GENERAL INSTALLATION, OPERATION, MAINTENANCE AND TROUBLESHOOTING MANUAL FOR IMO PUMP TWO SCREW PRODUCTS

WARNING

This manual, and the specific INSTRUCTION MANUAL, should be read thoroughly prior to pump installation, operation, maintenance or troubleshooting.

This manual now is identified as part no. SRM00064

Manual No. GTS/2300 CA-1	Rev. 0	July 1998

READ THIS ENTIRE PAGE BEFORE PROCEEDING

FOR THE SAFETY OF PERSONNEL AND TO PREVENT DAMAGE TO THE EQUIPMENT, THE FOLLOWING NOMENCLATURE HAS BEEN USED IN THIS MANUAL:

DANGER

Failure to observe the precautions noted in this box can result in severe bodily injury or loss of life.

WARNING

Failure to observe the precautions noted in this box can cause injury to personnel by accidental contact with the equipment or liquids. Protection should be provided by the user to prevent accidental contact.

CAUTION **ATTENTION**

Failure to observe the precautions noted in this box can cause damage or failure of the equipment.

Non-compliance of safety instructions identified by the following symbol could affect safety for persons:	Safety instructions where electrical safety is involved are identified by:	Safety instructions which shall be considered for reasons of safe operation of the pump and/or protection of the pump itself are marked by the sign: **ATTENTION**

CONTENTS

APPLICATIONS MANUAL FOR IMO PUMP TWO SCREW PRODUCTS

A. GENERAL

The instructions found herein cover the general installation, operation, maintenance and trouble-shooting of subject equipment:

NOTE: Individual contracts may have specific provisions that vary from this manual. Should any questions arise which may not be answered by these instructions, refer to the specific pump instruction manual provided with your order. For further detailed information and technical assistance to questions not answered by this manual, please refer to Imo Pump, Technical/ Customer Service Department, at 704 289-6511 for GTS pumps. For 2200/2300 Series pumps refer to Imo Pump-Warren, Technical/Customer Service Department at 413.436.7711.

This manual cannot possibly cover every situation connected with the installation, operation, maintenance and troubleshooting of the equipment supplied. Every effort was made to prepare the text of the manual so that engineering and design data was transformed into easily understood wording. Imo Pump must assume the personnel assigned to operate and maintain the supplied equipment and apply this instruction manual have sufficient technical knowledge and experience to use sound safety and operational practices which may not be otherwise covered by this manual.

In applications where equipment furnished by Imo Pump is to become part of a process or other machinery, these instructions should be thoroughly reviewed to determine proper fit of the equipment into overall plant operational procedures.

WARNING

If installation, operation, and maintenance instructions are not correctly and strictly followed and observed, injury to personnel or serious damage to pump could result. Imo Pump cannot accept responsibility for unsatisfactory performance or damage resulting from failure to comply with instructions.

B. TRANSPORT AND STORAGE

Always protect the pump against entry of water or other contaminants. Store the pump in a clean, dry and indoor environment. Pumps are delivered with internals oiled (unless specified otherwise by the customer order) and protective covers in or over all openings. These covers should remain in place during the mounting and alignment procedures. The covers must be removed just prior to attaching system piping to pump. If pumps are to be stored in other than a clean, warm, dry environment, or if they are to be stored for more than six months, contact Imo Pump for appropriate storage procedures.

C. DESCRIPTION OF THE PUMP

See specific pump instruction manual provided with your order.

D. INSTALLATION/ASSEMBLY

WARNING

On critical or dangerous equipment, provide safety and emergency systems to protect personnel and property from injury due to pump malfunction. If pumped liquids are flammable, toxic, corrosive, explosive or otherwise hazardous, provide for safety in the event of leakage or malfunction. **BEFORE** working on equipment, make sure all power to equipment is disconnected and locked-out.

D.1 TOOLS

The procedures described in this manual require common mechanics hand tools, dial indicators for alignment and suitable lifting devices such as slings, straps, spreader bars, etc.

D.2 LIFTING OF PUMP AND PUMP/DRIVER ASSEMBLIES

All pumps and pump/driver assemblies should be lifted with appropriate devices securely attached to the whole unit. Ensure unit's center-of-gravity is located between lifting points. See Figure 1. This will avoid tipping of pump or pump/driver assembly. Spreader bars should be used as necessary to insure load is properly distributed and lifting straps do not damage equipment.

Some pumps and pump/driver assemblies have designated lifting points that are shown on their outline drawings.

DANGER **ATTENTION**

Lifting a vertical pump/driver using straps or hooks attached to the pump or pump-to-driver bracket may be dangerous since the center-of-gravity of the assembly may be higher than the points of attachment. Take precautions to prevent slippage of slings and hooks. Always use properly rated lifting devices.

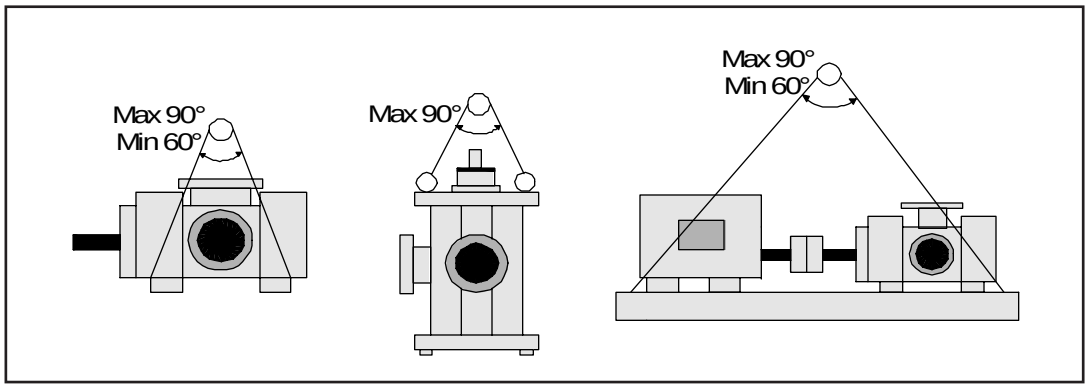


Figure 1 – Lifting Pumps and Pump/Driver Assemblies.

D.3 INSTALLATION OF PUMP ASSEMBLY

To insure adequate flow of liquid to pump's inlet port, place pump near liquid source and preferably place pump centerline below liquid surface. Use short, straight inlet lines.

A dry, clean, well-lit and well-ventilated site should be selected for installing the pump assembly.

Sufficient open space should be provided around pump to permit routine visual inspection, service, maintenance, or replacement. For installation and servicing of large pump units, ample overhead clearance should be provided to allow for lifting device maneuvering.

D.4 FOUNDATIONS AND BASEPLATES

Foundations and baseplates must be designed and installed so pump and driver alignment can be maintained at all times. Be sure baseplates are level and rest on smooth flat surfaces. Small pumps may be mounted on baseplates or directly to existing floors that meet the criteria of foundations. Larger pumps and/or drivers must be mounted to baseplates and foundations. It is recommended that pumps and their drivers be mounted on common baseplates. Use shims or blocks near foundation bolts to avoid springing unit when bolts are tightened.

