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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.
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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.

**Note:** 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:** OSHA regulations require that safety glasses are used when hazardous material is involved. Always wear appropriate safety glasses. If handling hazardous materials, always wear rubber gloves. Keep them handy and use them often.

**Note:** 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.

**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
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.
INTRODUCTION

This manual presents installation, servicing, troubleshooting, maintenance and spare parts information for the latest configuration of Sundyne LMV-333.

Parenthetical numbers included in the text correspond to item numbers on the illustrated figures. The item number of a part is based on the part's function, and the correct spare part can be ordered for any pump by referencing the item number and serial number.

Information that may be required regarding performance, alterations, or detailed technical data which is not included herein, may be found in the specification sheet and parts list accompanying the unit, or may be obtained from your Sundyne Corporation representative. Reference the pump serial number in any communication with the factory. Custom-made auxiliary equipment cannot be shown in this manual. Refer to the outline drawing for specifics.

I. INSTALLATION

1. INSPECTION
   Check visually for shipping damage. If damage is found, notify the carrier and Sundyne Corporation promptly.

2. STORAGE
   If the pump is not to be installed immediately:
   A. Protect from exposure to moisture and dust.
   B. Shipping cover and pipe plugs must be kept in place.
   C. Consult your Sundyne representative if storage time will exceed six months.
   D. For driver storage (motor or turbine), observe manufacturer’s instructions.

3. LONG-TERM STORAGE
   Certain long-term considerations should be met for any Sundyne pump which will not be operating for a period of time exceeding six months from date of factory shipment. This action will insure minimum corrosion damage to the gearbox and fluid-end components. Because of storage location and other unknown site factors beyond our control, Sundyne Corporation will not accept any liability for damage to the equipment during the storage period, nor does Sundyne Corporation guarantee the condition of the equipment during and after the storage period.
   To insure the original quality of the Sundyne pump prior to commissioning after storage, all components must be inspected by an authorized Sundyne service engineer. Any components not of Sundyne manufacture (except mechanical seals) must be inspected by that particular submanufacturer’s authorized service personnel. The cost of such service personnel and any component replacement will be at the purchaser’s expense.
   Factors which affect the quality of an uninstalled Sundyne pump are the humidity/temperature and the chemicals in the atmosphere surrounding the equipment. The method employed for long-term storage should prevent the humidity/temperature and airborne chemicals from making contact with the internal components of the equipment.
   When the equipment is to be stored in strong chemical environments or near salt water, protection should be executed immediately upon receipt of the equipment.
   Following is the Sundyne preferred list of recommended long-term storage procedures:
   A. Indoor, climate controlled building (maintains constant temperature and humidity).
   B. Inert gas purging of the component internals.
   C. Oil flooding of component internals.
   D. Desiccant bags.
   Because long-term storage of equipment is of a highly critical nature, it is recommended that Sundyne be contacted to provide more details on the above procedures.

4. SUCTION AND DISCHARGE PIPING
   A. Suction piping should have as few restrictions as possible to avoid NPSH losses and to provide the NPSH required as listed on the spec sheet.
B. A suction strainer is recommended to protect the impeller from damage by mill scale, weld slag, or other foreign particles. A cone shaped strainer with ¼ inch (6.35 mm) holes is preferred. For initial start-up, a screen with mesh openings of .060 inch (1.524 mm) can be attached over the cone then removed after the system is clean. Use caution not to run the pump with a clogged strainer.

C. A discharge check valve should be used if reverse flow is likely during shutdown.

Never leave the suction block valve closed with the discharge block valve open.

5. SEAL ENVIRONMENTAL CONTROL SYSTEM

Depending upon the pump seal arrangement and application, a seal environmental control system may be required.

A. Refer to the specification sheet and outline drawing to determine the seal arrangement and system requirements.

B. Many sealing options exist. Consult your Sundyne representative if alternatives are required.

6. GEARBOX HEAT EXCHANGER

A. The standard heat exchanger is a shell and tube water-cooled type.

B. Cool water should be provided at 150 psig (11 kg/cm²) maximum pressure. Coolant flow should be controlled to maintain a gearbox sump temperature between 140°F to 200°F (60°C to 93°C).

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

NOTE

Refer to the outline drawing for heat exchanger mounting configuration. The assembly should not be rearranged without consulting the factory. THE HEAT EXCHANGER IS NEVER MOUNTED HIGHER THAN THE GEARBOX MANIFOLD.

D. For more detail refer to section “II. LUBE SYSTEM”.

7. DRIVER AND COUPLING

Drivers are normally shipped separately from the gearbox and compressor. 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. See Section “IV. SERVICING” for further coupling information.

Drivers are to be installed and maintained in accordance with the manufacturer’s instructions.

8. LOCATION

The installation should provide clearance on either side for removal and service. Overhead clearance must be provided for lifting out the driver or gearbox assembly.

9. MOUNTING

The vertical motor stand should be mounted on a rigid concrete foundation, secured in position by 7/8-inch diameter bolts and grouted in place. The bolts should be installed in the foundation as shown on the outline drawing. The length of the bolts should be sufficient to extend at least ¼ inch above the nut. The base mounting pads should be leveled prior to grouting. Grout must be allowed to set for at least 48 hours before tightening foundation bolts. Customer shall provide a 4” x 4” x ¼” thick steel plate under each leveling screw.

10. ALIGNMENT

A. Spline driven units do not require alignment.

B. For units driven by flexible couplings, refer to section “IV. SERVICING”.

11. PIPING CONNECTIONS

A. Drain lines from the seal housing ports may be necessary. Refer to the outline drawing for port usage.

B. Port number 1 (shown in Figure 4) must always be open to atmosphere or piped to safety drain or flare with a backpressure not exceeding 7 psi (0.49 kg/cm²).

12. DIFFUSER CAVITY VENT

The diffuser cavity vent must be open to atmosphere or to a safety drain with no back pressure. See figure “Wet End Components” for location.

Note: Process fluid may accumulate causing a potentially hazardous situation if the diffuser cavity is not properly vented.
II. LUBE SYSTEM

DESCRIPTION

The integral Sundyne lube oil system consists of the following major components: gearbox sump, main lube pump, oil heat exchanger and oil filter. Oil is taken from the sump by the lube pump, then passed through internal passages to an externally mounted manifold through the heat exchanger, then through the filter, and back into the gearbox to the bearings. After passing through the bearings, the oil drains back to the sump.

The gearbox sump holds approximately seven U.S. quarts (6.6 liters) of oil not including auxiliary piping and heat exchanger. The oil level should always be maintained within the black circle in the sight glass. DON'T overfill gearbox as this will cause excessive foaming and overheating.

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

The standard heat exchanger is a shell and tube water cooled type mounted on the gearbox manifold. Cold water should be provided at 150 psig (11 kg/cm²) maximum pressure. See the specification sheet for cooling water requirements. Coolant flow should be controlled by a hand valve installed in the cooling fluid discharge line to maintain a gearbox sump temperature between 140°F to 200°F (60°C to 93°C). Approximately one hour may be required to stabilize temperature.

The oil filter is a disposable pleated paper element type. Gearbox oil and filter should be changed every six months. See Figure 3 for oil specifications.

1. OPTIONAL LUBE OIL SYSTEM AUXILIARIES

A. LUBE OIL PRIMING KIT

This prelube system is mandatory on some LMV-333 pumps. The kit consists of a motor driven positive displacement pump, check valve, gauges, and necessary piping. To start pump, operate the prelube pump at least 30 seconds with a minimum of 5 psig (0.35 kg/cm²) indication prior to starting the main driver. (If oil piping has been drained several minutes operation is suggested to allow trapped air to bleed from the system.

The prelube pump is to shutdown only after main driver is at full operating speed.

B. REMOTE HEAT EXCHANGER

Some large water cooled and all air cooled heat...
exchangers are mounted away from the gearbox. Except for packaged units, the interconnecting piping is the purchaser's responsibility. The heat exchanger must be mounted lower than the oil manifold; otherwise, air pockets may be present in the lube oil lines at start-up, causing oil starvation at the bearings. Equivalent length of piping and fittings must not exceed 20 feet (6 m), using a minimum of \( \frac{3}{8} \) inch (16 mm) I.D. tubing or pipe. If greater pipe lengths are required, pipe diameter must be increased accordingly.

A \( \frac{3}{8} \) INCH SOCKET-HEAD PIPE PLUG IN THE FILTER MANIFOLD IS REQUIRED WHEN USING THE GEARBOX HEAT EXCHANGER. THIS PLUG MUST BE REMOVED WHEN THE HEAT EXCHANGER IS NOT USED.

THE HEAT EXCHANGER INSTALLATION IS A SUNSTRAND FLUID HANDLING ASSEMBLY AND SHOULD NOT BE REARRANGED. THE HEAT EXCHANGER IS NEVER MOUNTED HIGHER THAN THE FILTER.

![Heat Exchanger Mounting Diagram](image)

**Figure 2. Heat Exchanger Mounting**

**C. GEARBOX SUMP HEATER**

A sump heater is required when ambient temperatures may fall below the temperature at which the gearbox oil becomes too viscous for proper lube pump operation. Both steam and electric sump heaters are available. The lube oil priming kit must be operated to circulate oil around the heater when the main drive motor is not running.

**2. OIL PRESSURE**

Depending upon the bearing configuration and the characteristics of the lube oil used, the gearbox internal lube pump will maintain oil pressure between 15 and 60 psig (1.0 and 4.2 kg/cm²) during normal operation. The gearbox should never be operated with less than 10 psig oil pressure.
III. STARTING

A. START-UP PROCEDURES

Perform the following tasks to start the Sundyne pump.

1. Run-in or 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 insure that the run-in conditions are compatible with the pump.

2. Check to insure that the driver has been serviced according to instructions provided by the driver manufacturer.

Check driver rotation prior to start. Driver rotation must be in the direction of cast-in arrow on the pump case. Rotation in reverse direction will result in bearing damage.

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 spec sheet and outline drawings for seal environment requirements. Be sure housing port piping is properly connected. If double seals are used, buffer fluid must be pressurized before suction pressure is applied to the pump.

6. Check to ensure the diffuser cavity vent is vented.

7. Remove the gearbox fill-vent plug and the filter breather cap from the fill fitting on the gearbox. Fill the reservoir with clean lubricating oil (see section “IV. SERVICING”, Figure 3 for oil specifications) until the fluid level is at the top of the black circle in the sight glass. Lube system capacity will vary with the heat exchanger and piping configuration. The gearbox holds approximately 7 quarts (6.6 liters). Replace the filter breather cap on the fill opening fitting and replace the fill-vent plug. If a

prelube pump is not used, remove the plug on top of the oil filter manifold and fill the oil filter and heat exchanger with oil.

8. If an auxiliary lube pump is installed, operate the pump to fill the heat exchanger and filter. Add oil as necessary through the fill fitting until the oil level stabilizes in the sight glass.

9. If no auxiliary lube pump is used, jog the main driver until oil pressure is observed on the pressure gauge. This should occur by the second or third jog of 2-3 seconds duration.

Never start the pump against a closed discharge valve. Always check to insure that the discharge valve is partially open.

10. If an auxiliary lube system is installed, it should be used in the following manner:

A. At the initial start-up or after changing the lube oil, run the pump for several minutes to work any trapped air out of the piping. Adjust the relief valve on the auxiliary pump to provide 25 psi (1.76 kg/cm²) oil pressure to the system.

B. The auxiliary system is intended to provide oil before starting the main driver. It should run for a minimum of 30 seconds maintaining an oil pressure of 5 psig before the main driver is started. Pressure switches and time delays can be used if automatic start sequences are desired.

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

11. Adjust the heat exchanger cooling flow to regulate the gearbox sump temperature between 140° and 200°F (60° and 93°C). Approximately one hour may be required to stabilize the temperature.
B. PUMP CONTROL DURING START-UP
Refer to Section “V. OPERATION AND CONTROL” for more detail.

