Installation, Operation & Maintenance Manual

Sundyne Pumps

Model: LMV-322

SA-07-11-30, Rev Orig.
Jun 2009

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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

April 2009	Add seal configurations / misc. updates

Contents

INTRODUCTION

Sundyne Centrifugal Pumps

Sundyne pumps provide high-energy performance and competitive efficiencies in an industrial quality, compact unit that is simple 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.

Equipment and Safety Precautions

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.*

When using more than one piece of protective equipment, consider their compatibility. For example, safety glasses will not interfere with hearing protection equipment. Be sure to clean all pieces of personal protective equipment immediately after each use.

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.*

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.*

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.

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.*

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.

Installing a Seal Environmental Control System

Install a system to control the seal environment. Also, verify that Port 1 is properly vented.

If required, install drain 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, uncouple; 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

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 5 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.

***Note**: Sundyne recommends that gearbox lube oil be changed at least every six months.*

For requirement information about priming the lube oil system, refer to the start-up section in this manual.

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. Your total satisfaction is our goal. 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?
    - o Pump flange bolts?
    - o Seal environment piping and port connections?
    - o Cooling water connections to heat exchanger(s) (if applicable)?
    - o Gearbox oil drain plug?
    - o 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**: Special considerations must be made before Port 1 can be piped to a flare. Consult your Sundyne Channel Partner or the factory before connecting Port 1 to a flare line.*

***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" (5mm) 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.
- ❑ 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 5 or 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 CW as viewed from the fan end of the motor. Is rotation correct? Once rotation is verified, bump the motor until gearbox oil pressure

gauge verifies pressure is developed; then start the main driver. Oil pressure will be between 15-60 psig (1.1-4.2 kg/cm^{2}g) depending on the type of bearings in the gearbox. The preceding motor bump procedure is recommended every time the pump is started.

- ❑ If pressure control is being used, throttle the discharge valve immediately after start-up to the pump design point. 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 can be found in Sundyne Field Engineering Bulletin, 40.2.33, available at Sundyne.com or from your local Channel Partner.

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.*

***Note**: Suction strainer should be removed after commissioning.*

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. Maximum forces/moments on flanges are available from your Channel Partner or Sundyne Corporation. **These values must not be exceeded**. 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 on both suction and discharge of the unit.

***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.*

Figure 1. Seal Housing Port Identification

PORT	DESCRIPTION
1	SEAL DRAIN
2	SEAL DRAIN SINGLE SEAL OR BUFFER FLUID **IN** (DOUBLE OR TANDEM SEAL)
5	SEAL FLUSH
6	SEAL FLUSH
7	SEAL DRAIN SINGLE SEAL OR BUFFER FLUID **OUT** (DOUBLE OR TANDEM SEAL)

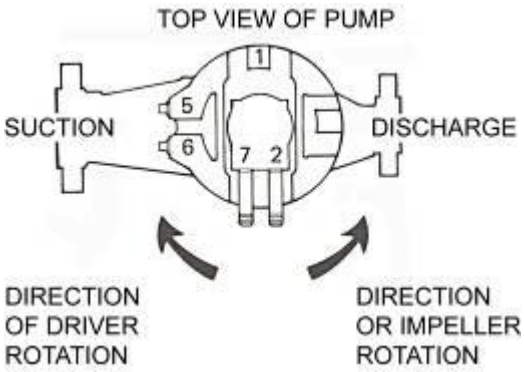
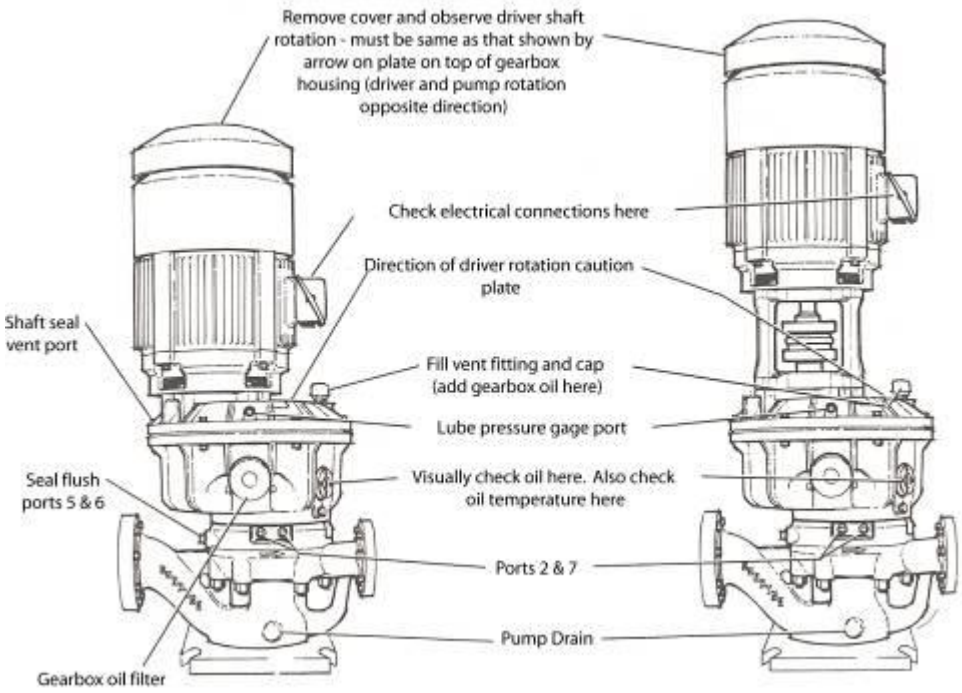


Figure 2. Service Check Points



Liquid Buffer System

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

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.

***Note**: No instrumentation should be used in environmental seal system that will restrict flow.*

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.

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 LMV Units

***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.

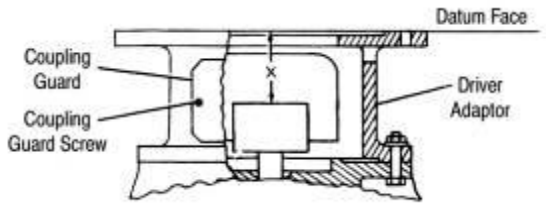
***Note:** Gearbox hub should be set flush with the gearbox shaft, unless otherwise noted in the pump documentation.*

Driver coupling is NOT Mounted

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

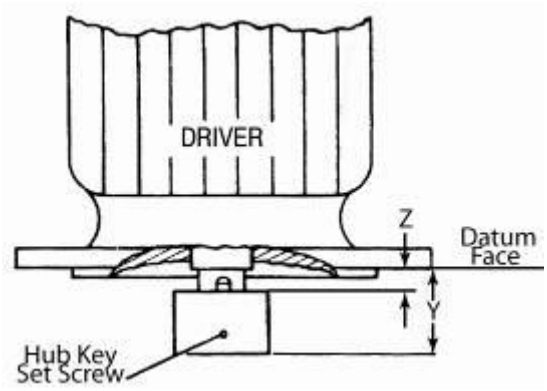
1. Measure the distance from the top surface of the gearbox hub, to the datum face of the driver adapter. This measurement is referred to as dimension"X".

Figure 3. 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. Subtract the hub height from Dimension Y. This will be Dimension Z.

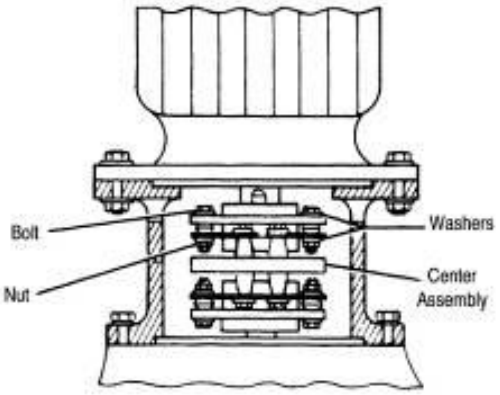
Figure 4. Dimension Y



5. Scribe the shaft to show dimension Z
6. Ensure that the coupling hub bore, keyways, and shaft are clean and free from burrs. Also determine that the key fits in the keyways.
7. 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.
8. Position the hub at the scribed line on the shaft.
9. Tighten the hub key set screw (if applicable).

***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.*

Figure 5. Assembly of Coupling Bolts and Washers



LUBE SYSTEM

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 (not provided on all units)
- Oil filter

The lube pump intakes oil from the sump and passes it internally to an integrally 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 (Not Provided on all Units)

The standard heat exchanger is a shell and tube water-cooled type. For optimum performance, the following conditions must be met.

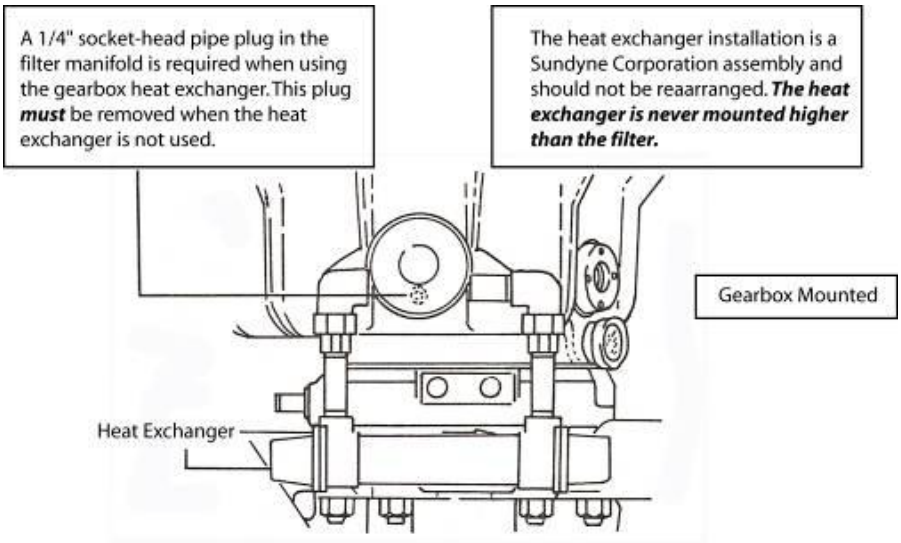
- Cool water must be provided to the tube side at a maximum pressure of 150 psig (11 kg/cm2) (103.5Kpag).
- Coolant flow must be controlled to maintain a gearbox sump temperature between 140°F and 160°F (60°to 71°C). Maximum recommended temperature is 180°F (82°C).

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.*

Figure 6. Heat Exchanger Mounting.



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.

Gearbox Sump

The gearbox sump holds approximately five U.S. quarts (4.7 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.***

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.*

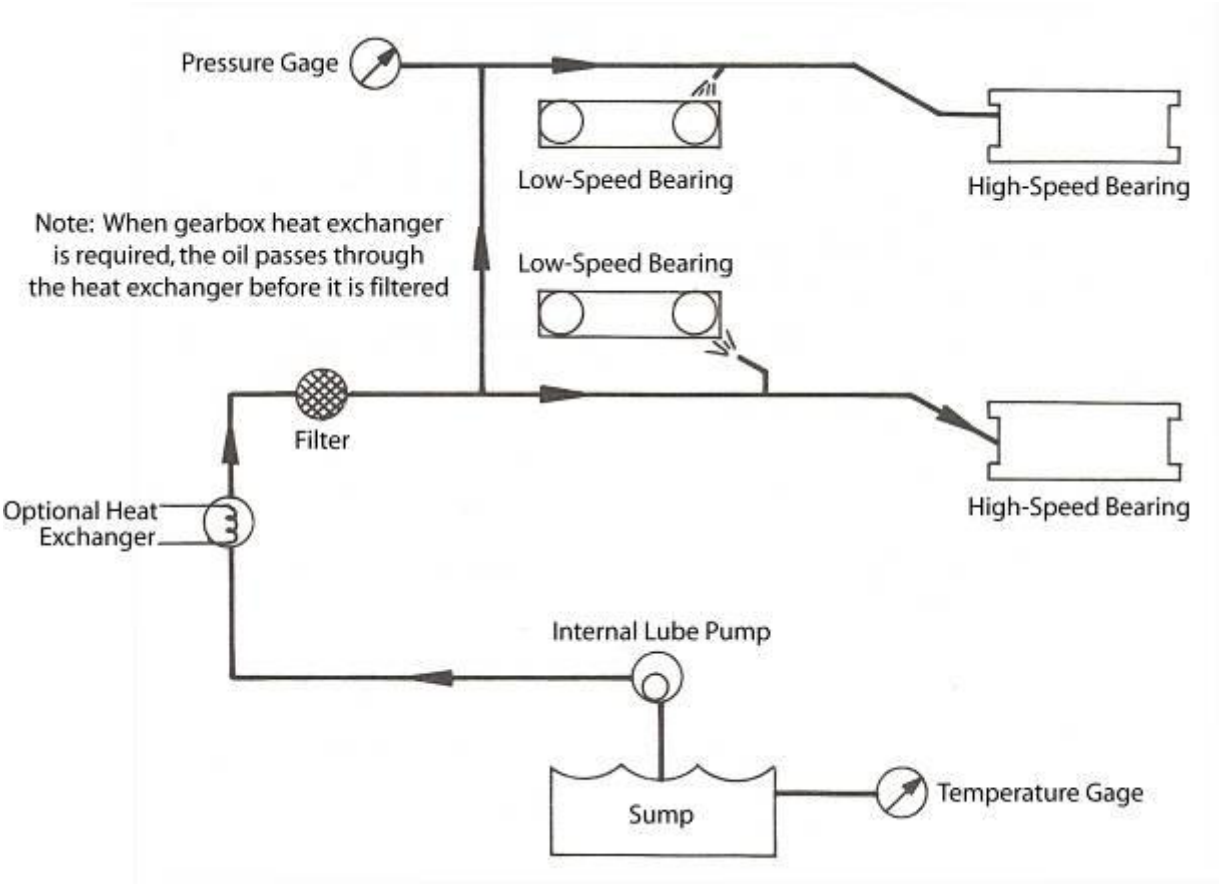
The Sundgard® oil filter part number is 22-362 for LMV-322.

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

The main lube pump is a positive displacement gear type pump directly driven by the input shaft.

Figure 7. Lube Oil Schematic



Oil Pressure

During normal operation, the gearbox internal lube pump will maintain oil pressure between 20 and 75 psig (1.0 and 4.2kg/cm^2). 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/cm^2)*

START UP

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/cm^2).
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 ¼ inch (6.4mm) 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 5 quarts (4.7 liters). Replace the filter breather cap on the fill-opening fitting and replace the fill-vent plug.

   Remove oil filter and fill with oil.

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 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 gearbox 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 is necessary 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.*

8. If applicable, 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.

Note: *If valve position is unknown, it is better to start with a higher flow rate than low or no flow. Once started, quickly adjust the Sundyne Pump to design flow.*

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.

For more information about parallel pump operation or pump control with a Sundyne pump, consult the Sundyne Pump Control Bulletin available from your local Channel Partner or at www.sundyne.com.

OPERATION & CONTROL

Operation of Sundyne Pumps

Under normal operation, several factors must be taken into consideration to ensure successful pump operation.

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 ($NPSH_a$) available greater than Net Positive Suction Head ($NPSH_r$) 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.

