place.

**Note:** *Never install shims behind the upper journal bearing.*

**STEP 12**
Continue the reassembly of the gearbox by placing the idler shaft (140) in the lower half of the gearbox. Do not allow the idler shafts lower ball bearing to slide into the bearing retainer at this stage of the assembly.

**STEP 13**
Position the bearing plate (102) on the lower half of the gearbox. Ensure that the lube passage
o-rings (936T) and housing gaskets (105) are positioned correctly.

**STEP 14**

Install the low speed shaft assembly into the bearing plate bearing liner with the shaft aligned so that the lube pump drive pins slip into the low speed shaft. The top surface of the bearing should be even with the top of the bearing liner. The idler shaft can then be allowed to drop into the lower bearing liner, engaging the four gears.
Several system factors may affect the performance of the pump. These factors are:
- Temperature
- Specific gravity
- Suction pressure
- Driver speed

These factors as well as internal problems must be considered when analyzing pump system performance. The following table gives diagnostic information that can be useful when analyzing gearbox and pump performance problems.

<table>
<thead>
<tr>
<th>Situation/Symptom</th>
<th>Possible Cause</th>
<th>Investigative/Corrective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>No flow, no pressure at start-up.</td>
<td>Pump not completely filled with liquid.</td>
<td>Bleed all vapor or air from port 6. Allow more cool-down time if pumping low temperature fluid. Check suction line for air leak if suction pressure is lower than atmospheric.</td>
</tr>
<tr>
<td>NPSH actually lower than NPSH requirement listed on specification sheet.</td>
<td>Suction line blocked – check suction screen and valve. Excessive pressure drop through suction piping. Flow restricted by vapor pockets in high points of suction line. Suction tank level or pressure too low. Entrained air or vapor in pumped fluid. NPSH reduced by presence of more volatile fluid in process fluid.</td>
<td></td>
</tr>
<tr>
<td>Failure of drive component, such as interconnecting shaft or impeller key, or item missing from assembly.</td>
<td>Disassemble and inspect.</td>
<td></td>
</tr>
<tr>
<td>Reverse direction of rotation.</td>
<td>Direction of driver shaft rotation must be as shown by arrow on pump casing. Note: Impeller and driver rotate in the same direction.</td>
<td></td>
</tr>
<tr>
<td>Insufficient total head.</td>
<td>Flow too high.</td>
<td>Check total head and flow rate against performance curve.</td>
</tr>
<tr>
<td>Wrong direction of driver shaft rotation. (It is possible for the pump to develop greater than 50 percent design total head in this condition).</td>
<td>Direction of driver shaft rotation must be as shown by arrow on pump casing. Note: Impeller and driver rotate in the same direction.</td>
<td></td>
</tr>
<tr>
<td>NPSH actually lower than NPSH requirement listed on specification sheet.</td>
<td>Refer to solutions listed under “No flow, no pressure at start-up”.</td>
<td></td>
</tr>
<tr>
<td>Flow too low, causing overheating of fluid resulting in internal boiling and unstable pump operation.</td>
<td>Increase through-flow rate. Bypass part of pump discharge to supply tank.</td>
<td></td>
</tr>
<tr>
<td>Diffuser discharge throat partially plugged or impeller damaged by passage of a solid particle.</td>
<td>Clean these areas of all obstructions and restore surfaces to a smooth polished finish free of all corrosion pitting. Edge of diffuser throat must be sharp.</td>
<td></td>
</tr>
<tr>
<td>Situation/Symptom</td>
<td>Possible Cause</td>
<td>Investigative/Corrective Action</td>
</tr>
<tr>
<td>------------------------------------------</td>
<td>-------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Insufficient total head cont.</td>
<td>Corrosion and/or erosion of diffuser throat (may also be accompanied by erosion of diffuser and cover surfaces adjacent to impeller).</td>
<td>If edge of throat is no longer sharp and smooth or has opened in size, head-rise may be reduced. Opening of the inlet area of the throat will result in higher flow rate and horsepower consumption. Corrosion/erosion of diffuser and cover surfaces will result in a significant horsepower increase.</td>
</tr>
<tr>
<td></td>
<td>Excessive recirculation from discharge to inlet.</td>
<td>Check flow through external plumbing. Pump o-ring (936C) damaged or missing. Integral centrifugal separator orifice worn.</td>
</tr>
<tr>
<td></td>
<td>Process fluid specific gravity or viscosity different from values shown on specification sheet.</td>
<td>Check actual viscosity and specific gravity at operating temperature. Viscosity higher than five centipoise will cause reduced head and flow and increased power consumption.</td>
</tr>
<tr>
<td></td>
<td>Driver speed too low.</td>
<td>Check speed against value listed on specification sheet.</td>
</tr>
<tr>
<td></td>
<td>Pressure gauges or flow meters in error</td>
<td>Calibrate instrumentation.</td>
</tr>
<tr>
<td>Driver overloaded</td>
<td>Fluid specific gravity or viscosity higher than values listed on specification sheet.</td>
<td>Check actual viscosity and specific gravity against value listed on specification sheet.</td>
</tr>
<tr>
<td></td>
<td>Electrical failure in electric driver.</td>
<td>Check circuit breaker heater size and setting. Check voltage and voltage balance between phases. Current for each phase should be balanced within three percent.</td>
</tr>
<tr>
<td></td>
<td>Mechanical failure in driver, gearbox or pump.</td>
<td>Remove driver and check for freedom of rotation, correct spacing of pump and gearbox shaft assemblies. Remove fluid end and search for any mechanical failure. Remove gearbox oil level sight glass and inspect bottom of sump for wear particles. Bearings are probably not damaged if no wear particles are present.</td>
</tr>
<tr>
<td></td>
<td>Corrosion pitting on surface of diffuser cover or diffuser, adjacent to impeller blades. Head rise is also reduced by this condition.</td>
<td>Disassemble pump and inspect. Rough or pitted surfaces can cause friction losses which will significantly increase horsepower consumption. Clean these areas of all obstruction and restore surfaces to a smooth polished finish. Check diffuser throat area at the inlet; erosion or corrosion resulting in roughness or increased area will increase horsepower consumption. Note: A larger throat size than design will allow a higher flow and horsepower for a given head rise.</td>
</tr>
<tr>
<td>Excessive discharge pressure pulsations.</td>
<td>Flow rate too low.</td>
<td>Increase flow rate through pump. Add bypass to suction tank if necessary.</td>
</tr>
<tr>
<td></td>
<td>Insufficient NPSH available.</td>
<td>Refer to solution for insufficient NPSH under “No flow, no pressure at startup,” above.</td>
</tr>
<tr>
<td></td>
<td>Defective flow control valve.</td>
<td>Check control valve.</td>
</tr>
<tr>
<td>Change of gearbox oil from normal color to milky pink or yellow</td>
<td>Gearbox oil contaminated with water or process fluid.</td>
<td>Inspect gearbox heat exchanger for leakage. Check for excessive pump seal leakage. Inspect shaft sleeve o-rings. Inspect that seal housing port 1 and other seal drains are open for unrestricted seal leakage flow.</td>
</tr>
<tr>
<td>Situation/Symptom</td>
<td>Possible Cause</td>
<td>Investigative/Corrective Action</td>
</tr>
<tr>
<td>------------------------------------------------------</td>
<td>----------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Shaft sleeve rubs on inside diameter of seal.</td>
<td>Gearbox journal bearing failure.</td>
<td>Install replacement exchange gearbox or repair gearbox as outlined under “Maintenance”.</td>
</tr>
<tr>
<td>Excessive gearbox oil consumption.</td>
<td>Low speed shaft seal (115) leakage.</td>
<td>Check upper gearbox housing lip seal drain port for leakage. Replace shaft seal if required.</td>
</tr>
<tr>
<td></td>
<td>High speed shaft mechanical seal (60C) leakage.</td>
<td>Check drain port 1 for leakage. Replace shaft seal if required.</td>
</tr>
<tr>
<td></td>
<td>Leakage through heat exchanger into cooling fluid.</td>
<td>Pressure test heat exchanger and replace if required.</td>
</tr>
<tr>
<td>Excessive oil foaming.</td>
<td>High oil level.</td>
<td>Shut down the unit and check oil level.</td>
</tr>
<tr>
<td></td>
<td>Low gearbox temperature. Incorrect lubricant.</td>
<td>Adjust coolant to heat exchanger, keeping oil temperature above 140°F, 60°C.</td>
</tr>
<tr>
<td>High gearbox temperature.</td>
<td>Heat exchanger fouled or coolant shut off.</td>
<td>Check coolant flow and/or clean heat exchanger.</td>
</tr>
<tr>
<td></td>
<td>Oil level too high.</td>
<td>Check oil level and adjust.</td>
</tr>
</tbody>
</table>