1. SINGLE UNITS
   A. Start pump with the suction valve open while throttling the discharge valve to bring the pump to the design flow operating point.
   B. If the process fluid is near boiling, a seal cavity vent back to the supply vessel may have to be opened to fill the pump with liquid.

2. PARALLEL OPERATION
   Check valves must be placed in the discharge piping of each pump to prevent back-flow. It is advantageous to install separate bypass loops around each pump for additional operational flexibility.
   A. Start first unit as described above for single units.
   B. Start second unit on bypass and maintain flow. Open discharge valve on second unit and maintain the design flow of both units. It is preferable that the units not operate at their peak head capability.
   C. Separate flow controls on each pump are recommended and provide a lower minimum flow range than can be achieved by pressure control.

C. CRITICAL START-UP CHECK LIST

1. KNOW YOUR MACHINE
   Prior to servicing and start-up of the Sundyne pump, carefully review the specification sheet, outline drawing, performance curves, and the instruction manual. It is important you become familiar with the pump configuration before starting and operating the pump.

2. DRIVER INSTRUCTIONS
   Follow installation and starting instructions of the driver manufacturer.

3. GEARBOX SERVICING
   Fill gearbox to the top of the black circle in the sight glass with lube oil which conforms to the specifications in Figure 3. Operate auxiliary lube pump to fill heat exchanger and filter. Add oil as necessary, approximately seven U. S. quarts (6.6 liters) through fill fitting until oil level stabilizes in sight glass.

4. ENVIRONMENTAL CONTROL SYSTEM
   Install seal environmental control system, if required, and drain piping.

5. PRESSURIZE FLUID LOOP
   Pressurize double seal buffer loop or external seal flush, if required, prior to admitting fluid into pump casing.

6. MOTOR ROTATION
   Rotation must be in same direction as arrow stamped on pump casing.

7. START PUMP
   Start pump with suction valve completely open while throttling discharge valve, to bring pump to design operating point.

8. HEAT EXCHANGER
   Adjust cooling flow to maintain gearbox sump temperature of 140° to 200°F (60° to 93°C).

9. CHECK
   Check total head, flow rate, and power consumption against pump specification sheet. Check that specific gravity, viscosity and NPSH are in accordance with specification sheet. These conditions will significantly alter performance of the pump.

10. DIFFUSER CAVITY VENT
    Ensure diffuser cavity vent is open. (Plug must be removed).

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Note: Process fluid may accumulate causing a potentially hazardous situation if diffuser cavity vent is not properly vented.
IV. SERVICING

GENERAL

The normal operating routine, including both minor and major overhaul intervals, depends to a great extent upon the service and duty cycle of the pump. The operating life of any piece of machinery is, under normal circumstances, determined by the careful and proper actions of the operator. All operating parameters should be frequently observed and logged. Any deviation from normal operating values should be investigated immediately to determine the cause, and corrective measures taken where necessary.

In addition to the major equipment, all lube pumps, heat exchangers, instrumentation, etc. must be checked periodically for correct performances per manufacturer's recommendations.

Specifically, the following items should be serviced at the intervals indicated. See Figure 6 for location of service check points.

1. GEARBOX OIL LEVEL

The oil level should be checked prior to initial start-up, and periodically thereafter. The fluid level must be maintained within the black circle in the sight glass. Oil may be added while the pump is in operation.

Overfilling the gearbox will cause excess foaming and overheating.

2. OIL PRESSURE

Depending upon the bearing configuration and the characteristics of the lube oil used, the gearbox

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The following lube oil specifications must be met by any oil used in Sundyne gearboxes:

- Gravity, API: 29.5 nominal
- Viscosity, SSU @ 100°F: 165-236 @ 210°F: 40-46
- Viscosity index: 90 minimum
- ISO Viscosity Grade: 32, 46
- Flash Point, °F: 360 minimum
- Pour Point, °F: -20 maximum
- Rust Test, ASTM D-665, Procedure B: Pass
- Oxidation Test, ASTM D-943, hours to 2.0 neutralization number: 2000
- EP Additive: Present
- Foam Limits, ASTM D-892 milliliters
  - Maximum, Sequence 1: 25/0
  - Maximum, Sequence 2: 50/0
  - Maximum, Sequence 3: 25/0

Note: No additional additives are recommended.

In general, 10 weight turbine oils and automatic transmission fluid (ATF) will meet these specifications. Properties should be verified by oil manufacturer prior to use. Some synthetic oils are suitable for use. Turbine oil viscosity usually changes less with use than ATF and would be preferred for most gearboxes.

Figure 3. Lube Oil Specifications
internal pump will maintain oil pressure between 15 and 60 psig (1.0 and 4.2 kg/cm²) during normal operation. A gearbox should never be operated with less than 10 psig oil pressure.

3. GEARBOX OIL AND FILTER CHANGE

Oil in the gearbox and the oil filter should be changed every six months.

4. SEAL LEAKAGE

Seal leakage out of port 1 should be checked periodically. Seals should be replaced if leakage increases to an unacceptable level. With double seals, buffer pressure and usage should be monitored to insure that seals are functioning properly. For specific seal information, please contact your factory or your local Sundyne representative.

5. ANTIFRICTION BEARINGS

Antifriction ball bearings on the gearbox idler shaft and low speed shaft should be replaced after three years, or whenever the unit is being overhauled.

Care must be exercised to insure that the correct replacement bearings are installed. Incorrect replacement bearings will jeopardize mechanical integrity of the unit. Replacement bearings should be purchased from Sundstrand to insure proper quality and fit.

6. DRIVER

Refer to driver manufacturer's specifications.

7. COUPLING

If a flexible coupling is used (see pump specification sheet), refer to the manufacturer's service recommendations.

8. FLEXIBLE COUPLING INSTALLATION AND SERVICING

For units without a motor stand proceed with sub-
FOR DRIVER AND COUPLING DETAIL WHEN VERTICAL MOTOR STAND IS
USER, REFER TO SECTION "VII. MAINTENANCE"

Figure 6. Service Check Points
(b) From Table 1 or 2, determine the end gap (distance between coupling hubs) for the size of coupling provided.

(c) Subtract the end gap value from the "X" dimension to determine the distance from the driver datum face to the coupling hub face ("Y" dimension - Figure 7). Scribe the shaft to show the "Y" dimension.

![Figure 7. Driver Coupling Hub](image)

(d) Make sure the coupling hub bore, keyways, and shaft are clean, free from burrs, and that the key will fit in the keyways. Heat the hub in an oil bath or oven to approximately 250°F (121°C), or more if necessary, so the hub will slide onto the motor shaft. Position the hub at the scribed line on the shaft.

NOTE

On Thomas couplings, before the hub is installed check to see if it is possible to assemble the coupling bolts and washers (Figure 12) from the motor side of the hub when installed. If this is not possible, assemble the short bolts with bevel washers into the hub flange before fitting it onto the shaft.

(5) Falk Steelflex Installation Instructions

(a) The driver adaptor has coupling guard plates which must be removed and stored while installing coupling. (See Figure 5.)

NOTE

The coupling seals should have a light coating of grease before installation and assembly. When mounting or remounting the coupling hub, for any reason, always put the seal ring on the gearbox or driver shaft first. Then install the coupling hub. The coupling will not seal properly if these rings are omitted (Figure 8).

![Figure 8. Falk Steelflex Coupling](image)

(b) Mount the driver on the driver adaptor and tighten the attaching bolts.

(c) From Table 1, determine the end gap (distance between coupling hubs) for the size of coupling provided.

(d) Using a feeler gauge, check the actual end gap (Figure 9) to verify that it is within the limits given in Table 1. If it is not, reposition the hub up or down until the end gap is within limits.

![Figure 9. End Gap](image)

NOTE

Generally, the gearbox hub is easier to adjust than the driver hub. However, due to manufacturing tolerances, the driver hub may have a looser fit. If neither hub moves easily, use a bearing puller and
heat the coupling hub. DO NOT heat hub any more than is absolutely necessary to loosen it.

(e) Fill the gap and grooves of the coupling with lubricant. When grids are furnished in two or more segments, install them so that all cut ends extend in the same direction; this will facilitate cover installation. Seat the grid on the coupling with a soft mallet (Figure 10).

Figure 10. Grid Assembly

Pack the spaces between and around the grid with as much lubricant as possible and wipe off the excess flush with the top of the grid. Position the seals on the hubs to line up with the grooves in the cover (Figure 8). Secure the covers with fasteners and tighten them to the torque specifications in Table 1. Grease coupling per step (6.b).

(f) It is good practice to coat the coupling assembly and shafts with grease or some form of protection in order to minimize the chance of corrosion.

(g) Replace the coupling guards and secure them with the screws provided.

(6) Servicing of Falk Steelflex Coupling

(a) Couplings should be lubricated at least once a year. Lubricate more often when the coupling is exposed to excessive moisture or extreme temperatures.

Remove both lube plugs and insert one grease fitting. Fill with grease until excess appears at opposite hole. Remove fitting and replace plugs.

(b) For operation in ambient temperatures of 0° to 150°F (-18°C to 66°C), grease with the following specifications should be used:

DROPPING POINT - 300°F (149°C) or higher.

CONSISTENCY - NLGI #2 with worked penetration value in the range of 250 to 300.

SEPARATION AND RESISTANCE - Low oil separation rate and high resistance to separation from centrifuging.

<table>
<thead>
<tr>
<th>Falk Coupling Size</th>
<th>End Gap Minimum</th>
<th>End Gap Normal</th>
<th>End Gap Maximum</th>
<th>Cover Bolt Torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>40T10</td>
<td>0.062 in. (1.57 mm)</td>
<td>0.125 in. (3.17 mm)</td>
<td>0.188 in. (4.77 mm)</td>
<td>100 lb.-in. (1.15 kg-m)</td>
</tr>
<tr>
<td>50T10</td>
<td>0.062 in. (1.57 mm)</td>
<td>0.125 in. (3.17 mm)</td>
<td>0.188 in. (4.77 mm)</td>
<td>200 lb.-in. (2.30 kg-m)</td>
</tr>
<tr>
<td>60T10</td>
<td>0.062 in. (1.57 mm)</td>
<td>0.125 in. (3.17 mm)</td>
<td>0.188 in. (4.77 mm)</td>
<td>200 lb.-in. (2.30 kg-m)</td>
</tr>
<tr>
<td>70T10</td>
<td>0.062 in. (1.57 mm)</td>
<td>0.125 in. (3.17 mm)</td>
<td>0.188 in. (4.77 mm)</td>
<td>200 lb.-in. (2.30 kg-m)</td>
</tr>
<tr>
<td>80T10</td>
<td>0.062 in. (1.57 mm)</td>
<td>0.125 in. (3.17 mm)</td>
<td>0.250 in. (6.35 mm)</td>
<td>200 lb.-in. (2.30 kg-m)</td>
</tr>
</tbody>
</table>

Table 1. Coupling Specifications (Falk Steelflex Type)
LIQUID CONSTITUENT: Good lubricating properties equivalent to a high quality, well refined, petroleum oil.

INACTIVE: Must not corrode steel or cause swelling or deterioration of neoprene.

CLEAN: Free from foreign inclusions.

For ambient down to $-30^\circ F (-34^\circ C)$, a grease with worked penetration value of 310-340 should be used. For ambient above or below those given, consult the Falk Corporation.

(c) If it should be necessary to disassemble the coupling, the following procedure should be followed. Remove the cover halves from the coupling. Use a screwdriver that will fit into the open loop ends of the grid. Begin at the open end of grid and pry the grid radially in even, gradual stages, proceeding alternately from side to side. See Figure 11.

NOTE

If other than Sundstrand supplied couplings are used, refer to manufacturer's recommendations for maintenance and lubricating procedures.