D.5 MOUNTING OF FOOT MOUNTED PUMPS AND DRIVERS

Some pumps are shipped on baseplates without drivers. For these units, install and tighten each coupling half on driver and pump shafts. Place driver on baseplate and set proper distance between shafts and coupling hubs (see Figure 2). Locate driver so pump and driver shafts are in axial alignment. See Section D.6 on Alignment.

Check pump feet individually to ensure that they do not move more than 0.002 in. (0.051 mm) when bolts are tightened. This is done to ensure that a “soft-foot” condition doesn’t exist.

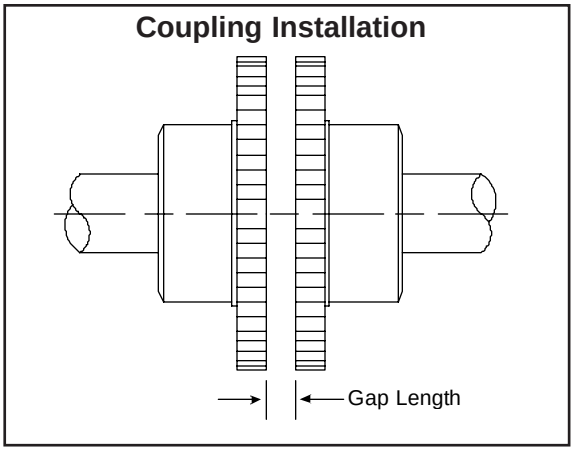


Figure 2 – Coupling Gap Measurement.

For pumps driven through a separate gearbox or other device, first align device relative to pump, and then align driver relative to device.

When not supplied by the manufacturer, coupling, shaft and/or belt guards conforming to ANSI B15.1 should be installed for personnel protection during pump operation.

Final alignment of pump and driver should take place after unit is secured to foundation. If baseplate is to be grouted, this should be completed before final alignment.

NOTE: Grouting is recommended to prevent lateral shifting of baseplate, not to take up irregularities in the foundation. For installations requiring grouting, a baseplate designed specifically for this purpose is needed.

NOTE: Pumps are not to be shimmed in place, they must be mounted directly to a baseplate and piping fitted to the pump.

WARNING

Install guards over couplings and shafts to protect personnel from accidental contact with rotating couplings, belts, sheaves, chains, shafts and/or keyways.

D.6 ALIGNMENT

D.6.1 General

All pump and driver assemblies must be aligned after site installation and at regular maintenance intervals. This applies to factory-mounted units (new or rebuilt) because factory alignment is often disturbed during shipping and handling. Flexible couplings shall be used to connect pump to its driver (unless otherwise specified by Imo Pump).

The objective of any aligning procedure is to align shafts (not align coupling hubs) by using methods that cancel out any surface irregularities, shaft-end float, and eccentricity. At operating temperatures above 175°F (65°C), pumps require “hot alignment” after pump and driver reach normal operating temperatures. Check and verify final alignment after all piping is connected to pump.

D.6.2 Flexible Shaft Couplings

Flexible couplings are intended to provide a flexible connection of aligned shaft-ends. Flexible couplings are not intended to compensate for major angular or parallel shaft misalignment. The allowable misalignment varies with the type of coupling. Any improvement in alignment beyond coupling manufacturer's minimum specification will extend pump, mechanical seal or packing, coupling, and driver service life by reducing bearing loads and wear.

CAUTION **ATTENTION**

- Flexible coupling are NOT intended to permit significant shaft misalignment. Proper alignment must be established/maintained to obtain proper operation and maximum life.
- Pump alignment requirements are nearly always more strict than coupling alignment requirements. Regardless of coupling manufacturer's stated limits. Pump-to-driver shaft alignment must be per pump's alignment requirement.
- Be sure all coupling set-screws and bolts are tight and coupling gap is properly set.

D.6.3 Aligning Foot Mounted Pumps, See Figure 3

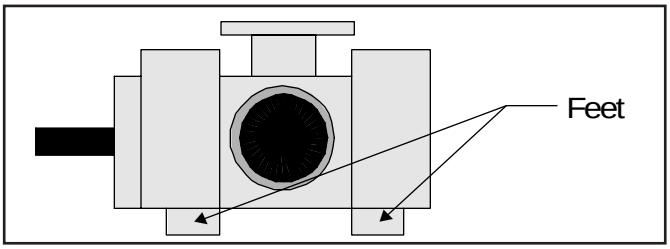
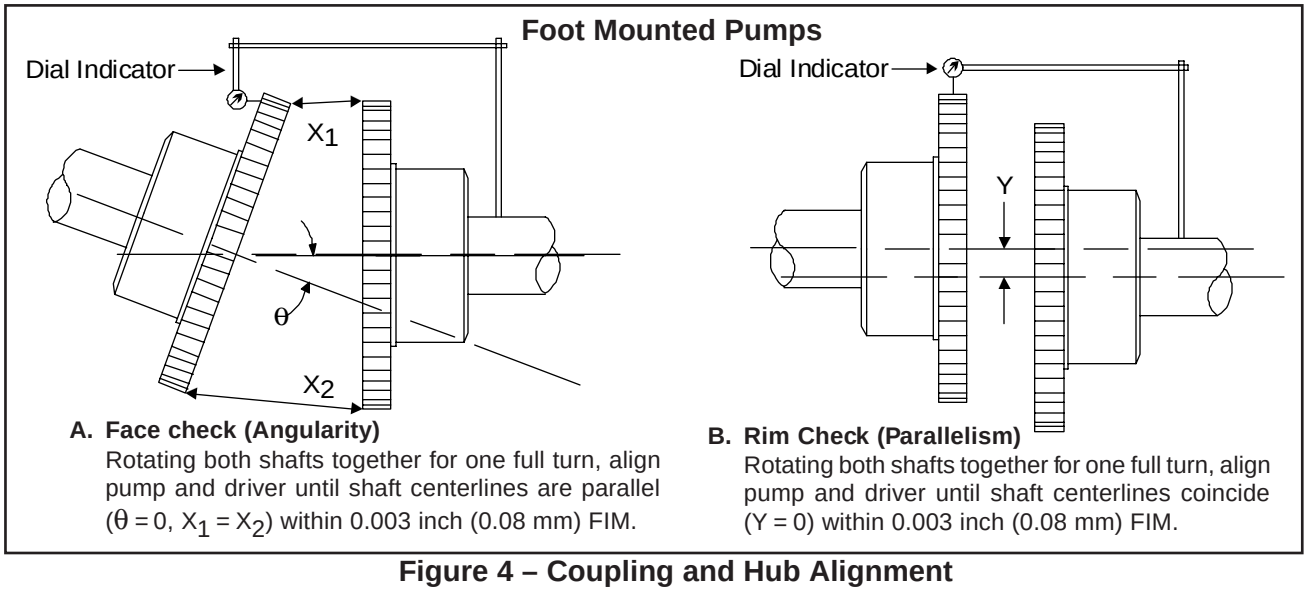


Figure 3 – Foot Mounted Pump

To install foot mounted pumps, perform the following:

- Install pump and driver onto baseplate after installing appropriate coupling halves on pump and driver shafts. Gear boxes and drivers should be shimmed to achieve proper alignment with the pump.
- Perform alignment of pump and driver shafts using dial indicators. Acceptable alignment has been attained when FIM (Full Indicator Movement) is less than or equal to 0.003 inch (0.08 mm) for face (angularity) and rim (parallelism) readings at or near coupling outer diameter while rotating both shafts together one full turn (360°). See Figure 4.