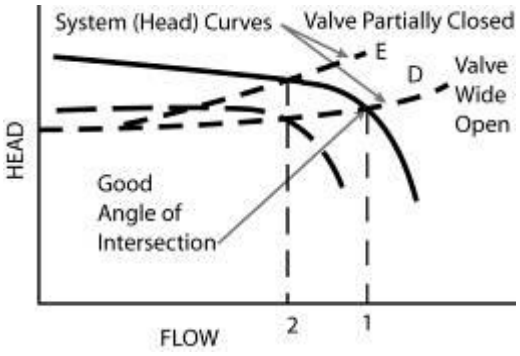
Entrained Gases

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. System Heat Curve



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.

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.*

Figure 9. Parallel Operation

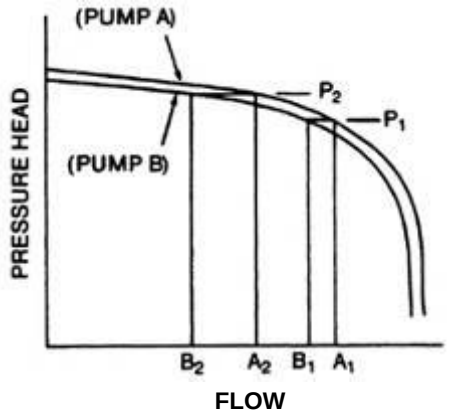
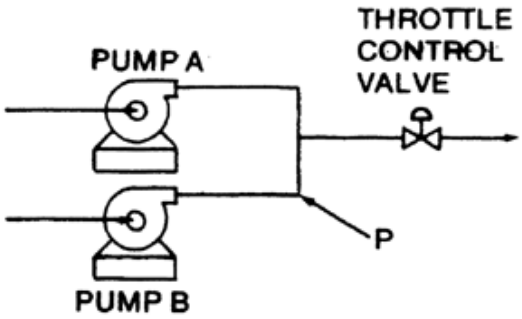


Figure 10. Parallel Units Common Valve



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.

See the Sundyne Control Bulletin for more information, available from you local channel partner or from www.sundyne.com.

MAINTENANCE

The following procedures apply to all configurations of the Sundyne LMV-322 process pump. Refer to the specification sheet to determine your specific pump configuration and optional equipment included. Disassembly should be done only to the extent necessary for repair. Parenthetical numbers included in the text correspond to item numbers in the parts list section.

Wet End Disassembly of LMV-322

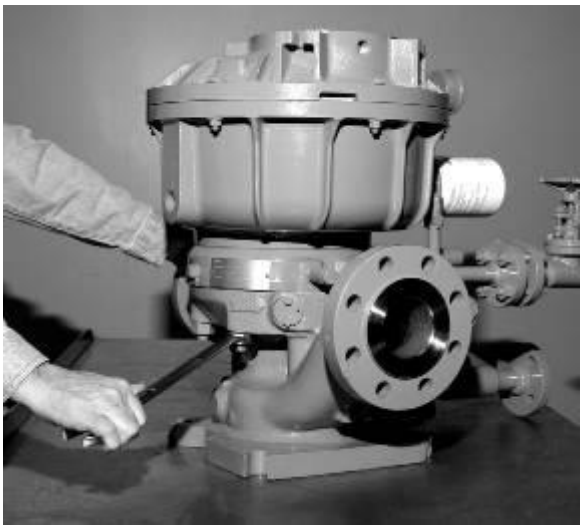
Shown here completely assembled with gearbox and driver.

The following replacement parts will be required as a result of pump disassembly and seal housing removal.

Part	Item No.	Qty.
O-Ring Repair Kit	-	1
Chemical Barrier Gasket (Optional)	106	1

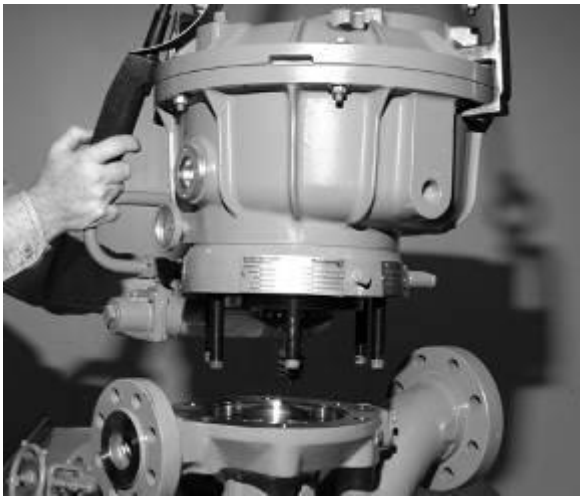
STEP 1

Remove the driver from the gearbox.
Units without a Flexible Coupling (shown here). Remove attaching bolts. Lift the driver from the gearbox. Remove the interconnecting shaft (110). Remove the old lubricant from the male and female spline areas of the interconnecting shaft. Before reassembly, apply 5 cc of antifretting compound (Sundyne Part Number MP01AA100) to each end of the splined interconnecting shaft (110).
Units with a Flexible Coupling - (Ref. Figure 18). Remove the coupling housing cover plate (116) by removing screws (904A). Disengage the input coupling (117). Remove the hex head cap screws (905J). Lift the driver from the gearbox. Remove the coupling housing (118) by removing attaching bolts. Remove the coupling hub (119) from the gearbox low-speed shaft (120). The coupling hub is installed with a light press fit and may require a puller to remove it.



STEP 2

Remove nuts (914A) from the pump casing studs.

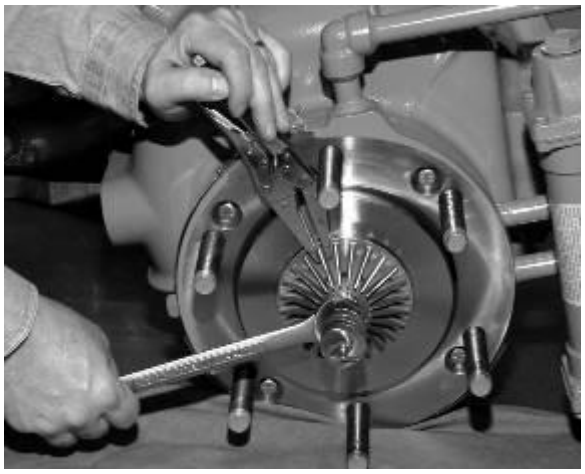


STEP 3

Lift the gearbox and seal housing assembly from the pump casing. Exercise care not to damage the inducer (9) if one is installed. Lay the assembly on its side.

STEP 4

Bend tab washer (5) to allow inducer (9) or impeller nut to be removed.

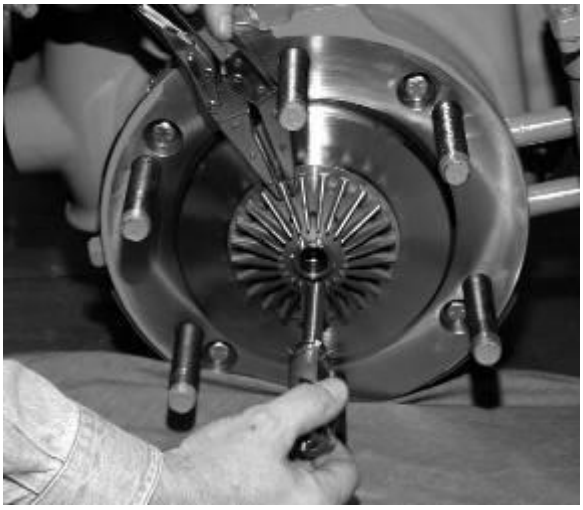


STEP 5

Prevent impeller (2) from turning.

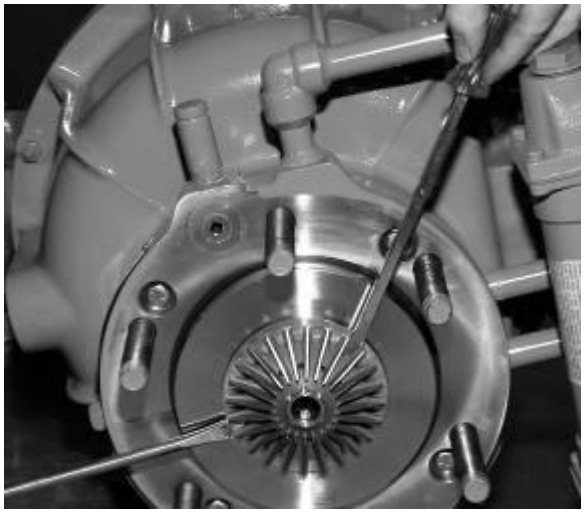
During reassembly, install a new impeller tab washer (5). Fit tabs into the slot of the inducer or impeller bolt.

Note: *Inducer or impeller bolt assembly will loosen by turning CW (left-hand thread).*



STEP 6

Hold impeller (2), remove impeller bolt assembly (3) or inducer (9), inducer stud, (10) and tab washer (5).

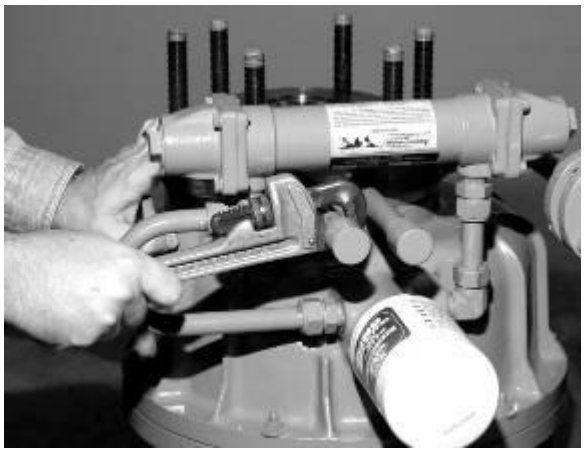


STEP 7

Pry impeller (2) from high-speed shaft and remove impeller key (4).

Note: *An inducer or impeller that has rubbed against surrounding surfaces may be out of balance and could result in high-speed shaft bearing failure if re-used in this condition.*

The impeller and inducer are balanced at the factory to less than 0.01 inch-ounces in two planes.



STEP 8

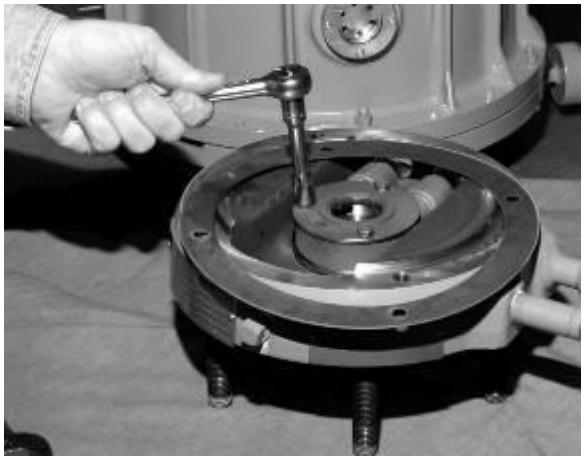
Turn gearbox upside-down.
Remove two 1/2" pipe nipples from seal housing.

STEP 9

Remove cap screws (905A).
Lift seal housing (30) from gearbox.

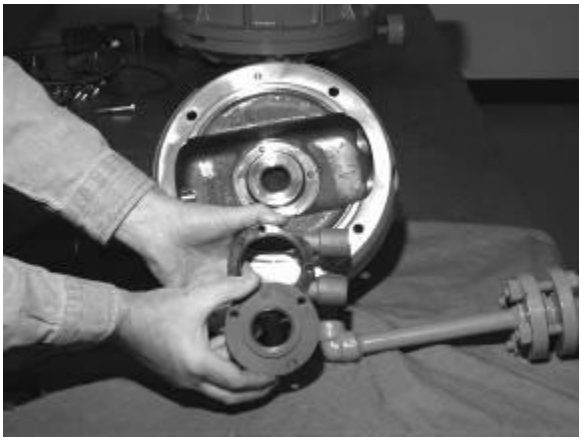
STEP 10

Lift out seal rotating face (51A).



STEP 11

Flip seal housing over and remove cap screws (905F), washers (916B) and throttle bushing (21B). Remove thermal barrier gasket (87A).



STEP 12

Lift out throttle bushing (21B) and seal retainer spacer (19A).

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 it's surface
- Shows signs of overheating
- Shows wear to a depth greater than 0.001" (0.03mm)

Inspect upper and lower thrust washers. If metal is smeared into radial lube grooves of the washer face, install a new washer.

***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 it's bearing journals, and have runout measured at the impeller fit (0.0012 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 10.

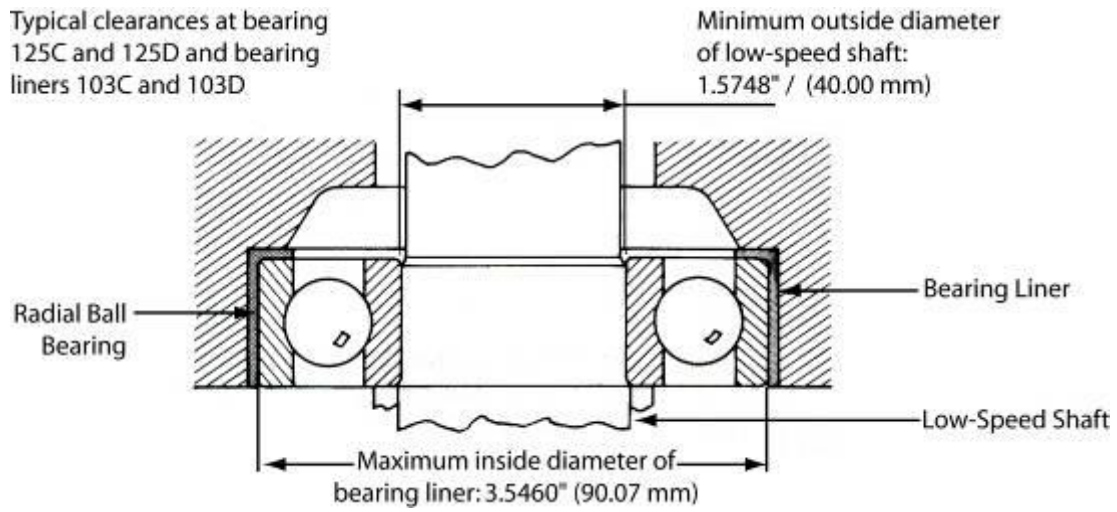
The impeller may rub on the diffuser cover plate (15) until o-rings (936D and 936E) are compressed by tightening hex nuts (914A). Check the gearbox input shaft for freedom of rotation after the pump is assembled and all bolts are tightened per Table 10.

Shaft Sleeve

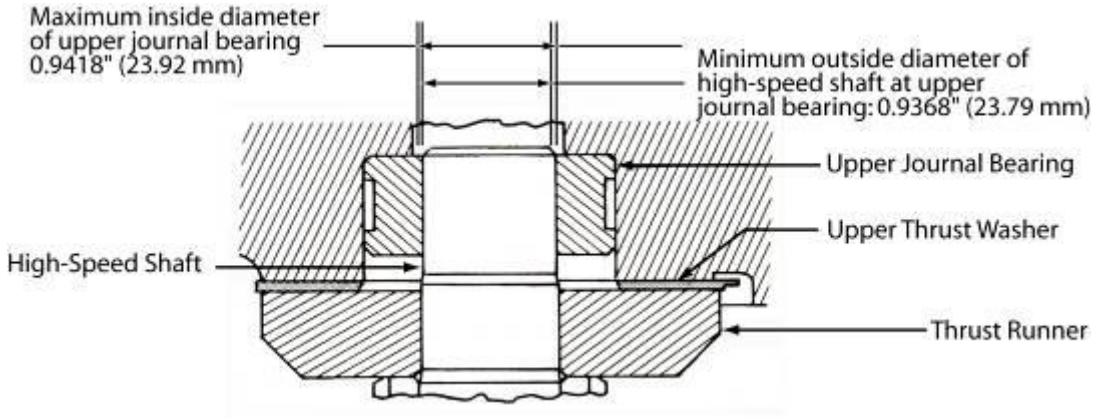
Ensure that there are no high spots on the end surfaces of the shaft sleeve or the impeller hub. High spots will distort the seal rotating face due to the clamping force of the impeller bolt. Ensure that shaft sleeve end faces are parallel within 0.0003" (0.0076mm).