Figure 11. Coupling Disassembly

(7) Thomas Type DBZ Installation Instructions.

(a) The driver adaptor has coupling guard plates that must be removed and stored while installing coupling. See Figure 5.

NOTE

The coupling is shipped with the center assembly assembled as shown in Figure 12 (initial view). If it is necessary to completely disassemble the center assembly, tie a wire through the bolt holes to maintain the order of the disc packs. Be careful to note the arrangement of the parts so that the coupling can be reassembled with the parts in the same order.

Figure 12. Thomas Coupling Alignment

(b) Mount the driver on the driver adaptor and tighten the attaching bolts.

(c) From Table 2, determine the end gap (distance between coupling hubs) for the size of coupling provided.

(d) Using a proper gauge, check the actual end gap (Figure 13) to verify that it is within the limits given in Table 2. If it is not, relocate the hub up or down until the end gap is within limits.

Figure 13. End Gap
NOTE

Generally, the gearbox hub is easier to adjust than the driver hub. If the hub does not move easily, use a bearing puller and heat the hub. DO NOT heat hub any more than is absolutely necessary to loosen it.

(e) Assemble the center assembly to the hubs using the bolts, nuts, and washers provided keeping the proper order of parts as noted in step (a). See Figure 12.

(f) It is good practice to coat the coupling assembly and shafts with grease or some form of protection in order to minimize the chance of corrosion.

(g) Replace the coupling guard plates.

(h) Removal for Maintenance - It may not always be possible to remove or install the center disc pack after the driver is installed. For easy removal, loosen the four lower bolts holding the lower disc pack to the gearbox coupling hub. Remove the mounting bolts holding the driver adaptor to the gearbox. Remove the driver, the driver adaptor and upper coupling as a total assembly. For assembly, follow this procedure in reverse.

B. UNITS WITH MOTOR STANDS

(1) If other than Sundstrand supplied couplings are used, they must be flexible disc or gear type couplings capable of tolerating reasonable amounts of parallel and angular misalignment and axial end float. Refer to coupling manufacturer's recommendation for installation and maintenance.

CAUTION

Lock out starting switch on driver prior to working on coupling.

(2) Coupling installation for turbine drivers is identical to that for motors.

(3) The gearbox coupling hub is normally mounted at the factory. The driver coupling hub will be mounted on all motors and tur-

<table>
<thead>
<tr>
<th>THOMAS COUPLING SIZE</th>
<th>END GAP</th>
<th>COVER BOLT TORQUE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MINIMUM</td>
<td>NORMAL</td>
</tr>
<tr>
<td>163</td>
<td>0.876 in. (22.24mm)</td>
<td>0.938 in. (23.81mm)</td>
</tr>
<tr>
<td>201</td>
<td>0.876 in. (22.24mm)</td>
<td>0.938 in. (23.81mm)</td>
</tr>
<tr>
<td>226</td>
<td>1.126 in. (28.59mm)</td>
<td>1.188 in. (30.18mm)</td>
</tr>
<tr>
<td>263</td>
<td>1.219 in. (30.97mm)</td>
<td>1.313 in. (33.36mm)</td>
</tr>
<tr>
<td>301</td>
<td>1.406 in. (35.72mm)</td>
<td>1.500 in. (38.10mm)</td>
</tr>
</tbody>
</table>

Table 2. Coupling Specifications (Thomas Type DBZ)
bines shipped from the Sundstrand factory. If the driver hub is mounted upon receipt of the unit, skip to sub-section C for installation instructions.

(4) If the driver coupling hub is not mounted, the following procedure should be followed for Falk or Thomas couplings:

Make sure coupling hub bore, keyways, and shaft are clean, free from burrs, and that the key will fit in the keyways. Heat the hub in an oil bath or oven to approximately 250°F (121°C), or more if necessary, so the hub will slide onto the motor shaft. Position the hub flush with the end of the driver. For Thomas couplings, alignment procedures may necessitate adjustments to this flush position.

NOTE

On Thomas couplings, before the hub is installed check to see if it is possible to assemble the coupling bolts and washers (Figure 19) from the driver side of the hub when installed. If this is not possible, assemble the bolts and washers into the hub flange before fitting it onto the shaft.

(5) DO NOT align from the gearbox end. The gearbox input shaft is manufactured such that it is free to move radially and axially. Prior to alignment, position the shaft at its dead position; then align.

C. INSTALLATION, ALIGNMENT, SERVICING

(1) Install stand per section “1. INSTALLATION”. Tighten foundation bolts prior to coupling installation and alignment.

(2) Make sure that the surface of the stand which the driver sits on is free of paint, weld splatter, etc. Mount the driver on the top of the stand, making sure that the driver flange does not bind on the adjusting bolts.

(3) Coupling alignment should be done prior to connecting suction and discharge piping. It is normally good practice to leave a section of piping on the suction and discharge of the pump casing to be fabricated after alignment has been completed. A recheck of alignment should be done after piping is installed.

(4) Falk Double Gear Coupling

(a) Refer to Figure 15. Pack the sleeve teeth with grease and lightly coat with grease before assembly. See sub-section 5b, Page 15 for lubricant requirements.

(b) To set angular alignment, remove the sti-

fening brackets (Figure 16), and attach a dial indicator with extension arm to the driver hub. Set the dial indicator on the gearbox hub face outside the bolt circle (Figure 17). Rotate the driver shaft (do not rotate gearbox shaft) to sweep the gearbox hub face. Using shims and jack screws at the base of the pump, adjust pump to hold the total indicator reading within the angular limit specified in Table 3 (Page 15).

(c) To set offset alignment, attach the dial indicator to the driver hub, and position indicator to sweep the O.D. of the gearbox coupling hub flange (Figure 18). Rotate the driver shaft (do not rotate gearbox shaft). Using the driver jack screws, adjust driver to hold the total indicator reading within the offset limit specified in Table 3. Recheck angular alignment to insure it is still within limits.

(d) Stagger the keyways on mating coupling hubs by 180°. Install the floating shaft assembly, including the centerplate with thrust button and the thrust plate in the lower coupling. The "GL" flanged sleeve with long internal gear teeth is installed in the upper position. The flanged sleeve with short internal gear teeth is installed in the lower position. Bolt the coupling in place. Torque bolts to values given in Table 3.

(e) Remove both lube plugs from each sleeve and add grease until an excess appears at an open hole. Replace all lube
Figure 16. Vertical Stand Assembly

plugs. It is good practice to coat the coupling assembly and shafts with grease or some form of protection in order to minimize the chance of corrosion.

(f) Tighten all mounting bolts and stiffening brackets and install coupling guard.

(5) Service of Falk Double Gear Coupling

(a) Couplings should be lubricated at least once every six months. Lubricate more often when the coupling is exposed to excessive moisture or extreme temperatures.

(b) For operation in ambient temperatures of -30°F to 200°F (-34°C to 93°C), grease with the following specifications should be used:

DROPPING POINT - 300°F (149°C) or higher.

CONSISTENCY - NGLI #1 EP grease with worked penetration value in the range of 310-340.

<table>
<thead>
<tr>
<th>FALK COUPLING SIZE</th>
<th>OPERATING LIMITS (TOTAL INDICATOR LIMIT)</th>
<th>BOLT TORQUE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OFFSET (MAX.)</td>
<td>ANGULAR (MAX.)</td>
</tr>
<tr>
<td>15GL 15GV</td>
<td>0.005 in. (0.127mm)</td>
<td>0.005 in. (0.127mm)</td>
</tr>
<tr>
<td>20GL 20GV</td>
<td>0.005 in. (0.127mm)</td>
<td>0.005 in. (0.127mm)</td>
</tr>
</tbody>
</table>

Table 3. Coupling Specification
(Falk Double Gear Type - Vertical)
SEPARATION AND RESISTANCE - Low oil separation rate and high resistance to separation from centrifuging.

TEXTURE - Smooth or fibrous.

MINIMUM TIMKEN O.K. LOAD - 30 lbs.

INACTIVE - Must not corrode steel or cause swelling or deterioration of Neoprene or Buna N.

CLEAN - Free from foreign inclusions.

DO NOT use cup grease.

(6) Thomas SN Type Spacer Coupling

(a) The motor coupling hub is fitted very tightly onto the driver shaft, making it very difficult to adjust after installation. Prior to alignment, mount the driver hub such that when the complete coupling is installed, there is a gap of 1/32 inch (0.4 mm) between the gearbox hub and gearbox housing.

The method of installation is such that the coupling will hang on the motor hub and slide on the gearbox input shaft. This will cause the disc pack to sag by the weight of the coupling. This sag is normally 1/16 inch (1.6 mm), and it must be taken into consideration when adjusting the shaft end gap. Be sure that the coupling does not touch the gearbox when in operation.

(b) To set angular alignment, loosen the stiffening brackets (Figure 16) and attach a dial indicator with extension arm to the driver hub. Set the dial indicator on the gearbox hub face outside the bolt circle (Figure 17). Rotate the driver shaft (do not rotate gearbox shaft) to sweep the gearbox hub face. Using shims and the jack screws at the base of the pump, adjust pump to hold the total indicator reading within the angular limit specified in Table 4 (page 17).

(c) To set offset alignment, attach the dial indicator to the driver hub, and position indicator to sweep the O.D. of the gearbox hub flange (Figure 18). Rotate the driver shaft (do not rotate gearbox shaft). Using the motor jack screws, adjust motor to hold the total indicator reading within the offset limit specified in Table 4. Recheck angular alignment to ensure it is still within limits.

(d) Refer to Figure 19. Measure the length of the floating shaft between hub faces. Measure the distance between the motor and gearbox hub faces. The floating shaft must be shorter than the distance between shaft hub faces by the sum of the end gaps specified in Table 4. If the length difference is not within the limits specified in Table 4, adjust the hubs until within limits. If necessary, heat the hub and use a bearing puller to move it. DO NOT heat hub any more than is absolutely necessary to loosen it.
<table>
<thead>
<tr>
<th>THOMAS COUPLING SIZE</th>
<th>END GAP</th>
<th>OPERATING LIMITS TOTAL INDICATOR READING</th>
<th>BOLT TORQUE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MINIMUM</td>
<td>NORMAL</td>
<td>MAXIMUM</td>
</tr>
<tr>
<td>SN226</td>
<td>0.563 in. (14.30mm)</td>
<td>0.594 in. (15.09mm)</td>
<td>0.625 in. (15.88mm)</td>
</tr>
<tr>
<td>SN262</td>
<td>0.438 in. (11.13mm)</td>
<td>0.469 in. (11.91mm)</td>
<td>0.500 in. (12.70mm)</td>
</tr>
<tr>
<td>SN312</td>
<td>0.469 in. (11.91mm)</td>
<td>0.500 in. (12.70mm)</td>
<td>0.531 in. (13.49mm)</td>
</tr>
</tbody>
</table>

Table 4. Coupling Specifications (Thomas SN Spacer Type - Vertical and Horizontal)

NOTE

On some units there are different size couplings on each end of the floating shaft. Be sure to use the proper end gap values for the respective couplings.

(e) Stagger the keyways on mating coupling hubs by 180°. Assemble and bolt in the disc pack assembly. Torque bolts to values given in Table 4.

NOTE

Disc packs must be assembled in the coupling exactly as received. If it is necessary to completely disassemble the disc pack, tie a wire through the bolt holes to maintain the proper order.

(f) It is good practice to coat the coupling assembly and shafts with grease or some form of protection in order to minimize the chance of corrosion.

(g) Tighten all mounting bolts and stiffening brackets and install coupling guard.
V. OPERATION & CONTROL

1. OPERATION OF SUNDYNE PUMPS

While the application of the pump in any particular system is not within the scope of this instruction manual, the importance of proper application to successful pump operation cannot be ignored. Several factors must always be considered. The experienced operator will be aware of the effects.

