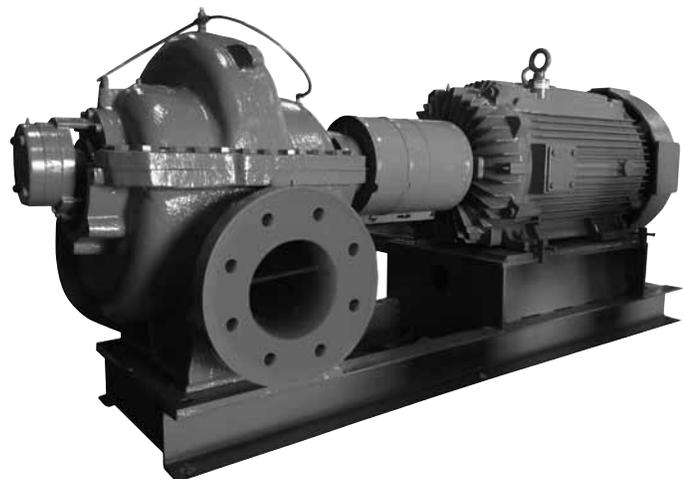
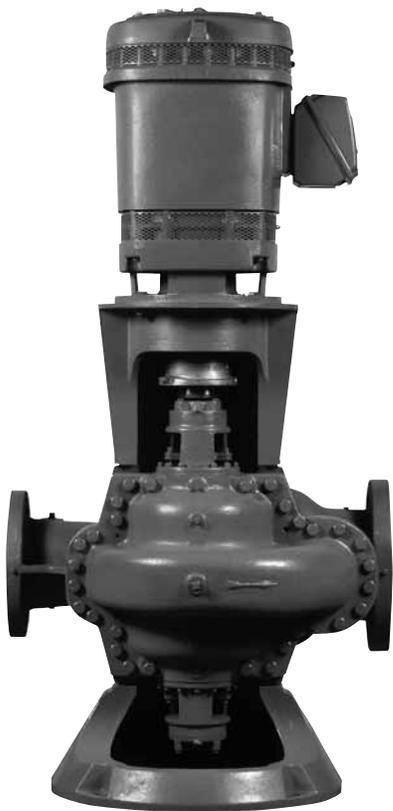


KP, KPV

Installation and operating instructions



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**Warning**

Prior to installation, read these installation and operating instructions. Installation and operation must comply with local regulations and accepted codes of good practice.

**Warning**

The use of this product requires experience with and knowledge of the product. Persons with reduced physical, sensory or mental capabilities must not use this product, unless they are under supervision or have been instructed in the use of the product by a person responsible for their safety. Children must not use or play with this product.

1. Delivery and handling

1.1 Delivery

The pump is delivered from factory in a crate or wooden box specially designed for transport by fork-lift truck or a similar vehicle.

Upon receipt, check the pump visually to determine whether any damage has happened during transport or handling. Check especially for these points:

1. broken or cracked equipment, including base frame, motor or pump feet and flanges
2. broken motor fan cover, bent eyebolts or damaged terminal box
3. missing parts.

Parts or accessories are sometimes wrapped individually or fastened to the equipment.

If any damage or losses have occurred, promptly notify Grundfos' representative and the carrier's agent.

1.2 Receiving

- Check pumping unit for shortages and damages immediately upon arrival. Pump accessories, when required, are packaged in a separate container and shipped with the unit.
- If equipment is damaged in transit, immediately report the damage to the truck line's agent. Make a complete report on the freight bill to speed satisfactory adjustment by the carrier.
- Unload and handle the equipment with a sling or tow motor. Do not lift unit by lifting lugs on the pump case or eye.
- Eyebolts on the motor! These are not intended to support the complete pump assembly but to aid in disassembly.

1.3 Handling



Warning
Handling should be performed by qualified personnel.

Note

All pump complete units should be lifted by fork truck from beneath the steel base.

Note

If cast iron lifting lugs are present on the dome, do not use for lifting the entire unit. They are for dome removal only.

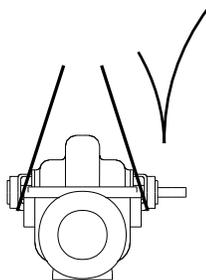


Fig. 1 How to lift and handle KP bare shaft pumps

1.4 Temporary storage

If the pump is not to be installed and operated soon after arrival, store it in a clean, dry place with slow, moderate changes in ambient temperature. Protect the pump from moisture, dust, dirt and foreign bodies. Prior to and during storage we recommend these precautions:

1. Ensure that the bearings are filled with the recommended

grease to prevent moisture from entering around the shaft. See [7.2 Pump bearing lubrication-General comments](#).

2. Ensure that suction and discharge ports of the pump and all other openings are covered with cardboard, wood or masking tape to prevent foreign objects from entering the pump.
3. Cover the unit with a tarpaulin or other suitable covering if it is to be stored where there is no protective covering.
4. Rotate the shaft 2 turns every 2 weeks to prevent corrosion of the bearing surfaces and the stuffing box/shaft seal faces due to moisture.
5. This equipment contains vegetable fiber gaskets that can dry out during extended storage periods. To avoid leaking, fill pumps with water and let stand for 24 hrs prior to start-up or pressure testing. Typically, this will allow dry gaskets to wick moisture back into themselves sealing the pump.
6. Split case pumps should only be pressurized with the medium they are intended to pump. No pressurized "air" test should be performed.

2. Applications

Paco KP horizontal split case pumps are typically used in these applications:

- circulation in heating and air conditioning systems, water condensing and boiler feed systems
- liquid transfer and pressure boosting in various industrial systems
- water distribution and water treatment in public water systems.

2.1 Pumped liquids

Clean, thin, non-aggressive liquids, not containing solid particles or fibres. Do not pump liquids that will attack the pump materials chemically.

When pumping liquids with a density and/or viscosity higher than that of water, head and flow will be reduced. Alternatively, use motors with correspondingly higher outputs.

The stuffing box packing rings/mechanical shaft seal O-rings chosen must be suitable for the liquid to be pumped.

Special stuffing box packing rings/shaft seal O-rings may be required if the pump is used for pumping treated water:

- at temperatures above 176 °F [80 °C]
- containing additives to prevent system corrosion, calcareous deposits, etc. (this may be the case in heating and ventilating systems).

When pumping liquids other than water, select an appropriate stuffing box/shaft seal. For further information, please contact Grundfos.



Warning
Absolute maximum operating temperature is 275 °F [135 °C]

3. Installation - Mechanical

All installations should be performed by personnel experienced with the placement, connection, and alignment of pumping equipment. The following instructions are general in nature, and may not deal with the specifics of your installation. Read these instructions thoroughly before installing and operating your Paco KP Double Suction Centrifugal Split Case Pump.

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3.1 KP model number and construction code

Example	29	60123	140001	1852
Product code				
Model code				
Materials of construction				
Motor code				

Production code	29
29: Split case	

Model code	60	12	3
Pump discharge			
20 = 2"			
30 = 3"			
40 = 4"			
50 = 5"			
60 = 6"			
80 = 8"			
10 = 10"			
12 = 12"			
14 = 14"			
Nominal maximum impeller diameter			
95 = 9.5"			
12 = 12"			
13 = 13"			
14 = 14"			
15 = 15"			
19 = 19"			
20 = 20"			
24 = 24"			
Impeller design			
Clockwise rotation:			
1, 3, 5, 7, 9			
Counter clockwise rotation:			
0, 2, 4, 6, 8			

Materials of construction 1 4 00 0 1

Packing or seal			
3 = Standard Packing			
1 = Type 21, Single Seal, Ceramic Seat, Buna			
2 = Type 21, Single Seal, Tung Crbd Seat, Viton			
6 = Type 21, Single Seal, Ni-Resist Seat, Viton			
7 = Type 21, Single Seal, Ni-Resist Seat, Buna			
8 = Type 1B, Single Seal, Ni-Resist Seat, Buna			
9 = Type 21, Single Seal, Ni Resist Seat, Viton			
A = Type 1, Single Seal, Ceramic Seat, Buna			
B = Type 1, Single Seal, Ni-Resist Seat, Viton			
C = Type 1, Single Seal, Tung Crbd Seat, Viton			
D = Type 1, Singel Seal, Ni Resist Seat, Buna			
E = Type 1, Single Seal, Ceramic Seat, Buna			
F = Type 1, Single Seal, Si Cbrd Seat, EPDM			
ID of packing or seal			
2 = 1"			
3 = 1-1/4"			
E = 1-1/2"			
4 = 1-3/4"			
5 = 2-1/4"			
6 = 2-3/4"			
7 = 3"			
K = 3-1/2"			
V = 4"			

General configuration (horizontal)

Code no	Item
00	Std.
01	Dbl- wear rings
02	Oil lube brgs
03	(01) + (02)
04	(01) + (05)
05	Recirc lines
20	Dbl Ext Shaft
21	Dbl Wear Rings
22	Recirc Lines
24	(21) + (22)
30	Dbl Ext Shaft
31	Dbl Wear Rings

General configuration (horizontal)

Materials of construction 1 4 00 0 1

Code no	Item
32	Recirc Lines
34	(31) + (32)
70	250 lb. Flange
71	Dbl Wear Rings
72	(71) + (73)
73	Recirc Lines
90	250 lb. Flange
91	Dbl Wear Rings

General configuration (Vertical)

Code no	Item
50	Std
51	Dbl. Wear Rings
52	Sleeve Bearing
80	250 lb. flange
81	Dbl. Wear Rings
82	Sleeve Bearing
92	250 lb. flange
93	Dbl. Wear Rings

Shaft/Sleeve Metallurgy

- 0 = Steel/Bronze
- 1 = Steel/S.S.
- 3 = S.S./Bronze*
- 6 = S.S./S.S. or S.S./no sleeves
- 7 = SS/Hard. SS
- A = 316 SS/Ni Al Bz
- X = Special

Pump Metallurgy

- 1 = Brz. Fitted
- 2 = Std. All Bronze
- 5 = All Iron
- 8 = Ductile Iron/Brz. Fitted
- X = Special

Motor code 1 78 2

Enclosure		
1 = ODP		
2 = TECF		
3 = explosion proof		

Voltage

HP	1 phase		3 phase	
	115/230 V	200 V	230/460 V	
1/3	21	23	24	
1/2	29	31	32	
3/4	35	37	38	
1	41	43	44	
1-1/2	47	49	50	
2	53	55	56	
3	59	61	62	
5	65	67	68	
7-1/2	71	73	74	
10	76	77	78	
15	--	81	82	
20	--	84	85	
25	--	01	87	
30	--	02	88	
40	--	03	89	
50	--	04	90	
60	--	05	91	
75	--	06	92	
100	--	07	93	
125	--	--	94	
150	--	--	95	
200	--	--	96	
250	--	--	97	
300	--	--	98	

RPM

- 1 = 3500
- 2 = 1750
- 3 = 1150

3.2 Pump identification

All Paco Pumps are identified by Catalog and Serial Numbers. These are stamped on the pump nameplate [Fig. 2](#) affixed to each pump casing and should be referred to in all correspondence with the Company.

