Installation, Operation & Maintenance Manual

Sundyne Pumps

Model: LMV-801

SA-07-11-36, Rev Orig.
Jan 2009

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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INTRODUCTION

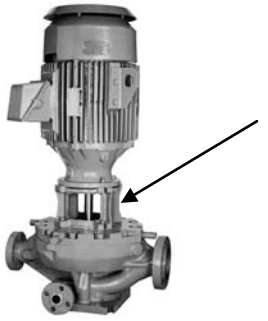
Sundyne Centrifugal Pumps

Sundyne pumps provide high-energy performance and competitive efficiencies in an industrial quality, compact unit that is simple to maintain. Sundyne pumps are single stage. Designed to increase the pressure of a continuous flow of fluid by applying centrifugal action, Sundyne pumps are most commonly used in HPI, CPI, and Boiler Feed applications. Commonly applied in refineries, petrochemical plants, and power generation plants, Sundyne pumps are used in high-head, low-to-medium flow processes. This manual presents installation, servicing, troubleshooting, maintenance, and spare parts information for the latest configuration of Sundyne centrifugal pumps.

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

***Note**: If the pump has a bearing box, the instructions are in a separate manual. The bearing box manual and the pump manual are designed to be used together.*

Extended Motor Shaft Option



Sundyne offers an extended motor shaft for use in extreme temperature conditions. The extended motor shaft and motor adapter separate the motor from the pump. This option is recommended when the process temperature is below 0° F (-18° C) or above 300° F (149° C). This option can be utilized on existing units through a field retrofit.

Text Symbols

The following symbols may be found in the text of this manual. They have the following meanings:

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

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

RECOMMENDED: Text accompanied by this symbol indicates recommended usage.

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

EQUIPMENT USE ALERT: Text accompanied by this symbol indicates that failure to follow directions could result in damage to equipment.

Equipment and Safety Precautions

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

CAUTION

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

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

Wearing Personal Protective Equipment

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

- Safety glasses, with the minimum requirement of side shields, must be worn at all times.
- Steel-toed shoes must be worn when lifting equipment greater than 15 pounds (7 kg) or if pallet jacks or forklifts are operated.
- Hearing protection is strongly recommended at all times when noise levels exceed 85 dB during an eight (8.0) hour period.

***Note**: Chemical resistant gloves must be used if chemical use is required (*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 seals. 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 is required when working on equipment located six feet or higher from the ground.

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

Preventative Machine Guards

Preventative guards must remain in place on all equipment.

***Note**: Only remove the guards while performing maintenance or repair.*

Replace the guards immediately after working on the equipment and prior to start up.

EXPLOSION/FIRE HAZARD

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

Pre-Commission Checklist

Familiarizing Yourself with the Pump

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

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

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

Driver Instructions

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

Verifying Auxiliaries

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

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

Installing a Seal Environmental Control System

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

If required, install drain piping overhead to ensure that the environment operates under normal conditions. For more information, contact Sundyne Corporation.

Checking Driver Rotation

Rotation must be counter-clockwise when looking at the end of the motor.

Piping Connections

Verify that the following bolted or threaded connections are tight:

- Pump flange bolts
- Seal environment piping and port connections
- Pump case drain plug

Start Up Checklist

Pressurizing the Fluid Loop

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

Setting the Valves

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

Control Checklist

Verifying Operating Conditions

Verify the following parameters against the specifications on the Specification sheet:

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

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

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

Installation and Start-Up Checklist

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

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

- ❑ Is all the information underlined above readily available?
- ❑ Are the following bolted/threaded connections tight?
    - Pump flange bolts?
    - Seal environment piping and port connections?
    - Pump case drain plug?
- ❑ Is a check valve installed in the discharge line?
- ❑ Is Port 1 open to atmosphere, or piped to safety drain or flare vent header? (Back pressure must not exceed 5 psig).

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

- ❑ Are all other seal system ports identified and connected according to the outline drawings?
- ❑ Do process conditions, suction pressure, suction temperature, discharge header pressure, and specific gravity agree with specification sheet information? **DO NOT** test the pump on water unless it is designed for water. Check with your representative or Sundyne Corporation if you must test on a different fluid than shown on the specification sheet.
- ❑ Prior to starting the unit, have you opened the suction valve fully and discharge throttled to allow design flow, typically 40-50% open? Check the control valve to be sure it is functional. Inspect the case drain, ports, and flanges for leaks. Has the pump been vented through Port 6. Check suction pressure to be sure it agrees with the specification sheet.
- ❑ Unlock the main driver circuit and bump the motor. Rotation is CCW, as viewed from the top end of the motor. Is rotation correct? Once rotation is verified start the main driver. After commissioning, bumping the motor is not required.
- ❑ If pressure control is being used, throttle the discharge valve immediately after start-up. Does the discharge pressure agree with the specification sheet? If flow control is being used, adjust the valve until flow agrees with the design value listed on the specification sheet.
- ❑ Listen for any unusual noises or pressure fluctuations.

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

INSTALLATION

Inspection

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

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

Storing Your Pump Short-Term

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

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

Storing Your Pump Long-Term

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

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

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

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

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

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

- Humidity
- Temperature
- Surrounding chemicals

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

Recommended Long-Term Storage Procedures

Sundyne recommends that you do the following to prevent damage to your pump during long-term storage:

1. Store your pump only in an indoor, climate controlled building. These conditions will maintain constant temperature and humidity.
2. Perform inert gas purging of component internals.
3. Use desiccant bags.

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

Suction and Discharge Piping

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

1. Install a suction strainer (12 mesh - .062" or 1.6mm opening) and clean the suction line prior to starting the pump. This procedure will protect the impeller from damage by mill scale, welding slag, or other foreign particles during initial startup.

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

2. When installing piping to the pump, ensure that all piping is supported independently from the pump.
3. All piping must always line up with the pump flanges.

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

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

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

5. Never use a suction pipe that is smaller in diameter than the pump suction inlet.
6. Sundyne recommends installation of a discharge check valve to prevent reverse rotation.
7. Use block valves (both suction and discharge) when isolating the pump during shutdown. This practice will minimize process leakage and prevent possible reverse rotation from pump back-flow.
8. It is recommended that suction and discharge pressure gauges be installed on any pump that is not flow controlled. If no flow measuring device is installed there is no way to determine accurately where on its curve the pump is operating.

Seal Environmental Control System

A seal environmental control system may be required depending upon the pump seal arrangement and application.

Always maintain the pump seal environment as detailed on the specification sheet that accompanies each unit.

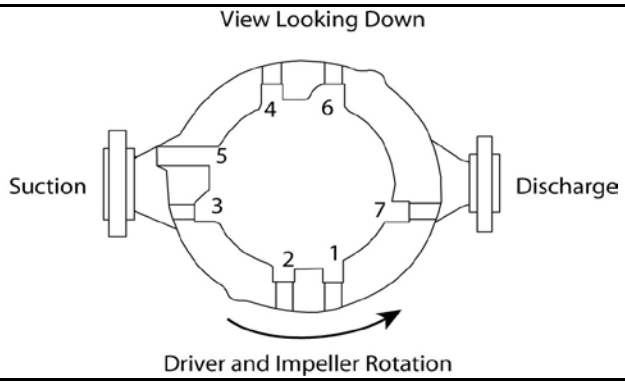
***Note**: For most applications, a standard control system can be obtained from the factory.*

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

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

Figure 1. Seal Housing Port Identification

Port	Description
1	Seal Drain
2	Seal Drain (Single Seal) or Buffer Fluid Out (Double or Tandem Seal)
3	Cooling In
4	Cooling Out
5	Seal Flush (From Separator)
6	Seal Flush and/or Vent
7	Seal Drain (Single Seal) or Buffer Fluid In (Double orTandem Seal)



Liquid Buffer System

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

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

START UP

Start-Up Procedures

Perform the following tasks to start the Sundyne pump.

1. Run-in of pump: If the pump is to be run under conditions which are considerably different from those conditions listed on the spec sheet (such as a change in specific gravity, suction pressure, flow rate, etc.) the factory should be consulted to ensure that the run-in conditions are compatible with the pump.
2. Check to ensure that the driver has been serviced per instructions provided by the driver manufacturer.
3. Auxiliaries - Check utility connections; verify that auxiliary piping is per Sundyne drawings; verify switch and instrument connections and set points; calibrate flow instruments and other transmitters.
4. Flushing screens should be installed in all field assembled piping connections.
5. Check the pump specification sheet and outline drawings for seal environment requirements. Be sure seal housing port piping is properly connected. If double seals are used, buffer fluid must be pressurized before suction pressure is applied to the pump. Port 1 must be open. Maximum allowable backpressure on port 1 is 5 psig (0.35 kg/cm²). If port 6 is not used for a seal flush, it is recommended that a hand bleed valve be installed at this location. Bleed air and vapor before starting.
6. Jogging is used to verify proper direction of rotation for the main driver.

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

Controlling the Pump During Startup

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

Single Operation

1. Start the pump with the suction valve open while throttling the discharge valve. This will ensure that the pump will reach the design flow operating point.
2. If the process fluid is near its vapor pressure, open the supply vessel seal cavity vent so that the pump can fill with liquid.

Parallel Operation

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

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

1. Start the first unit as described in the Single Operation instructions.
2. Start the second unit with the bypass valve set to maintain the flow above minimum flow.
3. Open the discharge valve on the second unit so that the design flow of both units is maintained.