Bearing and Shaft Clearances

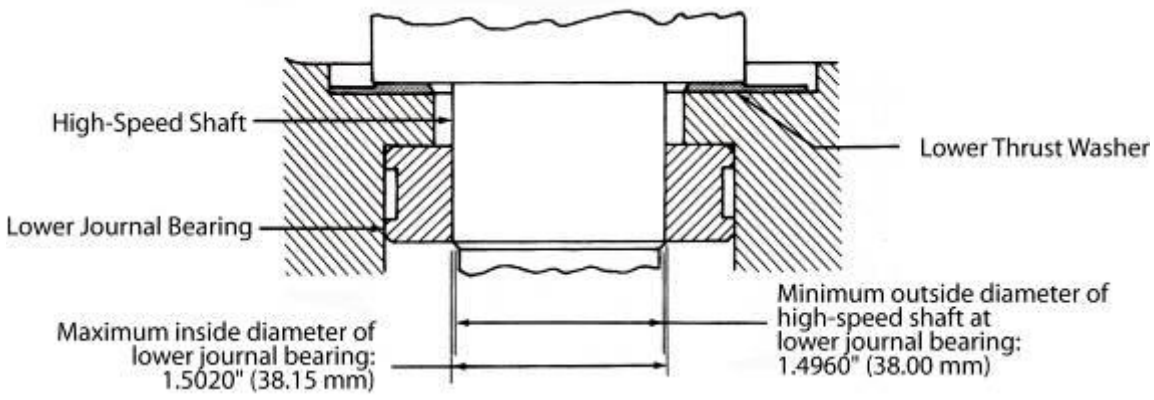
Figure 11. Bearing and Shaft Clearances



Low Speed Shaft and Bearing Liner Clearances



Upper Journal Bearing and High-Speed Shaft Clearances



Lower Journal Bearing and High-Speed Shaft Clearances

Procedure for Assembly of the Gearbox

The following replacement items will be required as a result of gearbox assembly.		
Part	**Item No.**	**Qty.**
5 cc Tube Antifretting Compound	---	2
Gearbox Oil Filter	185	1
Shaft Lip Seal	115	1
Housing Gasket	105	1
O-Ring Packing (interconnecting shaft)	936M	2
O-Ring Packing (oil seal)	936P	1
O-Ring Packing (lower housing oil passage)	936T	1
O-Ring Packing (slinger sleeve, outer)	936J	1

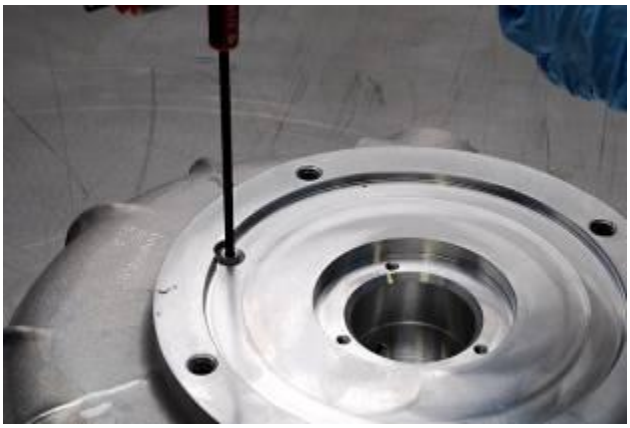
STEP 1

Install alignment pin on the bottom side of the lower housing.

STEP 2

Apply Teflon® paste to plug.

Note: *Teflon® tape should never be used on gearbox.*



STEP 3

Install plug.

STEP 4

Apply Teflon® paste to plug.

Note: *Teflon® tape should never be used on gearbox.*

STEP 5

Install plug.

STEP 6

Align lube oil hole on lower high-speed bearing with the cut out on the lower gearbox housing.

STEP 7

Set lower high-speed bearing into place.

STEP 8

Install and torque two journal bearing screws from the inside of the gearbox. Be sure to hold the bearing in place from the outside of the gearbox while installing the screws.

Note: Torque screws to:			
Sundyne Standard	*Item 905M*	*English 35-40 in-lbs*	*Metric 4.0-4.5 N-m*

STEP 9

Set the spiral wound anti-rotation pin in place. Position the tail of the anti-rotation pin to the outside diameter of the cavity.

STEP 10

Install the anti-rotation pin for the internal lube pump. The anti-rotation pin should be proud of the surface .100”-.125”.

STEP 11

Install o-ring (936T) on lower gearbox housing.

STEP 12

Install o-ring (936AG).

STEP 13

Install lower input bearing lube jet in the lower gearbox housing.

STEP 14

Install lower thrust washer (155A) in lower gearbox housing. Be sure to check that the tabs on the thrust washer are present and flat as seen in the picture.

STEP 15

The lube pump shoulder will butt up next to the anti-rotation pin.

STEP 16

Rotate the lube pump in the clockwise direction until the lube pump shoulder is seated against the anti-rotation pin.

STEP 17

Set the lube pump spring (23A) on top of the lube pump.

STEP 18

Use gearbox oil to lubricate the lower input shaft bearing and the lube pump.

STEP 19

Align the slots in the input shaft with the pins on the lube pump.

STEP 20

Slide the input shaft assembly into place.

STEP 21

Check that the input shaft springs back if pushed down. If it does not spring back, then the shaft has not been aligned with the lube pump correctly.

STEP 22

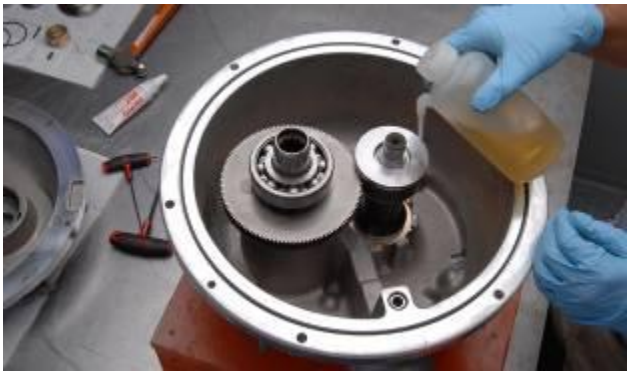
Apply gearbox oil to the lower thrust washer (155A).

STEP 23

Install the high-speed shaft (130).

STEP 24

Use gearbox oil to lubricate the upper input bearing and the upper thrust runner.



STEP 25

Install alignment pins into the upper gearbox housing.

STEP 26

Install alignment pins into the upper gearbox housing.

STEP 27

Slide the upper journal bearing (151B) into the upper gearbox housing.

STEP 28

Install and torque cap screw (905N) on the upper journal bearing.

Note: Torque screw to:			
Sundyne Standard	*Item 905N*	*English 35-40 in-lbs*	*Metric 4.0-4.5 N-m*

STEP 29

Install lube jet (174C) on upper gearbox housing.

STEP 30

Apply a small amount of petroleum jelly to the under side of the upper thrust washer (155B) to hold the thrust washer in place when the upper gearbox housing is installed.

Note: *If metal has been smeared onto the radial lube grooves of either the upper (155B) or lower (155A) thrust washer face, install a new washer.*

STEP 31

Install the upper thrust washer (155B) on the upper gearbox housing.

STEP 32

Set the upper gearbox housing (101B) in place. The upper gearbox housing will not sit flat against the lower gearbox housing at this point because the input gear is being pressed up by the lube pump spring. The gearbox housings should be easily pressed together and they should spring apart when released.

STEP 33

Assemble the upper housing to the output housing. Seat the locating pins (918M).

Torque cap screws (909B) and nuts (914E).

Note: Torque cap screws and nuts to:			
Sundyne Standard	*Item 909B*	*English 60-65 ft-lbs*	*Metric 81-88 N-m*

STEP 34

Install extended sight glass (191).

Note: Torque screws to:			
Sundyne Standard	*Item 906B*	*English 10-12 in-lbs*	*Metric 1.0-1.4 N-m*

STEP 35

Install a new shaft seal (115) using a special tool available from the factory. (Tool P/N TO06AA47). During reassembly, lubricate the lip of the new shaft seal (115) and the outside diameter of the input shaft with grease or oil.

STEP 36

Lightly tap the new shaft seal into place.
If the lip seal tool is not available, place tape over the keyway of the input shaft prior to installing the lip seal. Use caution to prevent damage to the seal.

STEP 37

Apply Teflon® paste to the threads of the vent cap and install.

Note: *Teflon® tape should never be used on the gearbox.*

STEP 38

Apply Teflon® paste to the oil drain plug and install.

Note: *Teflon® tape should never be used on the gearbox.*

STEP 39

If a heat exchanger is not present, apply Teflon® paste to a pipe plug and install on the side of the gearbox.

Note: *Teflon® tape should never be used on the gearbox.*

STEP 40

If a heat exchanger is not present, apply Teflon® paste to a second pipe plug and install on the side of the gearbox.

Note: *Teflon® tape should never be used on the gearbox.*

STEP 41

Note: *If a heat exchanger is not used, this port must be unplugged.*

Note: *Teflon® tape should never be used on the gearbox.*

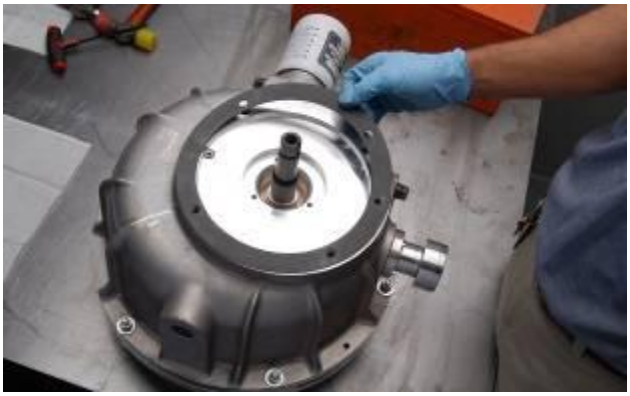
STEP 42

Install nipple (971A).

STEP 43

Install oil filter (185).

Gearbox Seal Assembly



STEP 1

Place housing gasket (87A) in position on lower gearbox housing.

STEP 2

Place gearbox seal rotating face (51D) on output shaft. The small chamfer on the I.D. should face toward the gearbox.

STEP 3

Install o-ring (936K).

STEP 4

Install o-ring (936P) on gearbox seal.

STEP 5

Position the gearbox seal (60C) in place with the carbon face toward the gearbox.

STEP 6

Torque the gearbox seal (60C).

Note: Torque seal to:			
Sundyne Standard	*Item 60C*	*English 75-80 in-lbs*	*Metric 8.5-9.0 N-m*

Steps for Single Seal Only

STEP 1

Assemble the single seal as shown at left. Flip the assembly over so that the carbon face points down and set the assembly in place.

Lower seal (60A)

Seal Spacer (52)

O-ring (936H)

Note: Seal spacer chamfer should face seal retainer .
No o-ring is placed between seal and seal spacer.

STEP 2

Place o-ring (936H) on the seal retainer.

STEP 3

Set seal retainer spacer (19A) in place.

STEP 4

Place o-ring (936H) on bottom side of the throttle bushing.

STEP 5

Set throttle bushing (21B) in place.

STEP 6

Torque hex head cap screws (905F).

Note: Torque screws to:			
Sundyne Standard	*Item 905F*	*English 95-102 in-lbs*	*Metric 11-11.5 N-m*

STEP 7

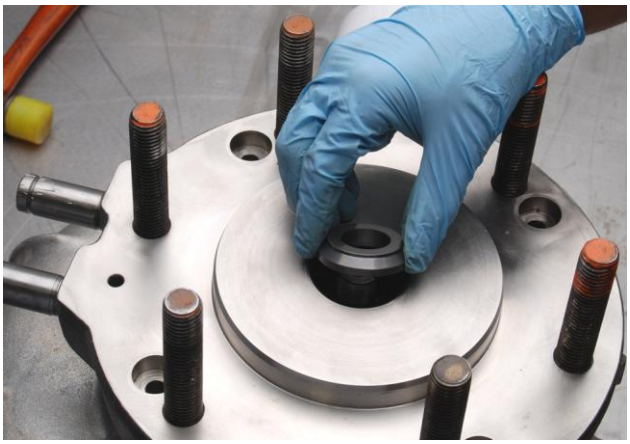
Place the shaft sleeve (50) on the output shaft.

STEP 8

Place o-ring (936J) on output shaft.

STEP 9

Turn over the seal housing and gently set it on the gearbox. Be sure to align the alignment pin on the gearbox with the hole on the seal housing.



STEP 10

Set the rotating face (51A) on high-speed shaft.

****continue on Page 64****

Steps for Dual Pressurized (Double Seal) Only

STEP 1

Install o-ring (936H) on the lower seal.

STEP 2

Set the lower seal in place on the seal housing. Be sure that the carbon face is visible.

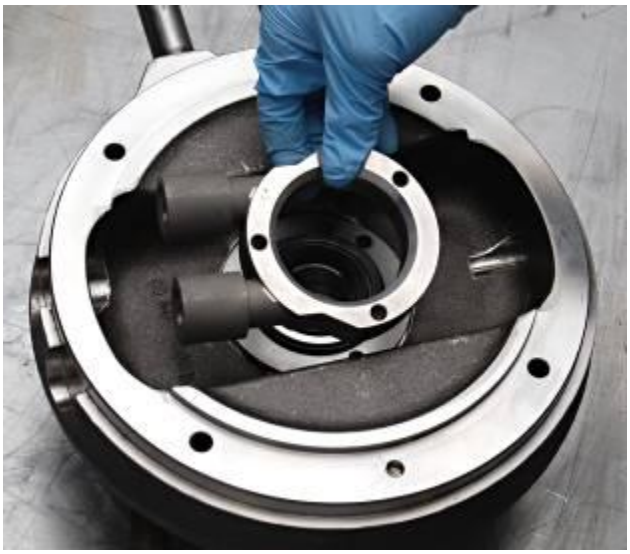
STEP 3

Place the seal spacer (52) in place on the lower seal.