A. Face check (Angularity)
Rotating both shafts together for one full turn, align pump and driver until shaft centerlines are parallel ($\theta = 0$, $X_1 = X_2$) within 0.003 inch (0.08 mm) FIM.

B. Rim Check (Parallelism)
Rotating both shafts together for one full turn, align pump and driver until shaft centerlines coincide ($Y = 0$) within 0.003 inch (0.08 mm) FIM.

Figure 4 – Coupling and Hub Alignment

D.7 PIPING AND VALVES

D7.1 General

Piping connected to pump MUST be independently supported and not allowed to impose strains on pump casing, including allowance for expansion and contraction due to pressure and temperature changes. In general, follow API 676, detailing the maximum allowable forces and moments on the piping. This includes all piping for auxiliary system such as seal flush, or pump heating lines. Shut-off valves should be installed in the suction, discharge, drain and seal lines so pump can be hydraulically isolated for service or removal. All new piping should be flushed clean before connecting to pump.

To prevent foaming and air entrainment, all return lines in re-circulating systems should terminate below liquid surface in reservoir. Bypass liquid from pressure relief and flow control valves should be returned to source (tank, reservoir, etc.), NOT to pump inlet line.

CAUTION **ATTENTION**

- Pipe strain will distort a pump. This could lead to pump and piping malfunction or failure.
- Return lines piped back to pump can cause excessive temperature rise at pump which could result in catastrophic pump failure.

D.7.2 Relief Valve

Use relief valves to protect pump from over-pressure. They need to be connected to pump discharge lines as close to pump as possible and with no other valving between pump and relief valve. Relief valve settings should be set as low as practical.

DO NOT set relief valve higher than maximum pressure rating of pump, including pressure accumulation at 100% bypass. Relief valve return lines should NOT be piped into pump inlet lines because they can produce a loop that will overheat pump. See Figure 5.

⚠ **DANGER**

The Imo Pump is a positive displacement type. It will deliver (or attempt to deliver) flow regardless of back-pressure on unit. Failure to provide pump over-pressure protection can cause pump or driver malfunction and/or rupture of pump and/or piping.

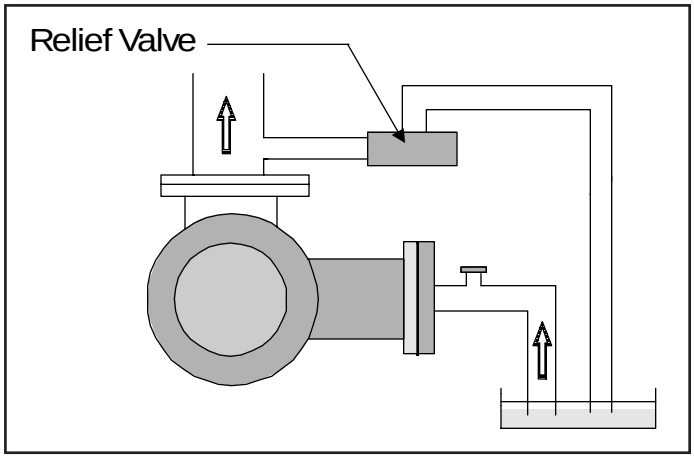


Figure 5 – Proper Relief Valve Return Line Arrangement

Some low pressure GTS pump models include built-in safety relief valves. Relief valves are intended for emergency operation, NOT system control. Extended operation of relief valves in these pumps could lead to pump damage or failure.

D.7.3 Suction Line

The suction line should be designed so pump inlet pressure, measured at pump inlet flange, is greater than or equal to the minimum required pump inlet pressure (also referred to as Net Positive Inlet Pressure Required or NPIPR). Suction line length should be as short as possible with piping diameters being equal to or larger than pump's inlet size. All joints in suction line must be leak free. If pump cannot be located below liquid level in reservoir, position suction line below liquid or install a foot valve so liquid cannot drain from pump while it is shut down. When pump is mounted vertically, or horizontally with inlet port oriented in a non-standard position, a foot valve or liquid trap should be installed in suction line to prevent suction line draining. See Figure 6.

CAUTION **ATTENTION**

DO NOT operate pump without liquid.

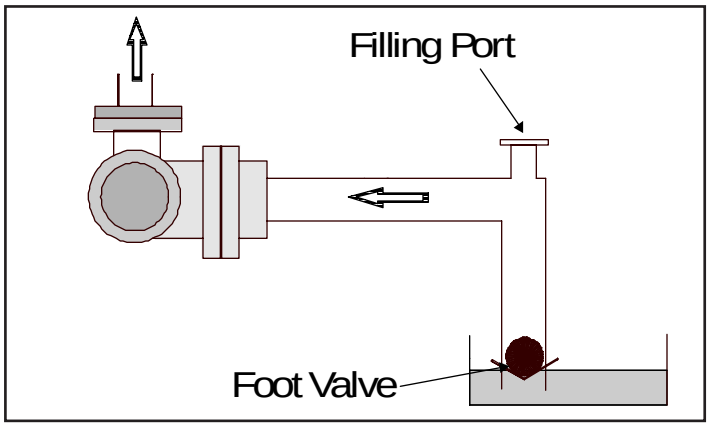


Figure 6 – Fluid Trap and Foot Valve Arrangements for Vertical Pumps.

D.7.4 Suction Strainer/Filter

Pump life is related to liquid cleanliness. Suction strainers or filters should be installed in all systems to prevent entry of contaminants into pump. See Figure 7.

The purpose of a suction strainer or filter is for basic protection of internal pumping elements. It should be installed immediately ahead of inlet port. Appropriate gages or instrumentation should be provided to monitor pump pressure. Pressure drop across a strainer must not cause inlet pressure to fall below NPIPR. General guidelines for strainer sizing are as follows:

- When pumping relatively clean viscous liquids (over 5000 SSU), use 10 to 12 mesh screens.
- When pumping relatively clean light liquids such as distillate fuels, hydraulic oil and light lube oils, use suction strainers of 100 to 200 mesh.
- When pumping heavy crude oils, use 5 to 6 mesh strainer screens.

Make sure size/capacity of strainer or filter is adequate to prevent having to clean or replace elements too frequently.

CAUTION **ATTENTION**

Before connecting pump to system, all system piping must be thoroughly flushed to remove debris which accumulates during fabrication, storage, and installation. An Imo Pump should not be used for flushing. Pay particular attention to suction line between suction strainer and pump to be sure it is clean.

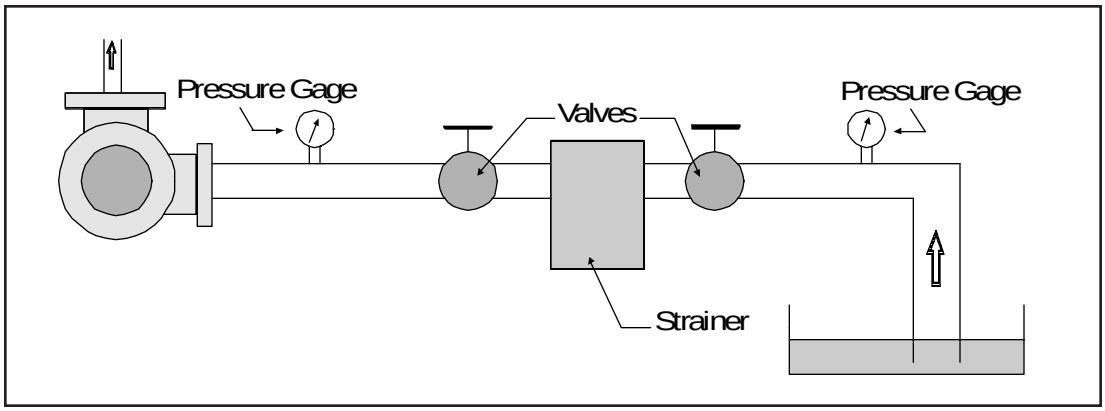


Figure 7 – Ideal Strainer Arrangement

D.7.5 System Filtration

Downstream filters may be required to protect system components.