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

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

OPERATION & CONTROL

Operation of Sundyne Pumps

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

Suction Conditions

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

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

Minimum Flow Conditions

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

- Internal flow separations
- Recirculation at low flow conditions

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

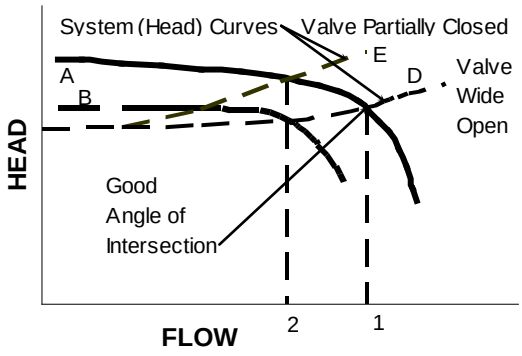
Entrained Gases

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

System Head Curve

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

Figure 2. Typical Operation



Note: *The curve for pump A has a significant angle of intersection with system curves D and E. The system curve D could represent a system with the control valve wide open while curve E could represent the same system but with the throttle valve closed to reduce flow from flow 1 to flow 2. Pump curve B, on the other hand, will provide only flow 2,*

even with the control valve wide open (curve D). When the control valve is partially closed to create system curve E, the curve E and lower pump curve B are practically parallel. The lack of a significant angle of intersection means that the system is unstable; pump flow is likely to fluctuate erratically and not respond to control valve position.

Parallel Operation

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

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

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

Figure 3. Parallel Operation

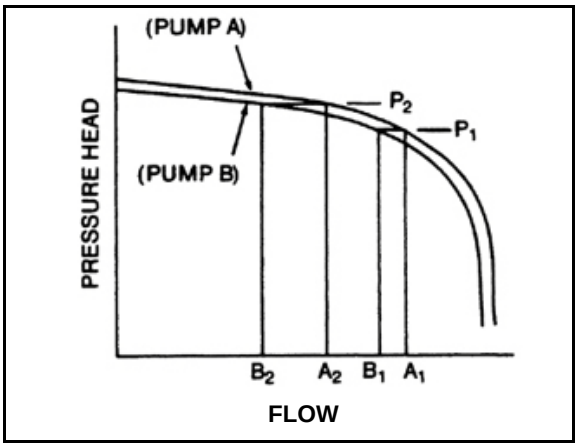
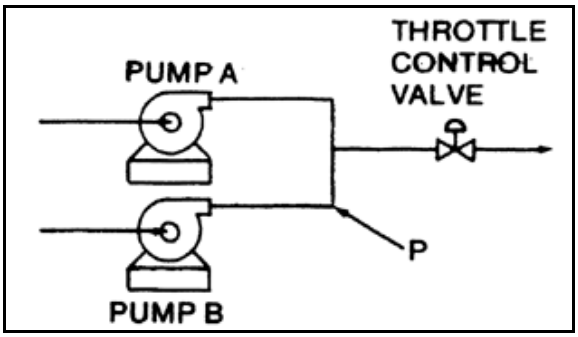


Figure 4. Parallel Units Common Valve



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

MAINTENANCE

Disassembling the LMV-801

The following procedures apply to all configurations of the LMV-801 process pump including the extended motor shaft and bearing box options. Refer to the specification sheet to determine your specific pump configuration and optional equipment included. Disassembly should be done only to the extent necessary for repair.

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

PART	ITEM NO.	QTY.
Impeller Tab washer	5	1
O-ring Repair Kit	--	1
Thermal Barrier Gasket	87A	1

STEP 1

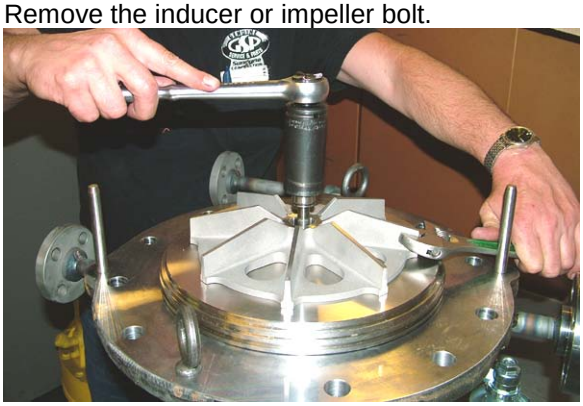
Remove the motor, bearing box and/or extended motor shaft adapter (if applicable), and seal housing from the pump casing.

Bearing box

Adapter for extended motor shaft

STEP 2

Remove the inducer or impeller bolt.

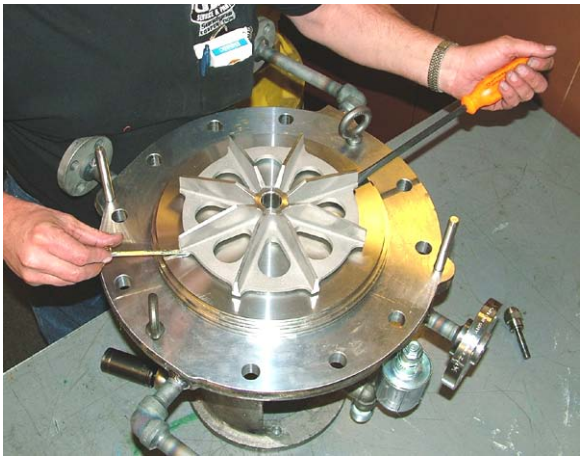


***Note:** Left hand thread.*

***Note**: Restricting the impeller from moving will be necessary.*

STEP 3

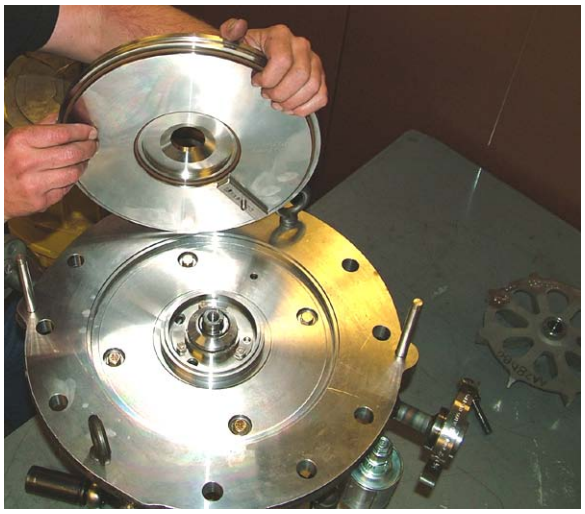
Remove the impeller by prying gently with two screwdrivers.



***Note**: The impeller is dynamically balanced and should be replaced if it shows any sign of damage.*

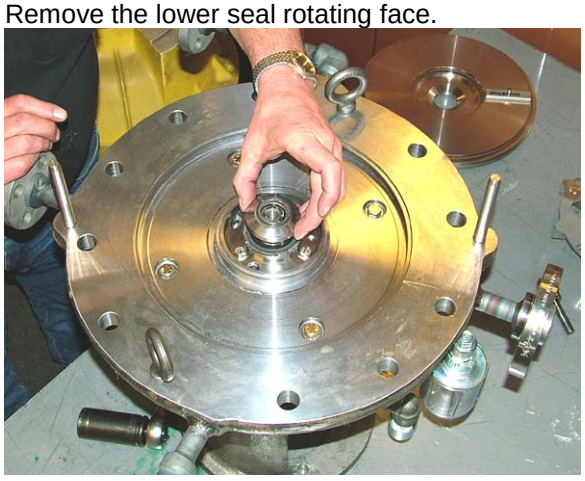
STEP 4

Remove the diffuser cover.



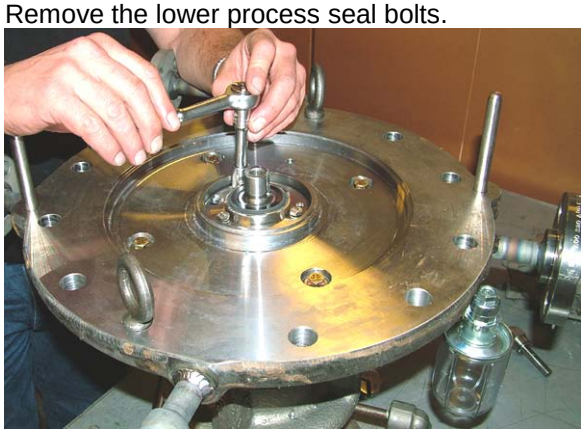
STEP 5

Remove the lower seal rotating face.



STEP 6

Remove the lower process seal bolts.



STEP 7

Remove the lower process seal.

STEP 8

Remove the lower shaft sleeve and o-ring.

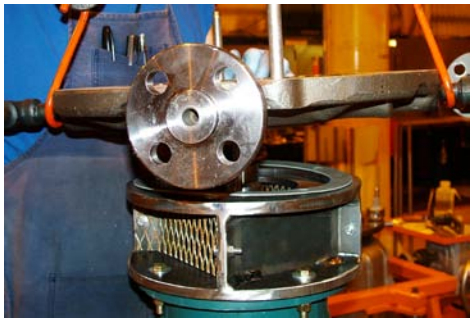
STEP 9

Remove the seal housing bolts.

STEP 10

Remove the seal housing from the motor, bearing box or extended motor shaft adapter, as applicable.

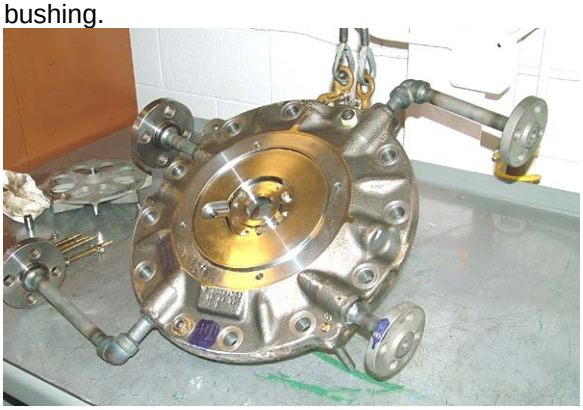
Seal housing with bearing box shown.