3.3 Nameplate

PACO PUMPS	
CAT#: 29-40159-140001-1952EE	
○	STOCK#: 98173512
SER#: 1971071543-10	
GPM: 650	TDH: 192' IMP. DIA: 13.44"
MFD BY GRUNDFOS CBS INC 34014412	

TM05 7638 1313

Fig. 2 KP pump nameplate

3.4 Location

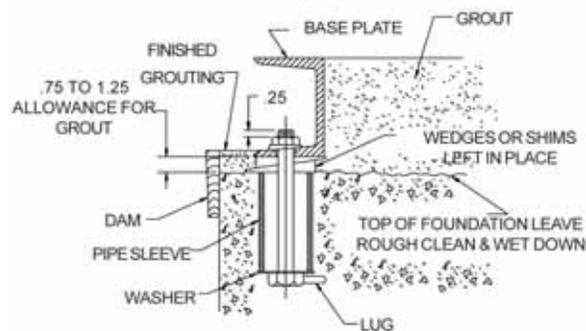
- Locate the pump as close to the suction supply as possible. Use the shortest and most direct suction piping practical. Refer to [3.8 Suction \(inlet\) piping](#)
- Locate the pump below system level wherever possible. This will facilitate priming, assure a steady liquid flow, and provide a positive suction head.
- Make sure sufficient NPSH (Net Positive Suction Head) is provided at the suction end by considering the pump's location in relation to the entire system. Available NPSH must always equal or exceed required NPSH specified on the pump performance curve.
- Always allow sufficient accessibility for maintenance and inspection. Provide a clear space with ample head room for use of a hoist strong enough to lift the unit.
- Make sure a suitable power source is available for the pump motor. Electrical characteristics should match those specified on the motor data plate, within the limits covered in [5. Installation-Electrical](#) & [6. Operation](#).
- Avoid pump exposure to sub-zero temperatures to prevent pump liquid from freezing. If freezing conditions exist during shutdown periods, see [Sections 6.5 Pump shutdown](#) and [6.6 Short duration shutdown](#) for specific recommendations.

Clearance of 24" on each side of pump will allow for maximum access while servicing. A minimum of 24" clearance is required to remove the top dome of the pump when accessing the rotating element.

Note

3.5 Pump foundation

Your KP pump should be permanently installed on a firm, concrete foundation mounting pad of sufficient size to dampen any vibration and prevent any deflection or misalignment. The pad may float on springs or be a raised part of the equipment room floor. The foundation should be poured without interruption to 3/4 to 1-1/2 inches below the final pump elevation. The top surface should be well scored or grooved before the concrete sets to provide a suitable bonding surface for grout. Anchor bolts should be set in pipe sleeves for positioning allowance, as shown in [Fig. 3](#). Allow enough bolt length for grout, lower base plate flange, nuts and washers. Allow the foundation to cure several days before proceeding with pump installation.



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Fig. 3 Anchor bolt installation

3.6 Securing the baseplate

- After the concrete pad has been poured and set, lower the pump base plate over the anchor bolts and rest it on loose adjustment wedges or shims placed near each anchor bolt and at intervals not to exceed 24" along each side.
- Shims or wedges must be placed to raise the bottom of the base 3/4" to 1-1/4" above the pad, allowing clearance for grout. Level the pump shaft, flanges, and base plate using a spirit level, adjusting the wedges or shims, as required.
- Check to make sure the piping can be aligned to the pump flanges without placing any strain on either flange.
- After pump alignment has been established, put nuts on foundation bolts and tighten them just enough to keep the unit base plate from moving. Construct a form or dam around the concrete pad and pour grout in and around the pump base. (See [Fig. 3](#)). Grout compensates for uneven foundation, distributes the weight of the unit, and prevents shifting. Use an approved, non-shrinking grout (such as Embecco 636 by Master Builders, Cleveland, Ohio or equivalent). Allow at least 24 hours for this grout to set before proceeding with piping connections.
- After the grout has thoroughly hardened, check the foundation bolts and tighten if necessary. Recheck the pump alignment after the foundation bolts are secured.

3.7 Piping

- Do not use pump as a support for piping! Use pipe hangers or other supports at proper intervals to provide complete piping support near the pump.
- Both suction and discharge piping should be independently supported and properly aligned to insure no strain is transmitted to the pump when the bolts are tightened. Use of expansion joints or vibration pads does not preclude the need to properly support the piping.
- Do not spring or force piping when making connections!
- Make sure all piping is as direct as possible.
- Avoid unnecessary bends and fittings.
- All KP flanges are cast to 250# diameter and thickness but drilled according to the pumps service. Non-standard hardware may be required.

3.8 Suction (inlet) piping

The sizing and installation of suction piping is particularly important. It must be selected and installed in a manner that minimizes pressure loss and permits sufficient liquid flow into the pump during starting and operation. Many NPSH problems can be traced directly to improper design of suction piping systems. Observe the following precautions when installing piping:

- Suction piping should be as direct as possible, and ideally the length should be at least ten times the pipe diameter. Short suction piping can be the same diameter as the suction opening. Longer piping should be one or two sizes larger (depending on length), reducing to the diameter of the suction opening near the pump.
- Use an eccentric reducer, with the eccentric side down, as shown in Fig. 4 when reducing pipe diameter to the diameter of the pump suction opening.
- At no time should suction piping be smaller in diameter than the pump suction opening.
- Horizontal suction lines should follow an even gradient, if possible. A gradual upward slope to the pump is recommended for suction lift conditions, and a gradual downward slope for positive suction head.
- Avoid any high points, such as pipe loops, as shown in Fig. 5, that may create air pockets and throttle the system or produce erratic pumping.

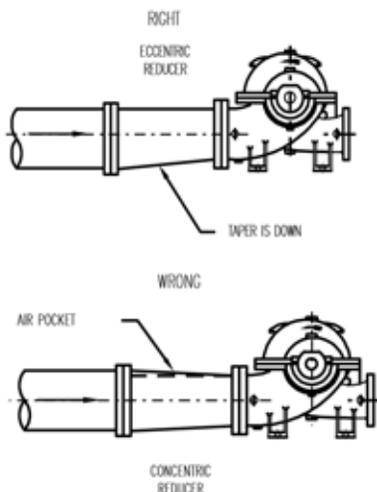


Fig. 4 Suction piping eccentric vs. concentric

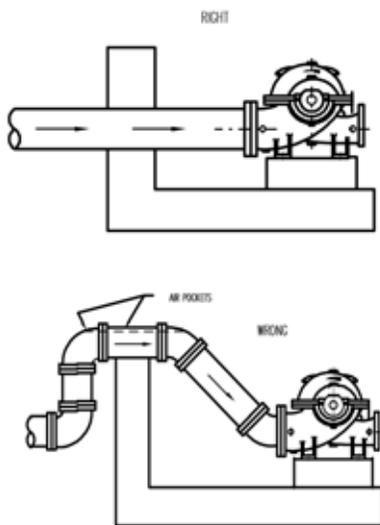


Fig. 5 Suction piping (Avoid high points)

- Install a valve in the suction line to isolate the pump during shutdown and maintenance.

- Valves should always be installed in positions that avoid air pockets. Globe valves should not be used, particularly when NPSH is critical.
- During pumping operation, valves on the suction line must always be at FULL OPEN.
- Pressure gauges properly sized for the range of operation, should be installed in gauge taps on the pump suction and discharge nozzles.

3.9 Discharge (outlet) piping

- Short discharge piping can be the same diameter as the pump discharge opening. Longer piping should be one or two sizes larger depending on length.
- Any high points in discharge piping may entrap air or gas and thus retard pump operation. Air vents or bleed valves as a means to release entrapped air are recommended.
- An even gradient is best for long horizontal runs of discharge piping.
- Install a valve near the pump discharge opening to prime and start the pump. The discharge valve is also used to isolate the pump during shutdown and maintenance.

3.10 Shaft sealing-general comments

- Paco offers both mechanical seals and packed stuffing boxes as a means to seal the shaft. Pumps with stuffing boxes are normally packed before shipment. If the pump is installed within 60 days after shipment, the packing material will be in good condition for operation with a sufficient supply of lubrication. If the pump is stored for a longer period, it may be necessary to repack the stuffing boxes (see [8.3 Packing replacement, each side](#), to repack the boxes).
- The stuffing box must be supplied at all times with a source of clean, clear liquid to flush and lubricate the packing (see [8.3 Packing replacement, each side](#)). When pumps are equipped with mechanical seals, no maintenance or adjustment is required.

3.11 Gland adjustment

- Make sure the flushing fluid lines are connected and their valves are open. After pump start-up, with the pump running the packing gland should be adjusted to permit 40 or 60 drops per minute leakage, this is required for shaft sleeve lubrication.
- The packing gland should be tightened evenly to provide uniform compression on the packing material. Do not operate packing dry, and do not over tighten packing gland to eliminate leaking as the shaft sleeve will become damaged. After initial start up, additional packing and adjustment may be required until the packing is properly seated.

3.12 Mechanical seals

- All Paco KP Double Suction Centrifugal Split Case Pumps that are equipped with mechanical seals are matched to the conditions for which the pump was sold. Observe the following precautions to avoid seal damage and obtain maximum seal life.
- Do not exceed temperature or pressure limitations for the mechanical seal used.
- Do not run the pump dry or against a closed valve! Dry operation will cause seal failure within minutes.
- Purge all air from the seal chambers and recirculation lines prior to operating the pump.
- Clean and purge suction piping in new installations before installing and operating pump. Pipe scale, welding slag and other abrasives can cause rapid seal failure.

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- The mechanical seal does not leak at all during normal operation, therefore if any appreciable leakage occurs, the seal should be removed, inspected and if necessary replaced. Mechanical seals should be stocked as spare parts to reduce equipment down time.