The system designer builder determines filter size (dirt holding capacity) by the amount and size of contamination expected to be produced by system and external contamination sources. Pressure drop across filter and frequency for cleaning/replacing filter elements, are determining factors when selecting filter and type.

D.7.6 Discharge Piping

In general, discharge piping should be sized to accommodate the pump's flow rate while minimizing pipe friction losses. It should also be designed to prevent gas and air pockets. Piping downstream of pump should include a vent at highest point in system to allow air to escape during priming.

D.8 SHAFT PACKING AND SEAL LEAKAGE

The pump should be installed so any leakage from shaft packing or shaft seal does not become a hazard. Packing leakage should be about 8 to 10 drops per minute. A small amount of liquid may also leak from mechanical or lip seals (usually less than 10 drops per hour). Provisions should be made to collect leakage from packing or shaft seals.

WARNING **DANGER**

If not appropriately collected, packing leakage may make floor slippery or expose personnel to hazardous fluids.

D.9 QUENCHED SHAFT SEALS

Some pumps include quenched mechanical shaft seals. For these pumps, a low pressure stream of steam, nitrogen, or clean water is supplied from an external source to atmospheric side of seal faces.

Quenching is used in selected seal applications to:

- Heat or cool seal area.
- Prevent build up of coke formations by excluding oxygen.
- Flush away undesirable material build-up around dynamic seal components.

When quenched mechanical seals are part of pump assembly, an appropriate quenching stream must be supplied by user.

NOTE: Refer to pump or pump/driver outline drawing and/or specific pump's instruction manual for quench connection size and port locations.

D.10 GAGES

Pressure and temperature gages are recommended for monitoring the pump's operating conditions. These gages should be easily readable and placed as close as possible to pump's inlet and discharge flanges. See Figure 8.

D.11 IDEALIZED INSTALLATION FOR PUMPS LOCATED ABOVE LIQUID LEVEL

Figure 8 is a compilation of Figures 5, 6 and 7 showing good-practice installation schemes for pumps located above the liquid reservoir in systems that recirculate the pumped liquid.

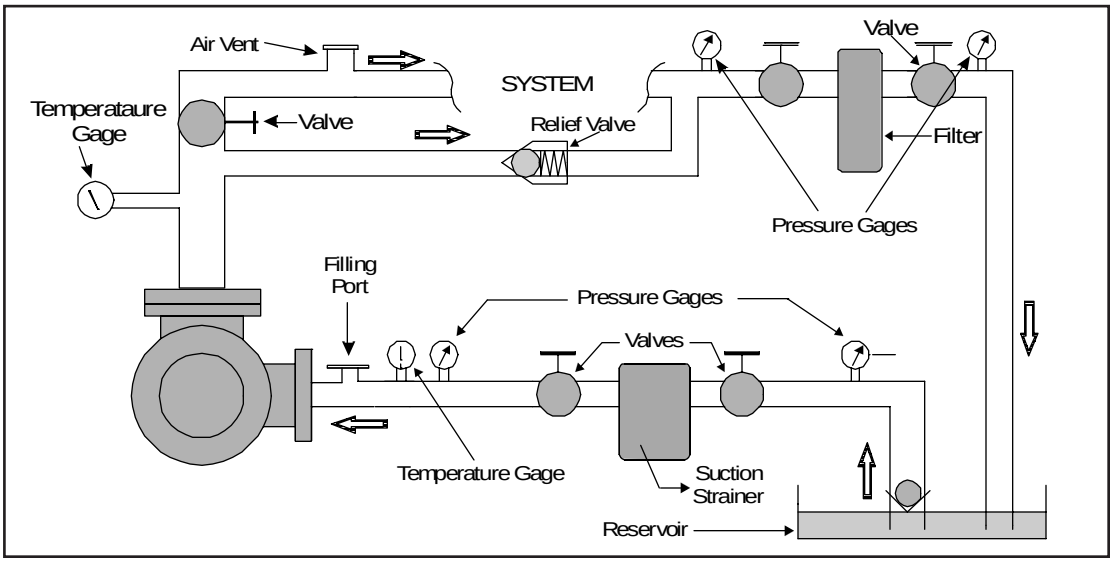


Figure 8 – Idealized Installation

E. Startup, Operation and Shutdown

CAUTION **ATTENTION**

Operation conditions, such as speed, liquid viscosity, temperature, inlet pressure, discharge pressure, filtration, duty cycle, drive type, mounting, etc., are interrelated. Due to these variable conditions, specific application limits may be different from pump's operating and structural limits. This equipment must not be operated without verifying that the system's operating requirements are within the pump's capabilities.

DANGER

Make sure all power equipment is disconnected and locked-out before proceeding.

E.1 ELECTRICAL CONNECTIONS

Verify electrical requirements for driver match electrical supply with respect to voltage, number of phases and terminal connections. Also, check that driver has been wired to rotate in correct direction.

E.2 ROTATION

Before connecting couplings, verify pump rotation to be sure it matches rotation of driver. When coupling is connected and shafts are correctly aligned, pump should turn freely by hand. Rotation direction is indicated by an arrow cast on casing or by an attached plate showing a rotation direction arrow. See Figure 9.

CAUTION **ATTENTION**

Operating pump in the reverse direction may cause pump damage.

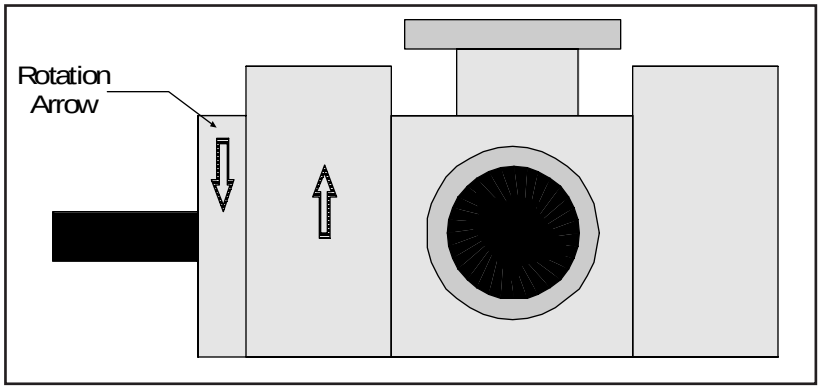


Figure 9 – Rotation Arrow

E.3 HYDROSTATIC TESTING THE SYSTEM

Before any system is hydrostatically tested, pump must be removed or isolated.