Seal housing with extended motor shaft adapter shown.

STEP 11

Remove upper process seal or the throttle bushing.



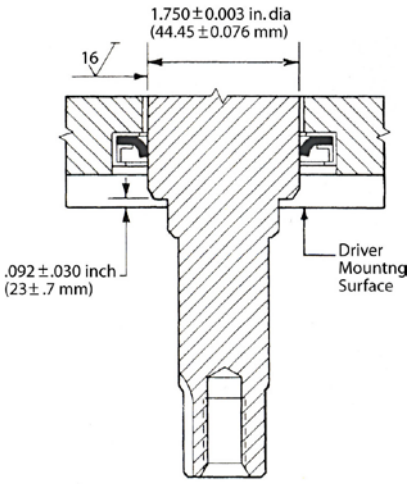
Inspection, Cleaning, & Shimming the Extended Motor Shaft

Shaft and Lip Seal

Inspect the lip seal (115A) and driver shaft for wear. Replace the lip seal and repair the shaft if required. Shaft size in the lip riding area to be 1.750 ± 0.003 inches (44.45 ± 0.076mm) diameter with 16 RMS or better surface finish.

Check the driver shaft for proper axial position. The shaft shoulder, which controls the position of the shaft sleeve, seal rotating face and impeller, must be recessed .092 ± .030 inches above the flange face as shown in the figure below. Impeller rub and seal leakage will result if this dimension is not held.

Figure 5. Driver Shaft Position



Extended Motor Shaft - Shoulder Dimension

This section to be used with Reassembling the LMV-801 section, steps 3 and 4.

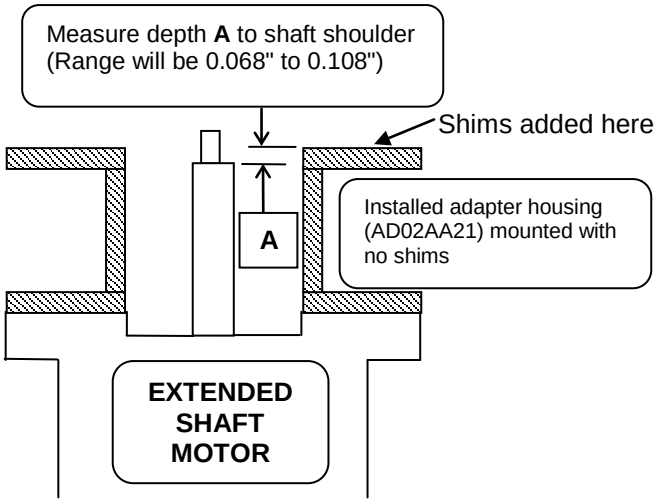
The shaft shoulder dimension A as shown in figure 6 must be measured as described below.

The motor must be positioned vertically with the shaft pointing upwards.

Measure the shaft shoulder dimension A, from the face of the motor adapter to the shaft shoulder. This dimension can be measured using a parallel bar and depth micrometer or tool # T-GA-010.

Dimension A is then used to determine the number of shims required per table in Figure 6.

Figure 6. Shoulder Dimension



Dimension A	Number of 0.010" (0.25mm) Shims Required
0.098" to 0.108" incl (2.49mm to 2.74mm incl)	0
0.088" to 0.097" incl (2.24mm to 2.48mm incl)	1
0.078" to 0.087" incl (1.98mm to 2.23mm incl)	2
0.068" to 0.077" incl (1.73mm to 1.97mm incl)	3

Shaft Sleeve

Ensure that there are no high spots on the end surfaces of the shaft sleeve or the impeller hub. High spots will distort the seal rotating face due to the clamping force of the impeller bolt. Ensure that shaft sleeve end faces are parallel within 0.0003” (.0076mm). Shaft sleeve end faces can be lapped to achieve the flatness required.

Note: *Shaft sleeve ends that are out of parallel beyond specification can contribute to mechanical seal leakage due to mating ring clamped against sleeve being out of square.*

Mechanical Seal

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

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

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

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

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

Reassemble the seal, throttle bushing, if used seal housing, and impeller using an o-ring repair kit. All o-rings that were disturbed by disassembly should be replaced. During reassembly, carefully check the torque values listed in Table 3.

The impeller may rub on the diffuser cover plate (15) until o-rings (936D and 936E) are compressed by tightening hex nuts (914A). Check the shaft for freedom of rotation after the pump is assembled and all bolts are tightened per Table 3.

Reassembling the LMV-801

The following procedures apply to the LMV-801 process pump single seal arrangement. For differences in the double and tandem seal arrangements see the seal arrangement drawings later in this manual. Refer to the specification sheet to determine your specific pump configuration and optional equipment included.

STEP 1

Install throttle bushing.

STEP 2 (Extended shaft motors only)

Mount the adapter to the motor.

Note: Ensure there are no shims or thermal barrier gaskets between the motor and the adapter.

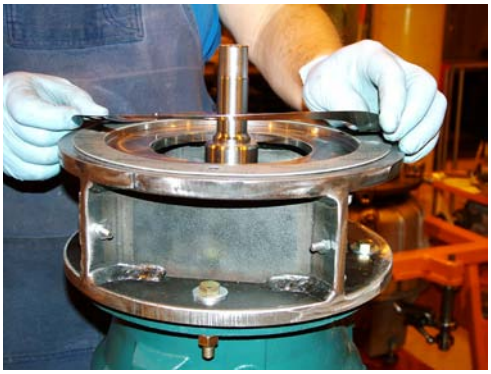
Torque bolts to 40 ft-lb.

STEP 3 (Extended shaft motors only)

Check the shaft shoulder dimension to determine number of shims required.
See previous section and figure 6, for method and table to determine the correct number of shims.

STEP 4 (Extended shaft motors only)

Install the alignment pin into the adapter. Install thermal barrier gasket and shims as required.



Installing the shim.

STEP 5

Install shaft sleeve on motor, bearing box or extended shaft motor adapter, as applicable.

STEP 6

Install the thermal barrier gasket (if not previously installed) and seal housing on the bearing box or extended shaft motor adapter. Torque to 40 ft-lbs.

Seal housing being installed onto bearing box.

Seal housing being installed onto extended motor shaft adapter.

STEP 7

Install the lower shaft sleeve o-ring.

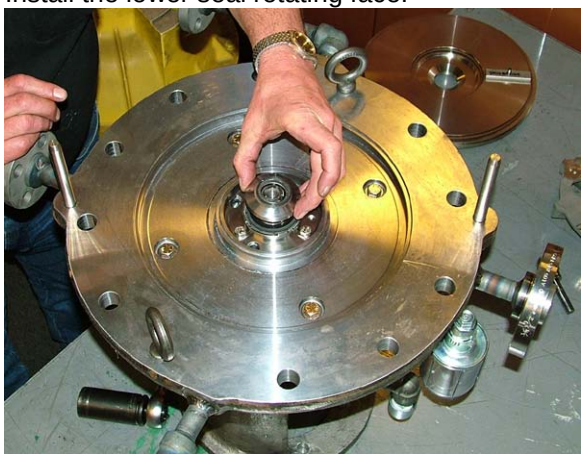
STEP 8

Install the lower process seal and bolts.

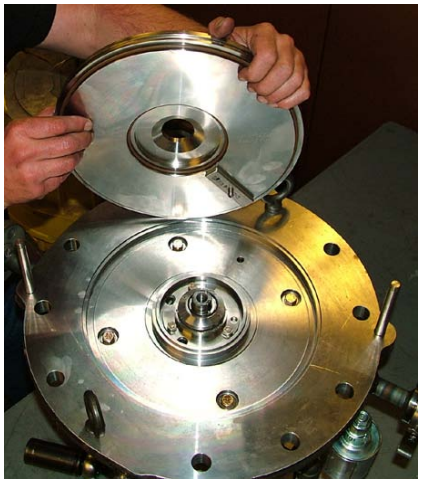
Lower process seal.

Tightening the bolts on the lower process seal.

STEP 9
Install the lower seal rotating face.



STEP 10
Install the inducer cover and o-rings, 936D and 936E.



STEP 11
Install the inducer or impeller bolt and 936G o-ring.