3.13 Coupling alignment

- The following anchoring and alignment procedure is typical and, if performed with care, should result in a smooth running, trouble-free installation.
- If the pump and motor were shipped mounted on the pump base as an assembly, remove the coupling guard.
- The pump and motor were accurately aligned at the factory, but handling during shipment usually alters this pre-alignment. Using a small straight edge and feeler gauges or a dial indicator, check for horizontal, vertical, and angular misalignment of the coupling hubs (Fig. 8).
- Coupling alignment is proper when the dial indicator reads no more than .005" runout in any direction (or when the straight edge contacts both hubs evenly in both horizontal and vertical positions). If misalignment is detected, loosen the motor and shift or shim as necessary to re-align, then re-tighten bolts. Always align the motor to the pump as piping strain will occur if the pump is shifted. Never reposition pump on base!
- After final piping connections to the pump have been made, motor wiring compared, correct rotation has been established, and piping filled with liquid, check shaft alignment once again.

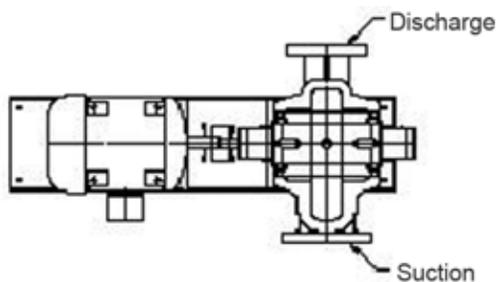


Fig. 6 Plan view clockwise (CW) rotation.

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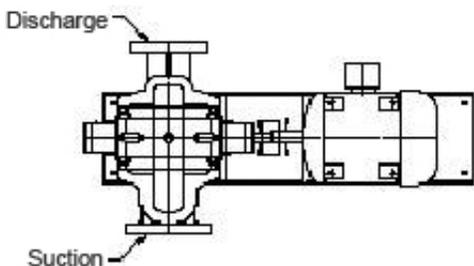


Fig. 7 Plan view counter clockwise (CCW) rotation.

- Leave the coupling guards off until the pump priming procedure is completed for a final shaft alignment check.
- To protect personnel from rotating machinery, Always install coupling guards after installation is complete; before starting pump

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!

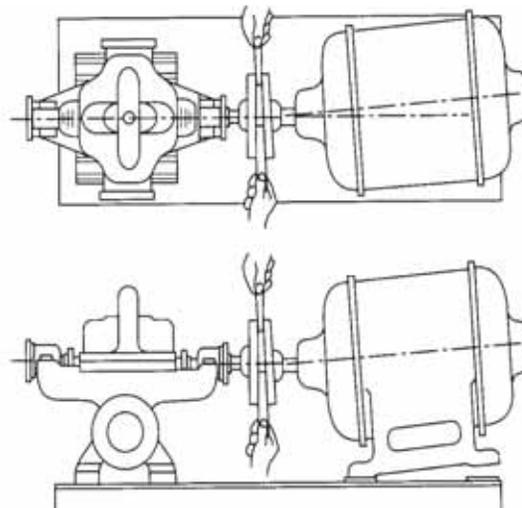


Fig. 8 Checking angular/parallel alignment

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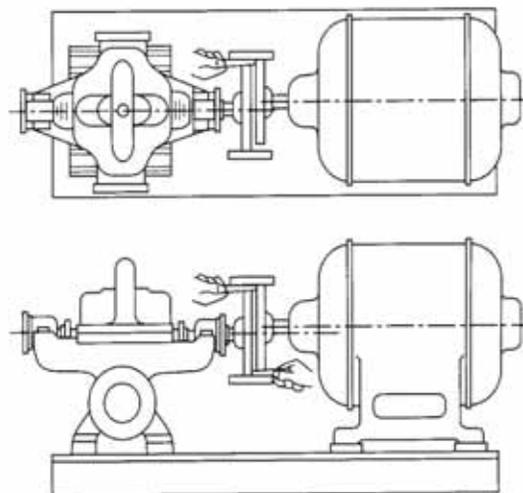


Fig. 9 Checking angular/parallel Alignment

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Caution Do not run the pump dry or against a closed valve!

4. Operating conditions

4.1 Ambient temperature and altitude

The ambient temperature and the installation altitude are important factors for the motor life, as they affect the life of the bearings and the insulation system.

Overheating may result from excessive ambient temperature or the low density and consequently low cooling effect of the air. In such cases, it may be necessary to use a motor with a higher output.

4.2 Liquid temperature

The maximum liquid temperature depends on the material of the mechanical shaft seal, o-rings and gaskets used:

Temperature range for BUNA: 32 °F up to 212 °F
[0 °C up to 100 °C].

Temperature range for VITON ®: 59 °F up to 275 °F [15 °C to 135 °C].

Temperature range for EPDM: 59 °F up to 275 °F [15 °C to 135 °C].

4.3 Pressures in the pump

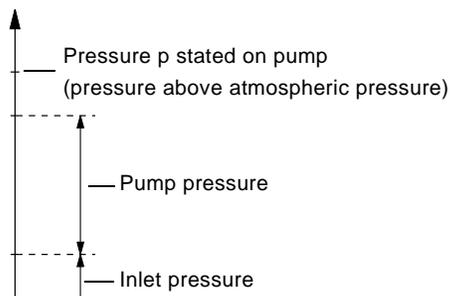


Fig. 10 Pressures in the KP pump

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4.3.1 Maximum discharge pressure



Warning
The maximum discharge pressure is the pressure (TDH) stated on the pump nameplate.

4.3.2 Minimum inlet pressure

The minimum inlet pressure must correspond to the NPSH curve for the pump + a safety margin of minimum 1.6 ft [0.5 m] head.

4.3.3 Maximum inlet pressure

Inlet pressure + pump pressure must be lower than max. pressure (TDH) of the pump.

4.3.4 Minimum flow rate

The pump must not run against closed discharge valve as this will cause an increase in temperature/formation of steam in the pump. This may cause shaft damage, impeller erosion, short life of bearings, damage to stuffing boxes or mechanical shaft seals due to stress or vibration.

The continuous flow rate must be at least 25 % of the flow rate in best efficiency point.

4.4 Maximum flow rate

The maximum flow rate must not exceed the value stated on the nameplate. If the maximum flow rate is exceeded, cavitation and overload may occur.

5. Installation-Electrical

The electrical connections should be carried out by an authorized electrician in accordance with local regulations.



Warning
Before removing the terminal box cover and before any removal/dismantling of the pump, make sure that the power supply has been disconnected and locked out.

5.1 Motors

- The operating voltage and frequency are marked on the motor nameplate.
- Make sure that the motor is suitable for the power supply of the installation site.

- The electrical connections should be carried out as shown on the motor nameplate or in the wiring diagram on the back of the terminal box cover.
- If further information is needed, contact the motor supplier.
- Read and match the starting and overload control devices with motor nameplate information. Always follow control manufacturer's instructions for proper installation and connection.
- Grease lubricated motors are fully lubricated at the time of manufacture and do not require further lubrication if prompt installation follows. If the motor has been in storage for six months or longer, refer to 7.1 Motor lubrication and lubricate before starting.



Warning
Whenever powered equipment is being used in explosive surroundings, the rules and regulations generally or specifically imposed by the relevant responsible authorities or trade organisations must be observed.

5.2 Frequency converter operation

- In principle, all three-phase motors can be connected to a frequency converter.
- However, frequency converter operation will often expose the motor insulation system to a heavier load and cause the motor to be more noisy than usual due to eddy currents caused by voltage peaks.

Note

If in doubt whether the motor supplied can handle frequency converter operation, contact the motor supplier.

- In addition, large motors driven via a frequency converter will be loaded by bearing currents.
- When the pump is operated via a frequency converter, check the following operating conditions:

Operating conditions	Action
2-, 4- and 6-pole motors of 45 HP and up	Check that one of the motor bearings is electrically isolated. Contact Grundfos.
Noise-critical applications	Fit a dU/dt filter between the motor and the frequency converter (reduces the voltage peaks and thus the noise).
Particularly noise-critical applications	Fit a sinusoidal filter.
Cable length	Fit a cable that meets the specifications laid down by the frequency converter supplier. (The length of the cable between motor and frequency converter affects the motor load).
Supply voltage up to 500 V	Check that the motor is suitable for frequency converter operation.
Supply voltage between 500 V and 690 V	<ul style="list-style-type: none"> • Fit a dU/dt filter (reduces the voltage peaks and thus the noise) or • check that the motor has reinforced insulation.
Supply voltage of 690 V and upwards	<ul style="list-style-type: none"> • Fit a dU/dt filter and • check that the motor has reinforced insulation.

6. Operation

6.1 Priming

- The Paco KP Double Suction Centrifugal Split Case Pump is not self-priming, and must be completely primed (filled with liquid) before starting.
- If the pump will operate with a positive suction head, prime by opening the suction valve and allowing liquid to enter the pump casing. Open the air vent at the top of the upper pump casing and the top of each suction dome, and make sure all air is forced from the pump by liquid before closing.
- IMPORTANT: Rotate the shaft by hand while priming and venting to free entrapped air from the impeller passageways.
- If the pump has suction lift, priming must be accomplished by other methods. The use of foot valves, ejectors or vacuum pumps, or by manual filling of the pump casing and suction line with liquid are possible methods suggested for this purpose.

Caution

Never run the pump dry in the hope that it will prime itself! Serious damage to the shaft seals, pump wear rings and shaft sleeves will result.

6.2 Pre-start checklist



Warning

In the interest of operator safety, the unit must not be operated above the nameplate conditions. Such operation could result in unit failure causing injury to operating personnel.

1. Make sure the suction and discharge piping has been cleaned and flushed to remove dirt and debris before operating pump.
2. Make sure all wiring connections to the motor (and starting device) match the wiring diagram and produce proper rotation.
3. If the motor has been in storage for an extended length of time, either before or after installation, refer to motor instructions before starting.
4. Check the voltage, phase, and line circuit frequency with the motor nameplate.
5. Turn rotating element by hand to make sure it rotates freely.
6. Tighten plugs in gauge and drain taps. If the pump is fitted with pressure gauges, keep gauge clocks closed when not in use.
7. Recheck the motor to pump alignment per section [3.13 Coupling alignment](#)
8. Check suction and discharge piping for leaks, and make sure all flange bolts are securely tightened.
9. If the pump will be run on a VFD, do not ramp up the pump from reduced speeds. Go directly on-line at full speed, especially at commissioning so adequate pressure is generated to flush wear rings and create a hydrostatic bearing effect.

6.3 Motor rotation

Caution

Never check driver rotation unless pump and driver couplings are disconnected and physically separated. Failure to follow this instruction can result in serious damage to pump and driver if rotation is wrong.