Note: *No o-ring is placed between seal retainer and seal spacer. Seal spacer chamfer should face seal retainer.*

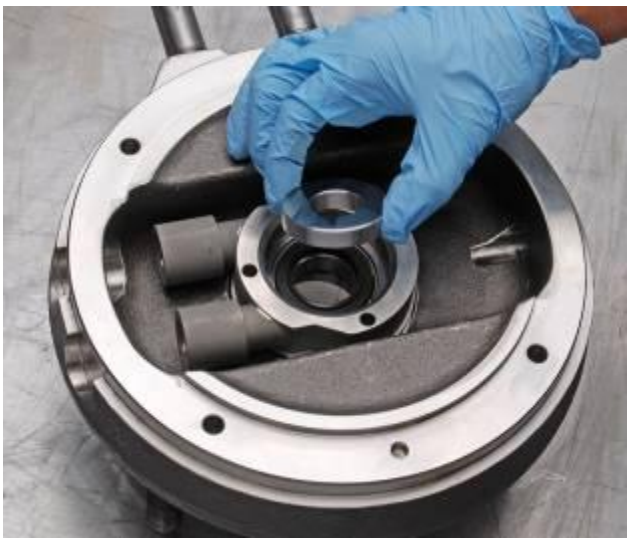
STEP 4

Place o-ring (936H) on the seal retainer.



STEP 5

Place the seal retainer spacer (19A) on the lower seal.

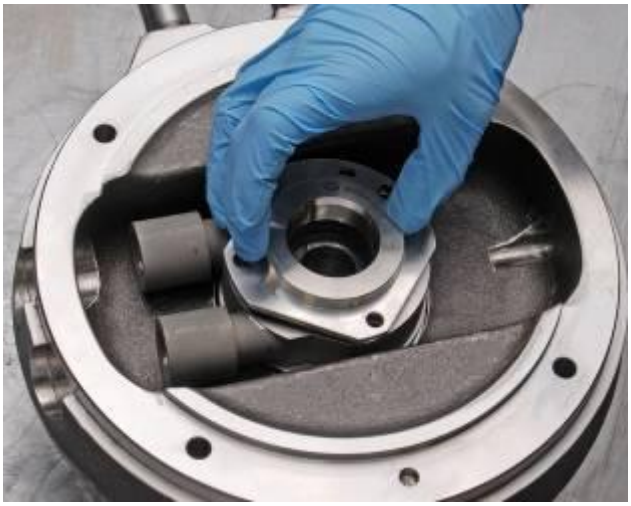


STEP 6

Set the rotating face (51C) on the carbon face of the lower seal. Try to keep the rotating face as centered as possible.

STEP 7

Place o-ring (936H) in place on the upper seal.



STEP 8

Place the upper seal (60B) on the seal retainer spacer. Be sure carbon face on the upper seal points toward the rotating face.

STEP 9

Install and torque the hex head cap screws (905F). Tighten each screw a little at a time to compress the seal in a controlled manner.

Note: Torque screws to:			
Sundyne Standard	*Item 905F*	*English 95-102 in-lbs*	*Metric 11-11.5 N-m*

STEP 10

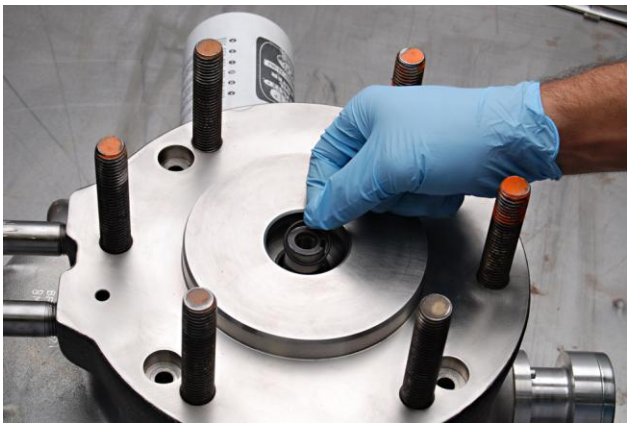
Install upper shaft sleeve.

STEP 11

Install o-ring (936J) on high-speed shaft

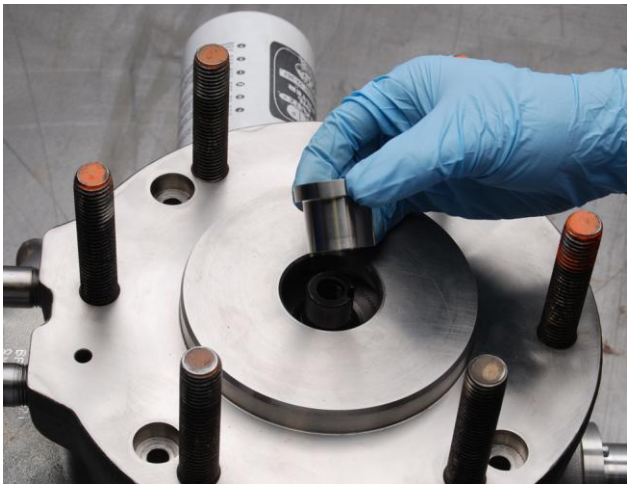
STEP 12

Turn over the seal housing and gently set it on the gearbox. Be sure to align the alignment pin on the gearbox with the hole on the seal housing.



STEP 13

Install o-ring (936J) on the output shaft.



STEP 14

Install lower shaft sleeve (50A).

****continue on Page 64****

Steps for Dual Unpressurized (Tandem Seal) Only

STEP 1

Install shaft sleeve (50B).

STEP 2

Install o-ring (936J) on high-speed shaft.

STEP 3

Assemble the following parts as shown.

Lower seal (60A)

Seal Spacer (52)

O-ring (936H)

Turn over the assembled parts and set in place on the seal housing.

Carbon should face down (into housing).

(This step is the same as for a single seal set-up.)

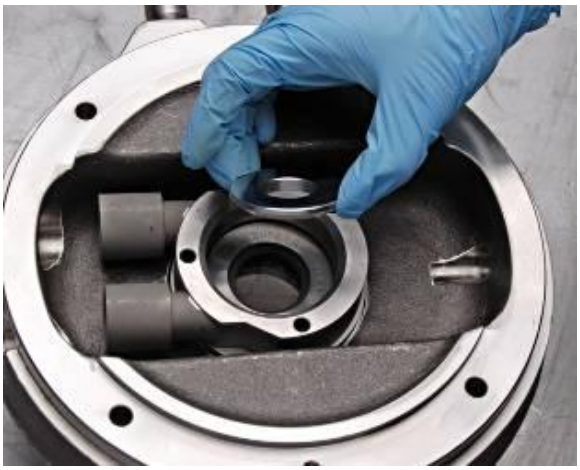
Note: No o-ring is placed between seal spacer and seal retainer
Seal spacer chamfer faces seal retainer.

STEP 4

Place o-ring (936H) on lower seal.

STEP 5

Install seal retainer spacer (19A).



STEP 6

Install rotating face (51B).

Note: *Try to keep retaining face as centered as possible.*

STEP 7

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

STEP 8

Install upper seal (60B).

Be sure that the carbon face points towards the rotating face.

STEP 9

Install and torque hex head cap screws (905F).

Note: Torque screws to:			
Sundyne Standard	*Item 905F*	*English 95-102 in-lbs*	*Metric 11-11.5 N-m*

STEP 10

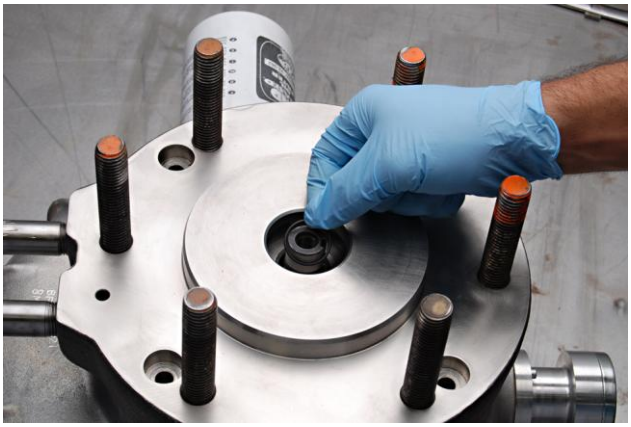
Turn over the seal housing and gently set it on the gearbox. Be sure to align the alignment pin on the gearbox with the hole on the seal housing.

STEP 11

Install o-ring (936J) on high-speed shaft.

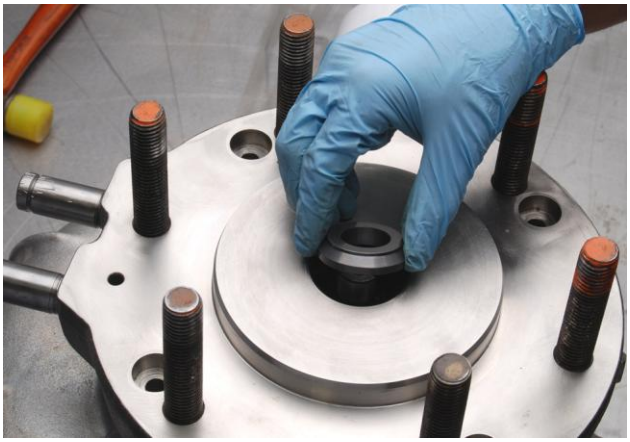
STEP 12

Install lower shaft sleeve (50A) on high-speed shaft.



STEP 13

Install o-ring (936J) on the output shaft.



STEP 14

Set the rotating face (51A) on high-speed shaft.

****continue on Page 64****

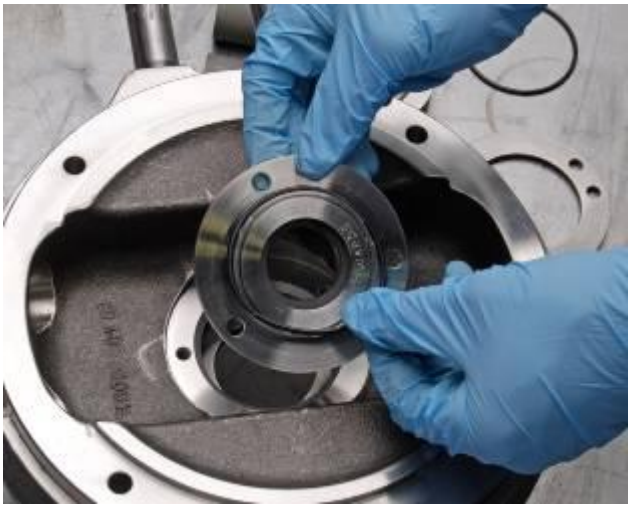
Steps for Isolation Bushing

STEP 1

Install upper shaft sleeve (50B).

STEP 2

Install o-ring (936J).



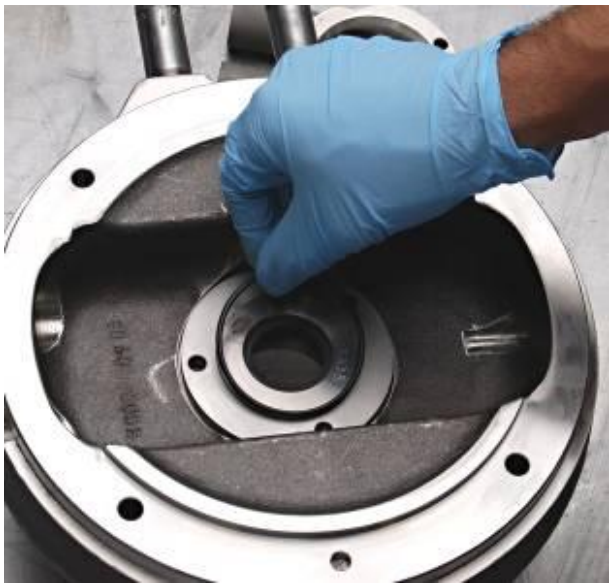
STEP 3

Install o-ring (936H) on the isolation bushing and install into seal housing.

STEP 4

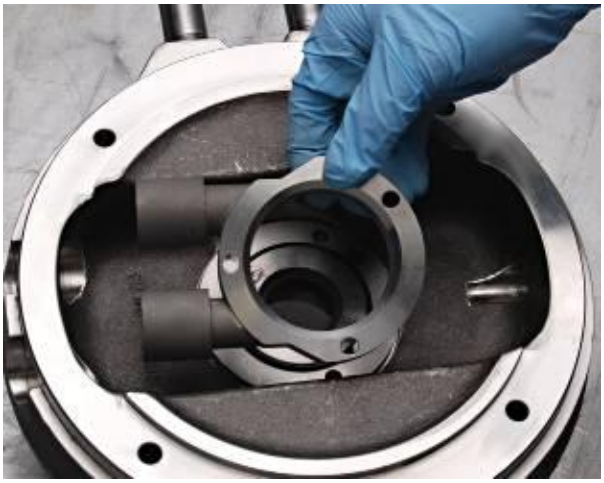
Place isolation bushing in place on the seal housing and then install the seal spacer (52) as shown.

Note: Seal spacer chamfer should face seal retainer .
No o-ring is placed between seal and seal spacer.



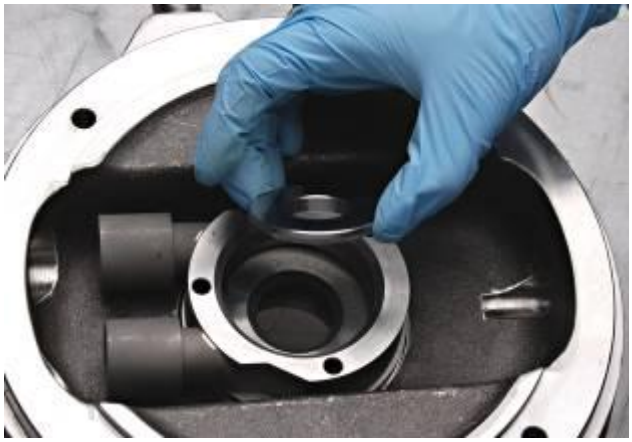
STEP 5

Place o-ring (936H) on isolation bushing.



STEP 6

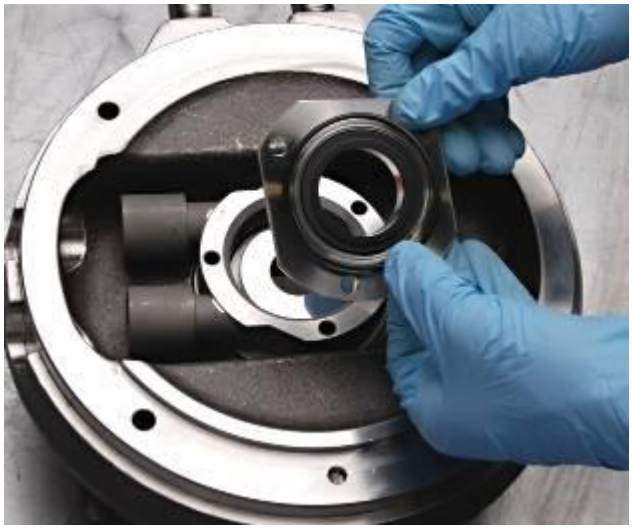
Install seal retainer spacer (19A).



STEP 7

Install rotating face (51B).

Note: *Try to keep rotating face as centered as possible.*



STEP 8

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

Be sure that the carbon face points towards the rotating face.

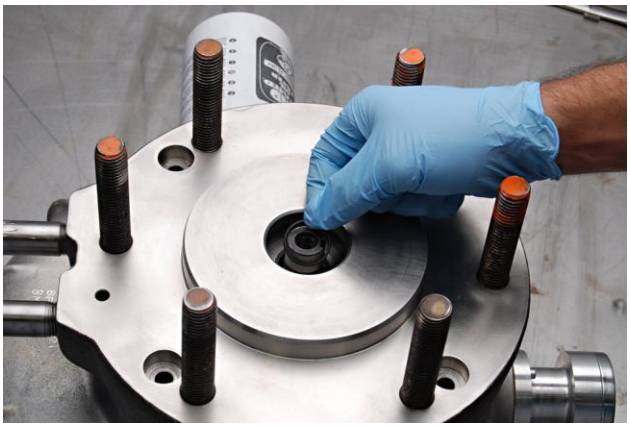
STEP 9

Install and torque hex head cap screws (905F).