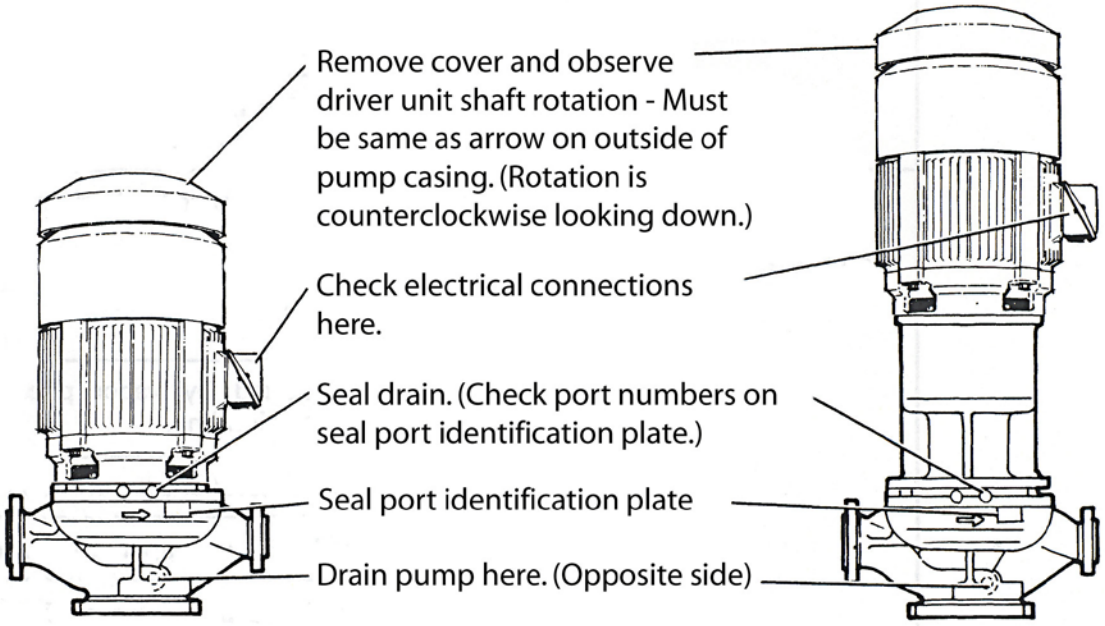
Torque impeller or inducer to 36-40 ft-lbs.

STEP 12
Install diffuser and o-rings 936B and 936C.

STEP 13
Install the seal housing and bearing box or extended motor shaft adapter (as applicable) onto the pump casing.

Pump, seal housing, and bearing box shown.

Figure 7. Service Check Points



TROUBLESHOOTING

Pump Diagnostics

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

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

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

Table 1. Pump Diagnostics

Situation/Symptom	Possible Cause	Investigative/Corrective Action
No flow, no pressure at start-up.	Pump not completely filled with liquid.	Bleed all vapor or air from port 6. Allow more cool-down time if pumping low temperature fluid. Check suction line for air leak if suction pressure is lower than atmospheric.
	NPSH actually lower than NPSH requirement listed on specification sheet.	Suction line blocked – check suction screen and valve. Excessive pressure drop through suction piping. Flow restricted by vapor pockets in high points of suction line. Suction tank level or pressure too low. Entrained air or vapor in pumped fluid. NPSH reduced by presence of more volatile fluid in process fluid.
	Failure of drive component, such as interconnecting shaft or impeller key, or item missing from assembly.	Disassemble and inspect.
	Reverse direction of rotation.	Direction of driver shaft rotation must be as shown by arrow on pump casing. Note: Impeller and driver rotate in the same direction.
Insufficient total head.	Flow too high.	Check total head and flow rate against performance curve.
	Wrong direction of driver shaft rotation. (It is possible for the pump to develop greater than 50 percent design total head in this condition).	Direction of driver shaft rotation must be as shown by arrow on pump casing. Note: Impeller and driver rotate in the same direction.
	NPSH actually lower than NPSH requirement listed on specification sheet.	Refer to solutions listed under “No flow, no pressure at start-up”.
	Flow too low, causing overheating of fluid resulting in internal boiling and unstable pump operation.	Increase through-flow rate. Bypass part of pump discharge to supply tank.
	Diffuser discharge throat partially plugged or impeller damaged by passage of a solid particle.	Clean these areas of all obstructions and restore surfaces to a smooth polished finish free of all corrosion pitting. Edge of diffuser throat must be sharp.

Situation/Symptom	Possible Cause	Investigative/Corrective Action
Insufficient total head cont.	Corrosion and/or erosion of diffuser throat (may also be accompanied by corrosion/ erosion of diffuser and cover surface adjacent to impeller).	If edge of throat is no longer sharp and smooth or has opened in size, head-rise may be reduced. Opening of the inlet area of the throat will result in higher flow rate and horsepower consumption. Corrosion/erosion of diffuser and cover surfaces will result in a significant horsepower increase.
	Excessive recirculation from discharge to inlet.	Check flow through external plumbing. Pump o-ring (936C) damaged or missing. Integral centrifugal separator orifice worn.
	Process fluid specific gravity or viscosity different from values shown on specification sheet.	Check actual viscosity and specific gravity at operating temperature. Viscosity higher than five centipoise will cause reduced head and flow and increased power consumption.
	Driver speed too low.	Check speed against value listed on specification sheet.
	Pressure gauges or flow meters in error	Calibrate instrumentation.
Driver overloaded.	Fluid specific gravity or viscosity higher than values listed on specification sheet.	Check actual viscosity and specific gravity against value listed on specification sheet.
	Electrical failure in electric driver.	Check circuit breaker heater size and setting. Check voltage and voltage balance between phases. Current for each phase should be balanced within three percent.
	Mechanical failure in driver or pump.	Remove driver and check for freedom of rotation, correct spacing of pump shaft assemblies. Remove fluid end and search for any mechanical failure.
	Corrosion pitting on surface of diffuser cover or diffuser, adjacent to impeller blades. Head rise is also reduced by this condition.	Disassemble pump and inspect. Rough or pitted surfaces can cause friction losses which will significantly increase horsepower consumption. Clean these areas of all obstruction and restore surfaces to a smooth polished finish. Check diffuser throat area at the inlet; erosion or corrosion resulting in roughness or increased area will increase horsepower consumption. Note: A larger throat size than design will allow a higher flow and horsepower for a given head rise.
Excessive discharge pressure pulsations.	Flow rate too low.	Increase flow rate through pump. Add bypass to suction tank if necessary.
	Insufficient NPSH available.	Refer to solution for insufficient NPSH under “No flow, no pressure at startup,” above.
	Defective flow control valve.	Check control valve.

Pump Mechanical Seal Diagnostics

The following table contains diagnostic information that is applicable to single seal, double seal, and tandem seal equipped units.

Repair procedures for mechanical seals are listed in this manual under Maintenance.

Table 2. Pump Mechanical Seal Diagnostics

Situation/Symptom	Possible Cause	Investigative/Corrective Action
Sudden increase in seal leakage.	Severe cavitation or loss of suction causing vibration and bouncing of seal face.	Correct pump suction condition causing cavitation. Bleed vapor from seal cavity and restart. Install double seal if loss of suction cannot be prevented.
	Seal icing on low temperature pumps or icing when handling fluids which vaporize at a temperature of less than +32°F (0°C) at atmospheric pressure	Quench with compatible fluid which will not freeze at pump temperature through seal drain port 2 or 7 to prevent ice formation on atmospheric side of seal during start-up and in running condition. Use purge of dry nitrogen gas through ports 2 or 7. Install double or tandem seal if ice is caused by water in process fluid or supply external seal flush of compatible fluid which does not contain water.
	Solid particles in seal cavity or seal spring area (seal faces usually have rough scratched appearance).	Inspect for clogged integral centrifugal separator orifices. Clean orifices if necessary (plan 31 if so equipped.) Supply external clean seal flush or double seal if particles cannot be removed by separator.
	Seal stationary face spring action is rough and sticky.	If parts are corroded, replace with parts made from compatible materials. If formation of solids causes sticky seal analyze fluid properties. Use external seal flush or double seal arrangement.
	Worn or damaged seal.	Disassemble seal and rebuild or replace per instructions in maintenance section.
	Wear pattern on seal rotating faces not uniform.	Lightly lap surfaces of shaft sleeve and impeller hub which contact rotating seal face to remove high spots. Install new seal faces.
	Wear pattern on stationary face smooth but not uniform.	Lap flat or replace seal.
	Edges of stationary face chipped and seal face worn. (Vapor flashing in seal cavity will cause excessive wear and/or cracking of rotating face.)	Install seal cavity bypass to suction tank. Prevent loss of pump suction. Supply cool seal flush. Install double seal.
	Seal rotating face cracked or broken. May be caused by damage at assembly or thermal shock caused by seal running dry.	Prevent loss of pump suction or supply continuous external seal flush. Install double seal.

Situation/Symptom	Possible Cause	Investigative/Corrective Action
	Chemical attack of seal faces, seal parts or o-rings.	Investigate fluid properties and determine suitable materials for replacement.
	Damage to mechanical seal secondary seal (Teflon® wedge or U-cup or elastomer o-ring).	Check for erosion and/or corrosion attack. Install seal flush or double seal arrangement.