After the unit has been wired and checked to ensure that all components in the system (disconnect device, magnetic starters, pilot devices and motors) are properly connected, check motor rotation as follows:

- Make sure coupling is disconnected, then momentarily energize the motors to insure that rotation is correct as indicated by the arrow cast into the pump casing. If rotation is incorrect, interchange two wires at the motor starter terminals T1 and T2.
- For Wye-Delta motors rotation has to be verified for both wye and delta connections.
- For proper rotation, reference rotation drawing in section [3.13](#)

6.4 Starting the pump



Warning

The pump must not be operated without an approved coupling guard in place. Failure to observe this warning could result in injury to operating personnel.

1. Install coupling guard on flexible coupled units.
2. Fully open valve (if any) in suction line, and close valve in discharge line.
3. If applicable, turn on any external source of cooling or lubricating fluid to the shaft seals.
4. Start the motor (pump).
5. Immediately after the pump reaches full operating speed, slowly crack open the discharge valve, and open bleed valves at system high points. Do not open discharge valve completely until system is full of liquid, purged of air and checked for leaks.
6. After entirely filling the system, fully open discharge valve and close system bleed valves.
7. If the pump is fitted with pressure gauges, open gauge cocks and record pressure reading for future reference. Verify that the pump is performing in accordance with the parameters specified on the performance curve.
8. Check and record voltage, amperage per phase, and kilowatts, if a watt meter is available.

6.5 Pump shutdown

- The following shutdown procedures will apply in most normal shutdowns for the Paco KP Double Suction Centrifugal Split Case Pump. If the pump will be inoperative for an extended length of time, follow storage procedures in [6.7 Extended period shutdown](#).
- Always close the discharge valve before stopping the pump. Close the valve slowly to prevent hydraulic shock.
- Cut and lock off power to the motor.

6.6 Short duration shutdown

- For overnight or temporary shutdown periods under non-freezing conditions, the pump may remain filled with liquid. Make sure the pump is fully primed before restarting.
- For short or frequent shutdown periods under freezing conditions, keep fluid moving within the pump casing and insulate or heat the pump exterior to prevent freezing.

6.7 Extended period shutdown

- For long shutdowns or to isolate the pump for maintenance, close the suction and discharge valves. If no suction valve is used and the pump has positive suction head, drain all liquid from the suction line to terminate liquid flow into the pump suction nozzle. If applicable, turn off any external source of cooling or lubricating fluid to the shaft seals. Remove plugs in pump drain and vent taps, as required, and drain all liquid from the pump casing. Remove packing, if applicable.
- If freezing conditions will exist during long shut down periods, after draining the pump, blow out all liquid in passages and pockets with compressed air.

- Freezing of pump liquid can also be prevented by filling the pump with antifreeze solution.
- Rotate the shaft by hand monthly to coat bearings with lubricant and retard oxidation and corrosion.
- Where applicable follow motor manufacturer's storage recommendations.

7. Maintenance

7.1 Motor lubrication



Warning

Do not attempt any maintenance, inspection, repair or cleaning in the vicinity of rotating equipment. Such action could result in personal injury to operating personnel. Before attempting any inspection or repair on the pump, the driver controls must be in the "OFF" position, locked and tagged to prevent injury to personnel performing service on the pump.

- Always follow motor manufacturer's lubrication instructions if available, and periodically check grease fittings and drain plugs for leaks.
- If lubricating instructions do not accompany motor, refer to the table below for recommended lubrication periods.

Motor RPM	Motor HP	Operating conditions		
		Standard	Sever	Extreme
1750 and below	10-40	1-3 yrs	6mo - 1 yr	6mo - 1 yr
	50-150	1 yr	3 mo	6 mo
above 1750	200 and Up	1 yr	3 mo	6 mo
		1 yr	3 mo	3 mo
		1 yr	3 mo	3 mo

Recommended Lubrication Periods

7.1.1 Standard conditions:

8 Hours per day operation, normal or light loading, clean air, 100°F, maximum ambient temperature.

7.1.2 Severe conditions:

Continuous 24-hour operation, shock loading or vibration, poor ventilation, 100°-150°F, ambient temperature.

7.1.3 Extreme conditions:

Continuous operation, heavy shock or vibration, dirt or dust in air, extreme ambient temperature.

- To lubricate motor while running or at rest, remove grease drain plug (if any) and filler plug on grease fitting. Grease with clean lubricant until grease appears at drain hole or along motor shaft.
- This table lists the recommended types of grease for motor lubrication. These types have all been thoroughly tested and should be used whenever possible.

Manufacturer	Bearing Lubricant
Chevron	SRI grease NLGI No.2
Texaco	Polystar RB2 NLGI No.2

Recommended bearing grease for motors

7.2 Pump bearing lubrication-General comments



Warning

Operation of the unit without proper lubrication can result in overheating of the bearings, bearing failures, pump seizures and actual breakup of the equipment, exposing operating personnel to personal injury.

Manufacturer	Lubricant
Shell	Dolium
Exxon	Polyrex
Chevron	SRI Grease NLGI 22
	Black Pearl NLGI 2
Phillips	Polytrac
Texaco	Polystar RB

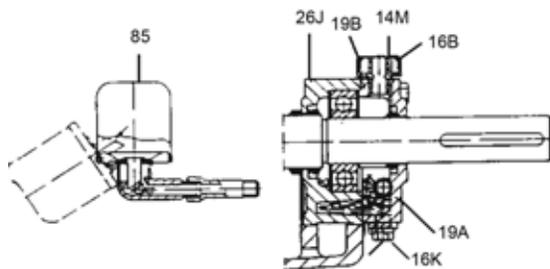
Recommended bearing Grease for pumps

- Re-greaseable bearings are packed with grease at our factory prior to shipping. This initial filling of grease is good for one year or 2000 hours of normal operation, whichever occurs first. After this time, a regular grease maintenance schedule must be implemented.

7.3 Grease replacement

- Remove the four (4) cap screws and remove bearing cap to allow access to the bearing.
- Using a clean rag, remove as much old grease as possible from bearing.
- Re-pack the bearing with sufficient grease to completely fill and cover the balls inside the bearing.
- Turn the pump shaft to insure even and complete lubrication.
- For drive end bearing maintenance, slide the bearing cap back as far as possible and visually inspect bearing for grease.
- Proceed as stated above removing old grease with a clean rag. If the cap cannot be moved sufficiently to allow access to bearing, the coupling hub may have to be removed.
- Reinstall caps when the task is complete.

- Do not over-grease! Too much grease can cause over-heating and premature bearing failure. The bearing manufacturers recommend that the bottom 1/3 of the bearing be filled with grease. After filling the bottom 1/3 with grease, the shaft should be rotated to cover the balls inside the bearing.
- On those Paco KP Centrifugal Split Case Pumps ordered with oil lubricated bearings, a regular oil maintenance program must be enforced. Pumps with oil lubricated bearings are fitted with a transparent reservoir (85) (constant level oiler) that maintains the oil level about the center line of the lower bearing. When necessary, the oil supply in the reservoir of the constant level oiler must be renewed. To refill, remove the reservoir and fill with oil. After filling with oil replace into operating position.



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Fig. 11 Oil lubricated bearing construction

- After the first 200 hours of operation the oil should be changed. To change the oil, remove the drain plug (16K) at the bottom of the bearing cover and the filler plug (16B) at the top of the housing. After draining oil, replace the fittings and refill with an acceptable oil selected from the table below. After the first oil change, the oil should be changed again at 2000 hours and then at intervals of 8000 hours or once yearly thereafter.

Lubricant Manufacturer	Bearing oil brand name
Aral Refining Co.	Aral Oil CMU Aral Oil Tu 518
British Petroleum Co.	BP Energol TH 100-HB
Calypsol Oil Co.	Calypsol Bison Oil SR 25 or SR36
Standard Oil Co.	Chevron Hydraulic Oil Circulating Oil 45
Esso Corporation	Esso-Mar 52 Teresso 47 Esstic 50
Fina Oil Company	Fina Hydran 43 Fina Cirkan 32
Gulf Refining Co.	Gulf Harmony 47 Gulf Paramount 45
Socony Mobil Oil Co.	Vac HLP 25 Mobilux D.T.E. 25
Shell Oil Company	Shell Tellus Oil 29
Sundco Oil Company	Sunvis 821
Texas Company	Texaco Ursa oil P 20
Wisura Rining Co.	Wisura Norma/Tempo 25 (36)

List of acceptable lube oils

7.4 Stuffing box packing shaft seal-water lubrication

- The stuffing box must be supplied at all times with a source of clean, clear liquid to flush and lubricate the packing. Only a sufficient volume of sealing liquid to create a definite direction of flow from the stuffing box inward to the pump casing is required. Piping from the pump discharge dome to the packing box is supplied on Paco KP Double Suction Centrifugal Split Case Pumps when requested.

7.5 Packing Maintenance

The stuffing box should be packed with fresh packing before initial start-up, after repairs to the pump, and in case of excessive leakage. Any time the packing is replaced, the shaft sleeves should be inspected for wear, roughness or scouring and replaced with new ones, if necessary. For instructions on filling the stuffing box see Packing Replacement; for seal gland adjustment see [8. Bearing, seal, & packing replacement](#).

7.6 Coupling maintenance

Coupling is pre-greased at the factory, after disassembly it must be greased again. For annual greasing refer to the coupling manufacturer's instructions.

7.7 Disassembly for maintenance general comments



Warning
Depending on the product being pumped, the pump should be washed down before any work is done on it.



Warning
Observe extreme caution when venting and/or draining hazardous liquids. Wear protective clothing in the presence of caustic, corrosive, volatile, flammable, or hot liquids. **DO NOT breathe toxic vapors. DO NOT allow sparking, flames, or hot surfaces in vicinity of the equipment.**

- Paco KP Double Suction Centrifugal Split Case Pumps are designed for ease of maintenance and, as such, the seals, sleeves, wear rings, clearances and bearings can be inspected without having to remove the complete rotating element or having to disconnect the suction or discharge piping, or disturbing the alignment of the pump set.
- Work on this equipment is to be performed only by qualified personnel. Read the following instructions completely before performing any maintenance on the pump.
- Before beginning disassembly of the pump, close the suction and discharge isolation valves, turn off any external source of cooling or lubricating fluid to the shaft seals, drain the pump case by opening the drain and vent plugs, and disconnect and lock off the motor power source.

Clearance of 24" on each side of pump will allow for maximum access while servicing. A minimum of 24" clearance is required to remove the top dome of the pump when accessing the rotating element.