**Pump Mechanical Seal Diagnostics**

The following table contains diagnostic information that is applicable to single seal, double seal, and tandem seal equipped units. Repair procedures for mechanical seals are listed in this manual under Maintenance.

**Table 2. Pump Mechanical Seal Diagnostics**

<table>
<thead>
<tr>
<th>Situation/Symptom</th>
<th>Possible Cause</th>
<th>Investigative/Corrective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sudden increase in seal leakage.</td>
<td>Severe cavitation or loss of suction causing vibration and bouncing of seal face.</td>
<td>Correct pump suction condition causing cavitation. Bleed vapor from seal cavity and restart. Install double seal if loss of suction cannot be prevented.</td>
</tr>
<tr>
<td></td>
<td>Seal icing on low temperature pumps or icing when handling fluids which vaporize at a temperature of less than +32°F (0°C) at atmospheric pressure</td>
<td>Quench with compatible fluid which will not freeze at pump temperature through seal drain port 2 or 7 to prevent ice formation on atmospheric side of seal during start-up and in running condition. Use purge of dry nitrogen gas through ports 2 or 7. Install double or tandem seal if ice is caused by water in process fluid or supply external seal flush of compatible fluid which does not contain water.</td>
</tr>
<tr>
<td>Sudden increase in seal leakage (continued)</td>
<td>Solid particles in seal cavity or seal spring area (seal faces usually have rough scratched appearance).</td>
<td>Inspect for clogged integral centrifugal separator orifices. Clean orifices if necessary (plan 31 if so equipped.) Supply external clean seal flush or double seal if particles cannot be removed by separator.</td>
</tr>
<tr>
<td>Situation/Symptom</td>
<td>Possible Cause</td>
<td>Investigative/Corrective Action</td>
</tr>
<tr>
<td>---------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Seal stationary face spring action is rough and sticky.</td>
<td>If parts are corroded, replace with parts made from compatible materials.</td>
<td>Install seal cavity bypass to suction tank. Prevent loss of pump suction. Supply cool seal flush.</td>
</tr>
<tr>
<td></td>
<td>If formation of solids causes sticky seal analyze fluid properties. Use external seal flush or double seal arrangement.</td>
<td>Install double seal.</td>
</tr>
<tr>
<td>Worn or damaged seal.</td>
<td>Disassemble seal and rebuild or replace per instructions in maintenance section.</td>
<td></td>
</tr>
<tr>
<td>Wear pattern on seal rotating faces not uniform.</td>
<td>Lightly lap surfaces of shaft sleeve and impeller hub which contact rotating seal face to remove high spots. Install new seal faces.</td>
<td></td>
</tr>
<tr>
<td>Wear pattern on stationary face smooth but not uniform.</td>
<td>Lap flat or replace seal.</td>
<td></td>
</tr>
<tr>
<td>Edges of stationary face chipped and seal face worn. (Vapor flashing in seal cavity will cause excessive wear and/or cracking of rotating face.)</td>
<td>Install seal cavity bypass to suction tank. Prevent loss of pump suction. Supply cool seal flush. Install double seal.</td>
<td></td>
</tr>
<tr>
<td>Seal rotating face cracked or broken. May be caused by damage at assembly or thermal shock caused by seal running dry.</td>
<td>Prevent loss of pump suction or supply continuous external seal flush. Install double seal.</td>
<td></td>
</tr>
<tr>
<td>Chemical attack of seal faces, seal parts or o-rings.</td>
<td>Investigate fluid properties and determine suitable materials for replacement.</td>
<td></td>
</tr>
<tr>
<td>Excessive radial high speed shaft movement.</td>
<td>Check high speed shaft journal bearings and replace if necessary.</td>
<td></td>
</tr>
<tr>
<td>Bent high speed shaft or severe out-of-balance.</td>
<td>Check if damage exists on impeller and/or inducer which will indicate that a large particle went through the pump. Deposits on the impeller/inducer causing unbalance.</td>
<td></td>
</tr>
<tr>
<td>Damage to mechanical seal secondary seal (Teflon® wedge or U-cup or elastomer o-ring).</td>
<td>Check for erosion and/or corrosion attack. Install seal flush or double seal arrangement.</td>
<td></td>
</tr>
<tr>
<td>Loose stack-up of high-speed shaft attaching components.</td>
<td>Check for correct impeller bolt/inducer torque. Check for cold flow of Teflon® o-rings.</td>
<td></td>
</tr>
</tbody>
</table>
SPECIFICATIONS

Falk Steelflex Type Coupling Specifications

Table 3. Falk Steelflex Type Coupling Specifications

<table>
<thead>
<tr>
<th>Falk Coupling Size</th>
<th>End Gap</th>
<th>Cover Bolt Torque</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Minimum</td>
<td>Normal</td>
</tr>
<tr>
<td>40T10</td>
<td>0.062 in. (1.57 mm)</td>
<td>0.125 in. (3.17 mm)</td>
</tr>
<tr>
<td>50T10</td>
<td>0.062 in. (1.57 mm)</td>
<td>0.125 in. (3.17 mm)</td>
</tr>
<tr>
<td>60T10</td>
<td>0.062 in. (1.57 mm)</td>
<td>0.125 in. (3.17 mm)</td>
</tr>
<tr>
<td>70T10</td>
<td>0.062 in. (1.57 mm)</td>
<td>0.125 in. (3.17 mm)</td>
</tr>
<tr>
<td>80T10</td>
<td>0.062 in. (1.57 mm)</td>
<td>0.125 in. (3.17 mm)</td>
</tr>
</tbody>
</table>