SPECIFICATIONS

Table 3. Torque Values

Gearbox ***Sundyne Standard Steel Screws & Bolts and NACE Compliant Steel Screws/Bolts (BG Material)***				
			Torque Values	
Item #	**Location**	**Size**	**English**	**Metric**
905H	Oil Filter Manifold	3/8 - 16 x 1/2	22 - 25 ft-lbs	30 - 34 N-m
905L	Gearbox Seal	1/4 - 20 x 1/2	75 - 80 in-lbs	8.5 - 9.0 N-m
905M, N	Journal Bearings	#10 - 24 x 1	35 - 40 in-lbs	4.0 - 4.5 N-m
905T	Chemical Barrier Gasket	1/4 - 20 x 5/8	75 - 80 in-lbs	8.5 - 9.0 N-m
909B	Gearbox Halves	1/2 - 13 x4	60 - 65 ft-lbs	81 - 88 N-m
909C	Gearbox Halves, Alignment	5/8 - 18 x 4 17/64	60 - 65 ft lbs	81 - 88 N-m
906B	Sight Glass	#8 - 32 x 1/2	10 - 12 in-lbs	1.0 - 1.4 N-m
Pumps & Compressors* ***Sundyne Standard Steel Screws and Bolts***				
			Torque Values	
Item #	**Location**	**Size**	**English**	**Metric**
3	Impeller Bolt/Inducer:			
	LMV/BMP-801, 802, 806, 322, 311, 331	1/2 - 20	36 - 40 ft-lbs	49 - 54 N-m
	LMV/BMP-341, 346	1/2 - 20	65 - 70 ft-lbs	88 - 95 N-m
	LMV-313, 343, BMP-338, 348 (High Flow)	3/4 - 10	85 - 90 ft-lbs	115-122 N-m
	LMC/BMC 3X1P, 3X1F, 3X3, 3X6P, 3X7	1/2 - 20	36 - 40 ft-lbs	49 - 54 N-m
906D	Diffuser Attaching Screws	1/4 - 20	95 - 102 in-lbs	11 - 11.5 N-m
905E	Mechanical Seal No. Spacer	1/4 - 20 x 12	95 - 102 in-lbs	11 - 11.5 N-m
905F	Throttle Bushing/Mechanical Seal	1/4 - 20 x 12	95- 102 in-lbs	11 - 11.5 N-m
905G	Double Seal with Spacer	1/4 - 20 x 3/4	95 - 102 in-lbs	11 - 11.5 N-m
914A	Case Nuts	3/4 - 10	250 - 275 ft-lbs	340 - 375 N-m
914A	Case Nuts	7/8 - 9	300 - 330 ft-lbs	405 - 445 N-m
905A	Seal Housing to Gearbox	3/8 - 16 x 1 3/4	35 - 40 ft-lbs	47 - 54 N-m
905P	Separator	1/4 - 20 x 5/8	95 - 102 in-lbs	11 - 11.5 N-m
Pumps & Compressors ***NACE Compliant Steel Screws / Bolts (BG Material)***				
			Torque Values	
Item #	**Location**	**Size**	**English**	**Metric**
3	Impeller Bolt/Inducer:			
	LMV/BMP-801, 802, 806, 322, 311, 331	1/2 - 20	36 - 40 ft-lbs	49 - 54 N-m
	LMV/BMP-341, 346	1/2 - 20	65 - 70 ft-lbs	88 - 95 N-m
	LMV-313, 343, BMP-338, 348 (High Flow)	3/4 - 10	85- 90 ft-lbs	115 - 122 N-m
	LMC/BMC 3X1P, 3X1F, 3X3, 3X6P, 3X7	1/2 - 20	36 - 40 ft-lbs	49 - 54 N-m
906D	Diffuser Attaching Screws	1/4 - 20	70 - 75 in-lbs	8.0 - 8.5 N-m
905E	Mechanical Seal No. Spacer	1/4 - 20	70 - 75 in-lbs	8.0 - 8.5 N-m
905F	Throttle Bushing/Mechanical Seal	1/4 - 20	70 - 75 in-lbs	8.0 - 8.5 N-m
905G	Double Seal with Spacer	1/4 - 20	70 - 75 in-lbs	8.0 - 8.5 N-m
914A	Case Nuts	3/4 - 10	160 - 200 ft-lbs	217 - 270 N-m
914A	Case Nuts	7/8 - 9	225 - 245 ft-lbs	305 - 332 N-m
905A	Seal Housing to Gearbox	3/8 - 16 x 1 3/4	27 - 30 ft-lbs	37 - 40 N-m
905P	Separator	1/4 - 20 x 5/8	70 - 75 in-lbs	8.0 - 8.5 N-m
* When using Teflon® o-rings, allow 15 minutes between torquing for the Teflon® to cold flow. Repeat torquing until there is no change in torque.				

***Note**: When using PTFE o-rings, allow 15 minutes between repeated torquing for the PTFE to cold flow. Repeat until there is no change in the torque value.*

Common Parts List

(Not Dependent on Seal Arrangement)

Table 4. Common Parts List

Item No.	Part Name	Qty	Item No.	Part Name	Qty
1	Pump Casing	1	911	Stud	12
2	Impeller	1	914A	Hex Nut	12
3	Impeller Bolt	1	916S	Washer	4
4	Impeller Key	*1	918A	Pin	1
5	Impeller Tab Washer	*1	924B	Bull Plug	1
9	Inducer (Optional)	1	924D	Bull Plug	1
10	Inducer Stud (Optional)	1	936A	O-ring Packing	*1
13	Diffuser	1	936B	O-ring Packing	*1
14A	Locating Pin	2	936C	O-ring Packing	*1
15	Diffuser Cover	1	936D	O-ring Packing	*1
914B	Hex Nut	4	936E	O-ring Packing	*1
115A	Shaft Seal	1	936F	O-ring Packing	*1
30	Seal Housing	1	936G	O-ring Packing	*1
87A	Spacer (or Thermal Barrier Gasket)	1	981	Baffle Plate	1
905A	Hex Head Cap Screw	4			

*Recommended spare parts.

Single Seal Arrangement and Parts

Figure 8. Single Seal Arrangement

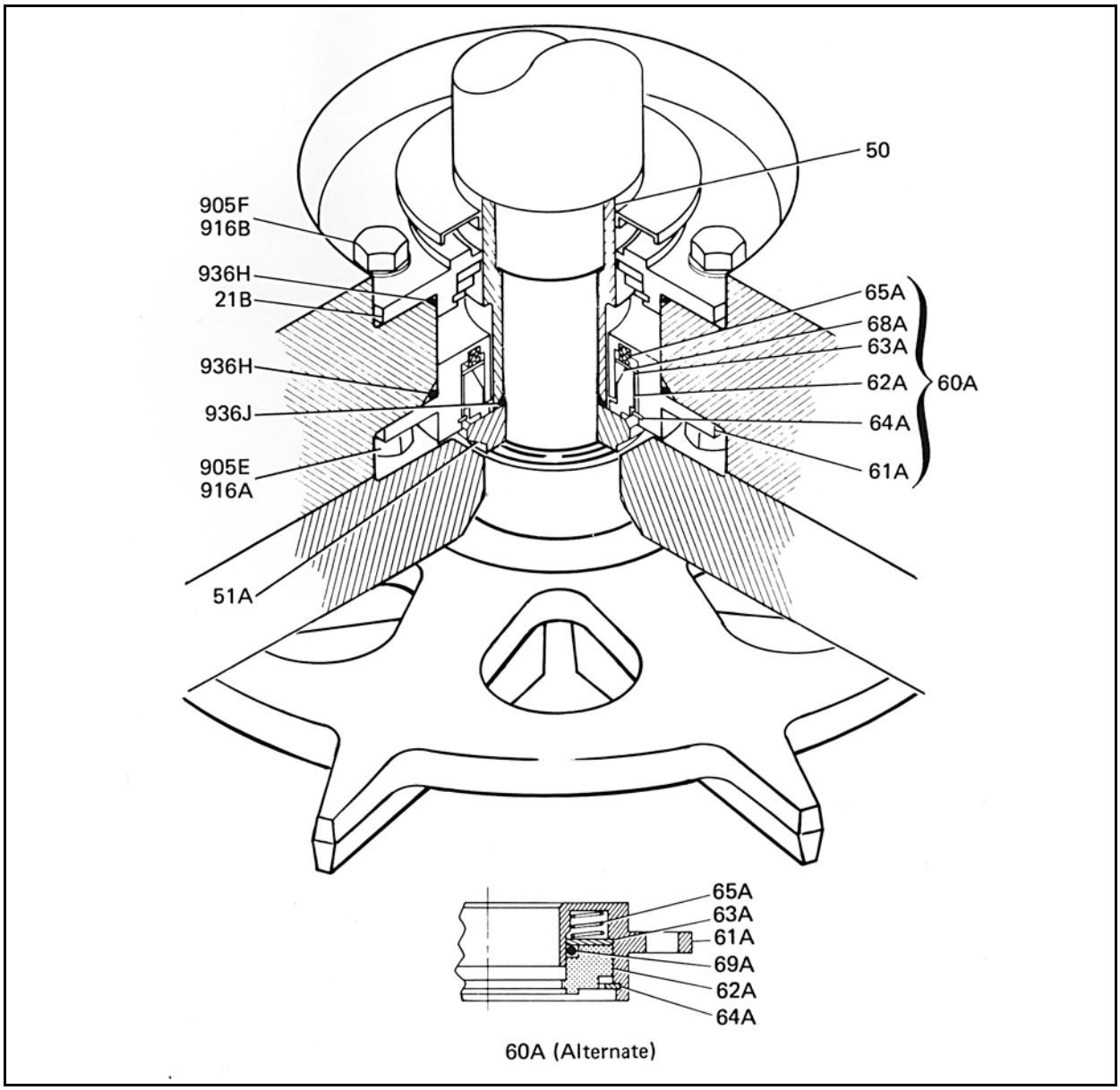


Table 5. Single Seal Arrangement

Item No.	Part Name	Qty.	Item No.	Part Name	Qty.
21B	Throttle Bushing (Upper)	*1	62A	- Seal Face Washer	**1
50	Slinger Sleeve Assembly	*1	63A	- Seal Spring Backup Disc	**1
51A	Seal Rotating Face	*1	64A	- Seal Retaining Ring	**1
60A	Mechanical Seal	*1	65A	- Seal Spring	**6
61A	- Retainer and Drive Sleeve Assembly	1	69A	- O-ring Packing	**1
62A	- Seal Face Washer	**1	905E	Hex Head Cap Screw	3
63A	- Seal Spring Backup Disc	**1	905F	Hex Head Cap Screw	3
64A	- Seal Retaining Ring	**1	916A	Washer	3
65A	- Seal Spring	**6	916B	Washer	3
68A	- Seal Wedge Ring	**1	936H	O-ring Packing	*2
60A	Mechanical Seal (Alternate)	*1	936J	O-ring Packing	*1
61A	- Retainer and Drive Sleeve Assembly	1			

