طرح نگهداشت و افزایش تولید 27 مخزن

INSTALLATION, OPERATION & MAINTENANCE MANUAL

نگهداشت و افزایش تولید میدان نفتی بینک

V02	APR. 2025	IFI	Kalaye Pump	M.Fakharian	S.Faramarzpour	
V01	JAN. 2025	IFI	Kalaye Pump	M.Fakharian	S.Faramarzpour	
V00	NOV. 2024	IFI	Kalaye Pump	M.Fakharian	S.Faramarzpour	
Rev.	**Date**	**Purpose of Issue/Status**	**Prepared by:**	**Checked by:**	**Approved by:**	**CLIENT Approval**

Status:

IFA: Issued for Approval
IFI: Issued for Information
AFC: Approved for Construction

REVISION RECORD SHEET

PAGE	V00	V01	V02	V03	V04
1	X	X	X		
2	X	X	X		
3	X	X			
4	X	X	X		
5	X				
6	X				
7	X				
8	X				
9	X				
10	X				
11	X				
12	X				
13	X				
14	X				
15	X				
16	X				
17	X				
18	X				
19	X				
20	X				
21	X				
22	X				
23	X				
24	X				
25	X				
26	X				
27	X				
28	X				
29	X				
30	X				
31	X				
32	X				
33	X				
34	X		X		
35	X		X		
36	X		X		
37	X		X		
38	X		X		
39	X		X		
40	X		X		
41	X		X		
42	X		X		
43	X		X		
44	X		X		
45	X		X		
46	X		X		
47	X		X		
48	X		X		
49	X		X		
50	X		X		
51	X		X		
52	X		X		
53	X		X		
54	X		X		
55	X		X		
56		X	X		
57		X	X		
58			X		
59			X		
60			X		
61			X		
62					
63					
64					
65					

PAGE	V00	V01	V02	V03	V04
66					
67					
68					
69					
70					
71					
72					
73					
74					
75					
76					
77					
78					
79					
80					
81					
82					
83					
84					
85					
86					
87					
88					
89					
90					
91					
92					
93					
94					
95					
96					
97					
98					
99					
100					
101					
102					
103					
104					
105					
106					
107					
108					
109					
110					
111					
112					
113					
114					
115					
116					
117					
118					
119					
120					
121					
122					
123					
124					
125					
126					
127					
128					
129					
130					

Table of Contents

1.0 INTRODUCTION

Binak oilfield in Bushehr province is a part of the southern oilfields of Iran, is located 20 km northwest of Genaveh city.

With the aim of increasing production of oil from Binak oilfield, an EPC/EPD Project has been defined by NIOC/NISOC and awarded to Petro Iran Development Company (PEDCO). Also, PEDCO (as General Contractor) has assigned the EPC-packages of the Project to "Hirgan Energy - Design and Inspection" JV.

2.0 GENERAL DEFINITION

The following terms shall be used in this document.

CLIENT:	National Iranian South Oilfields Company (NISOC)
PROJECT:	Binak Oilfield Development – Supply Of Fire Water Pumps
EPD/EPC CONTRACTOR (GC):	Petro Iran Development Company (PEDCO)
EPC CONTRACTOR/PURCHASER:	Joint Venture of: Hirgan Energy – Design & Inspection (D&I) Companies
VENDOR:	Kalaye Pump Company
EXECUTOR:	Executor is the party which carries out all or part of construction and/or commissioning for the project.
TPI:	Third Party Inspector.
SHALL:	Is used where a provision is mandatory.
SHOULD:	Is used where a provision is advisory only.
WILL:	Is normally used in connection with the action by CLIENT rather than by an EPC/EPD CONTRACTOR, supplier or VENDOR.
MAY:	Is used where a provision is completely discretionary.

3.0 SCOPE

The scope of this executive instruction includes all projects of Kalay-E-Pump Company and other common productions.

4.0 DESCRIPTION

4.1. Introduction

The Kp pump (fig 4-1) is a modular designed centrifugal pump which can be adapted to achieve almost all petrochemical liquid pumping requirements. The pump is manufactured in different sizes for various pumping capacities.