CAUTION **ATTENTION**

To prevent damage to pump, it is necessary to remove or isolate it from the system prior to starting hydrostatic testing.

E.4 PROTECTIVE DEVICES

E.4.1 General

Automatic shutdowns, emergency switches, and similar controls should be part of pumping system. They are generally supplied by system supplier or user.

E.4.2 Covers and Guards

Before start-up, insure all protective-covers and guards are in place.

WARNING **DANGER**

To protect personnel from accidental contact with rotating couplings, sheaves, belts, shafts keys, keyways, etc., install the following covers or guards over:

- Bracket openings on flange mounted pumps.
- Couplings and shafts on foot mounted pumps.
- Sheaves, gears, chains, belts or other type drives.

E.4.3 Valves

Check all valves, especially those that are manually operated, making sure they are in the proper open or closed position. Verify that there is no possibility of starting pump with a blocked suction or discharge line.

WARNING

Starting a pump with discharge line blocked and without adequate relief protection will cause catastrophic pump failure and possible injury to personnel.

E.5 INTERMEDIATE DRIVE LUBRICATION

Some Imo Pump units include intermediate gearboxes or other devices between pump and driver. When these devices are present, lubrication is required. Add lubricant to specified level per device manufacturer's recommendations before start-up.

E.6 HEATING JACKETS

Some pumps require heating before start-up. See Section E.12 on Thermal Shock and Operating Temperature Limits. This is usually done with steam, hot water, heat transfer fluid or electric heat strips. Some pumps are fitted with heating jackets (sometimes called steam jackets). Where electric heating is used, fill jacket with appropriate heat transfer fluid prior to start-up. Unless specified otherwise, maximum permissible pressure in a heating jacket is 150 psi gage.

WARNING

Provide safeguards to prevent personnel from coming in contact with hot liquid or other heated equipment surfaces.

E.7 QUENCHED SHAFT SEALS

When quenching fluid is hot water or steam, apply to seal at least 30 minutes prior to pump start-up to ensure seal area is thoroughly heated. When steam is used, it should be saturated at about 4 to 7 psi gage. When quench fluid is ambient temperature nitrogen, it can be applied just prior to pump start-up.

E.8 PUMPED LIQUIDS

In closed or re-circulating systems, check liquid level in tank before and after start-up to be sure it is within operating limits. If initial liquid level is low, or drops as system fills during start-up or pumping operations, add sufficient clean liquid to tank to bring liquid to its normal operating level. Use liquid recommended or approved for use with the equipment. Regular checks should be made on the condition of the liquid. In closed systems, follow supplier's recommendations for maintaining liquid and establishing when liquid is to be changed. Be sure temperature is controlled so liquid does not fall below its minimum allowable viscosity, which occurs at its maximum operating temperature. Also, insure that maximum viscosity at cold start-up does not cause pump inlet pressure to fall below its minimum required value.

CAUTION **ATTENTION**

- NEVER operate a pump without liquid in it!
- Operate only on liquids approved for use with pump.

WARNING

If not appropriately collected, packing or seal leakage may make floor slippery and/or expose personnel to hazardous fluids.

E.9 PRIMING

Prime pump before initial start-up by pouring liquid to be pumped directly into pump suction port. See Figure 10.

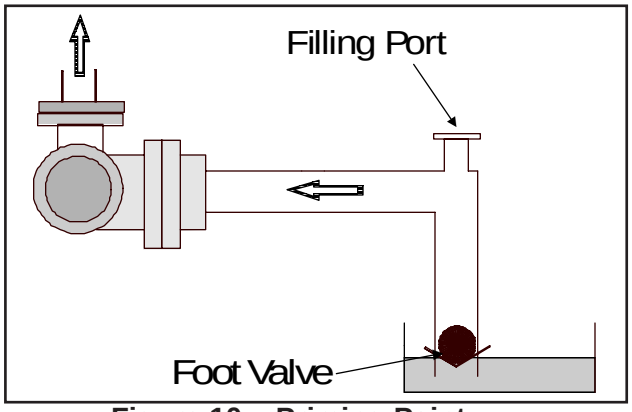


Figure 10 – Priming Point

E.10 START-UP

It is suggested that the driver be started and immediately stopped (jogged) three or four times in order to verify proper pump rotation and to ensure pump is filled with liquid. Open bleed port at high point in system and vent trapped air until a solid stream of liquid emerges (where practical). When pump is running, check for unusual noise or vibration. Investigate any abnormalities. Check inlet and discharge gages to see if pump is operating within its ratings.

WARNING

- Precautions must be taken when venting air in system using hazardous liquids.
- Provide hearing protection whenever high noise levels are expected from system components and/or environment.
- If operating temperatures exceed 140°F (60°C), measures should be taken to avoid skin contact.

E.11 SHAFT PACKING (STUFFING BOX) LEAKAGE

Pumps with packing-type seals must be checked to insure packing gland is not too tight. Excessive gland pressure on packing will cause a scored shaft, overheating and rapid breakdown of packing. Keep gland nuts only finger tight. After new packing has been installed, gland nuts should be tightened evenly but only tight enough to seat packing rings properly. Then, loosen gland nuts and re-tighten finger tight. The final adjustment should allow a leakage of approximately ten drops per minute while pump is operating. This leakage is necessary to lubricate the packing. Provide a place for safe draining and disposal of this leakage.

WARNING

If not appropriately collected, packing leakage may make floor slippery and/or expose personnel to hazardous fluids.

E.12 THERMAL SHOCK AND OPERATING TEMPERATURE LIMITS

During pump start-up, as well as during pump operation, pump must not see a thermal shock greater than 50°F (28°C) from liquid entering the pump. Rapid temperature changes beyond this limit must be avoided. Unless approved by Imo Pump, liquids entering pump inlet must not be hotter than 225°F (107°C) nor colder than 0°F (-18°C). The maximum rate of temperature change during pump heating or cooling should be about 1.5°F/minute (0.8°C/minute). A heated or cooled pump should be held at its start-up temperature for at least an hour prior to start-up. This will insure uniform temperature distribution throughout pump assembly.

CAUTION **ATTENTION**

Never exceed minimum or maximum allowable pump or liquid temperature. Do not expose equipment to thermal shock. Differences in metallurgy and their respective coefficients of expansion could cause distortion of pump parts resulting in a breakdown condition. Use of insulation and heating jacket or heat tracing to maintain pump at liquid temperature is recommended in high temperature applications.

E.13 SHUTDOWN

If system is to be shut down for a short period, do not drain pump as this would require re-priming at start-up. If pump is to be stored, apply a rust-inhibiting agent (one compatible with all pump materials) to all internal and external surfaces, especially those that are machined.

F. MAINTENANCE

DANGER

BEFORE starting any maintenance procedure, do the following:

- Shut off all power switches and circuit breakers.
- Remove any electrical service fuses.
- Lock electrical service panel supplying power to driver.
- Shut, wire or chain, and lock all valves in pump inlet/discharge piping.
- If applicable, shut off any steam or other fluid supply lines to pump.
- If applicable, shut off any steam supply lines to the pump.

F.1 FILTERS AND STRAINERS

All filter and strainer elements should be periodically checked for cleanliness and cleaned or replaced as necessary. This will protect equipment from damage due to pressure-drop across clogged or dirty elements.

F.2 FOUNDATION

Foundation and hold-down bolts should be checked for tightness at least every six months.