*Recommended Spare Parts

**Recommended Seal Spare Component Parts (Contained in Mechanical Seal Repair Kit)

Double Seal Arrangement and Parts

Figure 9. Double Seal Arrangement

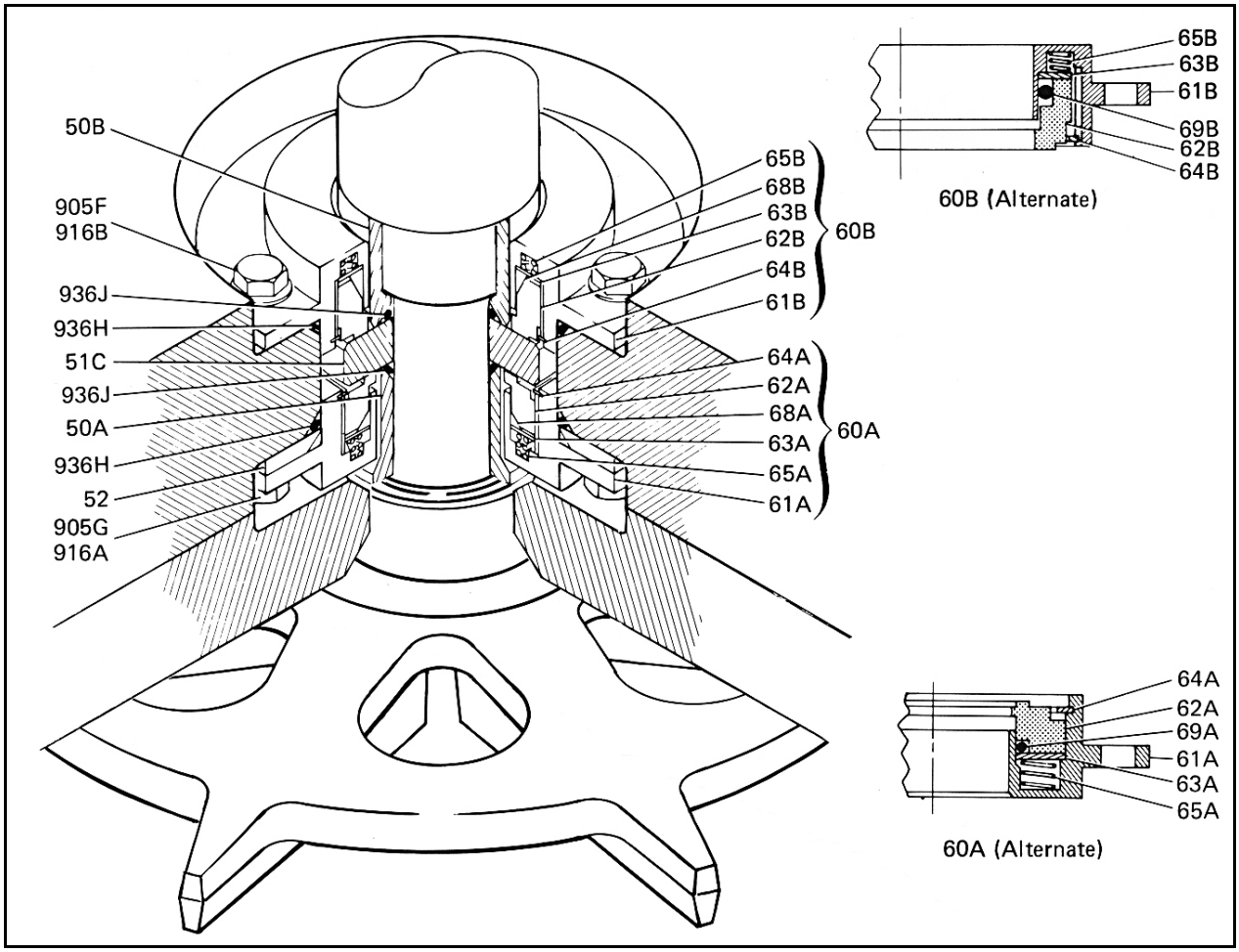


Table 6. Double Seal Arrangement

Item No.	Part Name	Qty.	Item No.	Part Name	Qty.
50A	Shaft Sleeve (Lower)	*1	61B	- Retainer & Drive Sleeve Assembly	1
50B	Shaft Sleeve (Upper)	*1	62B	- Seal Face Washer	**1
51C	Seal Rotating Face	*1	63B	- Seal Spring Backup Disc	**1
52	Seal Spacer	1	64B	- Seal Retaining Ring	**1
60A	Mechanical Seal (Lower)	*1	65B	- Seal Spring	**6
61A	- Retainer & Drive Sleeve Assembly	1	68B	- Seal Wedge Ring	**1
62A	- Seal Face Washer	**1	60B	Mechanical Seal (Alternate)	*1
63A	- Seal Spring Backup Disc	**1	61B	- Retainer & Drive Sleeve Assembly	1
64A	- Seal Retaining Ring	**1	62B	- Seal Face Washer	**1
65A	- Seal Spring	**6	63B	- Seal Spring Backup Disc	**1
68A	- Seal Wedge Ring	* *1	64B	- Seal Retaining Ring	**1
60A	Mechanical Seal (Alternate)	*1	65B	- Seal Spring	**6
61A	- Retainer & Drive Sleeve Assembly	1	69B	- O-ring Packing	**1
62A	- Seal Face Washer	**1	905F	Hex Head Cap Screw	3
63A	- Seal Spring Backup Disc	**1	905G	Hex Head Cap Screw	3
64A	- Seal Retaining Ring	**1	916A	Washer	3
65A	- Seal Spring	* *6	916B	Washer	3
69A	- O-ring Packing	**1	936H	O-ring Packing	*2
60B	Mechanical Seal (Upper)	*1	936J	O-ring Packing	*2