Falk Double Gear Type Coupling Specifications

Table 4. Falk Steelflex Type Coupling Specifications

<table>
<thead>
<tr>
<th>Falk Coupling Size</th>
<th>End Gap</th>
<th>Operating Limits</th>
<th>Bolt Torque</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Minimum</td>
<td>Total Indicator Reading</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Normal</td>
<td>Maximum</td>
<td>Offset (Maximum)</td>
</tr>
<tr>
<td>15G</td>
<td>0.140 in. (3.56 mm)</td>
<td>0.156 in. (3.96 mm)</td>
<td>0.172 in. (4.36 mm)</td>
</tr>
<tr>
<td>20G</td>
<td>0.140 in. (3.56 mm)</td>
<td>0.156 in. (3.96 mm)</td>
<td>0.172 in. (4.36 mm)</td>
</tr>
</tbody>
</table>
### Falk Double Gear Type-Vertical Specifications

Table 5. Falk Double Gear Type-Vertical Specifications

<table>
<thead>
<tr>
<th>Falk Coupling Size</th>
<th>Operating Limits (Total Indicator Limit)</th>
<th>Bolt Torque</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Offset (Maximum)</td>
<td>Angular (Maximum)</td>
</tr>
<tr>
<td>15GL</td>
<td>0.005 in.</td>
<td>0.005 in.</td>
</tr>
<tr>
<td>15GV</td>
<td>(0.127 mm)</td>
<td>(0.127 mm)</td>
</tr>
<tr>
<td>20GL</td>
<td>0.005 in.</td>
<td>0.005 in.</td>
</tr>
<tr>
<td>20GV</td>
<td>(0.127 mm)</td>
<td>(0.127 mm)</td>
</tr>
</tbody>
</table>

### Thomas Type DBZ Coupling Specifications

Table 6. Thomas Type DBZ Coupling Specifications

<table>
<thead>
<tr>
<th>Thomas Coupling Size</th>
<th>End Gap</th>
<th>Cover Bolt Torque</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Minimum</td>
<td>Normal</td>
</tr>
<tr>
<td>163</td>
<td>0.876 in.</td>
<td>0.938 in.</td>
</tr>
<tr>
<td></td>
<td>(22.24 mm)</td>
<td>(23.81 mm)</td>
</tr>
<tr>
<td>201</td>
<td>0.876 in.</td>
<td>0.938 in.</td>
</tr>
<tr>
<td></td>
<td>(22.24 mm)</td>
<td>(23.81 mm)</td>
</tr>
<tr>
<td>226</td>
<td>1.126 in.</td>
<td>1.188 in.</td>
</tr>
<tr>
<td></td>
<td>(28.59 mm)</td>
<td>(30.18 mm)</td>
</tr>
<tr>
<td>263</td>
<td>1.219 in.</td>
<td>1.313 in.</td>
</tr>
<tr>
<td></td>
<td>(30.97 mm)</td>
<td>(33.35 mm)</td>
</tr>
<tr>
<td>301</td>
<td>1.406 in.</td>
<td>1.500 in.</td>
</tr>
<tr>
<td></td>
<td>(35.72 mm)</td>
<td>(38.10 mm)</td>
</tr>
</tbody>
</table>
Thomas SN Spacer Type Vertical & Horizontal Coupling Specifications

Table 7. Thomas SN Spacer Type Vertical & Horizontal Coupling Specifications

<table>
<thead>
<tr>
<th>Thomas Coupling Size</th>
<th>End Gap</th>
<th>Operating Limits</th>
<th>Bolt Torque</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Minimum</td>
<td>Normal</td>
<td>Maximum</td>
</tr>
<tr>
<td>SN226</td>
<td>0.563 in. (14.30mm)</td>
<td>0.594 in. (15.09mm)</td>
<td>0.625 in. (15.88mm)</td>
</tr>
<tr>
<td>SN262</td>
<td>0.438 in. (11.13mm)</td>
<td>0.469 in. (11.91mm)</td>
<td>0.500 in. (12.70mm)</td>
</tr>
<tr>
<td>SN312</td>
<td>0.469 in. (11.91mm)</td>
<td>0.500 in. (12.70mm)</td>
<td>0.531 in. (13.49mm)</td>
</tr>
</tbody>
</table>

Metastream Coupling Specifications

Table 8. Metastream Coupling Specifications

<table>
<thead>
<tr>
<th>Metastream No.</th>
<th>Distance Between Shaft Ends</th>
<th>Operating Limits</th>
<th>Bolt Torque (ft-lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Nominal</td>
<td>Axial Misalignment*</td>
<td>Lateral Misalignment**</td>
</tr>
<tr>
<td>TSE1-0075-XXXX-0032</td>
<td>0.125 in. (3.2mm)</td>
<td>± 0.06 in. (±1.5mm)</td>
<td>± 0.034 in. (±0.9 mm)</td>
</tr>
<tr>
<td>TSE1-0135-XXXX-0032</td>
<td>0.125 in. (3.2mm)</td>
<td>± 0.08 in. (±2.0mm)</td>
<td>± 0.037 in. (±1.0mm)</td>
</tr>
<tr>
<td>TSE1-0230-XXXX-0048</td>
<td>1.220 in. (31.0mm)</td>
<td>± 0.10 in. (±2.5mm)</td>
<td>± 0.043 in. (±1.1 mm)</td>
</tr>
<tr>
<td>TSE1-0350-XXXX-0048</td>
<td>0.188 in. (4.8mm)</td>
<td>± 0.11 in. (±2.8mm)</td>
<td>± 0.048 in. (±1.2 mm)</td>
</tr>
<tr>
<td>TSRC-0075-XXXX-0030</td>
<td>0.118 in. (3.0mm)</td>
<td>± 0.06 in. (±1.5mm)</td>
<td>± 0.034 in. (±0.9 mm)</td>
</tr>
<tr>
<td>TSRC-0135-XXXX-0050</td>
<td>0.197 in. (5.0mm)</td>
<td>± 0.08 in. (±2.0mm)</td>
<td>± 0.037 in. (±1.0mm)</td>
</tr>
<tr>
<td>TSRC-0230-XXXX-0310</td>
<td>1.220 in. (31.0mm)</td>
<td>± 0.10 in. (±2.5mm)</td>
<td>± 0.043 in. (±1.1 mm)</td>
</tr>
</tbody>
</table>

* Meets NEMA end float specification without modification.
**Values based on angular deflection of 1/2° per end.
# Gearbox Lube Oil Specifications

Table 9. Gearbox Lube Oil Specifications

**Sundyne & Sunfio & HMP Gearbox Lubricant Recommendations**

**Effective:** FEBRUARY 2009  
**Rev:** G

For years the preferred gearbox lubricant for Sundyne pumps and compressors has been automatic automatic transmission fluid (ATF). However, over time the additives in automatic transmission fluid have changed to coincide with the technical improvements in automobile transmissions. The additives in the new formulations of ATF, such as Dexron III, have been found to have negative effects on Sundyne gearboxes and could compromise mechanical integrity and reliability of the equipment.