A. SUCTION CONDITIONS

The most common reasons for improper centrifugal pump operation are those relating to proper flow of liquid into the impeller. To avoid turbulence at the eye of the impeller, the suction pipe should be straight for at least three pipe diameters beyond the suction flange. Another rule of thumb is that suction piping should be at least one pipe size larger than the pump suction flange.

It is essential that liquid reaching the impeller eye has a high enough vapor pressure to prevent it flashing to a gas in the impeller. The result of the liquid flashing is cavitation, a phenomenon which can cause damage to the impeller and inducer. Cavitation is sometimes noticeable as a "pumping gravel" noise in centrifugal pumps. In high-speed single-stage pumps, this sound may not be discernible. The way to prevent cavitation is to maintain suction pressure at a high enough level and suction temperatures low enough to maintain Net Positive Suction Head available (NPSHA) greater than Net Positive Suction Head required (NPSHr) by the pumps.

B. MINIMUM FLOW CONDITIONS

Centrifugal pumps can also experience vibrations from internal flow separations and recirculation at low flow conditions. The operator should be aware of the minimum flow recommendations of the manufacturer. While a pump can operate with some noise due to recirculation without harm to the pump, excessive noise and vibration are signs that the pump may be subject to damage if operation is continuous. Noise and vibration may be accentuated by resonance in the discharge line, especially when a control valve is located well downstream from the pump.

C. ENTRAINED GASES

Entrained gases in the fluid will reduce the head and capacity of a centrifugal pump. Normally it is considered that two to three percent entrainment is limiting. The pump has been found to operate very well under adverse conditions of gas entrainment. However, the operator should expect a reduction in performance.

D. SYSTEM HEAD CURVE

The flow at which a centrifugal pump operates depends upon the point of intersection of the system head curve with the pump characteristic (head versus flow) curve. In order for control to be steady, the system curve must intersect the pump characteristic curve at a significant angle. Examples of satisfactory and unsatisfactory angles of intersection are shown on the following diagram.

![Diagram of System Head Curves](image)

Figure 20. Typical Operation

**NOTE**

The curve for pump A has a significant angle of intersection with system curves D and E. The system curve D could represent a system with the control valve wide open while system 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 pump flow is likely to drift aimlessly and not respond to control valve position.

E. PARALLEL OPERATION

When centrifugal pumps are operated in parallel, their control becomes more critical because one pump may tend to "overpower" another in terms of head at lower total flows. If pumps are connected together at their discharge head by a simple and unrestricted manifold, the discharge head of one pump is imposed upon another, all pumps see the same discharge head at any given moment in time. This situation is shown on the following curves:

---

19
Figure 21 shows the characteristic curves of two pumps designated A and B. Since no two pumps will have exactly the same performance, it is assumed that pump A produces a very slight amount more head than pump B. The pumps are arranged with a common manifold as shown in Figure 22.

![Graph showing pressure head vs flow for pumps A and B]

Figure 21. Parallel Operation

The pressure in the manifold is set at \( P_1 \); the flow through pump A indicated as \( A_1 \) on the preceding curve. At the same time, the flow through pump B is indicated as \( B_1 \). However, if the throttle valve is closed to cause the manifold pressure \( P \) to rise to \( P_2 \), then flows through pump A and B are \( A_2 \) and \( B_2 \) 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 would heat up and boil. During internal boiling, it could encounter liquid slugging and probable damage to the pump. This situation can be avoided by proper selection of the control system.

2. CONTROL OF SUNDYNE PUMPS

Proper operation of any centrifugal pump requires that the pump be operated in a range where (1) the system head curve and pump performance curve intersect at a significant angle, (2) the pump does not operate below the minimum flow recommended, and (3) the pump does not operate beyond the maximum capacity recommended. Rule of thumb would establish this at 20% beyond the best efficiency point as long as horsepower and NPSH requirements are not exceeded.

It is recommended that flow control rather than pressure control be used with the LMV-313. Pressure and flow controls both operate by throttling the discharge flow. However, flow control devices are much more sensitive to the changes in the point of intersection of the performance curve with the system head curve.

Minimum flow is determined by the larger of either (1) the amount of flow necessary to prevent damaging low flow recirculation, (2) the amount of flow necessary to prevent excessive temperature rise in the pump casing due to low flow recirculation, or (3) in the case of pumps operated in parallel, the minimum flow that will prevent one from deadheading the other.

The minimum flow necessary to prevent excessive vibrations caused by low flow recirculation has been found to be largely a function of the system design. It has been found through experience that the greater the distance the control valve is located from the pump discharge flange the more severe the effect of this vibration becomes.

If the pump is not operated below minimum flow recommendations, temperature rise within the pump is unlikely to be a problem. However, if operation at low flows becomes mandatory, or if the system causes the pump discharge line to be blocked for any period of time, a means of maintaining a minimum flow must be provided. This can be accomplished by use of either a continuous bypass or by a flow controlled bypass. Any bypass arrangements must return liquid to the suction tank or to a location with similar heat sink capability.

In the case of two or more pumps operating in parallel, it is essential that flow be controlled so that one pump will not deadhead the other and so that they share the work equally. The best way to accomplish this is to provide a separated control valve for each pump. Other systems can be used but must be designed with careful consideration of the system head and pump performance curves.

Various safety devices to protect the pump and system are available. Devices that monitor vibration, temperature or pressure changes can be installed. Consult the manufacturer for recommendations.
VI. TROUBLESHOOTING

1. GEARBOX & PUMP TROUBLESHOOTING

Pump performance is affected strongly by system factors such as suction pressure, temperature, specific gravity, driver speed, flow rate and control characteristics. These factors, as well as possible internal problems, should be considered carefully when analysing pump system performance. Pump performance characteristics are shown on the specification sheet and performance curve. Table 5 presents information which is useful in the analysis of gearbox and pump performance problems. Repair procedures appear under section “VII. MAINTENANCE”.

<table>
<thead>
<tr>
<th>TROUBLE</th>
<th>POSSIBLE CAUSE</th>
<th>INVESTIGATIVE/CORRECTIVE ACTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>No flow, no pressure at startup.</td>
<td>Pump not completely filled with liquid.</td>
<td>Bleed all vapor or air from port 6.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Allow more cool down time if pumping low temperature fluid.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Check suction line for air leak if suction pressure is lower than atmospheric,</td>
</tr>
<tr>
<td></td>
<td>NPSH actually lower than NPSH requirement listed on specification sheet.</td>
<td>Suction line blocked - check suction screen and valve.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Excessive pressure drop through suction piping.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Flow restricted by vapor pockets in high points of suction line.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Suction tank level or pressure too low.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Entrained air or vapor in pumped fluid.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NPSH reduced by presence of more volatile fluid in process fluid.</td>
</tr>
<tr>
<td>Failure of drive component, such as interconnecting shaft or impeller key, or item missing from assembly.</td>
<td>Disassemble and inspect.</td>
<td></td>
</tr>
<tr>
<td>Reverse direction of rotation.</td>
<td></td>
<td>Direction of driver shaft rotation must be as shown by arrow on pump casing. Note: Impeller and driver rotate in the same direction.</td>
</tr>
<tr>
<td>Insufficient flow or total head.</td>
<td>Flow too high.</td>
<td>Check total head and flow rate against performance curve.</td>
</tr>
<tr>
<td></td>
<td>NPSH actually lower than NPSH requirement listed on specification sheet.</td>
<td>Refer to solutions listed under “No flow, no pressure at startup”.</td>
</tr>
</tbody>
</table>

Table 5. Gearbox and Pump Troubleshooting
<table>
<thead>
<tr>
<th>TROUBLE</th>
<th>POSSIBLE CAUSE</th>
<th>INVESTIGATIVE/CORRECTIVE ACTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insufficient flow or total head. (Continued)</td>
<td>Excess clearance at impeller face</td>
<td>Disassemble and check for proper inducer housing shimming.</td>
</tr>
<tr>
<td></td>
<td>Flow too low, causing overheating of fluid resulting in internal boiling or unstable pump operation.</td>
<td>Increase through-flow rate.</td>
</tr>
<tr>
<td></td>
<td>Bypass part of pump discharge to supply tank.</td>
<td>Use seal cavity bypass and vent the high point of the pump to continuously increase inlet flow rate.</td>
</tr>
<tr>
<td></td>
<td>Diffuser discharge throat partially plugged or impeller damaged by passage of a solid particle.</td>
<td>Clean these areas of all obstructions and restore surfaces to a smooth polished finish (use emery cloth or machine), free of all corrosion pitting. Edge of diffuser throat must be sharp.</td>
</tr>
<tr>
<td></td>
<td>Corrosion and/or erosion of diffuser throat (may also be accompanied by corrosion/erosion of diffuser and cover surface adjacent to impeller).</td>
<td>If edge of throat is no longer sharp and smooth or has opened in size, head-rise may be reduced. Opening of the inlet area of the throat will result in higher flow rate and horsepower consumption. Corrosion/erosion of diffuser and cover surfaces will result in a significant horsepower increase.</td>
</tr>
<tr>
<td></td>
<td>Excessive recirculation from discharge to inlet.</td>
<td>Check flow through external plumbing.</td>
</tr>
<tr>
<td></td>
<td>Pump “O”ring (936C) damaged or missing.</td>
<td>Integral centrifugal separator orifice worn.</td>
</tr>
<tr>
<td></td>
<td>Process fluid specific gravity or viscosity different from values shown on specification sheet.</td>
<td>Check actual viscosity and specific gravity at operating temperature. Viscosity higher than five centipoises will cause reduced head and flow and increased power consumption.</td>
</tr>
<tr>
<td></td>
<td>Driver speed too low.</td>
<td>Check speed against value listed on specification sheet.</td>
</tr>
<tr>
<td></td>
<td>Pressure gages or flowmeters in error.</td>
<td>Calibrate instrumentation.</td>
</tr>
<tr>
<td>Driver overloaded.</td>
<td>Fluid specific gravity or viscosity higher than values listed on specification sheet.</td>
<td>Check actual viscosity and specific gravity against value listed on specification sheet.</td>
</tr>
<tr>
<td></td>
<td>Electrical failure in electric driver.</td>
<td>Check circuit breaker heater size and setting.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Check voltage and voltage balance between phases.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Current for each phase should be balanced within three percent.</td>
</tr>
</tbody>
</table>

Table 5. Gearbox and Pump Troubleshooting (Continued)
<table>
<thead>
<tr>
<th>TROUBLE</th>
<th>POSSIBLE CAUSE</th>
<th>INVESTIGATIVE/CORRECTIVE ACTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Driver overloaded. (Continued)</td>
<td>Mechanical failure in driver, gearbox or pump.</td>
<td>Remove driver and check for freedom of rotation of pump and gearbox shaft assemblies.</td>
</tr>
<tr>
<td></td>
<td>Corrosion pitting on surface of diffuser cover or diffuser, adjacent to impeller blades. Head-rise is also reduced by this condition.</td>
<td>Remove fluid end and search for any mechanical failure. Remove gearbox oil level sight glass and inspect bottom of sump for wear particles. Bearings are probably not damaged if no wear particles are present. 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 (use emery cloth or machine). Check diffuser throat area at the inlet; erosion or corrosion resulting in roughness or increased area will increase horsepower consumption. Note: A larger throat size than design will allow a higher flow and horsepower for a given head-rise.</td>
</tr>
<tr>
<td>Excessive discharge pressure pulsations.</td>
<td>Flow rate too low.</td>
<td>Increase flow rate through pump. Add bypass to suction tank if necessary.</td>
</tr>
<tr>
<td></td>
<td>Insufficient NPSH available.</td>
<td>Refer to solution for insufficient NPSH under “No flow, no pressure at startup,” above.</td>
</tr>
<tr>
<td></td>
<td>Defective flow control valve.</td>
<td>Check control valve.</td>
</tr>
<tr>
<td></td>
<td>Flow rate too low for control by back pressure control valve or parallel pump operation.</td>
<td>Increase pressure drop between pump and control valve. Increase flow rate.</td>
</tr>
<tr>
<td>Change of gearbox oil from normal color to milky pink or yellow.</td>
<td>Gearbox oil contaminated with water or process fluid.</td>
<td>Inspect gearbox heat exchanger for leakage. Check for excessive pump seal leakage. Inspect shaft sleeve “O” rings. Inspect that seal housing port 1 and other seal drains are open for unrestricted seal leakage flow.</td>
</tr>
<tr>
<td>Shaft sleeve rubs on inside diameter of seal.</td>
<td>Gearbox journal bearing failure.</td>
<td>Install replacement exchange gearbox or repair gearbox as outlined under “MAINTENANCE”.</td>
</tr>
</tbody>
</table>