Note: Torque screws to:			
Sundyne Standard	*Item 905F*	*English 95-102 in-lbs*	*Metric 11-11.5 N-m*

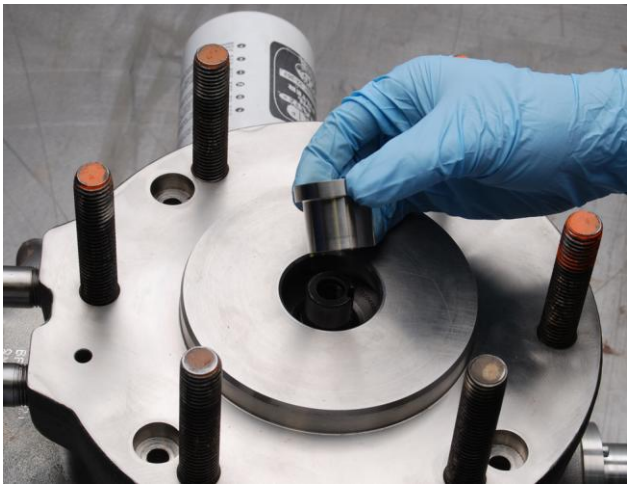
STEP 10

Turn over the seal housing and gently set it on the gearbox. Be sure to align the alignment pin on the gearbox with the hole on the seal housing.



STEP 11

Install o-ring (936J) on the output shaft.



STEP 12

Install lower shaft sleeve (50A).

****continue on Page 64****

Steps for Single Seal with Steam Bushing

STEP 1

Place the shaft sleeve (50) on the output shaft.

STEP 2

Place o-ring (936J) on output shaft.

STEP 3

Assemble the single seal as shown at left.

Lower seal (60A)

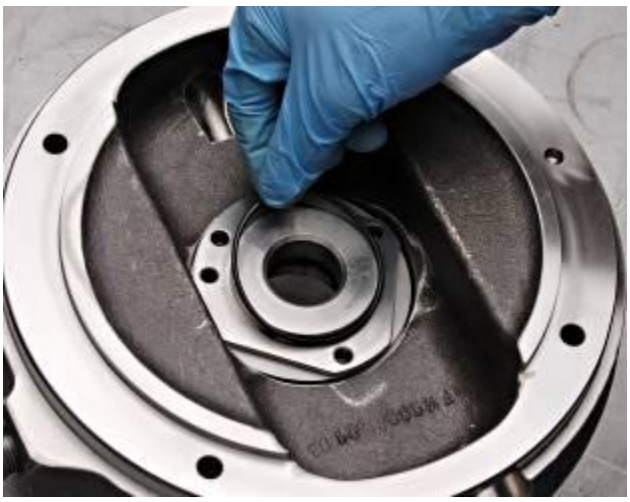
Seal Spacer (52)

O-ring (936H)

Flip the assembly over so that the carbon face points down and then set the assembly in place.

Carbon should face down (into housing).

Note: No o-ring is placed between seal spacer & seal retainer.
Seal spacer chamfer faces seal retainer.



STEP 4

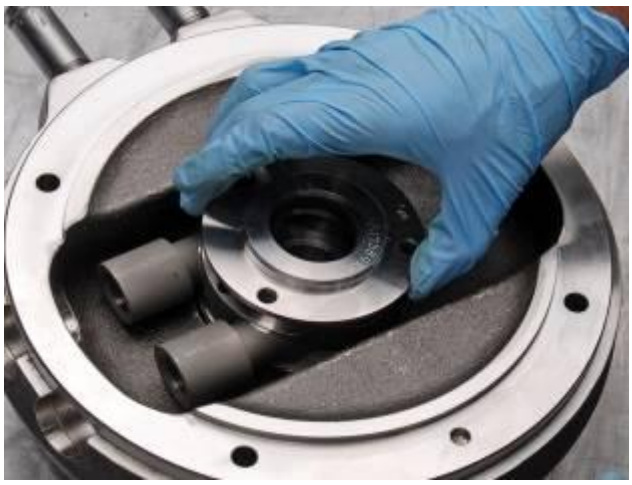
Place o-ring (936H) on the lower seal.

STEP 5

Set seal retainer spacer (19A) in place.

STEP 6

Place o-ring (936H) on bottom side of the steam bushing.



STEP 7

Flip the steam bushing over so that the o-ring faces the seal retainer spacer and then set the steam bushing in place.

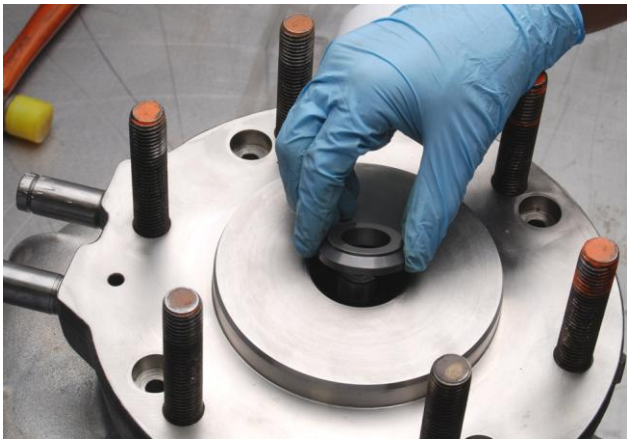
STEP 8

Install and torque hex head cap screws (905A).

Note: Torque screws to:			
Sundyne Standard	*Item 905F*	*English 95-102 in-lbs*	*Metric 11-11.5 N-m*

STEP 9

Turn over the seal housing and gently set it on the gearbox. Be sure to align the alignment pin on the gearbox with the hole on the seal housing.



STEP 10

Set the rotating face (51A) on high-speed shaft.

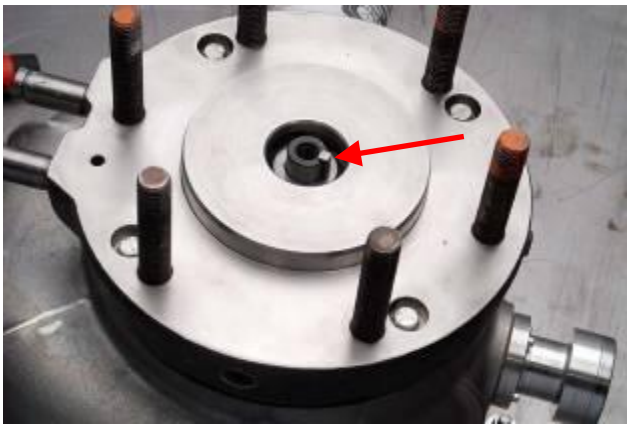
****continue on Page 64****

Continuation for Single, Dual Pressurized (Double), Tandem, and Steam Bushing Assemblies

STEP 1

Install and torque the four hex head cap screws (905A).

Note: Torque screws to:			
Sundyne Standard	*Item*	*English*	*Metric*
	905A	*35-40 ft-lbs*	*47-54 N-m*



STEP 2

Install impeller key (4).

STEP 3

Install o-ring (936G) on impeller hub.

STEP 4

Line up the keyway on the impeller with the key and set the impeller on the output shaft.

STEP 5

Place the tab washer (5) on the inducer (9).

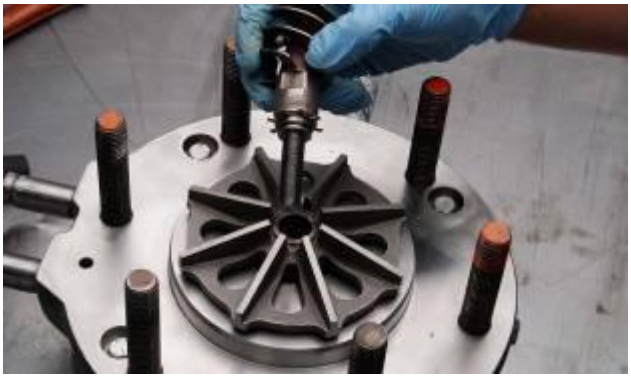
STEP 6

Install o-ring (936F) on the impeller.

STEP 7

Thread the impeller stud (10) into the inducer until it bottoms out.

Note: *Inducer stud is a left-hand thread.*



STEP 8

Thread the assembly onto the output shaft.

STEP 9

Securely hold the impeller in place when torque is applied to the inducer.

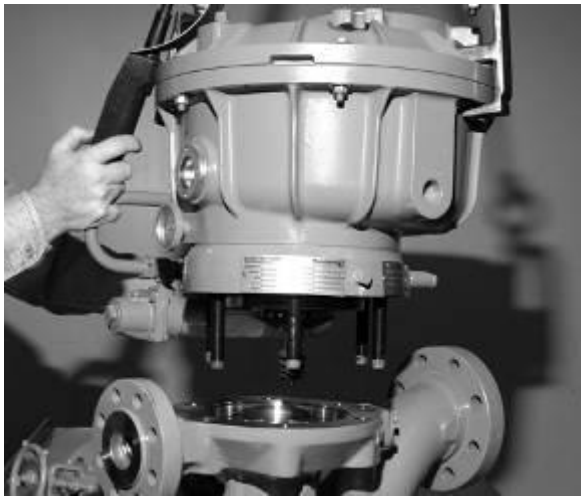
STEP 10

Torque the inducer to the proper torque. Fold short tabs on the tab washer into the corresponding slots on the inducer .

Note: Torque Inducer to:			
Sundyne Standard	*Item 9*	*English 36-40 ft-lbs*	*Metric 49-54 N-m*

STEP 11

Install o-ring (936A) on seal housing.



STEP 12

Align assembly and lower onto pump case.

Note: Torque case nuts to:			
Size: 3/4 - 10			
Sundyne Standard	*Item 914A*	*English 250-275 ft-lbs*	*Metric 340-375 N-m*
Size: 7/8 - 9			
Sundyne Standard	*Item 914A*	*English 300-330 ft-lbs*	*Metric 405-445 N-m*

TROUBLESHOOTING

Gearbox & Pump Diagnostics

Several system factors may affect the performance of the pump. These factors are:

- Temperature
- Specific gravity
- Suction pressure
- Driver speed
- Flow rate
- Control characteristics

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 1. Gearbox and Pump Diagnostics

Situation/Symptom	Possible Cause	Investigative/Corrective Action
No flow, no pressure at start-up.	Pump not completely filled with liquid.	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.
	NPSH actually lower than NPSH requirement listed on specification sheet.	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.
	Failure of drive component, such as interconnecting shaft or impeller key, or item missing from assembly.	Disassemble and inspect.
	Reverse direction of rotation.	Direction of driver shaft rotation must be as shown by arrow on pump casing. Motor should rotate clockwise when viewed from the motor fan. Note: Pump and driver rotate in opposite directions.
Insufficient flow or head rise.	Flow too high.	Check total head and flow rate against performance curve.
	Wrong direction of driver shaft rotation. (It is possible for the pump to develop greater than 50% design total head in this condition.)	Direction of driver shaft rotation must be as shown by arrow on pump casing. Motor should rotate clockwise when viewed from the motor fan. Note: Impeller and driver rotate in opposite directions.
	NPSH actually lower than NPSH requirement listed on specification sheet.	Refer to solutions listed under "No Flow, No Pressure at Start-Up".

Situation/Symptom	Possible Cause	Investigative/Corrective Action
	Flow too low, causing overheating of fluid resulting in internal boiling and unstable pump operation.	Increase through-flow rate. Bypass part of pump discharge to supply tank.
Insufficient flow or head rise. (continued)	Diffuser discharge throat partially plugged or impeller damaged by passage of a solid particle.	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.
	Corrosion and/or erosion of diffuser throat (may also be accompanied by corrosion/erosion of diffuser and cover surface adjacent to impeller).	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.
	Excessive recirculation from discharge to inlet.	Check flow through external piping. Integral centrifugal orifice worn.
	Process fluid specific gravity or viscosity different from values shown on specification sheet.	Check actual viscosity and specific gravity at operating temperature. Viscosity higher than five centipoise will cause reduced head and flow and increased power consumption.
	Driver speed too low.	Check speed against value listed on specification sheet.
	Pressure gauges or flow meters in error.	Calibrate instrumentation.
Driver Overloaded.	Fluid specific gravity or viscosity higher than values listed on specification sheet.	Check actual viscosity and specific gravity against value listed on specification sheet.
	Electrical failure in electric driver.	Check circuit breaker heater size and setting. Check voltage and voltage balance between phases. Current for each phase should be balanced within 3%.
	Mechanical failure in driver, gearbox or pump.	Remove driver and check for freedom of rotation of driver and gearbox shafts. Remove fluid end and inspect 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.
	Corrosion pitting on surface of diffuser cover or diffuser, adjacent to impeller blades. Head rise is also reduced by this condition.	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.
Excessive discharge pressure pulsations.	Flow rate too low.	Increase flow rate through pump. Add bypass to suction tank if necessary.
	Insufficient NPSH available.	Refer to solution for insufficient NPSH under "No Flow, No Pressure at Start-up" above.
	Defective flow control valve.	Check control valve.

Situation/Symptom	Possible Cause	Investigative/Corrective Action
Change of gearbox oil from normal color to milky pink or yellow.	Gearbox oil contaminated with water or process fluid.	Increase flow rate. 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.
Shaft sleeve rubs on inside diameter of seal.	Gearbox journal bearing failure.	Install replacement exchange gearbox or repair gearbox as outlined under "Maintenance".
Excessive gearbox oil consumption.	Low speed shaft seal (115) leakage.	Check upper gearbox housing lip seal drain port for leakage. Replace shaft seal if required.
	High-speed shaft mechanical seal (60C) leakage.	Check drain Port 1 for leakage. Replace shaft seal if required.
	Leakage through heat exchanger into cooling fluid.	Pressure test heat exchanger and replace if required.
Excessive oil foaming.	High oil level	Shut down the unit and check oil level.
	Low gearbox temperature. Incorrect lubricant.	Adjust coolant to heat exchanger, keeping oil temperature above 140°F, 60°C.
High gearbox temperature.	Heat exchanger fouled or coolant shut off. Oil level too high.	Check coolant flow and/or clean heat exchanger. Check oil level and adjust.

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

Situation/Symptom	Possible Cause	Investigative/Corrective Action
Sudden increase in seal leakage.	Severe cavitation or loss of suction causing vibration and bouncing of seal face.	Correct pump suction condition causing cavitation. Bleed vapor from seal cavity and restart. Install double seal if loss of suction cannot be prevented.
	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	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.