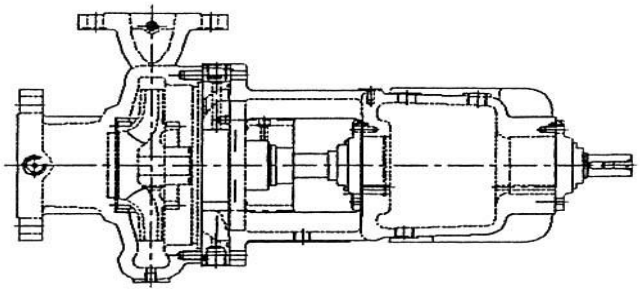

Fig 4-1

For ease of maintenance, the pump is constructed so that pipe connectors do not have to be disturbed when internal maintenance is required.
The main components of the pump are:

- Pump casing
- Impeller
- Shaft
- Bearing housing and bearing carrier
- Bearings
- Mechanical seal housing
- Mechanical seal

4.1.1. Pump Casing

The pump casing is designed with a horizontal centreline end inlet and vertical centreline top outlet which makes it self venting. The pressure and temperature of the pump depends upon the material from which the pump and flange have been manufactured.

4.1.2. Impeller

The impeller is fully closed and assembled to the shaft by the key. The impeller nut tightens the impeller, sealed by a Gasket which situates between them.

4.1.3. Shaft

Pump shaft mounted on bearings, has a keyed drive end carries the dynamic shaft seals and impeller. Shaft sleeve mounted on the shaft as the seat of shaft seal.

4.2. Bearing Housing

The bearing housing carries the pump bearings. The bearing cover is attached to the Bearing housing by 4 Screws, and labirance ring for sealing. Bearing lubricating system is flood and for oil lubricated bearings a sight glass enables the oil level to be viewed.

4.3. Bearings

The KP pump is fitted with one cylinder Roller bearing and two ball Bearing witch may configured differently dependent on use, and are oil lubricated.

4.4. Mechanical Seal Housing

The seal housing has spigots between the pump casing and bearing housing for optimum Concentricity, and is sealed to the pump volute casing face with gasket. The gasket is fully confined.

4.5. Mechanical Seal

The mechanical seal, attached to the drive shaft, seals the pump leakage from the bearing housing, and the environment. A Mech. Seal includes of two parts, stationary part and rotary witch both of them has polished surface the contact to each other perfectly for sealing.

5.0 PRESENTATION

5.1. General

The perfect running of our centrifugal pumps cannot be achieved without a strict respect for the advice given in these installation & Maintenance Instructions. Do not use the pump for duties other than those recommended by us in this manual or in the contract documentation.

The regulation instructions and descriptions given in this manual concern the standard operation. It does not cover construction variants or special adaptations.

5.2. Specifications

The KP pumps are equipped with a nameplate on which is includes:

- Pump model/size
- Pump speed (rpm)
- Rated capacity (m3/hr)
- Rated Head (m)
- Pump Serial number (Nº)

- Power (kw)
- ...

Here is a schematic of KPCo. name plate.

KALAYE PUMP

Tel Fax : 0098(21)33914711
E-mail : info@kalayepump.com
Tehran–Iran

Purchaser Ref. :	Mfr. Ref. :
Pump Type /Size :	Serial No. :
Liquid :	Pumping Temp.(°C) :
Capacity (m3/h) :	Diff. Head(m) :
Speed (rpm):	Power (kw) :
Hydro Test Press. (bar) :	Production Date :

6.0 TRANSPORTATION AND STORAGE

6.1. Transport

- The pump, coupling hub, and driver are generally shipped mounted on the base plate.
- The unit must be carefully packed so that it does not move. Check general condition of all parts on arrival.
- Observe the plant's safety precautions when lifting heavy components.
- When transporting with a crane, the rope should be slung round the unit as shown below in Figure 6.1.