Table 5. Gearbox and Pump Troubleshooting (Continued)
**Table 5. Gearbox and Pump Troubleshooting (Continued)**

<table>
<thead>
<tr>
<th>TROUBLE</th>
<th>POSSIBLE CAUSE</th>
<th>INVESTIGATIVE/CORRECTIVE ACTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excessive gearbox automatic transmission fluid consumption.</td>
<td>Low speed shaft seal (115) leakage.</td>
<td>Check drain port for leakage. Replace shaft seal if required.</td>
</tr>
<tr>
<td></td>
<td>High speed shaft mechanical seal (60°C) leakage.</td>
<td>Check upper gearbox housing drain port for leakage. Replace shaft seal if required.</td>
</tr>
<tr>
<td></td>
<td>Leakage through heat exchanger into cooling fluid.</td>
<td>Pressure test heat exchanger and replace if required.</td>
</tr>
<tr>
<td>Excessive oil foaming.</td>
<td>High oil level.</td>
<td>Shut down the unit and check oil level.</td>
</tr>
<tr>
<td></td>
<td>Low gearbox temperature. Incorrect lubricant.</td>
<td>Adjust coolant to heat exchanger, keeping oil temperature above 140°F., 60°C. Fill with ATF.</td>
</tr>
<tr>
<td>High gearbox temperature.</td>
<td>Heat exchanger fouled or coolant shut off.</td>
<td>Check coolant flow and/or clean heat exchanger.</td>
</tr>
<tr>
<td></td>
<td>Oil level too high.</td>
<td>Check oil level and adjust.</td>
</tr>
</tbody>
</table>

2. **PUMP MECHANICAL SEALS TROUBLESHOOTING**

Table 6 contains troubleshooting procedures for single seal equipped units. The information is also applicable to double and tandem seal units. The repair procedures for mechanical seals are listed in this manual under section “VII. MAINTENANCE”.

<table>
<thead>
<tr>
<th>TROUBLE</th>
<th>POSSIBLE CAUSE</th>
<th>INVESTIGATIVE/CORRECTIVE ACTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sudden increase in seal leakage.</td>
<td>Severe cavitation or loss of suction causing vibration and bouncing of seal face.</td>
<td>Correct pump suction condition causing cavitation. Bleed vapor from seal cavity and restart. Install double seal if loss of suction cannot be prevented.</td>
</tr>
<tr>
<td></td>
<td>Seal icing on low temperature pumps or icing when handling fluids which vaporize at a temperature of less than +32°F. (0°C.) at atmospheric pressure.</td>
<td>Quench with compatible fluid which will not freeze at pump temperature through seal drain port 2 or 7 to prevent ice formation on atmospheric side of seal during startup and in running condition. Use purge of dry nitrogen gas through ports 2 or 7. Install double or tandem seal if ice is caused by water in process fluid or supply external seal flush of compatible fluid which does not contain water.</td>
</tr>
</tbody>
</table>

Table 6. Pump Mechanical Seals
<table>
<thead>
<tr>
<th>TROUBLE</th>
<th>POSSIBLE CAUSE</th>
<th>INVESTIGATIVE/CORRECTIVE ACTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sudden increase in seal leakage, (Continued)</td>
<td>Solid particles in seal cavity or seal spring area (seal faces usually have rough scratched appearance).</td>
<td>Inspect for clogged integral centrifugal separator orifices. Clean orifices if necessary.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Supply external clean seal flush or double seal, if particles cannot be removed by separator.</td>
</tr>
<tr>
<td></td>
<td>Seal stationary face spring action is rough and sticky.</td>
<td>If parts are corroded, replace with parts made from compatible materials.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>If formation of solids causes sticky seal analyze fluid properties. Use external seal flush or double seal arrangement.</td>
</tr>
<tr>
<td></td>
<td>Worn or damaged seal.</td>
<td>Disassemble seal and rebuild or replace per instructions in maintenance section.</td>
</tr>
<tr>
<td></td>
<td>Wear pattern on seal rotating faces not uniform.</td>
<td>Lightly lap surfaces of shaft sleeve and impeller hub which contact rotating seal face to remove high spots. Install new seal faces.</td>
</tr>
<tr>
<td></td>
<td>Wear pattern on stationary face smooth but not uniform.</td>
<td>Lap flat or replace seal.</td>
</tr>
<tr>
<td></td>
<td>Edges of stationary face chipped and seal face worn. (Vapor flashing in seal cavity will cause excessive wear and/or cracking of rotating face.)</td>
<td>Install seal cavity bypass to suction tank.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Prevent loss of pump suction.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Supply cool seal flush.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Install double seal.</td>
</tr>
<tr>
<td></td>
<td>Seal rotating face cracked or broken. May be caused by damage at assembly or thermal shock caused by seal running dry.</td>
<td>Prevent loss of pump suction or supply continuous external seal flush.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Install double seal.</td>
</tr>
<tr>
<td></td>
<td>Chemical attack of seal faces, seal parts or &quot;O&quot;rings.</td>
<td>Investigate fluid properties and determine suitable materials for replacement.</td>
</tr>
<tr>
<td></td>
<td>Excessive radial high speed shaft movement.</td>
<td>Check high speed shaft journal bearings and replace if necessary.</td>
</tr>
<tr>
<td></td>
<td>bent high speed shaft or severe out-of-balance.</td>
<td>Check if damage exists on impeller and/or inducer which will indicate that a large particle went through the pump.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Deposits on the impeller/inducer causing unbalance.</td>
</tr>
</tbody>
</table>

Table 6. Pump Mechanical Seals (Continued)
<table>
<thead>
<tr>
<th>TROUBLE</th>
<th>POSSIBLE CAUSE</th>
<th>INVESTIGATIVE/CORRECTIVE ACTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sudden increase in seal leakage. (Continued)</td>
<td>Damage to mechanical seal secondary seal (Teflon® wedge or U-cup or elastomer “O” ring).</td>
<td>Check for erosion and/or corrosion attack. Install seal flush or double seal arrangement.</td>
</tr>
<tr>
<td></td>
<td>Loose stackup of high speed shaft attaching components.</td>
<td>Check for correct impeller bolt/inducer torque. Check for cold flow of Teflon® “O” rings.</td>
</tr>
</tbody>
</table>

Table 8. Pump Mechanical Seals (Continued)
VII. MAINTENANCE

The following procedures apply to LMV-333 centrifugal pumps. Refer to the specification sheet and outline drawing to determine specific configuration and optional equipment included in your unit. Parenthetical numbers in the text correspond to item numbers in the illustrations and parts lists.

PUMP & GEARBOX DISASSEMBLY PROCEDURE

CAUTION

No internal gearbox maintenance should be undertaken until the wet-end of the pump is removed from the gearbox.

1. Before proceeding, check to be sure the driver is locked out and that fluid pressures have been bled from the pump case.

2. Drain lube oil from the gearbox. The drain plug is shown in Figure 6, Page 9.

3. Drain process liquid from the pump case. The drain plugs are shown in Figure 6, Page 9.

4. Remove any auxiliary piping from the gearbox and seal housing (30). See Figure 24, Page 28.

5. The motor is assembled to the gearbox by one of three methods.

A. Motor mounted directly on the gearbox with a splined interconnecting shaft. On this configuration, disconnect the motor conduit and flange bolts and lift the motor away from the gearbox.

B. Motor mounted using a coupling housing between motor and gearbox. On this configuration, disconnect the motor conduit and split the coupling (see section "IV. SERVICING"). Remove the coupling housing flange bolts and lift motor away from the gearbox.

C. Motor supported on "A" frame motor stand and connected to the gearbox thru a double coupling. On this configuration, it is not necessary to remove the motor. Remove the coupling guard and coupling center spacer (see section "IV. SERVICING"). Remove the stiffening brackets from the top of the gearbox and install the turnbuckles for raising the gearbox and wet-end out of the pump case. The bottom end of the turnbuckles are hooked in eyebolts installed in the center section of the gearbox.

After raising the gearbox and wet-end, the assembly can be slipped to one side of the "A" frame and then lifted out with an overhead crane.

6. Use the following "Step by Step" procedures as a guide for further disassembly.
STEP 1
Remove any auxiliary piping from the gearbox and seal housing. Be sure gearbox oil has been drained.

STEP 2
Remove the case nuts (914A) and install eyebolts in the "tee" slots in the upper gearbox housing for use as lift points.

STEP 3
Lift the gearbox and seal housing from the pump casing, taking care not to damage the impeller or inducer. If a straight inducer is used, the diffuser will remain in the pump case. When the tapered inducer is used, the diffuser is bolted to the seal housing and will be withdrawn from the pump case.
STEP 4

If disassembly is only for a seal change, diffuser removal should not be required. To remove the diffuser, insert three eyebolts (customer furnished 5/16 - 18 UNC) into tapped holes in the surface of the diffuser. Use the eyebolts to lift the diffuser out of the pump case. The weight is approximately 60 pounds (27 kg). This step will require that "O" rings 936B, 936C, 936CB and 70B be replaced.

STEP 5

Replacing any major components will require diffuser removal for adjustments of the inducer housing shim (158F). After diffuser removal, inspect the "O" rings for deterioration and the case for corrosion and erosion. If the pump case has been left installed in the piping, be sure it is covered to prevent entry of foreign objects.

CAUTION

Any further disassembly should be done in an environment away from blowing dust and adverse weather conditions.

STEP 6

Place the gearbox on a suitable support with the impeller/inducer facing up.

NOTE

All inducers have a left-hand thread. See page 56 for the methods of securing the impeller or input shaft to prevent rotation.

STRAIGHT INDUCER

To remove the straight inducer (pictured), secure the impeller and unscrew the inducer.

TAPERED INDUCER

To remove the tapered inducer, the input shaft must be secured while the inducer (9) is loosened. The diffuser bolts (906F) and diffuser (13) can then be removed from the seal housing (30).
STEP 7

Remove the inducer (9) and "O" ring (936F). Inspect the inducer for cavitation or ingestion damage, and for any sign of rubbing on the outside diameter of the blades. If the inducer has been damaged or if any blades have been bent, the dynamic balance may have been affected and the inducer should be replaced.

STEP 8

The impeller is driven by a spline on the output shaft. Remove the impeller by inserting two screwdrivers on opposite sides of the impeller between the shroud and the diffuser cover (15). Gently raise the impeller off the spline and pilot of the shaft.

STEP 9

Remove the impeller (2) and "O" ring (936G).

NOTE

There are two "O" rings (936G) along with the impeller spacer (158C). These may be easier to remove after the diffuser cover (15) is removed. Inspect the impeller for damage and replace if material integrity or balance has been affected.
STEP 10

Remove the diffuser cover (15) and "O" ring (936E). If not already removed, remove the impeller spacer (158C) and "O" ring (936G) along with the single or tandem seal mating ring (51A). Refer to the pump specification sheet and Figure 24, 25, or 26 for the seal arrangements used.