Situation/Symptom	Possible Cause	Investigative/Corrective Action
	Solid particles in seal cavity or seal spring area (seal faces usually have rough scratched appearance).	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.
	Seal stationary face spring action is rough and sticky.	If parts are corroded, replace with parts made from compatible materials. If formation of solids causes sticky seal analyze fluid properties. Use external seal flush or double seal arrangement.
	Worn or damaged seal.	Disassemble seal and rebuild or replace per instructions in maintenance section.
	Wear pattern on seal rotating faces not uniform.	Lightly lap surfaces of shaft sleeve and impeller hub which contact rotating seal face to remove high spots. Install new seal faces.
	Wear pattern on stationary face smooth but not uniform.	Lap flat or replace seal.
	Edges of stationary face chipped and seal face worn. (Vapor flashing in seal cavity will cause excessive wear and/or cracking of rotating face.)	Install seal cavity bypass to suction tank. Prevent loss of pump suction. Supply cool seal flush. Install double seal.
	Seal rotating face cracked or broken. May be caused by damage at assembly or thermal shock caused by seal running dry.	Prevent loss of pump suction or supply continuous external seal flush. Install double seal.
	Chemical attack of seal faces, seal parts or o-rings.	Investigate fluid properties and determine suitable materials for replacement.
	Excessive radial high speed shaft movement. Bent high speed shaft or severe out-of-balance.	Check high speed shaft journal bearings and replace if necessary. 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.
	Damage to mechanical seal secondary seal (Teflon® wedge or U-cup or elastomer o-ring).	Check for erosion and/or corrosion attack. Install seal flush or double seal arrangement.
	Loose stack-up of high-speed shaft attaching components.	Check for correct impeller bolt/inducer torque. Check for cold flow of Teflon® o-rings.

SPECIFICATIONS

Falk Steelflex Type Coupling Specifications

Table 3. Falk Steelflex Type Coupling Specifications

Falk Coupling Size	End Gap			Cover Bolt Torque
	Minimum	Normal	Maximum	
40T10	0.062 in. (1.57 mm)	0.125 in. (3.17 mm)	0.188 in. (4.77 mm)	100 in-lb (1.15 kg-m)
50T10	0.062 in. (1.57 mm)	0.125 in. (3.17 mm)	0.188 in. (4.77 mm)	200 in-lb (2.30 kg-m)

Falk Double Gear Type Coupling Specifications

Table 4. Falk Steelflex Type Coupling Specifications

Falk Coupling Size	End Gap			Operating Limits Total Indicator Reading		Bolt Torque
	Minimum	Normal	Maximum	Offset (Maximum)	Angular (Maximum)	
15G	0.140 in. (3.56 mm)	0.156 in. (3.96 mm)	0.172 in. (4.36 mm)	0.005 in. (0.127 mm)	0.005 in. (0.127 mm)	280 in-lb (3.22 kg-m)
20G	0.140 in (3.56 mm)	0.156 in. (3.96 mm)	0.172 in. (4.36 mm)	0.005 in. (0.127 mm)	0.005 in. (0.127 mm)	420 in-lb (4.83 kg-m)

Falk Double Gear Type-Vertical Specifications

Table 5. Falk Double Gear Type-Vertical Specifications

Falk Coupling Size	Operating Limits (Total Indicator Limit)		Bolt Torque
	Offset (Maximum)	Angular (Maximum)	
15GL 15GV	0.005 in. (0.127 mm)	0.005 in. (0.127 mm)	280 in-lb (3.22 kg-m)
20GL 20GV	0.005 in. (0.127 mm)	0.005 in. (0.127 mm)	420 in-lb (4.83 kg-m)

Thomas Type DBZ Coupling Specifications

Table 6. Thomas Type DBZ Coupling Specifications

Thomas Coupling Size	End Gap			Cover Bolt Torque
	Minimum	Normal	Maximum	
163	0.876 in. (22.24 mm)	0.938 in. (23.81 mm)	1.005 in. (25.41 mm)	156 in-lb (1.80 kg-m)
201	0.876 in. (22.24 mm)	0.938 in. (23.81mm)	1.005 in. (25.41 mm)	300 in-lb (3.46 kg-m)
226	1.126 in. (28.59 mm)	1.188 in. (30.18 mm)	1.251 in. (31.76 mm)	516 in-lb (5.95 kg-m)

Thomas SN Spacer Type Vertical & Horizontal Coupling Specifications

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

Thomas Coupling Size	Distance Between Hub Ends	Operating Limits Total Indicator Reading		Bolt Torque
	Nominal	Offset (Maximum)	Angular (Maximum)	
SN 163	0.95 in. (24.13mm)	0.005 in (0.127mm)	0.009 in (0.229mm)	
SN 201	0.96 in. (24.38mm)	0.006 in (0.152mm)	0.010 (0.254)	
SN226	1.22 in. (30.99mm)	0.007 in. (0.178mm)	0.012 in (0.304mm)	516 in-lb (5.95 kg-m)

Metastream Coupling Specifications

Table 8. Metastream Coupling Specifications

Metastream No.	Distance Between Hub Ends	Operating Limits Total Indicator Reading		Bolt Torque (ft-lb)
	Nominal	Axial Misalignment*	Lateral Misalignment**	
TSE1-0075-XXXX-0032	0.125 in. (3.2mm)	±.06 in. (±1.5mm)	±0.034 in. (±0.9 mm)	22 ft-lb (3.04 kg-m)
TSE1-0135-XXXX-0032	0.125in. (3.2mm)	±.08 in. (±2.0mm)	±0.037 in. (±1.0mm)	48 ft-lb (6.64 kg-m)
* 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

Field Engineering Bulletin

Bulletin No. 40.2.04

Sundyne & Sunflo & HMP Gearbox Lubricant Recommendations

EFFECTIVE: FEBRUARY 2009 Rev: G

For years the preferred gearbox lubricant for Sundyne pumps and compressors has been automotive 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:

Use ISO Viscosity Grade 32 Lubricant **	Use ISO Viscosity Grade 46 Lubricant
Models: LMV/BMP-31X* LMC/BMC-31XF* LMC-BMC-31X* LMV-32X* All Sunflo Gearboxes HMP-3000 HMP-5000 LF-2000 Pinnacle Compressors LMG-310L	Models: LMV/BMP-33X* LMC/BMC-33XF* LMC/BMC-33XP* LMC/BMC-33X* LMV/BMP-34X* LMC/BMC-34XF* LMC/BMC-34XP* LMC/BMC-34X* BMP-33X* BMP-34X* LMG-330L *** LMG-4 ***

*** 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

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Recommended ISO VG 32 gearbox lube oil specifications:

Gravity, API	28 - 37
Pour Point, °C (°F)	-7 (20) max.
Flash Point, °C (°F)	204 (400) min.
Viscosity, cSt at 40°C cSt at 100°C SUS at 100°F SUS at 210°F	 28.8 to 35.2 5.2 min. 150 to 180 44 min.
Viscosity Index	95 min.
ISO Viscosity Grade	32
Color, ASTM D 1500	1.5
Neutralization Number, Maximum	0.20
Rust Protection, ASTM D 665, A & B	Pass
Demulsibility, ASTM D 1401 Time to 0 ml emulsion at 54°C (130°F) after 30 min. at 82°C (180°F) after 60 min.	 Pass Pass
Foam Limits, ASTM D 892 Sequence 1 Sequence 2 Sequence 3	 25/0 max. 50/0 max. 25/0 max.

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

Recommended ISO VG 46 gearbox lube oil specifications:

Gravity, API	28 - 37
Pour Point, °C (°F)	-7 (20) max.
Flash Point, °C (°F)	204 (400) min.
Viscosity, cSt at 40°C cSt at 100°C SUS at 100°F SUS at 210°F	 41.4 to 50.6 6.5 min. 217 to 260 48.8 min.
Viscosity Index	95 min.
ISO Viscosity Grade	46
Color, ASTM D 1500	2.0
Neutralization Number, Maximum	0.25
Rust Protection, ASTM D 665, A & B	Pass
Demulsibility, ASTM D 1401 Time to 0 ml emulsion at 54°C (130°F) after 30 min. at 82°C (180°F) after 60 min.	 Pass Pass
Foam Limits, ASTM D 892 Sequence 1 Sequence 2 Sequence 3	 25/0 max. 50/0 max. 25/0 max.

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

Parts List

General

Assemblies, subassemblies and components of the Sundyne LMV-322 Process Pump are illustrated in the following exploded drawings and cross-sectional views. Refer to your Sundyne specification sheet for those options applicable to your pump. The corresponding parts lists, keyed to each part by item number, identify detailed parts by part name, quantity, and location.

Recommended Spares

Recommended spares are indicated in the quantity column by an asterisk (*) to the specific quantity. A double asterisk (**) designates recommended spare components of a mechanical seal, which may be stocked other than, or in addition to, the entire assembled seal. The quantity column and the indicated spares recommended are based on support of one pump unit.

The type and quantity of spare parts may vary with each application, depending upon equipment location, operating conditions, and the type of liquid being pumped. An available supply of recommended spares provides immediate replacement parts without costly downtime and keeps inventory requirements to a minimum. You can obtain assistance for planning an adequate supply of recommended spare parts from your Sundyne channel partner.

Gearbox Exchange

A gearbox exchange can be arranged for a fixed price. A replacement gearbox, completely tested and with a full one-year warranty, can be shipped from Sundyne to anywhere in the Continental United States within 48 hours after receipt of order in Arvada.

Repair Kits

Seal and o-ring repair kits are not illustrated herein, but may be purchased directly from the factory. The use of these kits reduces maintenance time, prevents assembly mistakes, simplifies stocking and inventory and reduces delivery time.

Ordering Replacement Parts

When ordering replacement parts, give the pump serial number and list each part by part number as shown on the Parts List which is included with each pump shipment (preferred method), or list each part by item number (as listed in this manual), part name and pump model. Specify quantities desired.

Order parts from your local Sundyne channel partner or directly from Sundyne Corporation at the address on the back cover.

Gearbox Replacement Parts

Table 10. Gearbox Replacement Parts

Item No.	Part Name	Qty.	Item No.	Part Name	Qty.
185	Gearbox Oil Filter	1	936N	O-ring Packing	2
115	Input Shaft Lip Seal	1	936T	O-ring Packing	2
105/936AG	Housing Gasket / O-ring	1	158 Series	Shim Spacers	As Required
936M	O-ring Packing	2	MP01AA10 (Spline only)	Anti-fretting Compound	Tube

Pump Disassembly Replacement Parts

Table 11. Pump Disassembly Replacement Parts

The following replacement parts will be required as a result of pump disassembly for maintenance as shown in this section:					
Item No.	**Part Name**	**Qty.**	**Item No.**	**Part Name**	**Qty.**
87A	Thermal Barrier Gasket	1	936G	• O-ring Packing	
RKORP322	O-ring Repair Kit for the Pump end consisting of:		936H	• O-ring Packing	
936A	• O-ring Packing		936J	• O-ring Packing	
936D	• O-ring Packing		936K	• O-ring Packing	
936E	• O-ring Packing		936P	• O-ring Packing	
936F	• O-ring Packing		936V	• O-ring Packing	
			936Z	• O-ring Packing	
See Seal Graphics	Technical Seal Repair Kits High Seal Rotating Faces:				
51A	• Single	1	936B	• O-ring Packing	1
51A/51B	• Tandem	2	936C	• O-ring Packing	1
51C	• Double	1			

Torque Specifications

Table 12. Gearbox and Pump Torque Values

Gearbox *Sundyne Standard Steel Screws & Bolts and NACE Compliant Steel Screws/Bolts (BG Material)*				
			Torque Values	
Item #	**Location**	**Size**	**English**	**Metric**
905H	Oil Filter Manifold	3/8 - 16 x 1/2	22 - 25 ft-lbs	30 - 34 N-m
905L	Gearbox Seal	1/4 - 20 x 1/2	75 - 80 in-lbs	8.5 - 9.0 N-m
905M, N	Journal Bearings	#10 - 24 x 1	35 - 40 in-lbs	4.0 - 4.5 N-m
905T	Chemical Barrier Gasket	1/4 - 20 x 5/8	75 - 80 in-lbs	8.5 - 9.0 N-m
909B	Gearbox Halves	1/2 - 13 x4	60 - 65 ft-lbs	81 - 88 N-m
909C	Gearbox Halves, Alignment	5/8 - 18 x 4 17/64	60 - 65 ft lbs	81 - 88 N-m
906B	Sight Glass	#8 - 32 x 1/2	10 - 12 in-lbs	1.0 - 1.4 N-m
*Pumps & Compressors** *Sundyne Standard Steel Screws and Bolts*				
			Torque Values	
Item #	**Location**	**Size**	**English**	**Metric**
3	Impeller Bolt/Inducer:			
	LMV/BMP-801, 802, 806, 322, 311, 331	1/2 - 20	36 - 40 ft-lbs	49 - 54 N-m
	LMV/BMP-341, 346	1/2 - 20	65 - 70 ft-lbs	88 - 95 N-m
	LMV-313, 343, BMP-338, 348 (High Flow)	3/4 - 10	85 - 90 ft-lbs	115-122 N-m
	LMC/BMC 3X1P, 3X1F, 3X3, 3X6P, 3X7	1/2 - 20	36 - 40 ft-lbs	49 - 54 N-m
906D	Diffuser Attaching Screws	1/4 - 20	95 - 102 in-lbs	11 - 11.5 N-m
905E	Mechanical Seal No. Spacer	1/4 - 20 x 12	95 - 102 in-lbs	11 - 11.5 N-m
905F	Throttle Bushing/Mechanical Seal	1/4 - 20 x 12	95- 102 in-lbs	11 - 11.5 N-m
905G	Double Seal with Spacer	1/4 - 20 x 3/4	95 - 102 in-lbs	11 - 11.5 N-m
914A	Case Nuts	3/4 - 10	250 - 275 ft-lbs	340 - 375 N-m
914A	Case Nuts	7/8 - 9	300 - 330 ft-lbs	405 - 445 N-m
905A	Seal Housing to Gearbox	3/8 - 16 x 1 3/4	35 - 40 ft-lbs	47 - 54 N-m
905P	Separator	1/4 - 20 x 5/8	95 - 102 in-lbs	11 - 11.5 N-m
Pumps & Compressors *NACE Compliant Steel Screws / Bolts (BG Material)*				
			Torque Values	
Item #	**Location**	**Size**	**English**	**Metric**
3	Impeller Bolt/Inducer:			
	LMV/BMP-801, 802, 806, 322, 311, 331	1/2 - 20	36 - 40 ft-lbs	49 - 54 N-m
	LMV/BMP-341, 346	1/2 - 20	65 - 70 ft-lbs	88 - 95 N-m
	LMV-313, 343, BMP-338, 348 (High Flow)	3/4 - 10	85- 90 ft-lbs	115 - 122 N-m
	LMC/BMC 3X1P, 3X1F, 3X3, 3X6P, 3X7	1/2 - 20	36 - 40 ft-lbs	49 - 54 N-m
906D	Diffuser Attaching Screws	1/4 - 20	70 - 75 in-lbs	8.0 - 8.5 N-m
905E	Mechanical Seal No. Spacer	1/4 - 20	70 - 75 in-lbs	8.0 - 8.5 N-m
905F	Throttle Bushing/Mechanical Seal	1/4 - 20	70 - 75 in-lbs	8.0 - 8.5 N-m
905G	Double Seal with Spacer	1/4 - 20	70 - 75 in-lbs	8.0 - 8.5 N-m
914A	Case Nuts	3/4 - 10	160 - 200 ft-lbs	217 - 270 N-m
914A	Case Nuts	7/8 - 9	225 - 245 ft-lbs	305 - 332 N-m
905A	Seal Housing to Gearbox	3/8 - 16 x 1 3/4	27 - 30 ft-lbs	37 - 40 N-m
905P	Separator	1/4 - 20 x 5/8	70 - 75 in-lbs	8.0 - 8.5 N-m

* 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.