Note

8. Bearing, seal, & packing replacement

All normally required parts for Paco KP Pumps are available in kit form. Refer to drawings on page 13 and page 15.

8.1 Bearing replacement (horizontal)

- Remove motor.
- Remove coupling half from pump shaft (51) using a wheel puller and remove coupling key (11A)
- Remove bearing caps (113C) and (113D)
- Loosen set screws in eccentric locking rings of bearings (53 and 54) and turn rings in opposite direction of pump rotation to loosen on shaft, or remove retaining snap ring, whichever is applicable.
- Remove cap screws from each bearing housing (124) and slide, with bearing, off its end of shaft.

Note

The seal seats in the bearing housings of seal type pumps can be broken if care is not exercised during housing removal.

- Remove bearings (53, 54) from bearing housings.
- Install New Seals and Seal Seats.
- Reinstall bearing housings less bearings, noting that water slinger (79) is in correct place. Care must be taken not to break the seal seats of seal type pumps by striking them against shaft.
- Clean out housings and slide new bearings over shaft and into housings. Press only on inner race of bearing. Use bearing warmer, if available.

10. Turn eccentric locking rings in direction of pump rotation to tighten on shaft and tighten set screws, or replace spacer and retaining snap ring, whichever is applicable.
11. Pack ball bearings and bearing cap cavities with clean ball bearing grease. (See [7.2 Pump bearing lubrication-General comments](#)).
12. Replace bearing caps (113C, 113D).
13. Replace packing glands after following packing instructions Packing Replacement, each side, if packing type pump.
14. Gently tap coupling half on shaft (51) over key (11A). Do not tap if it can be pushed on. Undue force in driving on coupling half can damage ball-bearings and/or fracture the seal faces. If there is difficulty putting coupling onto shaft, heat up coupling half to a temperature of not more than 300° and then slide onto shaft using protective gloves.
15. Replace motor and realign.

On vertically mounted pumps, it will be necessary to remove the rotating assembly in order to change lower bearing and seal assembly.

Note

8.1.1 Mechanical seal replacement (horizontal)

1. Follow above steps to remove bearing housings (124).
2. Remove old seal head and seal seat from shaft sleeve and bearing housing or seal cap respectively

It is not necessary to remove bearings from housings, however, it is recommended that bearings be replaced.

Note

3. Inspect shaft sleeves (116) for scoring or pitting.
4. Replace if surface is rough to your fingernail.

8.1.2 Proper seal seat installation:

1. Clean seal cap or bearing housing.
2. Lightly lubricate new seat's rubber cap with liquid soap.
3. Press in seal seat with proper tool or fingers, making sure seat is seated squarely and all the way into seal cap or bearing housing. Do not touch seal seat or head faces.

8.2 Proper seal head installation

1. Clean and lightly lubricate shaft sleeves (116) or shaft (51). Make sure there are no sharp edges or corners to cut the seal's rubber parts.
2. Lightly lubricate seal face elastomers with liquid soap.
3. Slide assembly onto sleeve or shaft until spring touches shoulder, using proper tool or fingers. Do not compress spring. Make sure notches on carbon ring match retainer's lugs and spring is in position on seal head.
4. Reinstall bearing housings (124) with bearings, noting that water slingers (79) are in correct places. Care must be taken not to strike seal seats against shaft.
5. Follow remaining Bearing Replacement steps to complete assembly.

8.3 Packing replacement, each side

1. Remove packing gland.
2. Remove old packing lantern ring, if any, and packing behind lantern ring, with a packing hook.
3. If packing retainer comes out, replace it against retaining ring.
4. Insert two new packing rings one at a time, staggering the joints 180° and pushing them firmly back against the packing retaining washer.
5. Insert lantern ring, if any.

6. Insert three more rings of packing (applies to most sizes) staggering joints 180°. If no lantern ring is used, one extra ring of packing will be required.
7. Replace packing gland.
8. Packing requires lubrication. Therefore, it should always be allowed to leak a 40 to 60 drops per minute. Never over tighten packing gland.
9. Should it become necessary to over tighten the packing (suction lift applications) while starting the pump, make sure to loosen packing immediately after pump is started, allowing a leakage of a 40 to 60 drops per minute. Readjust after a few hours of running, if leakage increases.

9. Disassembly of horizontal pumps

1. Remove bolts and nuts holding casing halves (6A, 6B) together, and remove caps crews holding bearing housing (124) to pump casing.
2. Remove case roll pin (26B) then lift off upper case (6A).
3. Place casing gasket, as well as all other gaskets, in water to keep them from drying out and shrinking.
4. Remove shaft assembly from case.
5. To disassemble rotating assembly, refer to Bearing Replacement.
6. Unscrew and remove shaft sleeves (116) or impeller locknuts by turning them in direction of pump rotation. One has R.H. threads. The other has L.H. threads. Do not place wrench on the part of sleeve that comes in contact with seal or packing. Use strap wrench.
7. Remove wear ring retaining parts as necessary, locking pin (24) and/or rings (65).
8. Slide wear ring (45) off impeller.
9. Mark impeller (49) with a mark on coupling side before removing it from shaft to be sure it will be reassembled identically.
10. Press impeller (49) from shaft (51) and key (11).

10. Disassembly of vertical pumps

1. Remove coupling guard and remove coupling grid.
2. Remove all cap screws on bearing housings (124) except for two on lower case (6B) to hold rotating assembly in place while removing upper case (6A).
3. Remove case roll pin (26B) then lift off upper case (6A).
4. Place casing gasket, as well as all other gaskets, in water to keep them from drying out and shrinking.
5. Remove shaft assembly from case.
6. To disassemble rotating assembly, refer to Bearing Replacement.

11. Component inspection

1. While the pump is disassembled, all components should be inspected for wear, damage, deterioration or erosion.
2. Shaft sleeves should be inspected and if worn or deeply scored should be replaced.
3. Impeller wear ring (if used) and casing wear ring (45) should be checked for erosion or wear and if badly deteriorated, replaced to renew original pump performance. The design clearance is .018" to .022" diametrically. Clearances greater than .040" effect pump performance and new rings should be installed.
4. Examine the lapped faces of the mechanical seals for scoring, heat checking or cracking. Examine mechanical seal elastomers (rubber components) for deterioration or hardening. Replace mechanical seals if any damage exists.

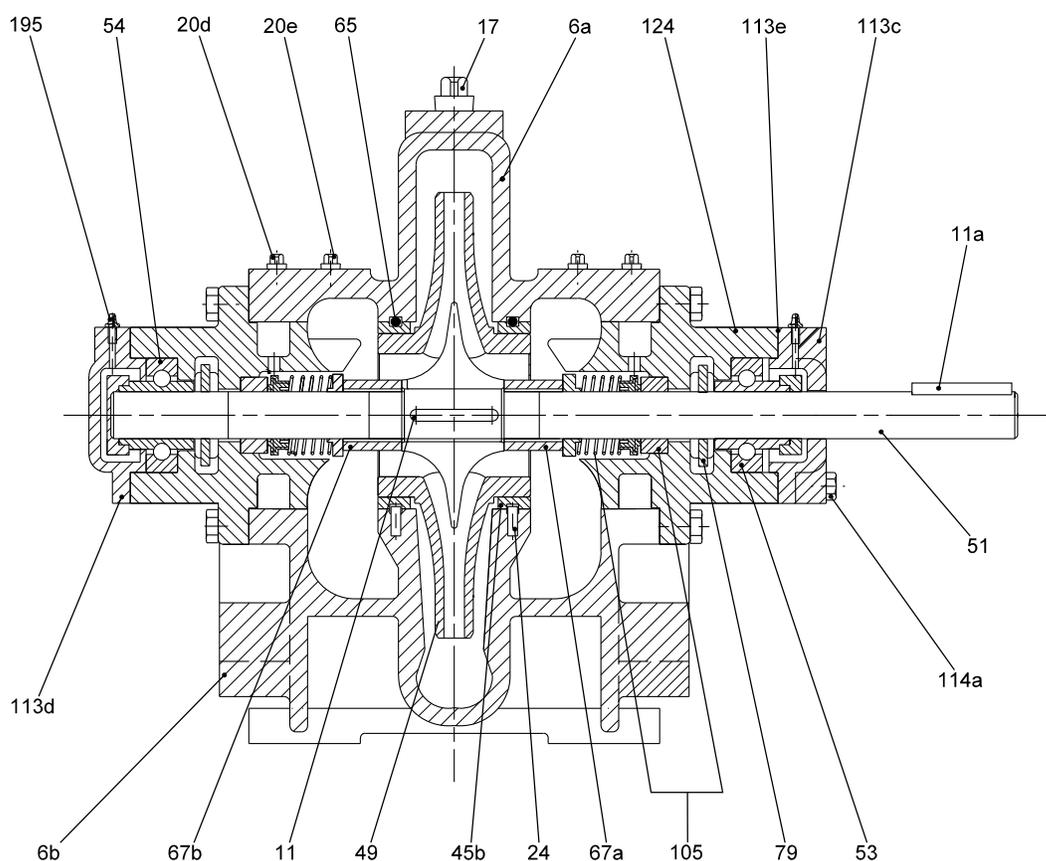
5. Check any external source of cooling or lubricating fluid lines, and/or recirculation lines and ports for clogs, kinks or other restrictions.
6. Clean machined mating surfaces of all components to remove grit, grime and/or old sealing material before reassembling pump.

12. Reassembly of pumps

1. Reinstall impeller (49) and key (11) on shaft (51), centering impeller on shaft with respect to sleeve or lock nut threads. Be sure impeller is installed on shaft the same way it came off, with vane curvature and per mark made during disassembly. For proper rotation, reference rotation drawing in section 3.13
2. Note that:
 - pump will deliver little or no water if impeller is installed backwards.

- Be sure a good O-ring gasket is in place on each sleeve, if shaft has sleeves. Replace as necessary.
3. Replace shaft sleeves (116) or nuts, turning them in opposite direction of pump rotation. Do Not place wrench on the part of sleeve that comes in contact with seal or packing. Tighten evenly so impeller position will not shift.
 4. Replace wear ring retaining ring (65) over wear ring (45).
 5. Slide wear ring (45) over each impeller hub.
 6. Replace wear rings (45) on impeller (49). Replace with seals or packing. Replace bearing housing (124) on shaft (51) not to damage seal (11B). Replace bearing (54) into outboard housing and washer and snap ring. Replace coupling key (11A) with coupling half.
 7. For packing type pumps, follow steps under Bearing Replacement ; then steps under Packing Replacement, each side.