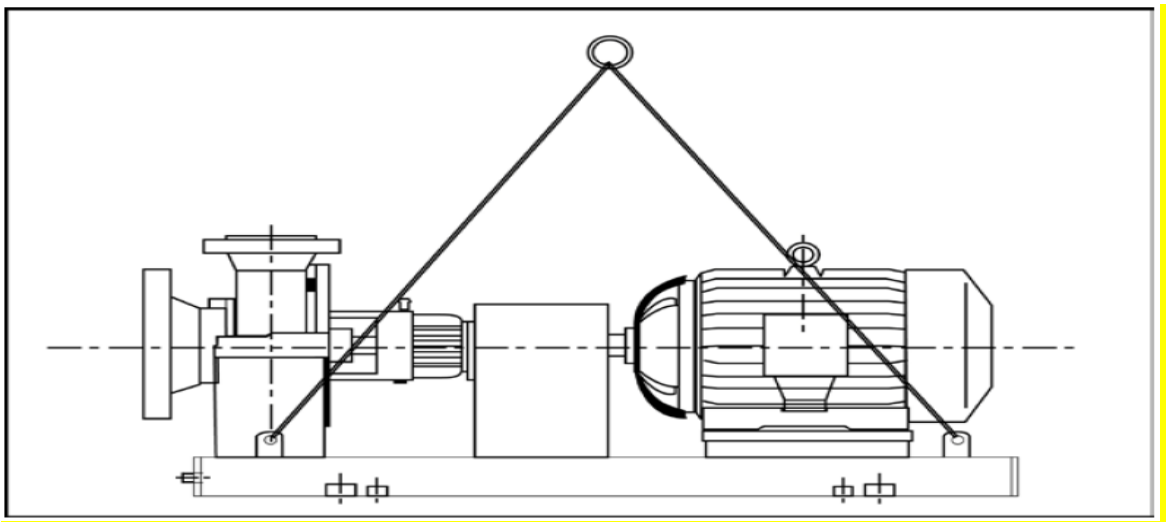

Fig 6-1- Correct position of the lifting ropes or chains

The rope should not be slung around the lugs attached to the motor or around the lugs attached to the pump.

- A complete pump set on steel base plate must be handled with the aid of apertures in the base plate anticipated for this use as indicated on the figure above.
- To avoid damage, the unit must be transported and handled with care. It should be gently lowered onto an even surface. Pay attention to and identify the signs marking the points of equilibrium and fastening places for ropes, or the openings for forklift trucks.

6.2. Storage

If the pump is not installed immediately, (within one month after shipping date) it should be safely stored prior to installation in a dry location free of dirt and grit. Furthermore, the pump unit (pump, driver, etc.) should not be subject to sudden temperature changes or vibrations. Observe the following steps:

1. Remove pump from shipping crate, but do not damage the crate because the unit is to be reboxed. Stored in a sheltered and dry location;
2. Plug the instrument taps.
3. Thoroughly dry the pump with hot air.
4. Any painted surface damaged in shipment should be repainted or sprayed with oil.
5. Keep the pump moisture-free by the following two means:

a) Spray the pump case, bearing housing with acid-free, moisture-free, protective oil or kerosene.

b) Place desiccant or humidor bags inside the suction and discharge areas of the pump.

6. Cover all the openings with plywood or metal covers. Recheck the condition of these covers every month and replace as necessary.
7. If the pump's external parts have protective coatings, periodically inspect and renew the coating as required.
8. Rotate the shaft 1 ¼ revolutions every week. Lubricate shaft bearings prior to rotation.
9. Check the packaging for damage every month.
10. Ensure pump flange covers remain in place.
11. Return the unit to the shipping crate.
12. When the pump is to be installed, remove all the protective coatings and desiccant or drain all oils.
13. Upon receipt, considering that the oil-lubricated drivers are not shipped oil-filled, fill the reservoir to maximum level with properly selected oil with rust and corrosion inhibitors.
14. If there is a risk of freezing temperatures or if the pump is to remain idle for a long period of time, empty the pump and any auxiliary circuits and close the isolating valves;
15. After prolonged storage, the gland packing may need changing as it will probably have dried out. Before changing however, run the pump for 24 hours with the packing loose, and gradually tighten down. If significant leakage persists, the packing must be changed.