*Recommended Spare Parts

**Recommended Seal Spare Component Parts (Contained in Mechanical Seal Repair Kit)

Tandem Seal Arrangement and Parts

Figure 10. Tandem Seal Arrangement

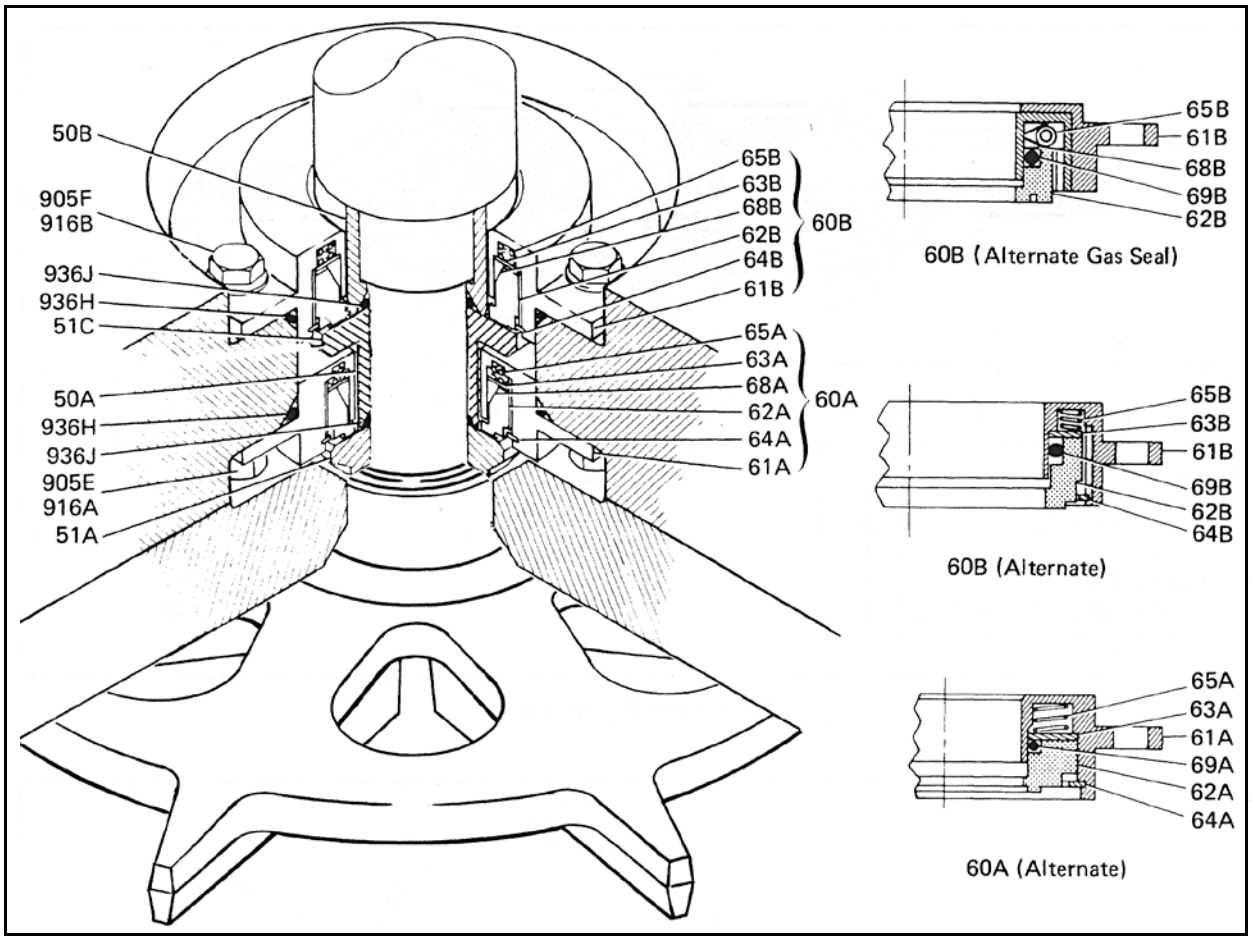


Table 7. Tandem Seal Arrangement

Item No.	Part Name	Qty.	Item No.	Part Name	Qty.
50A	Shaft Sleeve (Lower)	*1	64B	- Seal Retaining Ring	**1
50B	Shaft Sleeve (Upper)	*1	65B	- Seal Spring	**6
51A	Seal Rotating Face	*1	68B	- Seal Wedge Ring	**1
51C	Seal Rotating Face	*1	60B	Mechanical Seal (Alternate)	*1
60A	Mechanical Seal (Lower)	*1	61B	- Retainer & Drive Sleeve Assembly	1
61A	- Retainer & Drive Sleeve Assembly	1	62B	- Seal Face Washer	**1
62A	- Seal Face Washer	**1	63B	- Seal Spring Backup Disc	**1
63A	- Seal Spring Backup Disc	**1	64B	- Seal Retaining Ring	**1
64A	- Seal Retaining Ring	**1	65B	- Seal Spring	**6
65A	- Seal Spring	**6	69B	- O-ring Packing	**1
68A	- Seal Wedge Ring	**1	60B	Mechanical Seal (Gas Seal)	*1
60A	Mechanical Seal (alternate)	*1	61B	- Seal Retainer	1
61A	- Retainer & Drive Sleeve Assembly	1	62B	- Seal Face Washer	**1
62A	- Seal Face Washer	**1	65B	- Garter Spring	**1
63A	- Seal Spring Backup Disc	**1	68B	- Backing Ring	**2
64A	- Seal Retaining Ring	**1	69B	- O-ring Packing	**1
65A	- Seal Spring	**6	905E	Hex Head Cap Screw	3
69A	- O-ring Packing	**1	905F	Hex Head Cap Screw	3
60B	Mechanical Seal (Upper)	*1	916A	Washer	3
61B	- Retainer & Drive Sleeve Assembly	1	916B	Washer	3
62B	- Seal Face Washer	**1	936H	O-ring Packing	*2
63B	- Seal Spring Backup Disc	**1	936J	O-ring Packing	*3

*Recommended Spare Parts

**Recommended Seal Spare Component Parts (Contained in Mechanical Seal Repair Kit)

Inducer & Parts

Figure 11. Optional Equipment

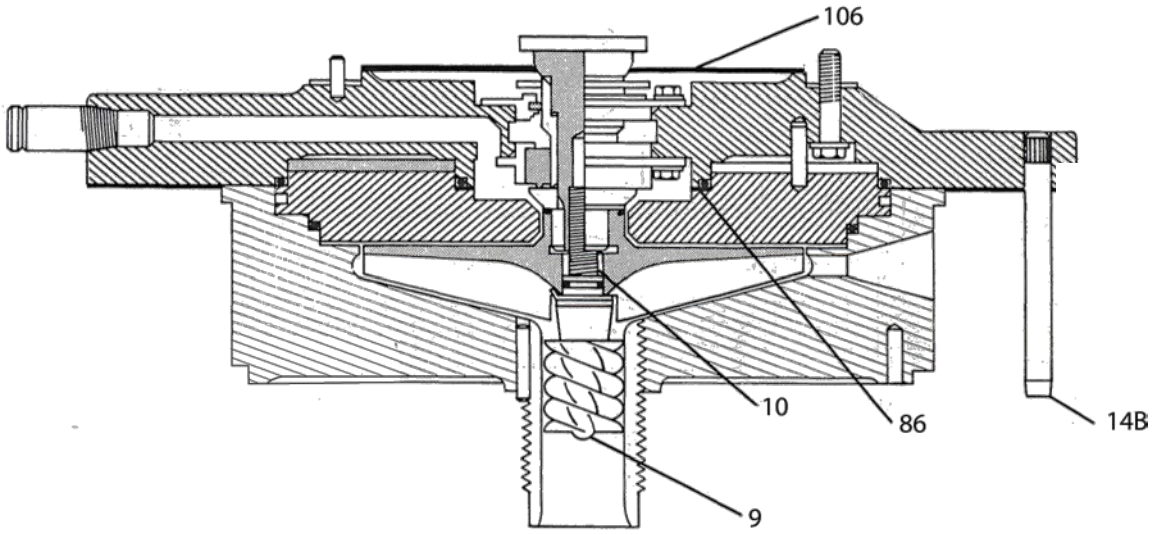


Table 8.

Item Number	Part Name	QTY.
9	Inducer	1
10	Inducer Stud	1
14B	Alignment Pin	2
86	Cover Gasket	1
106	Chemical Barrier Gasket	1

Diffuser Cone Extension

Figure 12. Diffuser Cone Extension

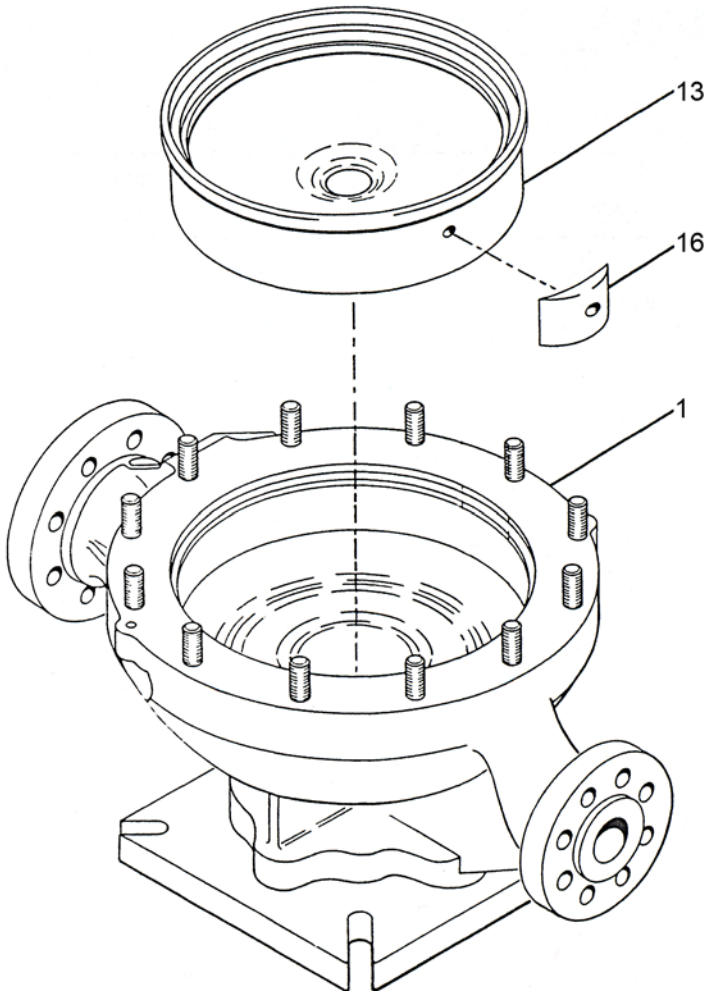
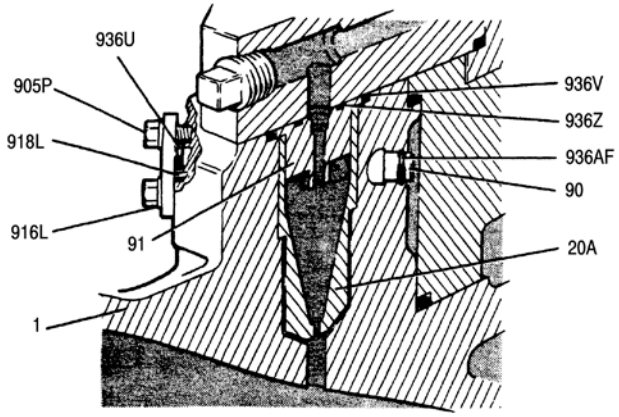


Table 9.

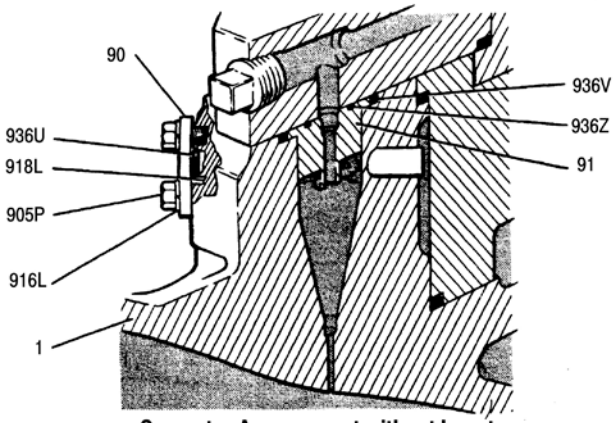
Item Number	Part Name	Qty.
1	Pump Case	1
13	Diffuser	1
16	Diffuser Extension	1

Integral Centrifugal Separator

Figure 13. Integral Centrifugal Separator



Separator Arrangement with Insert



Separator Arrangement without Insert

Table 10. Integral Centrifugal Separator Parts List

Item No.	Part Name	Qty.	Item No.	Part Name	Qty.
1	Pump Casing	1	918L	Pin	1
20A	Separator Insert	1	936U	O-ring Packing	*1
90	Separator Orifice	1	936V	O-ring Packing	*1
91	Separator Fitting	1	936Z	O-ring Packing	*1
905P	Hex Head Cap Screw	2	936AF	O-ring Packing	*1
916L	Washer	2			
*Recommended Spare Parts					