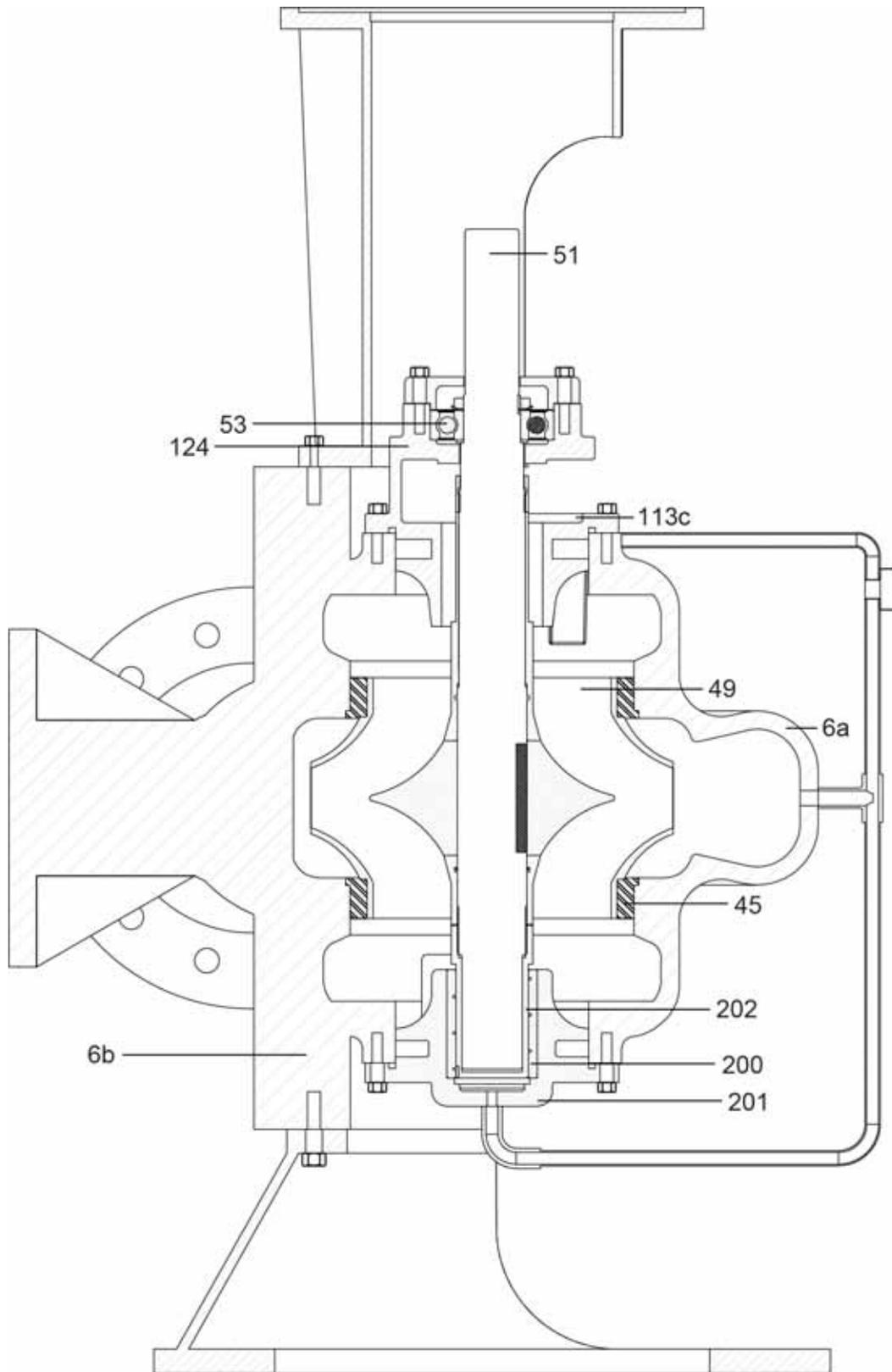
13. Horizontally mounted KP parts breakdown



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Pos. no.	Component	Material	ASTM standard
6a	Pump casing, upper	Cast Iron	ASTM A48 CL35
6b	Pump casing, lower	Cast iron	ASTM A48 CL35
11	Key, impeller	Steel	C1018, cold drawn steel
11a	Key, coupling	Steel	C1018, cold drawn steel
17	Pipe plug	Steel	
20	Drain plug R 1/2	Steel	
20a	Plug, drain outlet	Steel	
20b	Plug, inlet	Steel	
20c	Plug, outlet	Steel	
20d	Plug, shaft seal flushing	Steel	
20e	Plug, suction chamber	Steel	
24	Locking pin, wear ring	Steel	ANSI/ASME B18.8
26b	Roll pin	Steel	ANSI/ASME B18.8
26c	Screw	Steel	
45	Wear ring	Bronze	ASTM B148, C95200
45b	Wear ring with groove for retaining ring	Bronze	ASTM B148, C95200
49	Impeller	Silicon bronze	ASTM B584, C87600
51	Shaft	Steel	AISI 1144 Stress proof
53	Ball bearing, drive end	Steel	
54	Ball bearing, non-drive end	Steel	
54c	Washer	Steel	
54d	Retaining ring	Carbon Spring Steel	SAE 1060-1090
58	Seal cover	Grey Iron	
58a	Screw	Steel	
65	Retaining ring	Stainless steel, series 303	
66	O-ring	NBR	
67a	Impeller/shaft sleeve nut, right-hand thread	Bronze	III932, C89835
	Impeller/shaft lock nut, right-hand thread	Stainless steel	
67b	Impeller/shaft sleeve nut, left-hand thread	Bronze	III932, C89835
	Impeller/shaft lock nut, left-hand thread	Stainless steel	
72a	Gasket	Vegetable fiber (HYD-401)	
76	Nameplate	Aluminum	
79	Slinger	Neoprene	
105	Shaft seal		
109	O-ring	NBR	
109a	O-ring	NBR	
110	O-ring	NBR	
113	Bearing housing	Cast iron	ASTM A48, CL30
113c	Bearing cover, drive end	Cast iron	ASTM A48, CL30
113d	Bearing cover, non-drive end	Cast iron	ASTM A48, CL30
113e	Gasket	Vegetable fiber	
113f	Lip seal, non-drive end bearing	NBR	
179	Lip seal, drive-end bearing	NBR	
114	Screw	Steel	
114a	Screw	Steel	
114b	Screw	Steel	
116	Shaft sleeve	Bronze	III932, C89835
1151	Shaft sleeve, drive end	Bronze	I836 C89833
116b	Shaft sleeve, non-drive end	Bronze	I836 C89833
116c	Shaft sleeve, inner	Bronze	I836 C89833
116d	Shaft sleeve, outer	Bronze	I836 C89833
116e	Set screw	Steel	
124	Seal housing	Cast iron	ASTM A48 CL30
195	Lubricating nipple	Zinc coated steel	
200	Sleeve bearing	Graphalloy	Grade GM 343.3
201	Sleeve bearing housing	Cast Iron	
202	Lower sleeve	Stainless steel, series 416	

13.1 Vertically mounted KP parts breakdown



13.2 Sleeve bearing assembly/disassembly

13.2.1 Disassembly

1. Close the suction and discharge side valves before starting disassembly.
2. Remove motor, after electrically disconnecting all the connections.
3. Remove coupling guard and remove coupling grid
4. Drain the fluid from the pump. Pipe plug (20A) and the recirculation lines can be used for draining.
5. Remove bearing caps (113C).
6. Loosen set screws in eccentric locking rings of bearing (53) and turn ring in opposite direction of pump rotation to loosen on shaft, or remove retaining snap ring, or lock nut and lock washer whichever is applicable.
7. Remove all cap screws on bearing housings (124) except for the two on the lower case (6B) to hold the rotating assembly in place while removing upper case (6A).
8. Remove case roll pin (26B) then lift off upper case (6A).
9. Place casing gasket, as well as all other gaskets, in water to keep them from drying out and shrinking.
10. Remove shaft assembly from the case.
11. Remove the sleeves and then impeller.

13.2.2 Assembly

1. Using an appropriately rated sling and hoist, place the pump case assembly on the flat surface. Remove the hex head bolts. If required, clean both machined faces on the pump case assembly with fine grit and sand paper. Remove the two roll pins from the lower case. Using an appropriate eyebolt and hoist, remove the upper case and clean it if necessary.
2. Align the two wear rings (45) with wear ring register in the lower case. Using the soft face hammer and brass punch, drive the roll pins into the drilled holes on the wear ring bores.
3. Slide wear rings onto impeller wear rings, ensuring your hole and roll pin orientation marks are facing outward.
4. Pick up impeller (49) and position in lower case.
5. Refer to work order and determine correct rotation (clockwise or counter clock wise).
6. Carefully spray the shaft (51) with solvent and wipe off with clean rag. Install drive key into center key slot on the shaft by gently tapping with a soft faced hammer.
7. Slide the shaft (51) into the bore of the impeller.
8. Install the lower sleeve (202). Make sure it engages all the threads. The impeller butts against to lower sleeve or sleeve nut depending pump size. Install the sleeve and sleeve nut on the other side of the impeller. Using the spanner wrench, secure the sleeves against the impeller hubs.
9. Using the hoist, position the upper case over the four alignment studs and install onto lower case. Using the soft head hammer drive the two roll pins into the lower case and remove the four alignment studs.
10. Place the long cap screws in to the mounting holes located in the center area of the upper case and place remaining cap screws into the mounted hole located on the flange area of the upper case. First tighten the four cap screws in the center area using crisscross pattern and complete all.
11. Spray the mounting face surfaces and finished inside diameters seal housing with solvent and wipe off with rag. Carefully align and place the seal seat into the seal housing (124). Slide the seal head assembly onto the in-board or drive end of the shaft and seat up against the shaft sleeve.
12. Carefully slide and position the seal housing so the orientation of the two blades on the seal housing is 11 and 1 O'clock. Make sure you have the slinger on the shaft.