F.3 ALIGNMENT

Alignment of pump and its driver should be checked and corrected, if necessary, at least every six months. If system experiences an unusual amount of vibrations or large variations in operating temperatures, this should be done often. Well-maintained alignment will help insure maximum equipment life.

WARNING

Rotating parts, such as couplings, pulleys, external fans, or unused shaft extensions should be permanently guarded against accidental contact with personnel or clothing. This is particularly important where parts have surface irregularities such as keys or set-screws.

F.4 LUBRICATION

F.4.1 Bearings

Pump environment, operating conditions and intervals between bearing checks all effect bearing life. Bearings have a finite life and should be checked often for increase in temperature and/or rough operation. If either condition is noted, stop equipment and replace bearing. When grease or oil fittings are provided, lubricate bearings as specified in the following paragraphs or in the applicable pump instruction manual.

CAUTION **ATTENTION**

Continued running with a rough or worn bearing can lead to catastrophic bearing failure which could cause seal and/or pump failure.

F.4.2 Pump Lubrication

The GTS pump is lubricated with either oil/oil or grease/oil in the timing gear/bearing boxes. The 2300 Series pumps are lubricated with oil/oil in the timing gear/bearing boxes.

F.4.3 2200/2300 Series Pump Lubrication Specifications

Imo Pump recommends the use of high grade non-detergent oils with anti-foaming agents: i.e., oxidation and corrosion inhibitors. It is suggested that the oils conform to the approximate following characteristics:

ISO VG	150
Viscosity cST @ 40°C	135 – 165
SSU @ 100°C	800
Viscosity Index Min.	80
Flash Point OC°C	200°C
Gravity ° API	28

(These are guides only and are not rigid specifications).

The following lubricants are satisfactory for use and fall within the specification ranges listed above:

EXXON	Teresstic 150
MOBIL	DTE Extra Heavy
SHELL	Turbo 150
SUNCO	Sunvise 775
TEXACO	Regal R & O 150
GULF	Harmony 150 N

F.4.4 2200 and 2300 Pump Lubrication Change Invervals

For trouble free operation and long pump life it is recommended that the 2200 and 2300 Series pumps' gear and bearing housings be thoroughly cleaned and filled with new oil every 3 months. If conditions exist involving dust, heat or humidity that may effect oil breakdown, the lubrication should be changed more often.

F.4.5 2200 Series Pump Lubrication

The 2200 Series pumps are llubricated with ISO 150VG oil for all normal service operations. See Figure 11 for lubrication and sight glass locations.

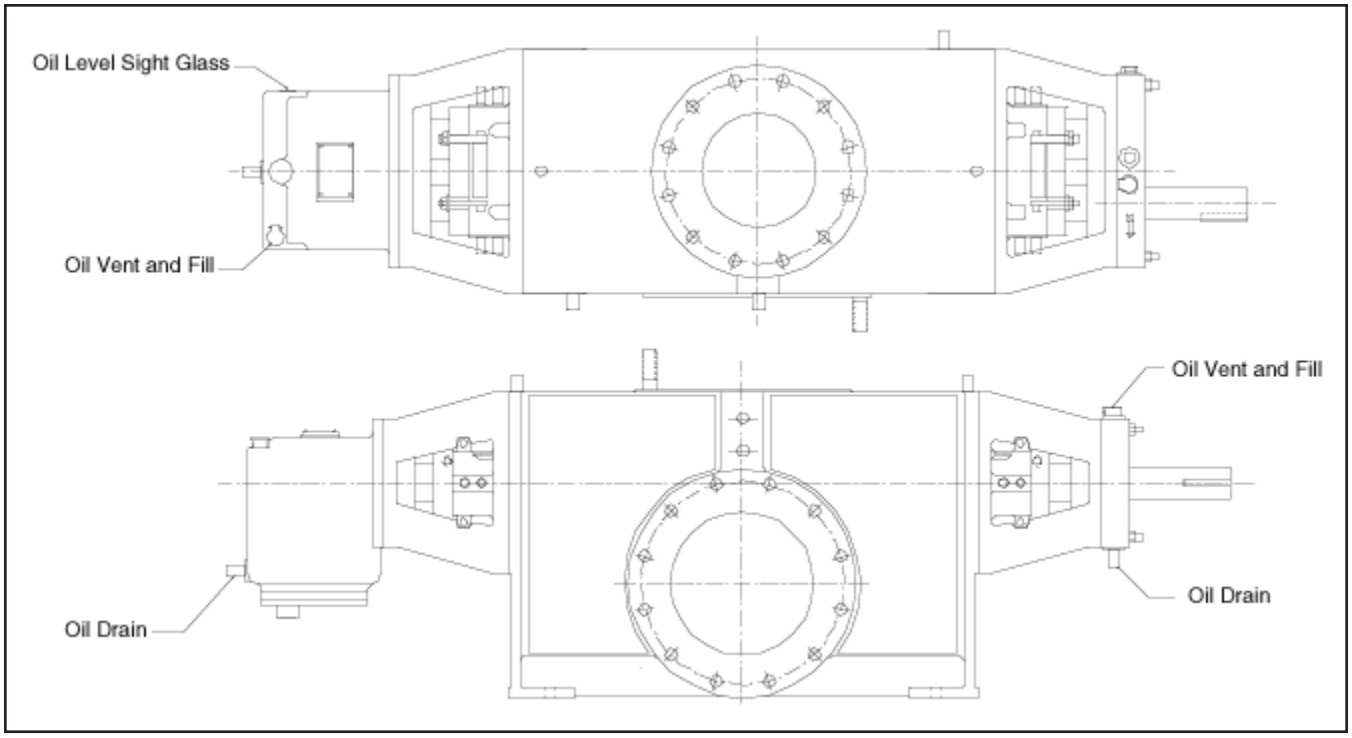


Figure 11 – Lubrication Points for 2300 Series Pumps

F.4.6 2300 Series Pump Lubrication

The 2300 Series pumps are lubricated with ISO 150VG oil for all normal service operations. See Figure 12 for lubrication and sight glass locations.