ISO Viscosity Grade 32 or 46 general purpose or synthetic oils are the recommended lubricants for Sundyne gearboxes as shown in Table 1 below. ISO VG 46 lubricants are now recommended for high horsepower gearbox models 33X and 34X with spherical roller bearings and high ambient temperature installations. Gearbox lube oil should be changed twice yearly or more frequently in severe environments which may be detrimental to the lubricant. Oxidized oil is frequently characterized by a darkening and/or thickening of the oil. Operating of gearboxes with oxidized lubricant should be avoided.

Synthetic oils possess different characteristics than conventional mineral oils which make them desirable for various extreme conditions such as high and low temperature operation. Synthetic oils offer very low pour points, high temperature oxidation stability and a higher viscosity index.

The operation of Sundyne equipment in high or low ambient conditions may require special consideration of gearbox lubricant and/or supplemental protective equipment such as heat exchangers or gearbox heaters.

The lubricant chosen must be compatible with gearbox elastomers Viton and Buna N. Any oil that contains an inert additive such as PTFE, molybdenum disulfide or silicon should not be used in Sundyne gearboxes. Use of lubricants containing inert additives will void the product warranty.

### Table 1:

<table>
<thead>
<tr>
<th>ISO Viscosity Grade 32 Lubricant</th>
<th>ISO Viscosity Grade 46 Lubricant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Models: LMV/BMP-31X*</td>
<td>Models: LMV/BMP-33X*</td>
</tr>
<tr>
<td>LMC/BCM-31X*</td>
<td>LMC/BCM-33X*</td>
</tr>
<tr>
<td>LMV-32X*</td>
<td>LMC/BCM-33XF*</td>
</tr>
<tr>
<td>All Sunfio Gearboxes</td>
<td>LMC/BCM-33X*F</td>
</tr>
<tr>
<td>HMP-3000</td>
<td>LMC/BCM-34X*</td>
</tr>
<tr>
<td>HMP-5000</td>
<td>LMC/BCM-34XF*</td>
</tr>
<tr>
<td>LF-2000 Pinnacle Compressors</td>
<td>LMC/BCM-34X*</td>
</tr>
<tr>
<td>LMO-310L</td>
<td>LMC/BCM-34X*P</td>
</tr>
</tbody>
</table>

---

**Notes:**

**ISO VG 32 oil may be substituted for ISO VG 46 on noted units provided the sump temperature does not exceed 60 °C (140 °F).**

**Use ISO VG 46 lubricant for high ambient temperatures above 40 °C (100 °F).**

**“X” this number defines the pump/compressor case**

---

10615 West 60th Avenue, Arvada, Colorado 80004 USA  
Tel: 303.429.3000  
Fax: 303.429.3098  
www.sundyne.com
### Recommended ISO VG 32 Gearbox Lube Oil Specifications:

<table>
<thead>
<tr>
<th>Property</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gravity, API</td>
<td>28 - 37</td>
</tr>
<tr>
<td>Pour Point, °C (°F)</td>
<td>-7 (20) max.</td>
</tr>
<tr>
<td>Flash Point, °C (°F)</td>
<td>204 (400) min.</td>
</tr>
<tr>
<td>Viscosity, cSt at 40°C</td>
<td>28.8 to 35.2</td>
</tr>
<tr>
<td>cSt at 100°C</td>
<td>5.2 min.</td>
</tr>
<tr>
<td>SUS at 100°F</td>
<td>150 to 180</td>
</tr>
<tr>
<td>SUS at 210°F</td>
<td>44 min.</td>
</tr>
<tr>
<td>Viscosity Index</td>
<td>95 min.</td>
</tr>
<tr>
<td>ISO Viscosity Grade</td>
<td>32</td>
</tr>
<tr>
<td>Color, ASTM D 1500</td>
<td>1.5</td>
</tr>
<tr>
<td>Neutralization Number, Maximum</td>
<td>0.20</td>
</tr>
<tr>
<td>Demulsibility, ASTM D 1401</td>
<td></td>
</tr>
<tr>
<td>Time to 0 ml emulsion at 54°C (130°F) after 30 min.</td>
<td>Pass</td>
</tr>
<tr>
<td>at 82°C (180°F) after 60 min.</td>
<td>Pass</td>
</tr>
<tr>
<td>Foam Limits, ASTM D 892</td>
<td></td>
</tr>
<tr>
<td>Sequence 1</td>
<td>250/0 max.</td>
</tr>
<tr>
<td>Sequence 2</td>
<td>500/0 max.</td>
</tr>
<tr>
<td>Sequence 3</td>
<td>250/0 max.</td>
</tr>
</tbody>
</table>

**Note:** No other additives are recommended.

### Recommended ISO VG 46 Gearbox Lube Oil Specifications:

<table>
<thead>
<tr>
<th>Property</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gravity, API</td>
<td>28 - 37</td>
</tr>
<tr>
<td>Pour Point, °C (°F)</td>
<td>-7 (20) max.</td>
</tr>
<tr>
<td>Flash Point, °C (°F)</td>
<td>204 (400) min.</td>
</tr>
<tr>
<td>Viscosity, cSt at 40°C</td>
<td>41.4 to 50.6</td>
</tr>
<tr>
<td>cSt at 100°C</td>
<td>6.5 min.</td>
</tr>
<tr>
<td>SUS at 100°F</td>
<td>217 to 260</td>
</tr>
<tr>
<td>SUS at 210°F</td>
<td>48.8 min.</td>
</tr>
<tr>
<td>Viscosity Index</td>
<td>95 min.</td>
</tr>
<tr>
<td>ISO Viscosity Grade</td>
<td>46</td>
</tr>
<tr>
<td>Color, ASTM D 1500</td>
<td>2.0</td>
</tr>
<tr>
<td>Neutralization Number, Maximum</td>
<td>0.25</td>
</tr>
<tr>
<td>Demulsibility, ASTM D 1401</td>
<td></td>
</tr>
<tr>
<td>Time to 0 ml emulsion at 54°C (130°F) after 30 min.</td>
<td>Pass</td>
</tr>
<tr>
<td>at 82°C (180°F) after 60 min.</td>
<td>Pass</td>
</tr>
<tr>
<td>Foam Limits, ASTM D 892</td>
<td></td>
</tr>
<tr>
<td>Sequence 1</td>
<td>250/0 max.</td>
</tr>
<tr>
<td>Sequence 2</td>
<td>500/0 max.</td>
</tr>
<tr>
<td>Sequence 3</td>
<td>250/0 max.</td>
</tr>
</tbody>
</table>