Extended Motor Shaft Adapter

Figure 14. Extended Motor Shaft Adapter

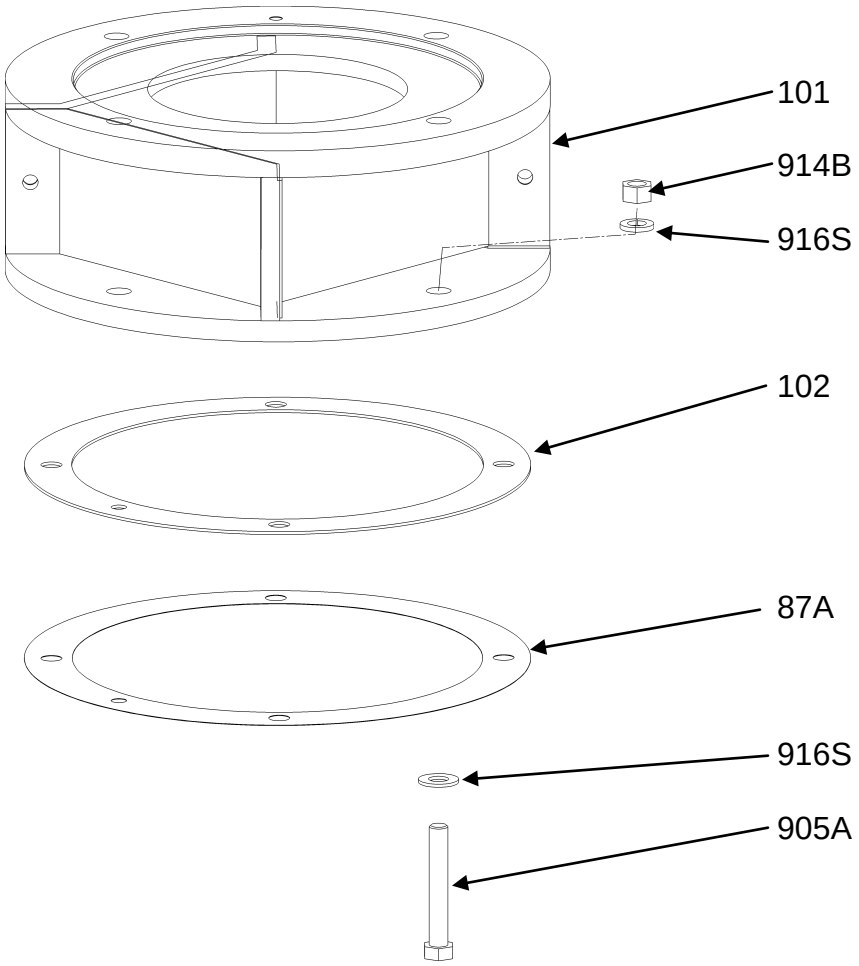


Table 11. Extended Motor Shaft Adapter Parts List

Item No.	Part Name	Qty.
101	Adapter, Extended Motor Shaft	1
102	Shims	As required
87A	Thermal Barrier Gasket	1
905A	Hex Head Cap Screw	4
916S	Washer, lock 3/8”	4
916S	Washer, flat 3/8”	4
914B	Nut, hex 3/8”-16	4

Recommended Spare Parts List

Table 12. Recommended Spare Parts List

ITEM NO.	PAGE NO.	DESCRIPTION	CLASS		
			1	2	3
			QTY	QTY	QTY
		PUMP			
4		Impeller Key	1	1	1
3 (or 10)		Impeller Bolt (or Inducer Stud)		1	1
87A		Thermal Barrier Gasket	1	2	2
115A		Lip Seal	1	2	2
RKORP801		**O-ring Repair kit (Includes following)**	1	2	2
936A		- O-ring Packing			
936D		- O-ring Packing			
936E		- O-ring Packing			
936F		- O-ring Packing			
936G		- O-ring Packing			
936H		- O-ring Packing			
936J		- O-ring Packing			
936V		- O-ring Packing			
936Z		- O-ring Packing			
5		- Impeller Tab Washer			
		SINGLE SEAL			
21B		Throttle Bushing		1	1
50		Slinger Sleeve		1	1
51A		Seal Rotating Face	1	1	2
60A		Mechanical Seal	1	1	2
936H		O-ring	4	8	8
936J		O-ring	1	2	2
		DOUBLE SEAL			
50A		Shaft Sleeve (Lower)		1	1
50B		Shaft Sleeve (Upper)		1	1
51C		Seal Rotating Face	1	1	2
60A		Mechanical Seal (Lower)	1	1	2
60B		Mechanical Seal (Upper)	1	1	2
936H		O-ring	4	8	8
936J		O-ring	2	4	4
		TANDEM SEALS			
50A		Shaft Sleeve (Lower)		1	1
50B		Shaft Sleeve (Upper)		1	1
51A		Seal Rotating Face	1	1	2
60A		Mechanical Seal (Lower)	1	1	2
60B		Mechanical Seal (Upper)	1	1	2
60B		Mechanical Seal (Upper Gas)	1	1	2
51C		Seal Rotating Face	1	1	2
936H		O-ring	4	8	8
936J		O-ring	3	6	6

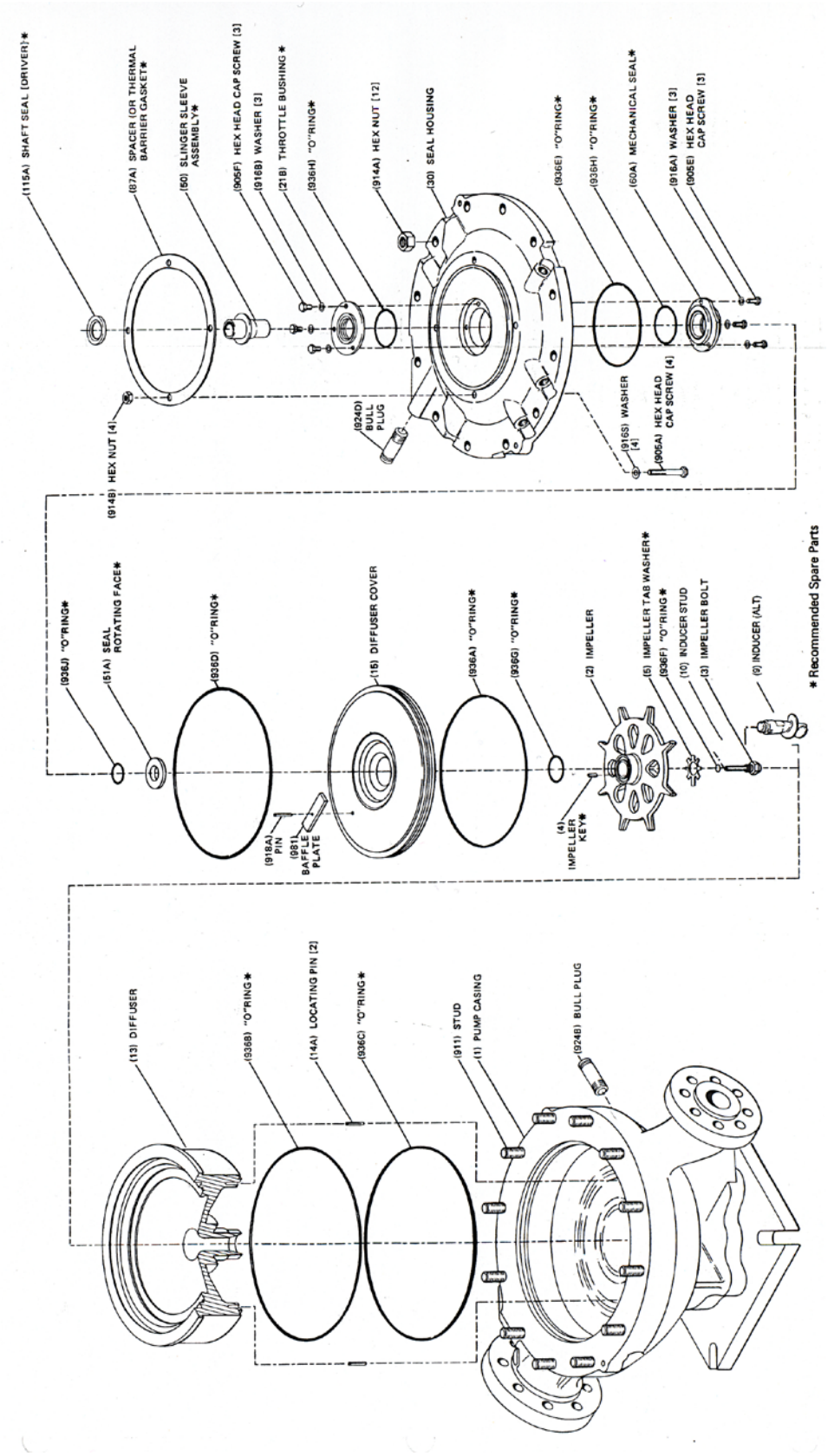
Notes: Seal repair kits for standard seals are available. O-rings for standard units are available as a packaged o-ring Kit. The o-ring repair kit does not include o-rings 936B and 936C.

Class 1: Minimum recommended spare parts necessary to perform a startup, and inspection of a new unit.

Class 2: Minimum recommended spare parts necessary to cover 1-2 years of normal operation.

Class 3: Minimum recommended spare parts stock necessary for critical services or units that will be installed in remote locations.

Figure 15. Pump Exploded View



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