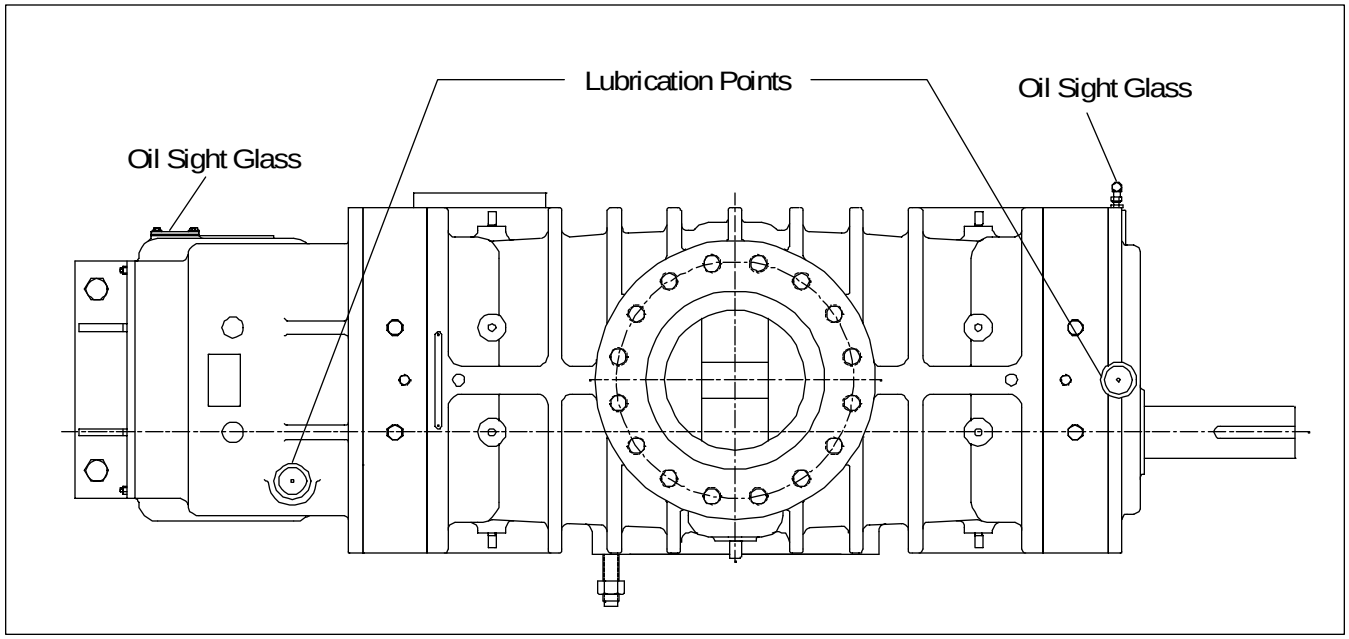


Figure 12 – Lubrication Points for 2300 Series Pumps

F.4.7 GTS Pump Grease Fittings

Lubricate the bearing through the grease fitting every 500 hours. For proper bearing lubrication refer to the GTS pump lubrication specified in Table 1. See Figure 13.

F.4.8 GTS Pump Gear Lubrication

The pumps are equipped with timing gears. With the pump stopped, check the oil level in the gear box. Oil should cover 3/4 of the sight glass.

F.4.9 GTS Pump Lubrication Change Intervals

For trouble free operation and long bearing/pump life it is recommended that the GTS first oil change after the initial startup is to be performed after 250 hours of operation. Subsequent oil changes should be made following each 500 to 1000 hours of operation.

Selection of the gear box is dependent upon the operating temperature of the pump. For proper GTS gear lubrication refer to the GTS pump lubrication specified in Table 1.

CAUTION	**ATTENTION**
When replacing or adding gearbox oil, filtration is recommended. Be careful to keep foreign material from entering the gearbox. Use only recommended oil approved for pump and equipment.	

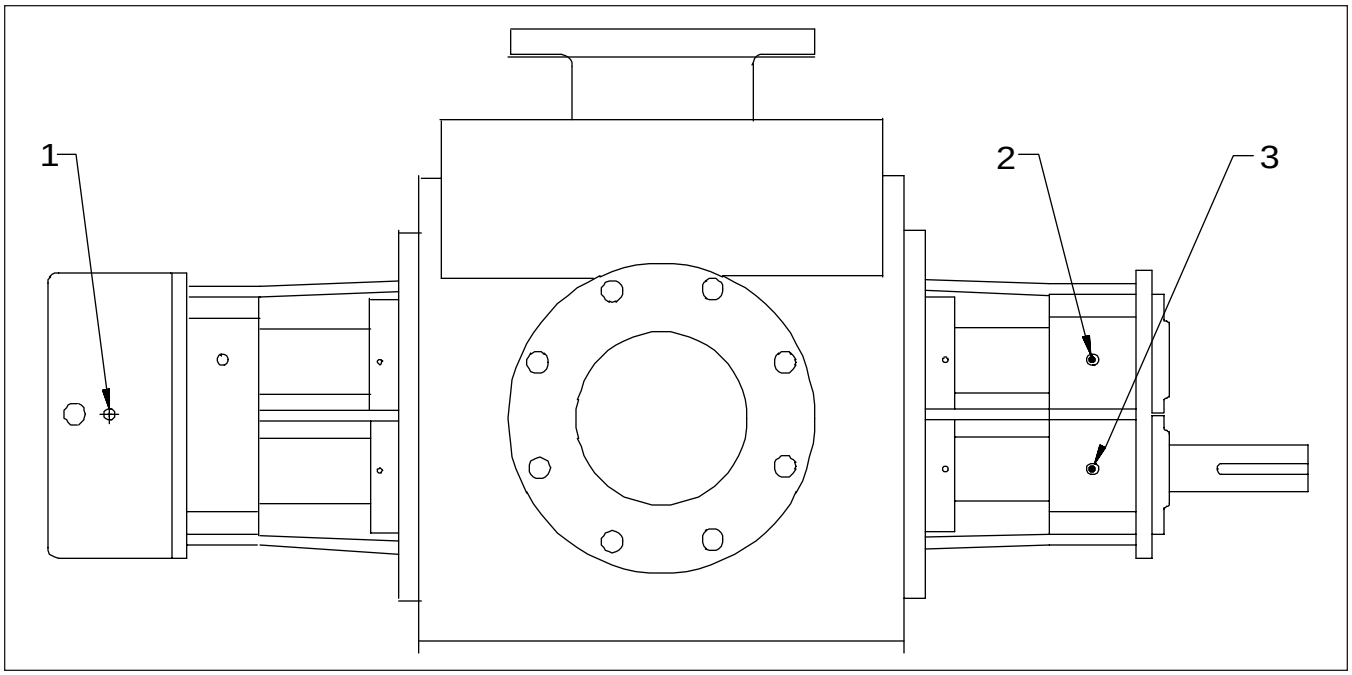


Figure 13 – Lubrication Points for a GTS Pump

	Lubrication Points			
	Gear/Bearing Housing (Location 1)		Bearings (Location 2 & 3)	
	Pumped Fluid Temperatures			
Manufacturer	**50° to 200°F (10° to 93°C)**	**200° to 500°F (93° to 260°C)**	**50° to 300°F (10° to 149°C)**	**300° to 500°F (149° to 260°C)**
Chevron	Chevron NL Gear Compound 100	Chevron NL Gear Compound 150	Chevron Polyurea EP Grease 2	Chevron Heavy Industrial Grease
Gulf	Gulf EP Lubricant HD 100	Gulf EP Lubricant HD 150	Gulfcrown Grease EP 2	Gulfflex Moly
Texaco	Manopra 100 Rando Oil HD E-100	Manopra 150 Rando Oil HD F-150	Multifak 2EP	Thermatex 2 EP
Mobil	Mobilgear 627	Mobil SHC 629 Mobilgear 629 Mobil DTE Oil X Heavy	Mobilux EP 2	Mobiltemp 78
Exxon	Teressatic 100 Sparten EP 100 Nuto H100	Sparten EP 150	Unirex N2 Beacon Q2	Norva EP 375
Shell	Omala Oil 100	Omala Oil 150	Alvania 3	Darina 2
BP	BP Eneregol GR-XP 100	BP Eneregol GR-XP 150	BP Energrease LS 3	BP Energrease HTB 2

Table 1 – GTS Series Lubrication Requirements

- For a combination of high temperature and pressure, a synthetic base lubricant such as Mobil SHC 629 and/or a synthetic grease such as Dow DC-44 is recommended. Special synthetic lubricants will be noted on the pump assembly drawing.