**Note:** No other additives are recommended.
# Gearbox Parts List

**Table 10. Gearbox Parts List**

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Part Name</th>
<th>Qty.</th>
<th>Item No.</th>
<th>Part Name</th>
<th>Qty.</th>
</tr>
</thead>
<tbody>
<tr>
<td>23A</td>
<td>Lube Pump Spring</td>
<td>1</td>
<td>173</td>
<td>Tube (Sump)</td>
<td>1</td>
</tr>
<tr>
<td>51D</td>
<td>Seal Rotating Face</td>
<td>1</td>
<td>174A</td>
<td>Lube Jet</td>
<td>1</td>
</tr>
<tr>
<td>60C</td>
<td>Mechanical Seal</td>
<td>1</td>
<td>174B</td>
<td>Lube Jet</td>
<td>1</td>
</tr>
<tr>
<td>98</td>
<td>Dust Cover (For Coupled Shaft Only)</td>
<td>1</td>
<td>174C</td>
<td>Lube Jet</td>
<td>1</td>
</tr>
<tr>
<td>101A</td>
<td>Gearbox Housing (Output)</td>
<td>1</td>
<td>174D</td>
<td>Lube Jet</td>
<td>1</td>
</tr>
<tr>
<td>101B</td>
<td>Gearbox Housing (Input)</td>
<td>1</td>
<td>177</td>
<td>Valve</td>
<td>1</td>
</tr>
<tr>
<td>102</td>
<td>Bearing Plate</td>
<td>1</td>
<td>180</td>
<td>Filter Manifold</td>
<td>1</td>
</tr>
<tr>
<td>105**</td>
<td>Housing Gasket</td>
<td>2</td>
<td>185</td>
<td>Oil Filter (FRAM PH-41)</td>
<td>*1</td>
</tr>
<tr>
<td>110</td>
<td>Interconnecting Shaft</td>
<td>1</td>
<td>186</td>
<td>Fill and Vent Fitting</td>
<td>1</td>
</tr>
<tr>
<td>115</td>
<td>Shaft Seal</td>
<td>*1</td>
<td>191</td>
<td>Sight Glass</td>
<td>1</td>
</tr>
<tr>
<td>A120</td>
<td>Low Speed Shaft Assembly</td>
<td>1</td>
<td>193C</td>
<td>Pressure Gage</td>
<td>1</td>
</tr>
<tr>
<td>120</td>
<td>Low Speed Shaft</td>
<td>1</td>
<td>905E</td>
<td>Hex Head Cap Screw</td>
<td>3</td>
</tr>
<tr>
<td>122A</td>
<td>Spur Gear (Low Speed)</td>
<td>1</td>
<td>905H</td>
<td>Hex Head Cap Screw</td>
<td>2</td>
</tr>
<tr>
<td>123A</td>
<td>Shaft Spacer (Low Speed)</td>
<td>1</td>
<td>905M</td>
<td>Hex Head Cap Screw</td>
<td>3</td>
</tr>
<tr>
<td>125C</td>
<td>Ball Bearing</td>
<td>*1</td>
<td>905N</td>
<td>Hex Head Cap Screw</td>
<td>3</td>
</tr>
<tr>
<td>125D</td>
<td>Ball Bearing</td>
<td>*1</td>
<td>909B</td>
<td>Bolt</td>
<td>7</td>
</tr>
<tr>
<td>A130</td>
<td>High Speed Shaft Assembly</td>
<td>1</td>
<td>909C</td>
<td>Bolt (alignment)</td>
<td>2</td>
</tr>
<tr>
<td>130</td>
<td>High Speed Shaft</td>
<td>1</td>
<td>914E</td>
<td>Hex Nut</td>
<td>7</td>
</tr>
<tr>
<td>132B</td>
<td>Pinion Gear (High Speed)</td>
<td>1</td>
<td>914F</td>
<td>Hex Nut (Alignment)</td>
<td>2</td>
</tr>
<tr>
<td>133B</td>
<td>Thrust Runner</td>
<td>1</td>
<td>916A</td>
<td>Washer</td>
<td>3</td>
</tr>
<tr>
<td>A140</td>
<td>Idler Shaft Assembly</td>
<td>1</td>
<td>916D</td>
<td>Washer</td>
<td>2</td>
</tr>
<tr>
<td>140</td>
<td>Idler Shaft</td>
<td>1</td>
<td>916H</td>
<td>Washer</td>
<td>14</td>
</tr>
<tr>
<td>122C</td>
<td>Spur Gear (Idler)</td>
<td>1</td>
<td>961J</td>
<td>Washer (alignment)</td>
<td>4</td>
</tr>
<tr>
<td>123B</td>
<td>Shaft Spacer (Idler)</td>
<td>1</td>
<td>918D</td>
<td>Pin</td>
<td>1</td>
</tr>
<tr>
<td>123C</td>
<td>Shaft Spacer (Idler)</td>
<td>1</td>
<td>920A</td>
<td>Key</td>
<td>1</td>
</tr>
<tr>
<td>125A</td>
<td>Ball Bearing</td>
<td>*1</td>
<td>920B</td>
<td>Key</td>
<td>1</td>
</tr>
<tr>
<td>125B</td>
<td>Ball Bearing</td>
<td>*1</td>
<td>920C</td>
<td>Key</td>
<td>1</td>
</tr>
<tr>
<td>132C</td>
<td>Pinion Gear</td>
<td>1</td>
<td>920D</td>
<td>Key</td>
<td>1</td>
</tr>
<tr>
<td>151A</td>
<td>Journal Bearing or Tilting Pad</td>
<td>1</td>
<td>920F</td>
<td>Key (For Coupled Shaft Only)</td>
<td>1</td>
</tr>
</tbody>
</table>
### Gearbox Replacement Parts

#### Table 11. Gearbox Replacement Parts

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Part Name</th>
<th>Qty.</th>
</tr>
</thead>
<tbody>
<tr>
<td>185</td>
<td>Gearbox Oil Filter</td>
<td>1</td>
</tr>
<tr>
<td>115</td>
<td>Input Shaft Lip Seal</td>
<td>1</td>
</tr>
<tr>
<td>105 / 936AG</td>
<td>Housing Gasket / O-Ring</td>
<td>2</td>
</tr>
<tr>
<td>936M</td>
<td>O-ring Packing</td>
<td>2</td>
</tr>
<tr>
<td>936N</td>
<td>O-ring Packing</td>
<td>2</td>
</tr>
<tr>
<td>936T</td>
<td>O-ring Packing</td>
<td>2</td>
</tr>
<tr>
<td>158 Series</td>
<td>* Shim Spacers</td>
<td>As Required</td>
</tr>
<tr>
<td>MP01AA10</td>
<td>Anti-fretting Compound</td>
<td>Tube</td>
</tr>
</tbody>
</table>

*Available in sets of five 0.005 inch (0.13mm), 0.010 inch (0.25mm)
### Torque Specifications

**Table 12. Gearbox and Pump Torque Values**

#### Gearbox

<table>
<thead>
<tr>
<th>Item #</th>
<th>Location</th>
<th>Size</th>
<th>English</th>
<th>Metric</th>
</tr>
</thead>
<tbody>
<tr>
<td>905H</td>
<td>Oil Filter Manifold</td>
<td>3/8 - 16 x 1/2</td>
<td>22 - 25 ft-lbs</td>
<td>30 - 34 N-m</td>
</tr>
<tr>
<td>905L</td>
<td>Gearbox Seal</td>
<td>1/4 - 20 x 1/2</td>
<td>75 - 80 in-lbs</td>
<td>8.5 - 9.0 N-m</td>
</tr>
<tr>
<td>905N</td>
<td>Journal Bearings</td>
<td>#10 - 24 x 1</td>
<td>35 - 40 in-lbs</td>
<td>4.0 - 4.5 N-m</td>
</tr>
<tr>
<td>905T</td>
<td>Chemical Barrier Gasket</td>
<td>1/4 - 20 x 5/8</td>
<td>75 - 80 in-lbs</td>
<td>8.5 - 9.0 N-m</td>
</tr>
<tr>
<td>909B</td>
<td>Gearbox Halves</td>
<td>1/2 - 13 x4</td>
<td>60 - 65 ft-lbs</td>
<td>81 - 88 N-m</td>
</tr>
<tr>
<td>909C</td>
<td>Gearbox Halves, Alignment</td>
<td>5/8 - 18 x 17/64</td>
<td>60 - 65 ft-lbs</td>
<td>81 - 88 N-m</td>
</tr>
<tr>
<td>906B</td>
<td>Sight Glass</td>
<td>#8 - 32 x 1/2</td>
<td>10 - 12 in-lbs</td>
<td>1.0 - 1.4 N-m</td>
</tr>
</tbody>
</table>