13. Assemble the roller bearing. Secure the bearing cap with screws.
14. Assemble the Sleeve bearing housing (which is press fitted with graphalloy Sleeve bearing).
15. Make sure the shaft is rotating after assembly the bearing housings.
16. Assemble the recirculation lines and pipe plugs as shown in picture

14. Recommended spare parts

The recommended spare parts depend greatly on the run time and application of the pump. As a minimum, it is recommended to keep the following kits:

- Shaft seal kit
- Bearing kit
- Gasket kit

15. Troubleshooting

Symptoms	Cause code
Pump does not deliver any liquid at start-up.	1*2*3*4*5*6*7*8*9*10*11*14*16*17*22*23*24*34
Pump stops delivering liquid after start-up.	2*3*4*5*6*7*8*9*10*11*12*13*22*23*24*34
Pump overheats and/or ceases to deliver liquid.	1*3*9*10*11*21*22*27*29*30*31*33*34*40*41
Insufficient flow rate.	2*3*4*5*6*7*8*9*10*11*14*16*17*20*21*22*23*24*25*26*34
Excessive flow rate.	15*18*20*34
Discharge pressure is too high.	4*14*16*18*20*22*23*24*25*26*34
Shaft seal leaks appreciably, or the packing leaks excessively.	27*28*29*30*33*34*35*36*39*41
Shaft seal or packing fails prematurely.	12*13*27*28*29*30*33*34*35*36*37*38*39*41
Pump uses too much power.	15*16*18*19*20*23*25*27*28*31*33*34*35*37*38*44
Pump runs rough and noisily.	2*3*4*5*6*7*8*9*10*11*15*17*18*21*23*24*27*28*29*30*31*32*33*34*40*41*42*45*46*47
Bearings overheat and/or fail prematurely.	27*28*29*30*31*32*33*34*40*41*42*43*44*45*46

15.1 Possible causes

- The pump has not been properly bled of air.
- The pump suction line has not been completely primed.
- The suction head (NPSHR) required by the pump is too high, or the net positive suction head available (NPSHA) at your facility is too low.
- The fluid pumped contains too much entrained air or gas.
- There are air pockets in the suction line.
- An entry of air has suddenly occurred in the suction line.
- An entry of air past the shaft seal into the pump has occurred.
- The inlet of the suction line is insufficiently submerged.
- The suction valve is closed or only partially open.
- The suction strainer is clogged with dirt or debris.
- The foot valve is clogged or undersized.
- Little or no cooling fluid supplied to the shaft seals.
- The lantern ring is not positioned opposite the flushing inlet, thereby restricting fluid flow.
- Pump drive rotational speed too low.
- Pump drive rotational speed too high.
- Pump rotation wrong or impeller installed backwards.
- Total head of installation (back Pressure) higher than rated total head of the pump.
- Total head of installation (back Pressure) lower than rated total head of the pump.
- Density of fluid pumped differs from that specified when the pump was purchased.
- Viscosity of fluid pumped differs from that specified when the pump was purchased.
- The pump is operating at too low a rate of flow (The discharge valve may be throttled too much).
- If pumps are operating in parallel, the pump characteristics may not be suitable for parallel operation.
- The impeller may be clogged with debris.
- The impeller may be damaged.
- The casing and impeller wear rings may be excessively worn.
- There may be internal leakage from the discharge to the suction compartments as the result of internal gasket failure.
- There may be a misalignment of the pump shaft.
- The shaft may chatter because it is bent.
- The pump may run rough due to improper balancing of the impeller.
- The shaft may not be running due to worn bearings.
- The impeller may be rubbing against the inside of the case.
- The concrete pad might not be of sufficient size to provide pump stability.
- The pump may have become misaligned during installation.

- The operating conditions of the installation do not agree with the data specified when the pump was purchased.
- The shaft seal may be incorrectly installed, or the stuffing box has not been packed correctly.
- The shaft sleeve may be scored or pitted in the region of the packing due to dirt or abrasive matter in the flushing fluid.
- Excessive tightening of the packing gland may block the flushing port thereby diminishing the sealing fluid flow.
- Packing material may have become wedged or extruded between the shaft and the bottom of the stuffing housing due to excessive clearance on the Packing backup washer.
- The mechanical seal may have been damaged by running dry.
- There may be excessive axial thrust (side loading) due to improper impeller central alignment.
- The bearings may be worn.
- The bearings may have been damaged during installation and/or dirt or other foreign matter may have entered the bearings during greasing or oiling.
- Excessive greasing may cause the bearings to overheat.
- Inadequate lubrication may be causing bearing failure.
- Dirt may have entered the bearings past the O-Rings.
- Moisture may have entered the bearing housing causing the bearings to rust.
- Shaft run out and water bracket misalignment.

16. Ordering parts

Paco Pumps has over 100 years of experience in the design, manufacture, and application of centrifugal pumps and pumping systems. Paco's commitment to state-of-the-art pump design and quality manufacturing assures maximum user benefits with optimum equipment life at lower cost. Paco's commitment to their customers continues through an extensive service organization. Highly trained technicians can assist customers with initial startup, troubleshooting, repair, and system analysis. Paco maintains an extensive stock of replacement parts and parts kits for our pumps. In order to reduce pump repair time and shorten inconvenient pump service interruptions, it is suggested that the pump user stock spare parts. Since spare parts requirements and quantities vary for specific pump constructions, use our online tools to help in defining your spare part requirements. For current products and pricing, please visit Express Suite/channel partners or our extranet site. To ensure that the proper replacement parts are ordered for your particular pump model: Identify all pertinent data from the pump name plate (see Pump Identification). This should always include the pump Catalog or Model Number, and the pump Serial Number. For replacement impellers, also include from the nameplate the operating conditions (GPM and TDH) and the impeller diameter. Identify all parts by item number and description as indicated by the appropriate assembly drawing in this manual, for your particular pump model.

17. Terms and condition of sales

17.1 The contract

The Contract shall be comprised of the following terms, together with such terms and conditions as are set forth in Seller's written proposal or quotation (the "Quotation"), including any documents, drawings or specifications incorporated therein by reference, and any additional or different terms proposed in Buyer's purchase order (the "Purchase Order") that are accepted by Seller in writing, which together shall constitute the entire agreement between the parties, provided, however, that preprinted terms on Buyer's purchase order or invoice shall not apply and Seller gives notice of objection to such terms. An offer by Seller in its Quotation that does not stipulate an acceptance date is not binding. This Contract shall be deemed to have been entered into upon written acknowledgment of the Purchase Order by an officer or authorized representative of Seller, which may not be modified, supplemented, or waived except in a writing executed by an authorized representative of the party to be bound.

17.2 Price

The price quoted in the Quotation shall be the Purchase Price unless otherwise agreed in the Purchase Order. The Purchase Price for equipment shall include packing for shipment. Field Services shall be provided at Seller's standard rates. All other costs, including packing for storage, freight, insurance, taxes, customs duties and import/export fees, or any other item not specified in the Contract, shall be paid by Buyer unless separately stated in the Quotation and included in the price quoted. Any sales, use, or other taxes and duties imposed on the transaction or the equipment supplied shall be paid or reimbursed by Buyer.

17.3 Payment terms

Payment shall be due within 30 days of the date of Seller's invoice in U.S. funds unless otherwise agreed. If Buyer does not observe the agreed dates of payment, Buyer shall pay interest to Seller on overdue amounts at a rate that is the higher of: 9% per annum or a rate 5% in excess of the rate borne from time to time by new issues of six-month United States Treasury bills. Seller shall be entitled to issue its invoice for the Purchase Price for equipment upon the earlier of shipment, or notice to Buyer that Seller is ready to ship, and for services, upon completion. If the Purchase Price exceeds \$250,000 USD, Buyer shall pay the Purchase Price in Progress payments as follows: Fifteen percent (15%) upon submittal of general arrangement drawings, thirty five percent (35%) after receipt of first Bowl Casting, twenty percent (20%) after first case/bowl hydro test or bowl machining and thirty percent (30%) after notification of ready to ship.

17.4 Acceptance and inspection

All equipment shall be finally inspected and accepted by Buyer within 14 days after delivery or such other period of time as is agreed in the Purchase Order. Buyer shall make all claims (including claims for shortages), excepting only those provided for under the warranty clause contained herein, in writing within such 14 day period or they are waived. Services shall be accepted upon completion. Buyer shall not revoke its acceptance. Buyer may reject the equipment only for defects that substantially impair its value, and Buyer's remedy for lesser defects shall be in accordance with Section 10, Warranty. If tests are made by Buyer to demonstrate the ability of the equipment to operate under the contract conditions and to fulfill the warranties in Section 10, Buyer is to make all preparations and incur all expenses incidental to such tests. Seller will have the right of representation at such tests at its expense, and the right to technically direct the operation of the equipment during such tests, including requiring a preliminary run for adjustments.

17.5 Title and risk of loss

Full risk of loss (including transportation delays and losses) shall pass to Buyer upon delivery, regardless of whether title has passed to Buyer, transport is arranged or supervised by Seller, or start-up is carried out under the direction or supervision of Seller. Delivery shall be ex works, INCOTERMS 2000. Loss or destruction of the equipment or injury or damage to the equipment that occurs while the risk of such loss or damage is borne by Buyer does not relieve Buyer of its obligation to pay Seller for the equipment.

17.6 Patent or trademark information

If the equipment sold hereunder is to be prepared or manufactured according to Buyer's specifications, Buyer shall indemnify Seller and hold it harmless from any claims or liability for patent or trademark infringement on account of the sale of such goods.

17.7 Changes

Buyer may request, in writing, changes in the design, drawings, specifications, shipping instructions, and shipment schedules of the equipment. As promptly as practicable after receipt of such request, Seller will advise Buyer what amendments to the Contract, if any, may be necessitated by such requested changes, including but not limited to amendment of the Purchase Price, specifications, shipment schedule, or date of delivery. Any changes agreed upon by the parties shall be evidenced by a Change Order signed by both parties.

17.8 Cancellation or termination

Buyer shall have the right to cancel the Contract upon 15 days' prior written notice to Seller, and Seller shall stop its performance upon the receipt of such notice except as otherwise agreed with Buyer. If Buyer cancels the Contract, it shall pay: (a) the agreed unit price for equipment or components completed and delivered, (b) additional material and labor costs incurred, and for engineering services supplied by Seller with respect to the canceled items, which shall be charged to Buyer at Seller's rates in effect at the time of cancellation, but which shall not exceed the contract price for such items, and (c) such other costs and expenses, including cancellation charges under subcontracts, as Seller may incur in connection with such cancellation or termination. Terms And Conditions Of Sale

17.9 Delivery and delays

Seller shall use its best efforts to meet quoted delivery dates, which are estimated based on conditions known at the time of quotation. Seller shall not be liable for any nonperformance, loss, damage, or delay due to war, riots, fire, flood, strikes or other labor difficulty, governmental actions, acts of God, acts of the Buyer or its customer, delays in transportation, inability to obtain necessary labor or materials from usual sources, or other causes beyond the reasonable control of Seller. In the event of delay in performance due to any such cause, the date of delivery or time for completion will be extended to reflect the length of time lost by reason of such delay. Seller shall not be liable for any loss or damage to Buyer resulting from any delay in delivery.