Figure 12. Exploded View Drawing

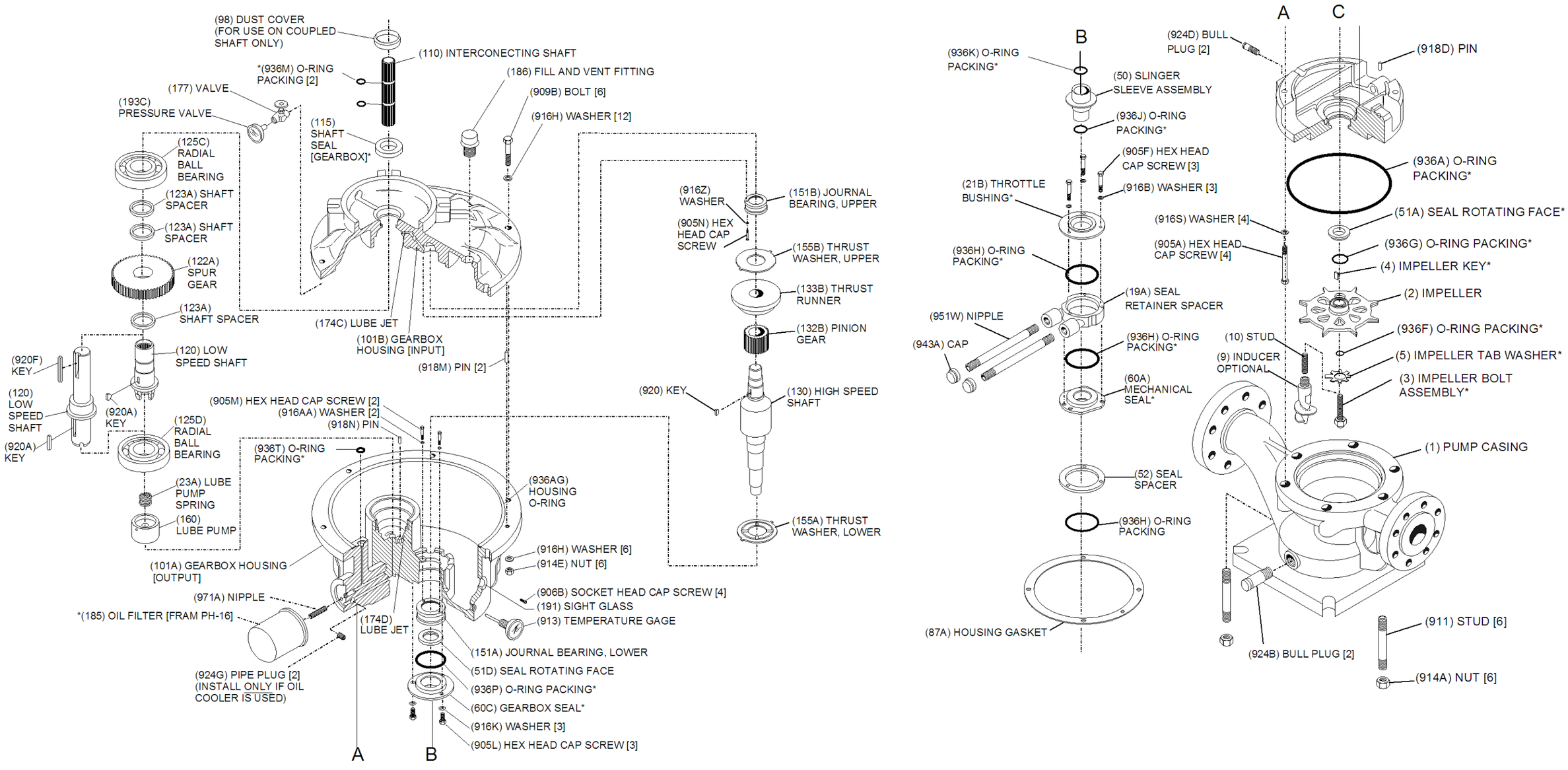
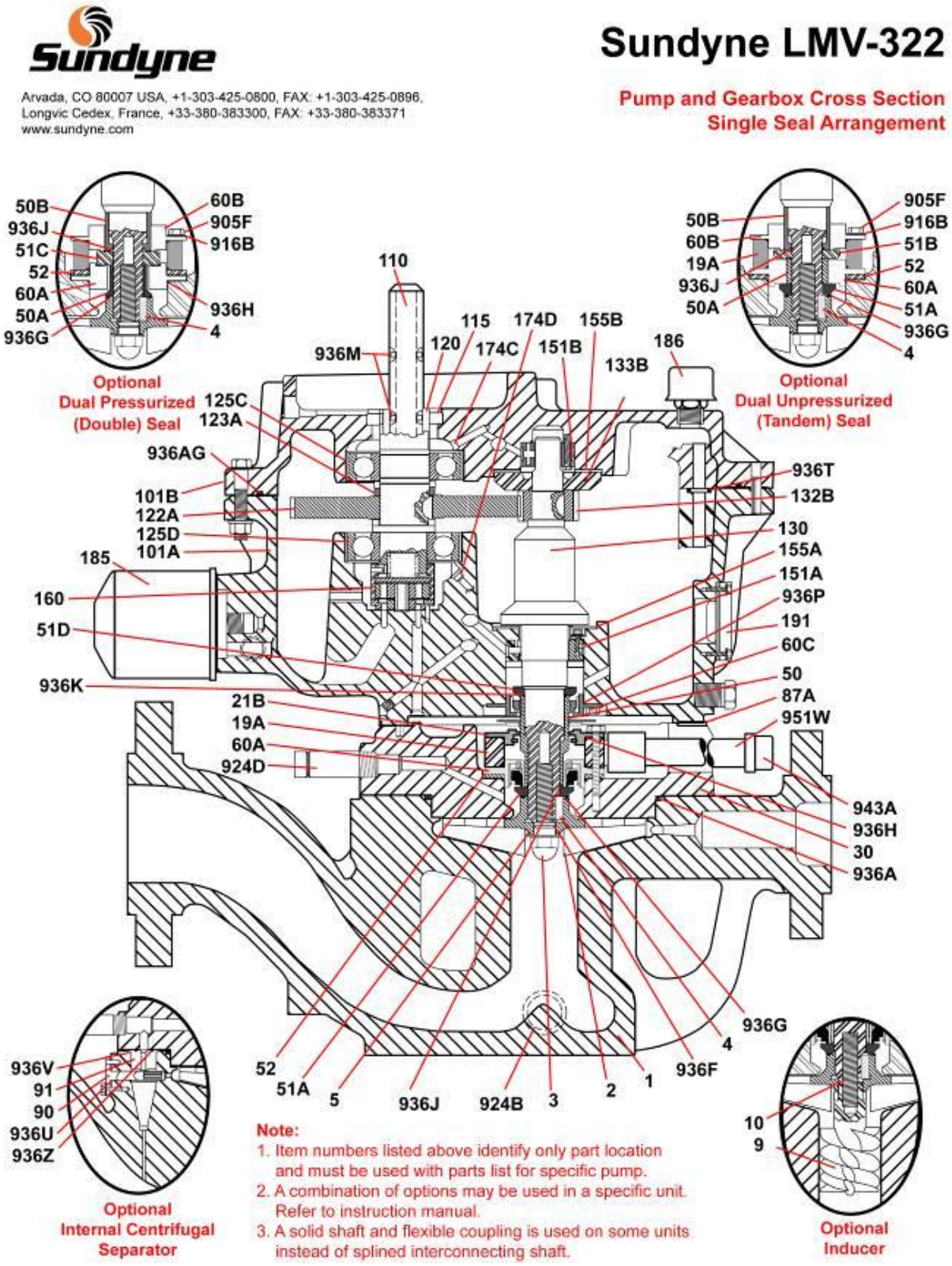
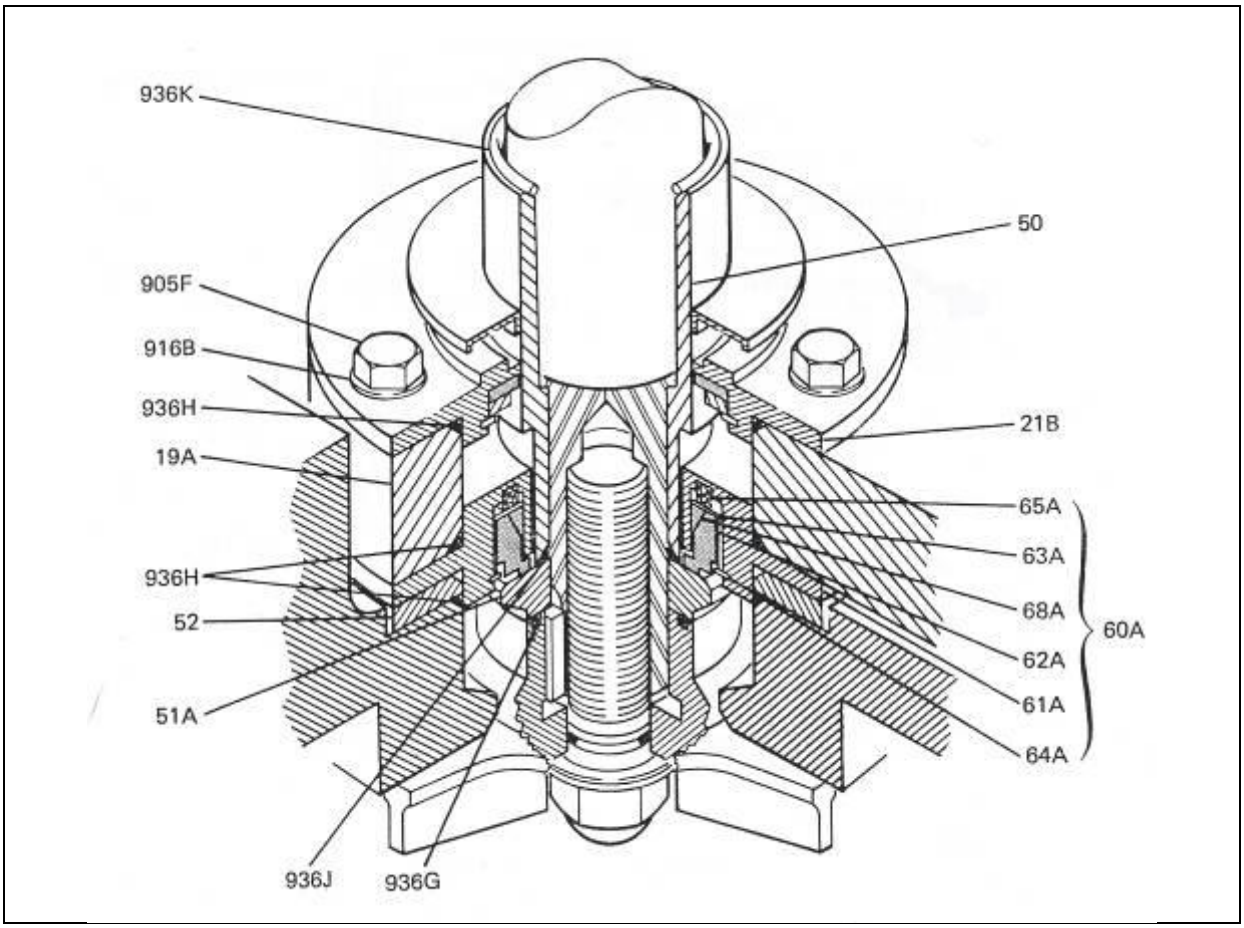


Figure 13. LMV-322 Cross Sectional Drawing



Single Seal Arrangement

Figure 14. Single Seal Arrangement

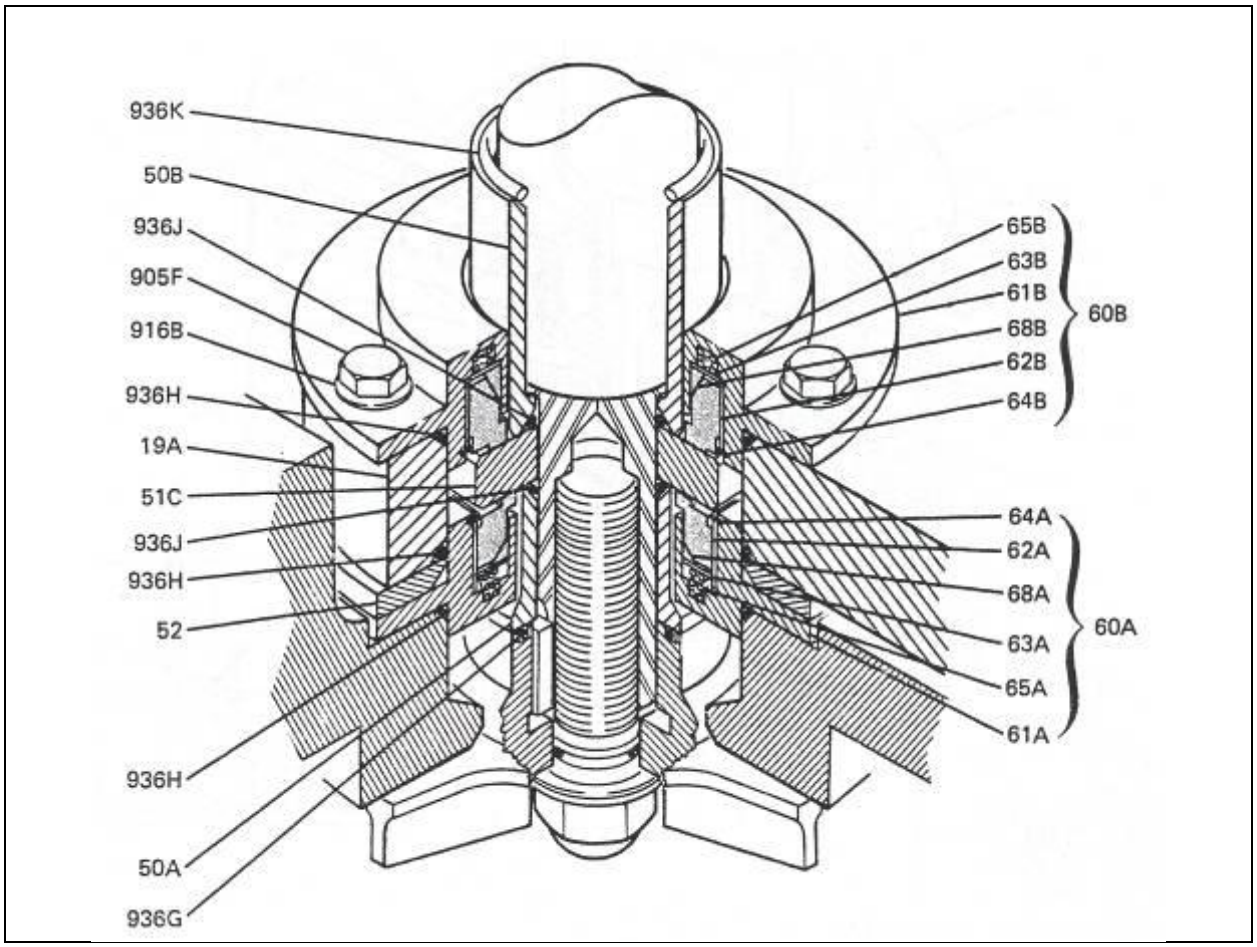


Item Name	Part Name	Qty.	Item Name	Part Name	Qty.
19A	Seal Retaining Spacer	1	905F	Hex Head Cap Screw	3
21B	Throttle Bushing	1	916B	Washer	3
50	Slinger Sleeve	1*	936H	O-Ring Packing	3*
51A	Seal Rotating Face	1*	936G	O-Ring Packing	1*
52	Seal Spacer	1	936H	O-Ring Packing	3*
60A	Mechanical Seal (Pump Lower)	1*	936J	O-Ring Packing	1*
61A	- Retainer & Drive Sleeve Assembly	1	936K	O-Ring Packing	1*
62A	-Seal Face Washer	1**			
63A	-Seal Spring Backup Disc	1**			
64A	-Seal Retaining Ring	1**			
65A	-Seal Spring	6**			
68A	-Seal Wedge Ring***	1**			