STEP 11

Using a 7/16" socket wrench, remove the three 1/4 - 20 UNC screws (905G). The screws and lockwashers (916K) are the same metallurgy as the pump wet-end. They secure the lower process mechanical seal (60A).

STEP 12

Remove the mechanical seal (60A), "O" ring (936H) and seal spacer (52). Refer to the parts list for the use of the spacer (52) since it is not used on all pumps. If the disassembly was only for a seal change with a single seal arrangement, further disassembly may not be required. Inspect the seal (60A) and the mating ring (51A) and note any scoring, heat checking, chipping of the carbon, or corrosion as these may be important clues in resolving seal reliability problems. If the seal arrangement is double or tandem, proceed with the following steps.
**STEP 13**

Using a 9/16" socket wrench, remove the four 3/8-16 UNC screws (905A) and seal washers (916S). The bolts secure the seal housing (30) to the output gearbox housing. Standard flat washers can be used in place of the seal washers (916S) during reassembly.

**STEP 14**

Lift the seal housing (30) from the gearbox taking care not to damage the upper mechanical seal (60B). The seal housing weighs approximately 90 pounds (40 kg). Remove the thermal barrier gasket (67A) from the seal housing face.

**NOTE**

The thermal barrier gasket is not intended to seal liquid but to keep heat transfer from the pump to the gearbox to a minimum. Gasket thickness is important and if replaced, care should be taken that .062 inch (1.575 mm) thick stock is used.

**STEP 15**

If a single seal arrangement is used, remove the throttle bushing (21B). If the seal arrangement is double or tandem, remove the upper mechanical seal (60B). Inspect for excessive wear and replace as necessary.
STEP 16

Remove the shaft sleeve. Refer to Figure 24, 25, or 26
which details the sleeve and mating ring configura-
tions for various seal arrangements. Inspect the shaft
sleeves for damage.

CAUTION

Parallelism from face to face is critical. The end faces
must be parallel within 0.0003 inch (0.0076 mm). If only
very slight nicks and dings are present, the sleeves can
be lapped on a fine flat stone to remove the high spots.
Do not remove more than 0.001 inch (0.0254 mm) stock
from either end to correct any damage.

STEP 17

Using a 7/16" socket wrench, remove the three ¼-20
UNC screws (905L) holding the gearbox mechanical
seal (60C). Remove the gearbox seal and the seal
mating ring (51D) along with "O" ring (935P). Inspect
the gearbox seal for excess wear or damage.

NOTE

The chamfer on the seal mating ring does not have an
"O" ring installed. The chamfer is intended to provide
clearance at the radius on the shaft shoulder.

STEP 18

Before proceeding with the gearbox disassembly,
invert the gearbox with the input shaft facing up. DO
NOT remove the lower housing first. Set lower housing
on a raised surface to provide clearance and prevent
damage to the shaft. Remove the two alignment bolts
(909C). These should have a snug slip fit and usually
have to be tapped out using a drift and mallet. The
alignment bolts align all three housing assemblies for
proper internal bearing alignment. Remove the seven
flange bolts (909B).
STEP 19

Remove the input gearbox housing (101B). Lift points are the four “tee” slots. Take care to lift slowly while rocking the housing to allow the input ball bearing outer race to slide out of the bearing liner in the input housing. Do not allow the input or idler shaft to come out with the input housing as further disassembly will be more difficult.

NOTE

Remove lube jets and journal bearings. Clean all lube passages with solvent and blow dry with clean air. Clean all other parts thoroughly and lubricate with ATF or light turbine oil. Reinstall jets into housings immediately.

STEP 20

Lift the idler shaft assembly (A140) out of the bearing liner in the output housing and temporarily lean it against the inside of the bearing plate (102). The large spur gear on the lower end of the idler shaft will not normally fit thru the hole in the bearing plate.

NOTE

The lower idler bearing may be either a plain journal bearing or an angular contact ball bearing. If your unit uses the ball bearing withdraw the outer race from the liner squarely and gently or the bearing may disassemble.

STEP 21

Visually inspect helical gear (122A), spur gear (122C) and pinion gears (132B and 132C) for pits, chips, gear tooth wear or excessive wear between gear and shaft. The thrust runner and gears are shrink fitted to the shaft. Use a 10 ton hydraulic press or equivalent for gear removal.

A new gear can be installed on the low speed shaft by heating the part to 250°F (121°C) and pressing it into position on the shaft. Using a 10 ton press, the part should be pressed rapidly into place to avoid heating of the shaft. In 400 hp gearboxes heat the gear to 375° - 400°F (190° - 204°C) and cool the shaft to 0°F (-18°C). No more than 0.001 inch (0.03mm) gap should exist between the shaft shoulder, gears, spacers, and bearings. The high-speed shaft assembly is dynamically balanced; high-speed shaft gears cannot be replaced in the field.

NOTE

Remove lube jets and journal bearings. Clean all lube passages with solvent and blow dry with clean air. Clean all other parts thoroughly and lubricate with ATF or light turbine oil. Reinstall jets into housings immediately.
STEP 22

The main lube pump (160) is a non-reversible design and is held in place in the bearing plate (102) with two long Allen-head cap screws. Four screw heads can be seen before removal of the pump; the two shorter screws hold the pump assembly together. Upon removal, inspect the pump for freedom of rotation, the drive pin for integrity and wear, and the rotor assembly for any signs of foreign particle ingestion.

STEP 23

The gearbox split line, on each side of the bearing plate, uses a gasket (105) and an “O” ring (936T) to retain the gearbox oil. The gaskets retain splash lubrication and should be installed without use of gasket sealant. The “O” rings seal pressurized lube oil in the passages feeding the bearings. If one of the “O” rings (936T) were left out of the assembly, an approximate 15 psi (1.05 kg/cm) decrease in oil pressure would be expected.

STEP 24

Replace the idler shaft assembly (A140) temporarily in the output housing (101A) to allow easier removal of the bearing plate (102). Lift the bearing plate off squarely, taking care not to bind on the upper output shaft journal bearing (151B).
STEP 25

Remove the idler shaft assembly (A140) and inspect for smooth rotation of the ball bearing and damage or wear to the gear teeth. The upper idler bearing is a plain journal and should be inspected for excess scoring or smeared material. Lift the high speed shaft assembly (A130) out of the lower journal bearing (151A). Inspect the shaft journals for scoring or signs of a bearing failure, evidenced by smeared material on the journals. Also inspect for damage or wear on the gear teeth and both thrust runners for scoring or smeared material.

NOTE

Refer to Figure 20, "BEARING AND SHAFT CLEARANCES" to determine the suitability of specific components for reuse.

STEP 26

Using a 5/16" socket wrench, remove the three screws (905M) holding the lower journal bearing (151A). The journal bearing uses two types of tilt pad thrust assemblies. The high capacity bearing (155A) is a separate assembly and is not secured with screws. The low capacity thrust pads are integral with the bearing cartridge (151A). Refer to your parts list and Figure 18 and 19 to determine the configuration used. Be sure to retain the shims (158) that are installed under the bearing cartridge for reuse at reassembly.

NOTE

The "high capacity" thrust bearing is pictured here and in STEP 26. The lower thrust runner for the "high capacity bearing" is pictured in STEP 25.
STEP 27

Remove the three screws (905N) holding the upper journal bearing (151B) in place in the bearing plate (102). Retain the shims (158) for reuse at assembly. The upper journal bearing uses a thrust washer (155B) instead of a tilt pad thrust bearing. Inspect the high speed journal and thrust bearings for scoring or signs of failure (smeared material). Some light scoring or burnishing of the bearing surfaces is common but bearings with smeared material should not be reused. The suitability for reuse is a judgement decision and if in doubt, they should be replaced. Important clues to the cause of a failure may sometimes be learned from a visual inspection. Do not throw away failed bearings if further analysis is required.

STEP 28

Using a hammer and punch, remove input shaft lip seal (115). Exercise care to avoid damaging the gearbox housing.

NOTE

If the aluminum housing bore for the lip seal is scratched, apply a light coat of oil-proof gasket cement to the outside diameter of the new shaft seal before replacing.
Step 29

Inspect anti-friction bearing (125C and 125D) for smooth rotation, worn outside diameter of outer races and snugness of the inner races on the shafts. Replace if bearings have been in operation for more than one year, if rotation is not smooth, or if outside or inside diameters are worn.

**CAUTION**

It is essential to replace anti-friction bearings with the manufacturer’s approved replacement bearings. Non-approved replacement bearings may jeopardize mechanical integrity of the gearbox/pump.

Anti-friction bearings should be pressed onto the shaft using a press which contacts only the inner race. Bearing damage will occur by pressing or pulling the outer race. No more than 0.001 inch (0.03 mm) gap should exist between bearings, spacers, gears and shaft shoulders. Do not use heat to assemble bearings to the shaft.

Inspect the inside of the anti-friction bearing liners, see Figure 27. If a bearing liner inside diameter is more than referenced in Figure 27, replace the gearbox input housing (101B), gearbox output housing (101A), or bearing plate (102), whichever contains the worn liner. Bearing liners are not replaceable in the field.

Step 30

If the gearbox or lube system has been contaminated with particulate matter or process fluid, remove the pressure relief valve (175), lube jets (174 A, B, C, and D) and flush out the oil passages. The lube jets are drilled with a .032 inch (0.8128 mm) diameter hole. Take care not to use Teflon® tape downstream from the oil filter (i.e. oil pressure gauge fitting) because small pieces of the tape may block the lube jet.

Follow steps in reverse order for reassembly. Refer to pages 51 through 59 for clearance adjustments.

**CAUTION**

Note: Before operating the pump, ensure that the diffuser cavity vent is open.
Note 1: Ensure that diffuser cavity vent (item 924B in the figure above) is open to atmosphere or to safety drain with no back pressure. Failure to do so could result in serious injury or death.
Figure 26. 400 HP Gearbox Exploded View
<table>
<thead>
<tr>
<th>Section</th>
<th>Diagram</th>
</tr>
</thead>
<tbody>
<tr>
<td>Idler Shaft Upper Bearing (400 HP Gearbox Only)</td>
<td><img src="image1.png" alt="Diagram of Idler Shaft Upper Bearing" /></td>
</tr>
<tr>
<td>Lower Idler Bearing and Shaft Clearances</td>
<td><img src="image2.png" alt="Diagram of Lower Idler Bearing and Shaft Clearances" /></td>
</tr>
<tr>
<td>Input Shaft Upper Bearing</td>
<td><img src="image3.png" alt="Diagram of Input Shaft Upper Bearing" /></td>
</tr>
<tr>
<td>Input Shaft Lower Bearing</td>
<td><img src="image4.png" alt="Diagram of Input Shaft Lower Bearing" /></td>
</tr>
</tbody>
</table>

Figure 27. Bearing and Shaft Clearance
Figure 27. Bearing and Shaft Clearances Continued

Figure 28 deleted; no longer applicable.
Figure 29. Shaft Assemblies

Figure 30. Chemical Barrier Gasket (Option)
MECHANICAL SEAL REPAIR

1. Seal repair kits are available for most Sundyne seals. The seal repair kits contain all the seal assembly components except the retainer and drive sleeve assembly (61). Refer to Figure 31 which shows sectional drawings for common seals. The rotating face (mating ring) is not included in the repair kit for the mechanical seal. Repair kits for the throttle bushing (21B) used with the single seal arrangement are also available.

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

3. Replace or rebuild a faulty mechanical seal. Seals may be rebuilt by replacing the seal face washer, wedge rings, “O” ring, and springs.

Replace or tap the seal rotating face if the wear track is rough or worn to a depth greater than 2 HE light bands. A combined total of 0.010 inch (0.25 mm) 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. A maximum of 0.005 inch (0.1270 mm) may be removed from each carbon seal face. Remove any high spots on the end surfaces of the shaft sleeves and impeller hub. The end surfaces of the shaft sleeves must be parallel within 0.0003 inch (0.0076 mm).