#### Pumps & Compressors

**Sundyne Standard Steel Screws and Bolts**

<table>
<thead>
<tr>
<th>Item #</th>
<th>Location</th>
<th>Size</th>
<th>English</th>
<th>Metric</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Impeller Bolt/Inducer:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>LMV/BMP-801, 802, 806, 322, 311, 331</td>
<td>1/2 - 20</td>
<td>36 - 40 ft-lbs</td>
<td>49 - 54 N-m</td>
</tr>
<tr>
<td></td>
<td>LMV/BMP-341, 346</td>
<td>1/2 - 20</td>
<td>65 - 70 ft-lbs</td>
<td>88 - 95 N-m</td>
</tr>
<tr>
<td></td>
<td>LMV-313, 343, BMP-338, 348 (High Flow)</td>
<td>3/4 - 10</td>
<td>85 - 90 ft-lbs</td>
<td>115-122 N-m</td>
</tr>
<tr>
<td></td>
<td>LMC/BMC 3X1P, 3X1F, 3X3, 3X6P, 3X7</td>
<td>1/2 - 20</td>
<td>36 - 40 ft-lbs</td>
<td>49 - 54 N-m</td>
</tr>
<tr>
<td>906D</td>
<td>Diffuser Attaching Screws</td>
<td>1/4 - 20</td>
<td>95 - 102 in-lbs</td>
<td>11 - 11.5 N-m</td>
</tr>
<tr>
<td>905E</td>
<td>Mechanical Seal No. Spacer</td>
<td>1/4 - 20 x 12</td>
<td>95 - 102 in-lbs</td>
<td>11 - 11.5 N-m</td>
</tr>
<tr>
<td>905F</td>
<td>Throttle Bushing/Mechanical Seal</td>
<td>1/4 - 20 x 12</td>
<td>95 - 102 in-lbs</td>
<td>11 - 11.5 N-m</td>
</tr>
<tr>
<td>905G</td>
<td>Double Seal with Spacer</td>
<td>1/4 - 20 x 3/4</td>
<td>95 - 102 in-lbs</td>
<td>11 - 11.5 N-m</td>
</tr>
<tr>
<td>914A</td>
<td>Case Nuts</td>
<td>3/4 - 10</td>
<td>250 - 275 ft-lbs</td>
<td>340 - 375 N-m</td>
</tr>
<tr>
<td>914A</td>
<td>Case Nuts</td>
<td>7/8 - 9</td>
<td>300 - 330 ft-lbs</td>
<td>405 - 445 N-m</td>
</tr>
<tr>
<td>905A</td>
<td>Seal Housing to Gearbox</td>
<td>3/8 - 16 x 1 3/4</td>
<td>35 - 40 ft-lbs</td>
<td>47 - 54 N-m</td>
</tr>
<tr>
<td>905P</td>
<td>Separator</td>
<td>1/4 - 20 x 5/8</td>
<td>95 - 102 in-lbs</td>
<td>11 - 11.5 N-m</td>
</tr>
</tbody>
</table>

**Pumps & Compressors**

**NACE Compliant Steel Screws / Bolts (BG Material)**

<table>
<thead>
<tr>
<th>Item #</th>
<th>Location</th>
<th>Size</th>
<th>English</th>
<th>Metric</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Impeller Bolt/Inducer:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>LMV/BMP-801, 802, 806, 322, 311, 331</td>
<td>1/2 - 20</td>
<td>36 - 40 ft-lbs</td>
<td>49 - 54 N-m</td>
</tr>
<tr>
<td></td>
<td>LMV/BMP-341, 346</td>
<td>1/2 - 20</td>
<td>65 - 70 ft-lbs</td>
<td>88 - 95 N-m</td>
</tr>
<tr>
<td></td>
<td>LMV-313, 343, BMP-338, 348 (High Flow)</td>
<td>3/4 - 10</td>
<td>85 - 90 ft-lbs</td>
<td>115-122 N-m</td>
</tr>
<tr>
<td></td>
<td>LMC/BMC 3X1P, 3X1F, 3X3, 3X6P, 3X7</td>
<td>1/2 - 20</td>
<td>36 - 40 ft-lbs</td>
<td>49 - 54 N-m</td>
</tr>
<tr>
<td>906D</td>
<td>Diffuser Attaching Screws</td>
<td>1/4 - 20</td>
<td>70 - 75 in-lbs</td>
<td>8.0 - 8.5 N-m</td>
</tr>
<tr>
<td>905E</td>
<td>Mechanical Seal No. Spacer</td>
<td>1/4 - 20</td>
<td>70 - 75 in-lbs</td>
<td>8.0 - 8.5 N-m</td>
</tr>
<tr>
<td>905F</td>
<td>Throttle Bushing/Mechanical Seal</td>
<td>1/4 - 20</td>
<td>70 - 75 in-lbs</td>
<td>8.0 - 8.5 N-m</td>
</tr>
<tr>
<td>905G</td>
<td>Double Seal with Spacer</td>
<td>1/4 - 20</td>
<td>70 - 75 in-lbs</td>
<td>8.0 - 8.5 N-m</td>
</tr>
<tr>
<td>914A</td>
<td>Case Nuts</td>
<td>3/4 - 10</td>
<td>160 - 200 ft-lbs</td>
<td>217 - 270 N-m</td>
</tr>
<tr>
<td>914A</td>
<td>Case Nuts</td>
<td>7/8 - 9</td>
<td>225 - 245 ft-lbs</td>
<td>305 - 332 N-m</td>
</tr>
<tr>
<td>905A</td>
<td>Seal Housing to Gearbox</td>
<td>3/8 - 16 x 1 3/4</td>
<td>27 - 30 ft-lbs</td>
<td>37 - 40 N-m</td>
</tr>
<tr>
<td>905P</td>
<td>Separator</td>
<td>1/4 - 20 x 5/8</td>
<td>70 - 75 in-lbs</td>
<td>8.0 - 8.5 N-m</td>
</tr>
</tbody>
</table>

*When using Teflon® o-rings, allow 15 minutes between torquing for the Teflon® to cold flow. Repeat torquing until there is no change in torque.*
# Mechanical Seals