* Recommended Spare Parts
** Recommended Seal Space Component Parts
*** Specific to Type 9AB Seal Design

Double Seal Arrangement

Figure 15. Double Seal Arrangement

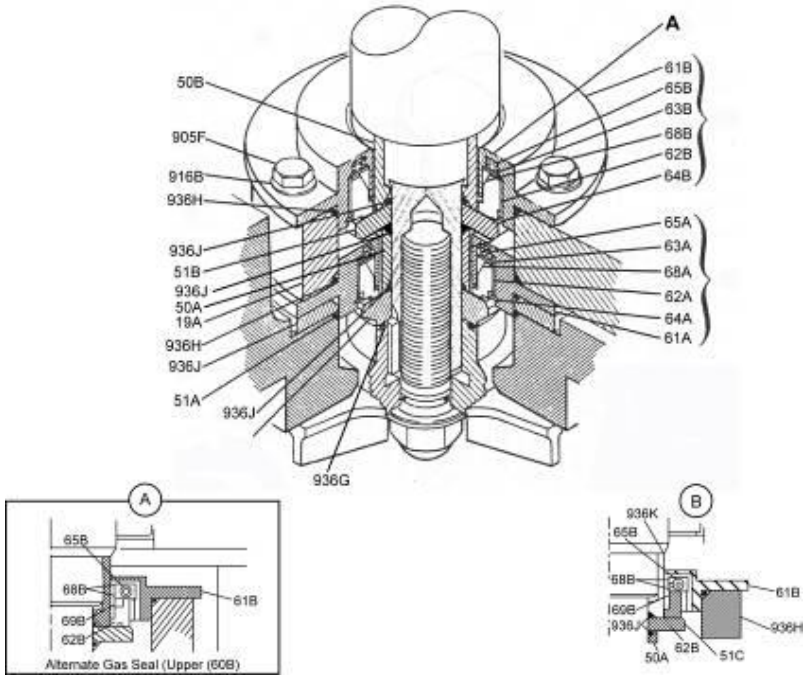


Item Name	Part Name	Qty.	Item Name	Part Name	Qty.
19A	Seal Retaining Spacer	1	60B	Mechanical Seal (Upper)	1*
50A	Shaft Sleeve (Lower)	1	61B	- Retainer & Drive Sleeve Assy.	1
50B	Shaft Sleeve (Upper)	1*	62B	- Seal Face Washer	1**
51C	Seal Rotating Face	1*	63B	- Seal Spring Backup disc	1**
52	Seal Spacer	1	64B	- Seal Retaining Ring	1**
60A	Mechanical Seal (Lower)	1*	65B	- Seal Spring	6**
61A	- Retainer & Drive Sleeve Assy.	1	68B	- Seal Wedge Ring***	1**
62A	- Seal Face Washer	1**	905F	Hex Head Cap Screw	3
63A	- Seal Spring Backup Disc	1**	916B	Washer	3
64A	- Seal Retaining Ring	1**	936G	O-Ring Packing	1*
65A	- Seal Spring	6**	936H	O-Ring Packing	3*
68A	- Seal Wedge Ring***	1**	936J	O-Ring Packing	2*
			936K	O-Ring Packing	1*

* Recommended Spare Parts
** Recommended Seal Space Component Parts
*** Specific to Type 9AB Seal Design

Tandem Seal Arrangement

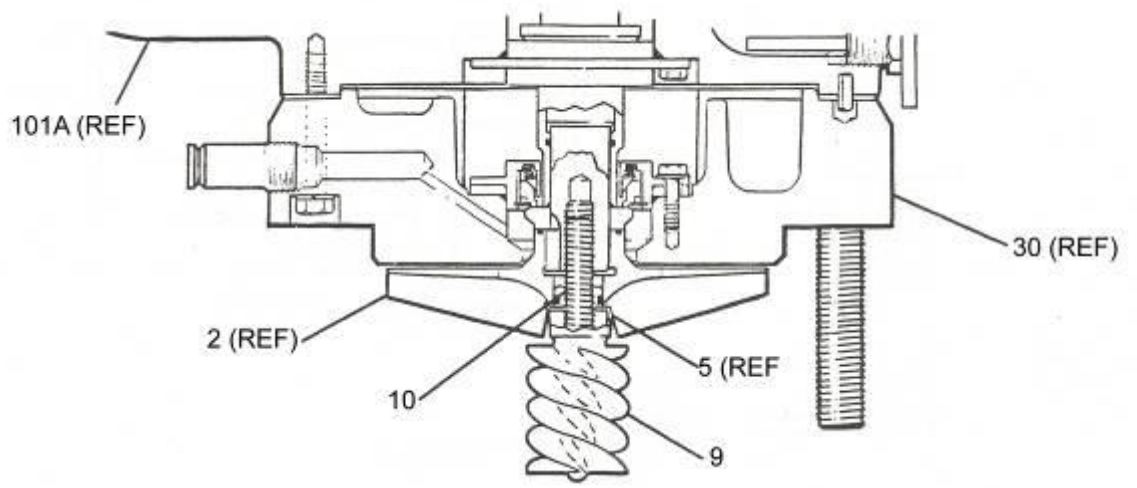
Figure 16. Tandem Seal Arrangement



Item Name	Part Name	Qty.	Item Name	Part Name	Qty.
19A	Seal Retaining Spacer	1	63A	- Seal Spring Backup disc	1**
50A	Shaft Sleeve (Lower)	1	64A	- Seal Retainer Ring	1**
50B	Shaft Sleeve (Upper)	1*	65A	- Seal Spring	6**
51A	Seal Rotating Face	1*	68A	- Seal Wedge Ring***	1**
51B	Seal Rotating Face	1*	60B	Mechanical Seal (Upper Alternate Gas)	1*
51C	Seal Rotating Face	1*	61B	- Seal Retainer	1**
52	Seal Spacer	1	62B	- Seal Face Washer	1**
60A	Mechanical Seal (Lower)	1*	65B	- Garter Spring	1**
61A	- Retainer & Drive Sleeve	1	68B	- Backing Ring	2**
62A	- Seal Face Washer	1**	69B	- O-Ring Packing or Tec Seal	1**
63A	- Seal Spring Backup Disc	1**	905F	Hex Head Cap Screw	3
64A	- Seal Retainer Ring	1**	916B	Washer	3
65A	- Seal Spring	6**	936G	O-Ring Packing	1*
68A	- Seal Wedge Ring***	1**	936H	O-Ring Packing	3*
60B	Mechanical Seal (Upper)	1*	936J	O-Ring Packing (2 pc seal requires 3)	2*
61B	- Retainer & Drive Sleeve Assy.	1**	936K	O-Ring Packing	1*
62B	- Seal Face Washer	1**			

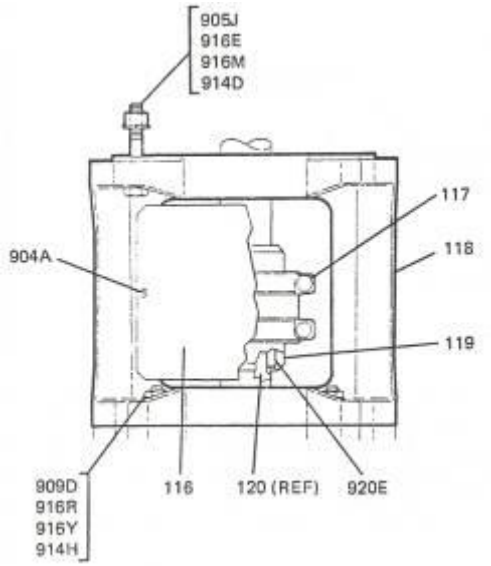
* Recommended Spare Parts
** Recommended Seal Space Component Parts
*** Specific to Type 9AB Seal Design

Figure 17. Inducer and Inducer Stud



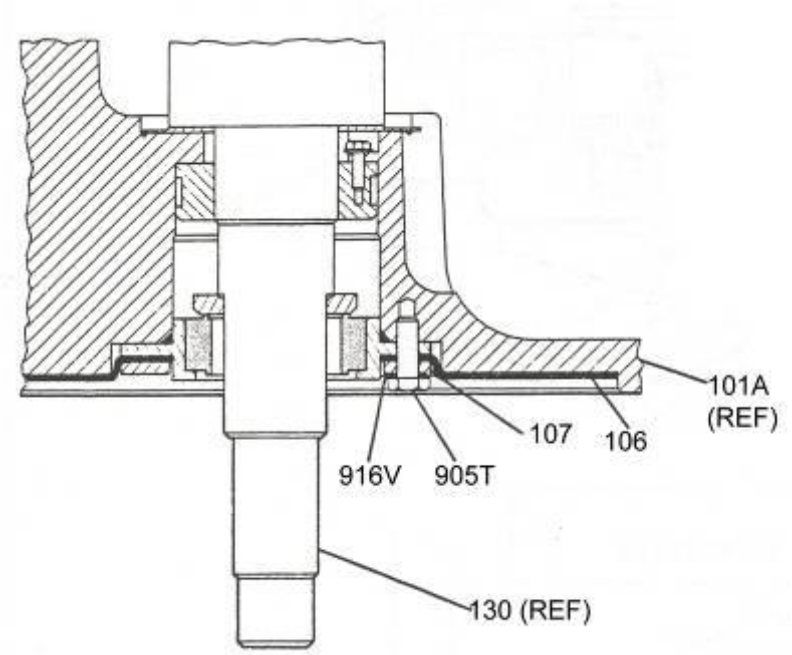
Item Name	Part Name	Qty.
9	Inducer	1
10	Inducer Stud	1

Figure 18. Flexible Coupling Adapter



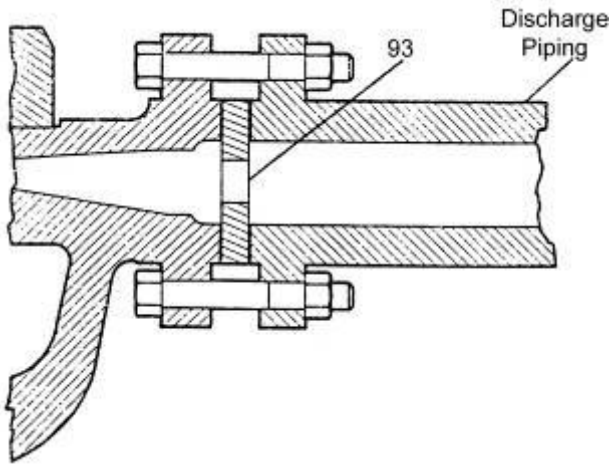
Item Name	Part Name	Qty.
116	Coupling Housing Cover	1
117	Input Coupling	1
118	Coupling Housing	1
119	Hub	1
904A	Screw	4
905J	Hex Head Cap Screw	4
909D	Bolt	4
914D	Nut	4
914H	Nut	4
916E	Washer	4
916M	Washer	4
916R	Washer	4
961Y	Washer	4
920E	Key	1

Figure 19. Chemical Barrier Gasket



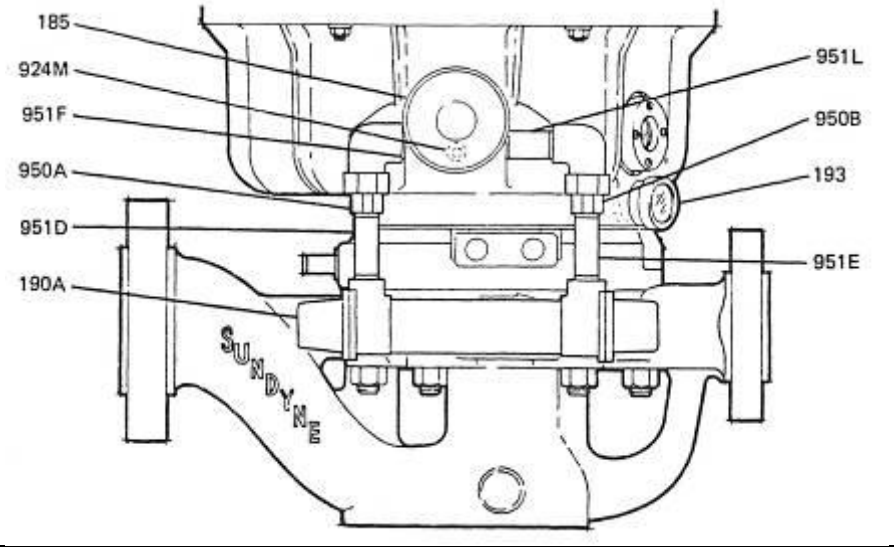
Item Name	Part Name	Qty.
106	Chemical Barrier Gasket	1*
107	Seal Spacer	1
905T	Hex Head Cap Screw	3
916V	Seal Washer	3*
* Recommended Spares		

Figure 20. Discharge Orifice



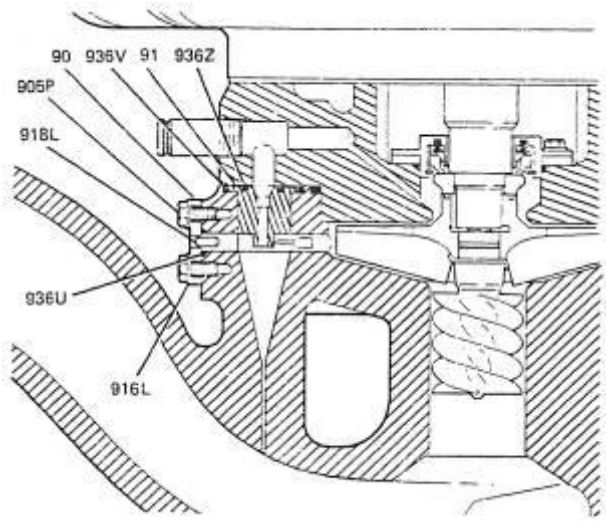
Item Name	Part Name	Qty.
93	Discharge Orifice	1

Figure 21. Heat Exchanger Option



Item Name	Part Name	Qty.	Item Name	Part Name	Qty.
185	Oil Filter	1	950B	Elbow, Female Union	1
190A	Heat Exchanger	1	951D	Nipple	1
193	Temperature Gage	1	951E	Nipple	1
924M	Pipe Plug	1	951F	Nipple	1
950A	Elbow, Female Union	1	951L	Nipple	1

Figure 22. Centrifugal Separator



Item Name	Part Name	Qty.
90	Separator Orifice	1
91	Separator Fitting	1
905P	Hex Head Cap Screw	2
916L	Washer	2
918L	Pin (Alignment)	1
936U	O-Ring Packing	1*
936V	O-Ring Packing	1*
936Z	O-Ring Packing	1*
*Recommended Spares		

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