**Figure 31. Seal Repair**
Figure 32. Single Seal Arrangement
<table>
<thead>
<tr>
<th>ITEM NO.</th>
<th>PART NAME</th>
<th>QTY</th>
<th>ITEM NO.</th>
<th>PART NAME</th>
<th>QTY</th>
</tr>
</thead>
<tbody>
<tr>
<td>50A</td>
<td>Shaft Sleeve (Lower)</td>
<td>1</td>
<td>68B</td>
<td>Seal Wedge Ring</td>
<td>1</td>
</tr>
<tr>
<td>50B</td>
<td>Shaft Sleeve (Upper)</td>
<td>1</td>
<td>60C</td>
<td>Mechanical Seal (Gearbox)</td>
<td>1</td>
</tr>
<tr>
<td>51C</td>
<td>Seal Rotating Face</td>
<td>1</td>
<td>61C</td>
<td>Retainer &amp; Drive Sleeve Assembly</td>
<td>1</td>
</tr>
<tr>
<td>51D</td>
<td>Seal Rotating Face (Gearbox)</td>
<td>1</td>
<td>62C</td>
<td>Seal Face Washer</td>
<td>1</td>
</tr>
<tr>
<td>52</td>
<td>Seal Spacer</td>
<td>1</td>
<td>64C</td>
<td>Seal Retaining Ring</td>
<td>1</td>
</tr>
<tr>
<td>60A</td>
<td>Mechanical Seal (Lower)</td>
<td>1</td>
<td>65C</td>
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<td>1</td>
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<tr>
<td>61A</td>
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<td>1</td>
<td>69C</td>
<td>&quot;O&quot; Ring Packing</td>
<td>8</td>
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<td>62A</td>
<td>Seal Face Washer</td>
<td>1</td>
<td>905F</td>
<td>Hex Head Cap Screw</td>
<td>1</td>
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<td>6</td>
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<td>Washer</td>
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<td>916K</td>
<td>Washer</td>
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<td>&quot;O&quot; Ring Packing</td>
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<td>1</td>
<td>936J</td>
<td>&quot;O&quot; Ring Packing</td>
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<td>936K</td>
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<td>&quot;O&quot; Ring Packing</td>
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Figure 33. Double Seal Arrangement
<table>
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<th>ITEM NO.</th>
<th>PART NAME</th>
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<th>ITEM NO.</th>
<th>PART NAME</th>
<th>QTY</th>
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<td>Seal Face Washer</td>
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<td>Garter Spring</td>
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<td>Seal Rotating Face</td>
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<td>68B</td>
<td>Backing Ring</td>
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<td>51C</td>
<td>Seal Rotating Face</td>
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<td>69B</td>
<td>“O” Ring Packing</td>
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<tr>
<td>51D</td>
<td>Seal Rotating Face (Gearbox)</td>
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<td>60C</td>
<td>Mechanical Seal (Gearbox)</td>
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<tr>
<td>52</td>
<td>Seal Spacer</td>
<td>1</td>
<td>61C</td>
<td>Retainer &amp; Drive Sleeve Assembly</td>
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</tr>
<tr>
<td>60A</td>
<td>Mechanical Seal (Lower)</td>
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<td>61D</td>
<td>Seal Face Washer</td>
<td>1</td>
</tr>
<tr>
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<td>Retainer &amp; Drive Sleeve Assembly</td>
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<td>62A</td>
<td>Seal Retaining Ring</td>
<td>1</td>
</tr>
<tr>
<td>61B</td>
<td>Retainer &amp; Drive Sleeve Assembly</td>
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<td>Seal Spring</td>
<td>8</td>
</tr>
<tr>
<td>62A</td>
<td>Seal Face Washer</td>
<td>1</td>
<td>68A</td>
<td>“O” Ring Packing</td>
<td>1</td>
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<td>63A</td>
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<td>69A</td>
<td>Hex Head Cap Screw</td>
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<td>905E</td>
<td>Hex Head Cap Screw</td>
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<td>Washer</td>
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<td>916B</td>
<td>Washer</td>
<td>3</td>
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<tr>
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<td>916K</td>
<td>Washer</td>
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<td>62B</td>
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<td>936I</td>
<td>“O” Ring Packing</td>
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<tr>
<td>64B</td>
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<td>936J</td>
<td>“O” Ring Packing</td>
<td>1</td>
</tr>
<tr>
<td>65B</td>
<td>Seal Spring</td>
<td>8</td>
<td>936K</td>
<td>“O” Ring Packing</td>
<td>1</td>
</tr>
<tr>
<td>60B</td>
<td>Mechanical Seal (Gas Seal)</td>
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<td>936L</td>
<td>“O” Ring Packing</td>
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</tr>
<tr>
<td>61B</td>
<td>Seal Retainer</td>
<td>1</td>
<td>64A</td>
<td>“O” Ring Packing</td>
<td>1</td>
</tr>
</tbody>
</table>

Figure 34. Tandem Seal Arrangement
GEARBOX OVERHAUL

1. GENERAL

A. The main lube oil pump is driven directly from the input shaft. The pump is non-reversible and rated at 8.9 gpm at 3600 rpm and 7.3 gpm at 2960 rpm.

B. The high speed bearings supporting the output shaft are supplied in various configurations. Be sure the correct bearing part number is used in the correct location (refer to the parts list).

C. Carefully inspect gearbox components for excessive wear, corrosion, or signs of overheating. Refer to Figure 28 for bearing fits and clearances. If the gearbox has suffered major damage, it may be less expensive to exchange the gearbox rather than proceed with an overhaul. For details on the exchange gearbox program, please contact your local Sundstrand Fluid Handling representative. If there is a question regarding the deterioration of any of the components, please contact Sundyne field service.

D. If particulate matter is found in the gearbox, it will be necessary to flush internal lube passages and the external lube system. To flush the internal lube passages, remove the lube jets (174A, B, C & D) which supply oil to each ball bearing. The lube jets have a 0.031 inch diameter orifice hole. Be sure it is not clogged. Also, remove the internal pressure relief valve (175) from the bearing plate. Flush the oil passages and clean the housings.

2. GEARBOX INTERNAL REPAIR

A. In general, most gearbox repairs will be limited to replacing badly worn or failed components. Refer to Figure 28 for bearing and shaft clearances.

B. Gearbox housing ball bearing steel liners are not intended to be replaced in the field. They are bored on location in each housing and then staked.

C. If further information is required to evaluate components, contact Sundyne field service. Training aids are available.

3. GEARBOX REASSEMBLY

A. Before beginning the reassembly, check to be sure the gearbox housings have been cleaned and the internal oil passages flushed if needed.

B. Check to be sure any replacement parts needed are of the correct part number for the position in which the part will be used. Refer to the parts list for the specific gearbox being worked on.

C. Ball bearings on the input (A120) and idler (A140) shaft assemblies should be changed after three years in service. During a field overhaul, a judgement is required to determine if the ball bearings should be replaced. The nature of the overhaul and the length of time the gearbox has been in service are major factors. Should you elect to change bearings a hydraulic press and a oil bath type of bearing heater will be required. The ball bearings are held on the shaft with a light shrink fit. The gears have a moderate shrink fit and are driven by a key. If a bearing puller is lacking a gear may have to be removed along with a ball bearing in order to facilitate the bearing removal. Do not heat the gears or bearings above 350°F for more than two hours during reassembly.

D. The output shaft assembly (A130) is dynamically balanced and usually does not require disassembly. Inspect for damage to the bearing journals and thrust runners, discoloration from overheating, and even contact on the gear teeth.

E. The reassembly will be the reverse of the disassembly procedures with the exception of setting the output shaft (A130) position and axial end float.

4. OUTPUT SHAFT SHIM ADJUSTMENTS

A. If any major components (output shaft assembly, high speed bearings, or gearbox housings) have been replaced, readjustment of the bearing shims (158) may be required.

B. Refer to Figure 35. Shims (158) are used under both high speed bearing assemblies (151A & B). The shims are adjusted to achieve both axial float (end play) and proper shaft extension. Both must be checked with the output shaft thrust toward the impeller. The adjustments are made with dry bearings. Oil under the thrust surfaces will produce inaccurate readings.

C. A suggested procedure for shimming follows:

1. Install bearings (151A & B) without shims in the output housing and bearing plate.

2. Place the output housing on a raised surface (open side up) with room for the output shaft to project thru.

3. Install the output shaft (A130) in the output housing bearing.

4. Install the bearing plate using caution not to damage the thrust washer (1558). Temporarily leave out the idler shaft assembly (A140), gearbox gasket (106) and “C” ring (9367) from the gearbox split line. Install the
<table>
<thead>
<tr>
<th>ITEM NO.</th>
<th>PART NAME</th>
<th>QTY</th>
</tr>
</thead>
<tbody>
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<td>Gearbox Output Housing</td>
<td>1</td>
</tr>
<tr>
<td>102</td>
<td>Gearbox Bearing Plate</td>
<td>1</td>
</tr>
<tr>
<td>151A</td>
<td>Standard Capacity Tilt Pad Thrust Bearing</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Bearing/Journal Bearing</td>
<td></td>
</tr>
<tr>
<td>151B</td>
<td>Journal Bearing</td>
<td>1</td>
</tr>
<tr>
<td>155A</td>
<td>High Capacity Tilt Pad Thrust Bearing</td>
<td>1</td>
</tr>
<tr>
<td>158</td>
<td>Shims (As Required)</td>
<td>1</td>
</tr>
</tbody>
</table>

NOTE: SHIMS (158) ARE ADJUSTED TO OBTAIN NOTED SHAFT END FLOAT AND NOTED SHAFT EXTENSION. SHAFT EXTENSION MUST BE CHECKED WITH THRUST IN NOTED DIRECTION. MEASUREMENTS ARE MADE WITH DRY (NO OIL) BEARINGS.

Figure 35. Output Shaft Shim Adjustment
two alignment bolts (909C). Do not install the
gearbox input housing. Using short bolts or
"C" clamps, clamp the bearing plate to the
lower housing to assure a metal-to-metal fit
between the faces.

(5) Turn the assembly over with the output shaft
extended up. Load the output shaft toward the
impeller (against bearing 151A). Measure the shaft extension dimension. (Standard depth micrometers can be used if the
gearbox seal rotating face (51D) is installed on the
shaft). Determine the amount of shim to be installed under bearing (151A). Refer to
Figure 35.

(6) Install a dial indicator in a position of your
convenience (inside or outside gearbox) and
measure shaft axial float. From the total float
reading, subtract the amount of shim to be
used under bearing (151A), then subtract
0.015 inch (desired end float). The remaining
amount should be the required thickness for
the shim under bearing (151B).

(7) Shims (158) are normally supplied in 0.005
and .010 thickness. Select the proper thick-
esshims that best obtain the shaft ex-
tension and end float dimensions.

NOTE
Axial float should be 0.015 ± .002 inches.
It is preferre to have slightly excess end float
as opposed to having too little.

(8) Install the shims and recheck both dimen-
sions. Repeat the procedure if necessary.

(9) After proper shimming, complete the re-
assembly of the gearbox as a reverse of the
disassembly procedures.

---

**PUMP ASSEMBLY AND CLEARANCE ADJUSTMENTS**

1. **GENERAL**

The reassembly of the wet end will be the reverse of the
disassembly procedures as detailed under
"PUMP AND GEARBOX DISASSEMBLY". The
exceptions will be in adjusting the shims for the impeller
and inducer housing. If the disassembly was only for a
seal change, the original shims should be satisfactory.
If any major components have been replaced
(gearbox, seal housing, diffuser, pump case, etc.),
changes to the original shimming may be necessary.