## Table 13. Mechanical Seals

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Lower Process Seal</th>
<th>Upper Process Seal</th>
<th>Gearbox Seal</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>60A</td>
<td>60-B</td>
<td>60C</td>
<td></td>
<td>Mechanical Seal Assembly</td>
</tr>
<tr>
<td>61A</td>
<td>61B</td>
<td>61C</td>
<td></td>
<td>Seal Retainer</td>
</tr>
<tr>
<td>*62A</td>
<td>62B*</td>
<td>*62C</td>
<td></td>
<td>Seal Face Washer</td>
</tr>
<tr>
<td>*63A</td>
<td>63B</td>
<td>N/A</td>
<td></td>
<td>Seal Spring Backup Ring</td>
</tr>
<tr>
<td>*64A</td>
<td>64B*</td>
<td>*64C</td>
<td></td>
<td>Seal Retaining Ring</td>
</tr>
<tr>
<td>65A</td>
<td>65B*</td>
<td>*65C</td>
<td></td>
<td>Seal Spring</td>
</tr>
<tr>
<td>*68A</td>
<td>68B*</td>
<td>N/A</td>
<td></td>
<td>Teflon Wedge</td>
</tr>
<tr>
<td>*69A</td>
<td>69B*</td>
<td>*69C</td>
<td></td>
<td>Secondary may be “U” Cup or o-ring</td>
</tr>
</tbody>
</table>

*Seal Repair Kits are Available and contain all parts marked with a single asterisk.*

Item 60C to be used on gearbox only.

To maximize seal performance consult the parts list for correct seal configuration. For additional information, please contact your area representative or the Sundyne factory direct.
1 ½" gas seal for upper tandem position on light hydrocarbon service only

Gearbox Seal Only
## Pump Disassembly Replacement Parts

### Table 14. Pump Disassembly Replacement Parts

The following replacement parts will be required as a result of pump disassembly for maintenance as shown in this section:

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Part Name</th>
<th>Qty.</th>
</tr>
</thead>
<tbody>
<tr>
<td>87A</td>
<td>Thermal Barrier Gasket</td>
<td>1</td>
</tr>
<tr>
<td>RKORP311</td>
<td>O-ring Repair Kit for the pump end consisting of:</td>
<td></td>
</tr>
<tr>
<td>936A</td>
<td>• O-ring Packing</td>
<td></td>
</tr>
<tr>
<td>936D</td>
<td>• O-ring Packing</td>
<td></td>
</tr>
<tr>
<td>936E</td>
<td>• O-ring Packing</td>
<td></td>
</tr>
<tr>
<td>936F</td>
<td>• O-ring Packing</td>
<td></td>
</tr>
<tr>
<td>936G</td>
<td>• O-ring Packing</td>
<td></td>
</tr>
<tr>
<td>936H</td>
<td>• O-ring Packing</td>
<td></td>
</tr>
<tr>
<td>936J</td>
<td>• O-ring Packing</td>
<td></td>
</tr>
<tr>
<td>936K</td>
<td>• O-ring Packing</td>
<td></td>
</tr>
<tr>
<td>936P</td>
<td>• O-ring Packing</td>
<td></td>
</tr>
<tr>
<td>936V</td>
<td>• O-ring Packing</td>
<td></td>
</tr>
<tr>
<td>936Z</td>
<td>• O-ring Packing</td>
<td></td>
</tr>
<tr>
<td>See Seal Graphics</td>
<td>Technical Seal Repair Kits High Seal Rotating faces:</td>
<td></td>
</tr>
<tr>
<td>51A</td>
<td>• Single</td>
<td>1</td>
</tr>
<tr>
<td>51A/51B</td>
<td>• Tandem</td>
<td>2</td>
</tr>
<tr>
<td>51C</td>
<td>• Double</td>
<td>1</td>
</tr>
<tr>
<td>936B</td>
<td>• O-ring Packing</td>
<td>1</td>
</tr>
<tr>
<td>936C</td>
<td>• O-ring Packing</td>
<td>1</td>
</tr>
</tbody>
</table>
## Pumps Parts List

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Part Name</th>
<th>Qty</th>
<th>Item No.</th>
<th>Part Name</th>
<th>Qty</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Pump Casing</td>
<td>1</td>
<td>911</td>
<td>Stud</td>
<td>12</td>
</tr>
<tr>
<td>2</td>
<td>Impeller</td>
<td>1</td>
<td>914A</td>
<td>Hex Nut</td>
<td>12</td>
</tr>
<tr>
<td>3</td>
<td>Impeller Bolt</td>
<td>1</td>
<td>916B</td>
<td>Washer</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>Impeller Key</td>
<td>*1</td>
<td>916S</td>
<td>Washer</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>Impeller Tab Washer</td>
<td>*1</td>
<td>918A</td>
<td>Pin</td>
<td>1</td>
</tr>
<tr>
<td>9</td>
<td>Inducer (Optional)</td>
<td>1</td>
<td>924B</td>
<td>Pipe Plug</td>
<td>1</td>
</tr>
<tr>
<td>10</td>
<td>Inducer Stud (Optional)</td>
<td>1</td>
<td>924D</td>
<td>Bull Plug</td>
<td>1</td>
</tr>
<tr>
<td>13</td>
<td>Diffuser</td>
<td>1</td>
<td>936A</td>
<td>O-ring Packing</td>
<td>*1</td>
</tr>
<tr>
<td>14A</td>
<td>Locating Pin</td>
<td>2</td>
<td>936B</td>
<td>O-ring Packing</td>
<td>*1</td>
</tr>
<tr>
<td>15</td>
<td>Diffuser Cover</td>
<td>1</td>
<td>936C</td>
<td>O-ring Packing</td>
<td>*1</td>
</tr>
<tr>
<td>21B</td>
<td>Throttle Bushing</td>
<td>1</td>
<td>936D</td>
<td>O-ring Packing</td>
<td>*1</td>
</tr>
<tr>
<td>30</td>
<td>Seal Housing</td>
<td>1</td>
<td>936E</td>
<td>O-ring Packing</td>
<td>*1</td>
</tr>
<tr>
<td>50</td>
<td>Slinger Sleeve Assembly</td>
<td>1</td>
<td>936F</td>
<td>O-ring Packing</td>
<td>*1</td>
</tr>
<tr>
<td>51A</td>
<td>Seal Rotating Face</td>
<td>*1</td>
<td>936G</td>
<td>O-ring Packing</td>
<td>*1</td>
</tr>
<tr>
<td>51C</td>
<td>Seal Mating Ring</td>
<td>*1</td>
<td>936H</td>
<td>O-ring Packing</td>
<td>*1</td>
</tr>
<tr>
<td>87A</td>
<td>Spacer (or Thermal Barrier Gasket) (Large)</td>
<td>1</td>
<td>936J</td>
<td>O-ring Packing</td>
<td>*1</td>
</tr>
<tr>
<td>905A</td>
<td>Hex head Cap Screw</td>
<td>3</td>
<td>981</td>
<td>Baffle Plate</td>
<td>1</td>
</tr>
<tr>
<td>905F</td>
<td>Hex Head Cap Screw</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Recommended spare parts
# Single Seal Arrangement and Parts