17.10 Warranty

Seller warrants that the equipment or services supplied will be free from defects in material, and workmanship for a period of 12 months from the date of initial operation of the equipment, or 18 months from the date of shipment, whichever shall first occur. In the case of spare or replacement parts manufactured by Seller, the warranty period shall be for a period of six months from shipment. Repairs shall be warranted for 12 months or, if the repair is performed under this warranty, for the remainder of the original warranty period, whichever is less. Buyer shall report any

claimed defect in writing to Seller immediately upon discovery and in any event, within the warranty period. Seller shall, at its sole option, repair the equipment or furnish replacement equipment or parts thereof, at the original delivery point. Seller shall not be liable for costs of removal, reinstallation, or gaining access. If Buyer or others repair, replace, or adjust equipment or parts without Seller's prior written approval, Seller is relieved of any further obligation to Buyer under this section with respect to such equipment or parts. The repair or replacement of the equipment or spare or replacement parts by Seller under this section shall constitute Seller's sole obligation and Buyer's sole and exclusive remedy for all claims of defects. SELLER MAKES NO OTHER WARRANTY OR REPRESENTATION OF ANY KIND WITH RESPECT TO THE EQUIPMENT OR SERVICES OTHER THAN AS SPECIFIED IN THIS SECTION 10. ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, ARE HEREBY DISCLAIMED. For purposes of this Section, the equipment warranted shall not include equipment, parts, and work not manufactured or performed by Seller. With respect to such equipment, parts, or work, Seller's only obligation shall be to assign to Buyer any warranty provided to Seller by the manufacturer or supplier providing such equipment, parts or work. No equipment furnished by Seller shall be deemed to be defective by reason of normal wear and tear, failure to resist erosive or corrosive action of any fluid or gas, Buyer's failure to properly store, install, operate or maintain the equipment in accordance with good industry practices or specific recommendations of Seller, or Buyer's failure to provide complete and accurate information to Seller concerning the operational application of the equipment.

17.11 Technical documents

Technical documents furnished by Seller to Buyer, such as drawings, descriptions, designs and the like, shall be deemed provided to Buyer on a confidential basis, shall remain Seller's exclusive property, shall not be provided in any way to third parties, and shall only be used by Buyer for purposes of installation, operation and maintenance. Technical documents submitted in connection with a Quotation that does not result in a Purchase Order shall be returned to Seller upon request.

17.12 Limitation of liability

Seller shall in no event be liable for any consequential, incidental, indirect, special or punitive damages arising out of the Contract, or out of any breach of any of its obligations hereunder, or out of any defect in, or failure of, or malfunction of the equipment, including but not limited to, claims based upon loss of use, lost profits or revenue, interest, lost goodwill, work stoppage, impairment of other equipment, environmental damage, nuclear incident, loss by reason of shutdown or nonoperation, increased expenses of operation, cost of purchase of replacement power or claims of Buyer or customers of Buyer for service interruption whether or not such loss or damage is based on contract, tort (including negligence and strict liability) or otherwise. Seller's maximum liability under this Contract shall not exceed the Purchase Order amount of the equipment or portion thereof upon which such liability is based. All such liability shall terminate upon the expiration of the warranty period, if not sooner terminated.

17.13 This company is an equal opportunity employer

This agreement incorporates by reference applicable provisions and requirements of Executive Order 11246 and FAR Section 52.222-26 (covering race, color, religion, sex and national origin); the Vietnam Era Veterans Readjustment Assistance Act of 1974 and FAR Section 52.222-35 (covering special disabled and Vietnam era veterans); and the Rehabilitation Act of 1973 and FAR Section 52.222-36 (covering handicapped individuals). By

acceptance of this agreement Buyer certifies that it does not and will not maintain any facilities in a segregated manner, or permit its employees to perform their services at any location under its control where segregated facilities are maintained, and further that appropriate physical facilities are maintained for both sexes. Buyer agrees that it will obtain a similar certificate prior to award of any nonexempt lower-tier subcontracts.

17.14 Law and arbitration

The Contract shall be governed by the law of the State of Texas. Any disputes arising out of this Contract shall be resolved by informal mediation in any manner that the parties may agree within 45 days of written request for mediation by one party to the other. Any dispute that cannot be resolved through mediation shall be resolved by binding arbitration conducted in English in Portland, Oregon under the Commercial Rules of the American Arbitration Association except as otherwise provided in this Section. The arbitration shall be conducted by three arbitrators chosen in accordance with said Rules. The arbitrators are not entitled to award damages in excess of compensatory damages. Judgment upon the award may be entered in any court having jurisdiction..

18. Seal and bearing replacement (Large vertical pumps)

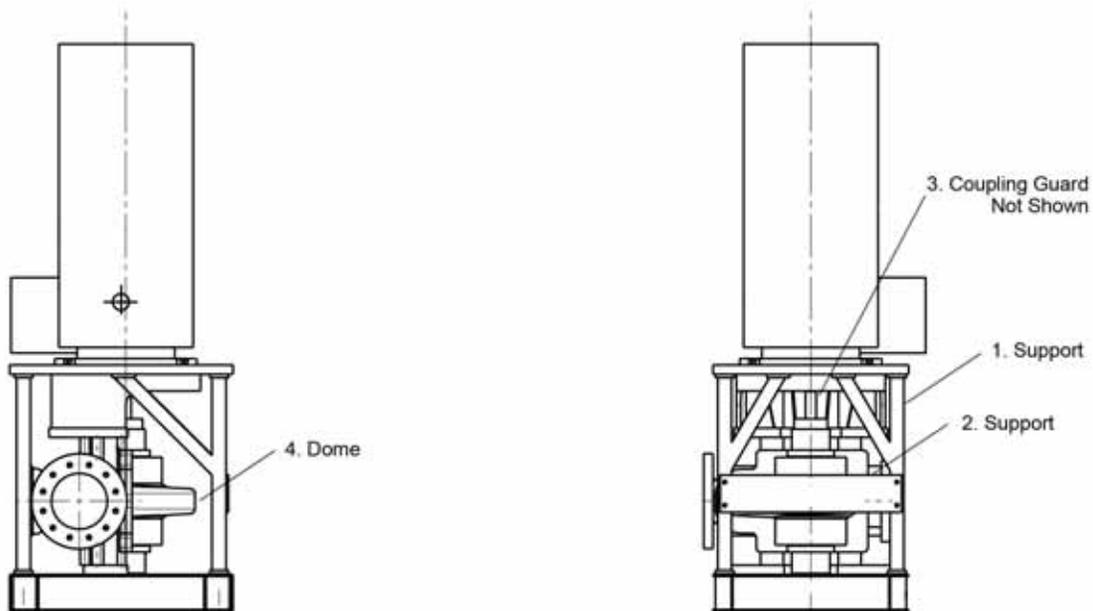


Fig. 12 Large vertical KPV with stand

1. Lock/tag out electrical connection to motor.
2. Close suction and discharge water valves
3. Drain pump water
4. Remove piece 2
5. Remove piece 1
6. Any shims that are removed from piece 1 must go back in same location on reassemble
7. Remove coupling guard (3) but not the motor bracket
8. Remove cover assembly on Falk coupling, then remove grid assemble from coupling halves
9. Remove cap screws from each of bearing housings - leaving two cap screws on upper bearing lower case to
10. hold rotating assembly in place when removing upper case
11. Remove case roll pins
12. For removing upper case half (4) Use two 3/4" threaded rod 14" long for removing upper case and 1/2" eye bolt in top of upper case dome
13. Once these are in place, remove all case cap screws and remove upper case
14. Use sling through upper bearing housing window and remove the cap screws that were holding rotating assembly in place. Remove rotating assembly
15. Remove bearing cap off of lower bearing housing
16. Remove snap ring and washer from end of shaft
17. Use wheel puller to remove bearing housing and bearing from pump shaft
18. Remove bearing, lip seal, and seal seat from bearing housing. Clean bearing housing
19. Remove seal head from shaft sleeve
20. Clean shaft sleeve, if worn or deeply scored, it should be replaced
21. Replace new lip seal and seal seat in bearing housing
22. Clean case wear rings and impeller wear rings
23. Installing seal head on shaft sleeve, lubricate seal elastomer with liquid soap and also shaft sleeve. Install spring and seal head onto shaft sleeve making sure seal head moves back and forth on shaft sleeve
24. Reinstalling bearing housing, care must be taken not to strike seal seat against shaft, make sure you have slinger in the open window of bearing housing when sliding bearing housing onto shaft
25. Will need a bearing warmer to heat the inner race of bearing to install on shaft end. Heat inner race of bearing to 200 degrees Fahrenheit. Slide bearing onto shaft. Install washer and snap ring
26. Use Poly-urea grease to hand pack bearing after bearing cools
27. Install bearing cap
28. Removing bearing housing from drive end
29. Remove coupling half
30. Remove bearing cap
31. Measure from the inner race of bearing to end of shaft. This will tell you where on the shaft the new bearing will sit.
32. Use same steps as above on removing and cleaning of bearing housing
33. After rotating assembly is completely reassembled and coupling half is on shaft
34. Make sure upper and lower case is clean
35. Install rotating assembly back into lower case
36. There are roll pins in lower case or (case wear rings)

whichever they have to line up the same as a standard horizontal pump.

37. Once rotating assembly is back in lower case install two cap screws in upper bearing housing to hold the rotating assembly in place
38. In bearing housing, make sure the 1/2" holes that are threaded are facing to the back
39. Put the two 3/4" all thread in lower case so the upper dome can be slid into place. Make sure to grease the o-rings on bearing housings so the upper dome dose not pinch the o-rings
40. Install the case roll pins. Install all case cap screws and tighten
41. Install cap screws on lower bearing housing first and tighten.
42. Install cap screws on upper bearing housing and tighten
43. Install recirculation lines
44. Reassemble Falk grid assembly using Polyurea grease on coupling halves
45. Install coupling guard on motor bracket
46. Install piece 1. If shims were removed put back in same location
47. Install piece 2.

Caution

Upper bearing is friction fit on shaft. If lifting rotating assembly above ground pick up with slings on both sides of the impeller. Do not allow anyone to stand under or below rotating assembly.

Note

The above procedure works for changing any component of the rotating assembly. (impellers, sleeves, etc.) Case work requires removing the motor.

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