F.5 COOLING

The 2200 and 2300 Series pump may require cooling of the timing gear housing. This determination is made when the service is examined and the selection made. If the pump requires cooling, the pump will be supplied with a heat exchanger. It will be necessary to supply water at a maximum of 50 psig. Flow requirements will vary according to a particular installation but you should insure that a supply of 2 GPM coolant is available. Once the pump is running the flow can be adjusted to keep bearings and gear temperatures within prescribed limits.

For high horsepower installations, or, unusual circumstances, (that is extremely high product temperatures or ambient conditions) a more sophisticated cooling system may be required. Consult Imo Pump for guidance.

F.6 PACKING

A pump should be repacked when all packing gland travel is exhausted or when packing is damaged. Follow packing replacement instructions in applicable pump instruction manual.

F.7 SHAFT SEALS AND LEAKAGE

Visually check equipment frequently for signs of damage/leakage from shaft seals, gaskets or O-rings. Be sure all connections are tight. Shaft seals have a finite life which is affected by operating conditions and environment. Expect them to wear and eventually fail. When leakage becomes unacceptable, replace seal.

NOTE: A very small amount of leakage (~10 drops per hour per seal) is normal.

WARNING

Since leakage or seal failure can be expected to eventually occur, be sure installation can withstand this situation. Take appropriate measures if liquid is hazardous.

F.8 SPARE PARTS

Where pump out-of-service time is of vital concern, and down time must be minimized, a set of spare parts should be retained on-site.

F9. DISASSEMBLY AND RE-ASSEMBLY

Various procedures for disassembly and re-assembly apply to different pumps. The specific instruction manual supplied with your order will provide these procedures.

G. FIELD AND FACTORY SERVICE AND PARTS

Imo Pump maintains a staff of trained service personnel that can provide pump installation, pump start-up, maintenance/overhaul and troubleshooting supervision as well as installation and maintenance training.

Our factories provide overhaul and test facilities in the event the user prefers to return pumps for inspection or overhaul. Pumps that have been factory-overhauled are normally tested and warranted “as-new” for a period of one year from date of shipment.

For field service or factory overhaul assistance, contact your local Imo Pump Sales Office or representative at the Technical/Customer Service Department in Monroe, NC, or Warren, MA, USA.

Most pumps have repair kits available. Minor Repair Kits are used to repair leaking seals, bad bearings and/or for re-assembly after pump tear-down. They include (as applicable) pump shaft seals, packing, all gaskets/O-rings and bearings. Major Repair Kits are sufficient to rebuild completely worn-out pumps to “as-new” condition.* They include all parts found in Minor Repair Kits plus all major internal parts subject to wear. Because kits have all the necessary parts, it is recommended that kits be purchased verses selecting individual parts. When parts are individually selected from the Parts List, needed components are often overlooked. In addition, mixing worn or used parts with new parts causes rapid wear and shortened service life from the new parts.

* Some Imo Pump bores are integral to the pump body and are not included in a Major Repair Kit.

H. TROUBLESHOOTING

MALFUNCTION	POSSIBLE CAUSE	REMEDY
Loss of Flow or Low Capacity	System component malfunction	Inspect all system components. Correctany malfunctions. Ensure that suction and discharge lines are open and all valves are in proper positions.
	Pump not primed or vented	Check reservoir liquid level. Fill as necessary. Vent air from pump.
	Low pump speed	Ensure that driver is receiving full power.
	Incorrect pump rotation	Driver incorrectly wired.
	Obstruction in piping	Inspect piping and all system valves. Remove any obstructions.
	Worn rotor and/or housing	Replace worn rotors and/or housing.
	System bypass	Check all system bypass valves for leakage, including relief valves. Repair as required.
	Insufficient inlet pressure	Remove obstruction or clean suction strainer or replace element.
	Leak from shaft seal	Tighten packing glands or install new packing. Check mechanical seals for damage. Replace if necessary.
	Leak in suction line	Correct leak or adjust relief valve or replace seal piping.
Loss of Suction	Suction line closed, blocked or leaking.	Verify that suction line valve is locked-open. Inspect suction line piping flanges and valves and remove any obstruction or repair any leakage. Clean or replace filter.
	Worn pump rotors	Replace worn parts and/or housing.
	Excessive viscosity	Reduce viscosity by heating pump and/or system liquids.
	Dirty suction strainer	Clean or replace strainer.
	Leak from shaft seal	Tighten packing glands or install new packing. Check mechanical seals for damage. Replace if necessary.
	Leak in suction line	Correct leak or adjust relief valve or replace seal piping.
	Wrong direction of rotation	Driver incorrectly wired.
Low Discharge Pressure	Low liquid level in reservoir	Check liquid level in reservoir. Fill as necessary.
	Air in system	Ensure that pump is vented and suction lines are full of fluid.
	Wear of rotors and/or housings	Replace worn rotors and/or housings.
	Obstruction in piping	Inspect piping and suction and discharge line valves. Remove any obstruction.
	Dirty suction strainer	Clean or replace suction strainer.
	System bypass	Check all system bypass valves for leakage and repair as required.

H. TROUBLESHOOTING *(Continued)*

MALFUNCTION	POSSIBLE CAUSE	REMEDY
Excessive or Unusual Noise or Vibration	Misalignment	Check pump and driver alignment and correct as required.
	Restricted suction line	Check suction line and remove any obstructions.
	Air in system	Ensure that pump is vented and suction lines are full of liquid. Check reservoir level. Fill as necessary. Check all lines, flanges, joints and connections for leakage. Repair as necessary.
	Dirty suction strainer	Clean suction strainer or replace element.
	Relief valve chatter or leakage.	Check discharge relief valve pressure setting. Readjust/repair/replace relief valve.
	Internal rubbing of pump parts	Verify pump and driver alignment. Inspect pump wearing parts. Replace as required.
	Mechanical problem	Check for loose or mispositioned coupling, broken shaft or worn bearing and repair. Replace as required.
Rapid Wear of Pump	Liquid contains abrasive foreign matter.	Clean or replace suction strainer. Collect samples of liquid and test for foreign matter.
	Misalignment	Check pump and driver alignment. Correct as required.
	Insufficient liquid	Check for low pumping capacity and/or loss.
Excessive Power Usage	Liquid more viscous than specified.	Heat liquid to proper viscosity and/or design temperature.
	Pump suction and/or discharge lines closed or blocked	Ensure that the suction and discharge lines are open, and remove obstructions if present.
	Internal rubbing of pump parts	Verify pump and driver alignment. Inspect pump wearing parts. Replace as required.
	Excessive pump speed	Reduce pump speed to design limits.
	Mechanical problems	Check for bent shaft, tight shaft packing, or pipe strain. Repair or replace as required.
Pump Failure	Foreign matter in pump	Rotate pump in opposite direction, flush pump. Disassemble and clean if necessary.
	Excessive heat causing inner part expansion.	Allow pump to cool. Restart only if it can be rotated by hand.
	Damaged bearing, or timing gears	Insufficient oil in gearbox. Disassemble pump and replace necessary parts.
	Solidified material	Heat pump and piping system.
	Improper pump alignment	Check coupling for angular and parallel alignment. Realign if necessary.
	Excessive pipe loads	Remove condition causing loads.