## Table 16. Single Seal Arrangement

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Part Name</th>
<th>Qty.</th>
<th>Item No.</th>
<th>Part Name</th>
<th>Qty.</th>
</tr>
</thead>
<tbody>
<tr>
<td>21B</td>
<td>Upper Throttle Bushing</td>
<td>1</td>
<td>905L</td>
<td>Hex Head Cap Screw</td>
<td>3</td>
</tr>
<tr>
<td>50</td>
<td>Slinger Sleeve Assembly</td>
<td>*1</td>
<td>916A</td>
<td>Washer</td>
<td>3</td>
</tr>
<tr>
<td>51A</td>
<td>Seal Rotating Face</td>
<td>*1</td>
<td>916B</td>
<td>Washer</td>
<td>3</td>
</tr>
<tr>
<td>51D</td>
<td>Seal Rotating Face (Gearbox)</td>
<td>*1</td>
<td>916K</td>
<td>Washer</td>
<td>3</td>
</tr>
<tr>
<td>60A</td>
<td>Mechanical Seal (Lower)</td>
<td>*1</td>
<td>936H</td>
<td>O-ring Packing</td>
<td>*2</td>
</tr>
<tr>
<td>60C</td>
<td>Mechanical Seal (Gearbox)</td>
<td>*1</td>
<td>936J</td>
<td>O-ring Packing</td>
<td>*1</td>
</tr>
<tr>
<td>905E</td>
<td>Hex Head Cap Screw</td>
<td>3</td>
<td>936K</td>
<td>O-ring packing</td>
<td>*1</td>
</tr>
<tr>
<td>905F</td>
<td>Hex Head Cap Screw</td>
<td>3</td>
<td>936P</td>
<td>O-ring Packing</td>
<td>*1</td>
</tr>
</tbody>
</table>

*Recommended Spare Parts
Double Seal Arrangement and Parts

Figure 13. Double Seal Arrangement

Table 17. Double Seal Arrangement

<table>
<thead>
<tr>
<th>ITEM NO.</th>
<th>PART NAME</th>
<th>QTY</th>
<th>ITEM NO.</th>
<th>Part Name</th>
<th>QTY</th>
</tr>
</thead>
<tbody>
<tr>
<td>19A</td>
<td>Seal Retaining Spacer</td>
<td>1</td>
<td>60B</td>
<td>Mechanical Seal (Upper)</td>
<td>*1</td>
</tr>
<tr>
<td>50A</td>
<td>Shaft Sleeve (Lower)</td>
<td>*1</td>
<td>61B</td>
<td>- Retainer &amp; Drive Sleeve Assembly</td>
<td>1</td>
</tr>
<tr>
<td>50B</td>
<td>Shaft Sleeve (Upper)</td>
<td>*1</td>
<td>62B</td>
<td>- Seal Face Washer</td>
<td>**1</td>
</tr>
<tr>
<td>51C</td>
<td>Seal Rotating Face</td>
<td>*1</td>
<td>63B</td>
<td>- Seal Spring Back-Up Disc</td>
<td>**1</td>
</tr>
<tr>
<td>52</td>
<td>Seal Spacer</td>
<td>1</td>
<td>64B</td>
<td>- Seal Retaining Ring</td>
<td>**1</td>
</tr>
<tr>
<td>60A</td>
<td>Mechanical Seal (Lower)</td>
<td>*1</td>
<td>65B</td>
<td>- Seal Spring</td>
<td>**6</td>
</tr>
<tr>
<td>61A</td>
<td>- Retainer &amp; Drive Sleeve Assembly</td>
<td>1</td>
<td>68B</td>
<td>- Seal Wedge Ring</td>
<td>**1</td>
</tr>
<tr>
<td>62A</td>
<td>- Seal Face Washer</td>
<td>**1</td>
<td>905F</td>
<td>Hex Head Cap Screw</td>
<td>3</td>
</tr>
<tr>
<td>63A</td>
<td>- Seal Spring Back-Up Disc</td>
<td>**1</td>
<td>916B</td>
<td>Washer</td>
<td>3</td>
</tr>
<tr>
<td>64A</td>
<td>- Seal Retaining Ring</td>
<td>**1</td>
<td>936H</td>
<td>O-ring Packing</td>
<td>*4</td>
</tr>
<tr>
<td>65A</td>
<td>- Seal Spring</td>
<td>**6</td>
<td>936J</td>
<td>O-ring Packing</td>
<td>*2</td>
</tr>
<tr>
<td>68A</td>
<td>- Seal Wedge Ring</td>
<td>**1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Recommended Spare Parts
**Recommended Seal Spare Component Parts
Tandem Seal Arrangement and Parts

Figure 14. Tandem Seal Arrangement

Table 18. Tandem Seal Arrangement

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Part Name</th>
<th>Qty.</th>
<th>Item No.</th>
<th>Part Name</th>
<th>Qty.</th>
</tr>
</thead>
<tbody>
<tr>
<td>21B</td>
<td>Upper Throttle Bushing</td>
<td>1</td>
<td>905L</td>
<td>Hex Head Cap Screw</td>
<td>3</td>
</tr>
<tr>
<td>50</td>
<td>Slinger Sleeve Assembly</td>
<td>*1</td>
<td>916A</td>
<td>Washer</td>
<td>3</td>
</tr>
<tr>
<td>51A</td>
<td>Seal Rotating Face</td>
<td>*1</td>
<td>916B</td>
<td>Washer</td>
<td>3</td>
</tr>
<tr>
<td>51D</td>
<td>Seal Rotating Face (Gearbox)</td>
<td>*1</td>
<td>916K</td>
<td>Washer</td>
<td>3</td>
</tr>
<tr>
<td>60A</td>
<td>Mechanical Seal (Lower)</td>
<td>*1</td>
<td>936H</td>
<td>O-ring Packing</td>
<td>*2</td>
</tr>
<tr>
<td>60C</td>
<td>Mechanical Seal (Gearbox)</td>
<td>*1</td>
<td>936J</td>
<td>O-ring Packing</td>
<td>*1</td>
</tr>
<tr>
<td>905E</td>
<td>Hex Head Cap Screw</td>
<td>3</td>
<td>936K</td>
<td>O-ring packing</td>
<td>*1</td>
</tr>
<tr>
<td>905F</td>
<td>Hex Head Cap Screw</td>
<td>3</td>
<td>936P</td>
<td>O-ring Packing</td>
<td>*1</td>
</tr>
</tbody>
</table>

*Recommended Spare Parts
Separator Arrangements

Figure 15. Separator Arrangements

Separator Arrangement with Insert

Separator Arrangement without Insert
Pump and Gearbox Cross Section (Single Seal Arrangement)

Figure 16. Pump and Gearbox Cross Section

Note:
1. Item numbers listed above identify only part location and must be used with parts list for specific pump.
2. A combination of options may be used in a specific unit. Refer to instruction manual.
3. A solid shaft and flexible coupling is used on some units instead of splined interconnecting shaft.
4. Units built prior to January 2009 may have housing gaskets, Item 105, in place of 936AG o-ring.

March 9, 2004
LMV-311 Gearbox (Exploded View)

Figure 17. 200 HP Gearbox.
Figure 18. Pump Casing and Seal Housing (Exploded View)

*Recommended Spare Parts
Gaskets

Figure 19. Chemical Barrier Gasket (option)

Figure 20. Flexitallic Gasket (option)
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