2. **IMPELLER SPACER ADJUSTMENTS**

A. The gearbox should be fully assembled and the
seal housing (30) along with the thermal barrier
gasket (87A) should be installed before proceed-
ing. Refer to Figure 36. The diffuser cover (15)
and process mechanical seals and their asso-
ciated "O" rings can be temporarily left off during
this procedure.

The intent is to position the exit flow path from the
impeller within the opening of the diffuser
annulus. This is accomplished by changing the
thickness of impeller spacer (158C). This adjust-
ment must be made with the thrust of the output
shaft away from the gearbox.

B. Position the gearbox vertically with the output
shaft up. Install all components of the rotating
assembly (shaft sleeves, rotating faces, and
impeller) along with the original impeller spacer
(158C).

C. There are two methods for setting the impeller to

diffuser. Both require the use of the shaft loading
tool. Install the tool as shown in Figure 37.

D. **METHOD 1.** If a dial indicator and surface gauge
are available, measure dimensions "A" and "B"
(Figure 36) and record the readings. Next, using a
depth micrometer, measure dimensions "C" and
"D". Compare "B" to "C" and "A" to "D". Select the
spacer thickness to arrive within the tolerances
for position specified in Figure 36.

NOTE
Some diffuser openings are much wider than the
impeller opening. The primary tolerance is the
0.025 ± .020 inch (0.635 ± .508 mm) setting.
The diffuser opening must not overlap the impel-
er opening.

E. **METHOD 2.** If necessary gauging is not available
for measuring dimensions "A" and "B", the follow-
ing alternate method could be used. Measure
dimensions "C" and "D" and transfer these
dimensions to a template by scribing position
marks to indicate the diffuser opening. Place the
straight edge of the template on the seal housing
and visually adjust the impeller opening to the
scribe marks. (The diffuser cover (15) must be
temporarily left off or a notch in the template will
be necessary. A transfer template is shown in
Figure 37.

F. Remove the shaft loading tool and assemble the
process mechanical seals, "O" rings, shaft
elements, and seal rotating faces along with the
diffuser cover (15), impeller spacer (158C) and
impeller (2).
Figure 36. Impeller Shim Adjustment

REFER TO FIGURES 40 & 41 FOR TOOLING DETAILS

TORQUE NUT TO:
STANDARD-31 FT. LBS. (4.29 KG-M)
HIGH CAPACITY 56 FT. LBS. (7.7 KG-M)

NOTE: SHAFT LOADING TOOL TORQUE VALUES ARE DETERMINED
BY TYPE OF THRUST BEARING USED IN A SPECIFIC UNIT. REFER TO
UNIT NAME PLATE FOR STANDARD OR HIGH CAPACITY THRUST.

Figure 37. Shaft Loading Tool Installation
3. INDUCTOR HOUSING SHIM ADJUSTMENTS

A. Reinstall the bolt from the shaft loading tool and torque the impeller.

B. Remove the inducer housing (6) and shims (158F) from the diffuser (13).

C. Place the diffuser (13) over the impeller and allow it to rest on the seal housing surface. The surfaces must be clean. Leave out "O" rings (936A) and (936F) temporarily.

D. Insert the inducer housing (6) into the diffuser bore without the "O" ring (936CA) and shims (158F). Install the crossover bar from the shaft loading tool and torque the nut for the proper preload. Allow the end of the inducer housing to contact the impeller firmly. This should result in a gap between the inducer housing and the diffuser where the shims are normally installed.

E. With feeler gauges, measure the gap between the inducer housing flange and the diffuser. Take readings at four points around the flange. Record the minimum reading and add 0.008-0.010 inch (0.203-0.254 mm) to the gap reading. The results should be the shim thickness required to produce the clearances given in Figure 39.

F. The shim (158F) is made with 0.002 or 0.003 inch (0.051 or 0.076 mm) thick laminations. Peel off the layers that are not needed. Remove the inducer housing (6) and install the shim (158F), "O" ring (936CA) and inducer housing (6) in the diffuser.

**CAUTION**

Inducer housing shimming is critical. Too small a clearance will result in the impeller rubbing and hardware damage. Too large a clearance and loss of performance will occur. Obviously a larger clearance would be preferred to hardware damage.

G. Remove the shaft loading tool. If a tapered inducer is used (see detail, Figure 39), install and torque the inducer (see Table 9). If a straight inducer is used, remove the diffuser assembly and install it in the pump case. Install the inducer and continue with pump assembly.

Figure 38. Inducer Housing Adjustment
### Table 8. Torque Values

**Gearbox**

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

<table>
<thead>
<tr>
<th>Item #</th>
<th>Location</th>
<th>Size</th>
<th>English</th>
<th>Metric</th>
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<tr>
<td>906D</td>
<td>Diffuser Attaching Screws</td>
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<td>95 - 102 in-lbs</td>
<td>11 - 11.5 N-m</td>
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<td>905E</td>
<td>Mechanical Seal No. Spacer</td>
<td>1/4 - 20 x 12</td>
<td>95 - 102 in-lbs</td>
<td>11 - 11.5 N-m</td>
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<td>905F</td>
<td>Throttle Bushing/Mechanical Seal</td>
<td>1/4 - 20 x 12</td>
<td>95 - 102 in-lbs</td>
<td>11 - 11.5 N-m</td>
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<tr>
<td>905G</td>
<td>Double Seal with Spacer</td>
<td>1/4 - 20 x 3/4</td>
<td>95 - 102 in-lbs</td>
<td>11 - 11.5 N-m</td>
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<td>914A</td>
<td>Case Nuts</td>
<td>3/4 - 10</td>
<td>250 - 275 ft-lbs</td>
<td>340 - 375 N-m</td>
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<td>914A</td>
<td>Case Nuts</td>
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<td>300 - 330 ft-lbs</td>
<td>405 - 445 N-m</td>
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<td>Seal Housing to Gearbox</td>
<td>3/8 - 16 x 1 3/4</td>
<td>35 - 40 ft-lbs</td>
<td>47 - 54 N-m</td>
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<td>905P</td>
<td>Separator</td>
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<td>95 - 102 in-lbs</td>
<td>11 - 11.5 N-m</td>
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**Pumps & Compressors**

<table>
<thead>
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<th>Location</th>
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<th>English</th>
<th>Metric</th>
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<td>Mechanical Seal No. Spacer</td>
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<td>8.0 - 8.5 N-m</td>
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<td>Throttle Bushing/Mechanical Seal</td>
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<td>70 - 75 in-lbs</td>
<td>8.0 - 8.5 N-m</td>
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<tr>
<td>905G</td>
<td>Double Seal with Spacer</td>
<td>1/4 - 20</td>
<td>70 - 75 in-lbs</td>
<td>8.0 - 8.5 N-m</td>
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<td>3/8 - 16 x 1 3/4</td>
<td>27 - 30 ft-lbs</td>
<td>47 - 54 N-m</td>
</tr>
<tr>
<td>905P</td>
<td>Separator</td>
<td>1/4 - 20 x 5/8</td>
<td>70 - 75 in-lbs</td>
<td>8.0 - 8.5 N-m</td>
</tr>
</tbody>
</table>

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

Most Sundyne pumps and compressors require only standard tools to accomplish field overhauls. However, with the model LMV333 pump, one or two special tools are recommended to simplify overhaul procedures and to provide more consistency in the setting of high speed shaft loading and clearances. The following sub-section is intended to provide details for the field manufacture and use of these tools.

1. SHAFT LOADING TOOL

The purpose of the shaft loading tool is to preload the shaft against the lower thrust bearing with an approximate 1000 pounds (453.5 kg) end load. This removes slack from the bearing stack-up and allows for more consistency in adjusting the impeller and inducer housing shims. See Figure 40 and 41 for details.

Tool items 6, 7, and 8 are not required for pumps using the tapered inducer configuration because the diffuser in these machines is bolted to the seal housing. The tool detail 1 can simply be laid across the open end of the inducer housing for applying preload to the shaft.

With either configuration, it is important that the mating surfaces of the diffuser and seal housing are clean and that any high spots due to nicks and dings must be removed so that errors will not be introduced during shimming and reassembly.

Figure 40. Shaft Loading Tool

SEE FIGURE 41 FOR DETAILS

TORQUE ITEM 5 TO:
STANDARD-31 FT. LBS.
(4.29 KG-M)
HIGH CAPACITY 56 FT.
LBS. (7.7 KG-M)
### Figure 41. Shaft Loading Tool Details

<table>
<thead>
<tr>
<th>ITEM</th>
<th>QTY</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>1 x 3 rectangle bar stock or 1 x 3 inch channel (steel)</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>Same as Item 1</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>Tension bolt (loads impeller and rotating assembly)</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>Flat washer ¾”</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>Nut ¾-10 UNC</td>
</tr>
<tr>
<td>6</td>
<td>2</td>
<td>Bolt ¾-10 UNC, 8” long min., threaded full length. (Holds diffuser against seal housing)</td>
</tr>
<tr>
<td>7</td>
<td>2</td>
<td>Bolt ½-12 UNC, 2” long</td>
</tr>
<tr>
<td>8</td>
<td>2</td>
<td>Flat washer ½”</td>
</tr>
</tbody>
</table>
2. IMPELLER LOCKING TOOL

In order to torque the inducer to 85-95 ft-lbs (11.8-13 kg-m), the impeller (rotating assembly) must be kept from rotating. The method used depends on whether the pump uses a straight or tapered inducer.

A. With the straight inducer, the impeller can be held in place by using a strap wrench or hose clamp around the impeller outside diameter and blocking it against rotation while the inducer is torqued. The diffuser and inducer housing are then installed over the inducer and impeller.

B. When the tapered inducer is used, it must be installed after the diffuser and inducer housing are in place. It is not recommended to lock the impeller by inserting a rod thru the diffuser discharge into the impeller since damage to the hardware is likely. The recommended method is to lock the input shaft. Refer to Figure 42 for suggested tool details for both the splined and coupled shaft configurations. (The 90 ft-lb [12.4 kg-m] inducer torque multiplied by the gearbox input/output ratio will result in the torque at the input shaft when the inducer is tightened. Usually this will be 3 or 4 times the inducer torque and cannot be held by hand.)
**CRITICAL STARTUP CHECK LIST**

**KNOW YOUR MACHINE:**

Prior to servicing and start-up of the Sundyne Pump, carefully review the specification sheet, outline drawing, performance curves, and the instruction manual. It is important you become familiar with the pump configuration before starting and operating the pump.

**DRIVER INSTRUCTIONS:**

Follow installation and starting instructions of the driver manufacturer.

**GEARBOX SERVICING:**

Fill gearbox within ¼ inch from top of oil level sight glass with lube oil which conforms to the specifications in Table 6 (Page 18). Operate auxiliary lube pump to fill heat exchanger and filter. Add oil as necessary, approximately seven U.S. quarts (6.8 liters) through fill fitting until oil level stabilizes in sight glass.

**ENVIRONMENTAL CONTROL SYSTEM:**

Install seal environmental control system, if required, and overhead drain piping.

**PRESSURIZE FLUID LOOP:**

Pressurize double seal buffer fluid loop or external seal flush, if required, prior to admitting fluid into pump casing.

**MOTOR ROTATION:**

Rotation must be in same direction as arrow stamped on pump casing.

**START PUMP:**

Start pump with suction valve completely open while throttling discharge valve, to bring pump to design operating point.

**HEAT EXCHANGER:**

Adjust cooling flow to maintain gearbox sump temperature of 140° to 200° F (60° to 93° C).

**CHECK:**

Check total head, flow rate, and power consumption (364 hp max. continuous) against pump specification sheet. Check that specific gravity, viscosity and NPSH are in accordance with specification sheet. These conditions will significantly alter performance of the pump.

**DIFFUSER CAVITY VENT:**

Ensure diffuser cavity vent is open. (Plug must be removed).

**CAUTION**

Note: Process fluid may accumulate causing a potentially hazardous situation if diffuser cavity vent is not properly vented.