7.0 CONSERVATION

All exposed, machined, working surfaces (flanges, seals, surfaces supporting the motor), shaft ends, unpainted couplings and the like have been cleaned and treated with anticorrosive agents. After being cleaned, all parts inside the pump housing have been sprayed with anticorrosive agents.

The period of protection offered by these conservation measures is approximately 18 months if stored in a dry place. If stored under unfavorable climatic conditions, this protective period may be considerably reduced. Should the anticorrosive layer become damaged, it can be repaired by repainting or respraying.

The anticorrosive layer applied to the exposed parts does not need to be removed before putting the pump into operation.

8.0 INSTALLATION

Correct and orderly installation/assembly is necessary for trouble-free operation of the unit. KALAYE PUMP does not assume any liability for damage resulting from inadequate installation/assembly. The chosen location for installation must offer enough space for maintenance activities. Consult also API Recommended Practice 686 to ensure proper installation in your facility.

8.1. Concrete Foundation Preparation

1. Choose a solid ground location for foundation; check that the bearing capacity of the soil is at least one third higher than both static and dynamic loads together.

2. The effects of vibrating equipment on the surrounding area should be investigated and the isolation required for the foundation should be considered. It is important to consider that the driver and the driven machinery must be supported from a common foundation.

3. A minimum compressive strength of 4061 psi (28 MPa) for the concrete is to be reached after 30 days. Check with your supplier the strength and time of setting.

4. All foundation materials shall be selected to prevent deterioration due to exposure to an aggressive environment; the use of a protective coating should be considered.

5. The mass of the concrete foundation should be five (5) to ten (10) times the mass of the supported equipment.

6. Imaginary lines extended downward 30 degrees to either side of a vertical line through the pump shaft should pass through the bottom of the foundation and not the sides, as shown in Figure 8.1.

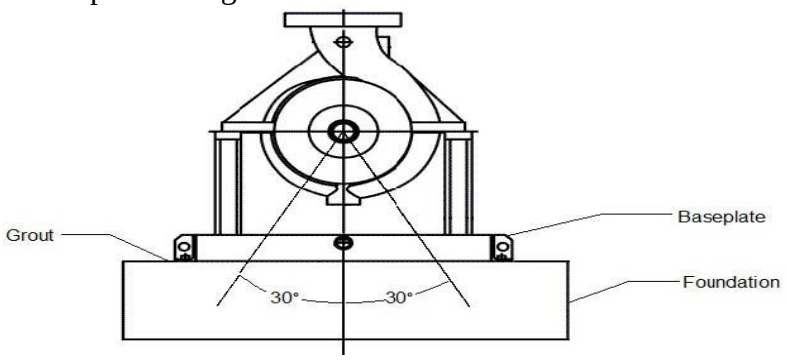

Figure 8.1 Imaginary lines.

7. Build foundation approximately 3 inches (76 mm) larger overall than the pump baseplate for machines up to 500 horsepower (372 kW), and 6 inches (152 mm) larger for machines greater than 500 horsepower (372 kW) to provide ample anchorage for the foundation bolts.

8. Since water can accidentally flow in the floor, a height for the surface of the foundation of 4 inches (100 mm) at least above floor level is recommended.

9. Use a template to accurately locate foundation bolts according to the General Arrangement.

10. Choose foundation bolts of size specified in general arrangement. they should be long enough to allow a minimum of two threads above the nuts.

11. Provide pipe enclosures for the bolts, which are three or four diameters larger than the bolts.

12. Protect area around the bolts from contact with the concrete.

13. Pour the concrete and provide a chamfer at all corners.

14. Allow concrete to cure completely (at least seven days) before preparing the surface for grout preparation.

8.2. Leveling Base plate

Before leveling the unit onto the foundation, the following preparations must be made:

1. Chip away all damaged concrete with a hammer and chisel, eliminating about one inch of the surface of the foundation. After surface chipping is done, the foundation shall be thoroughly cleaned free of debris. Clean the anchor holes.

2. Check that the placement and dimensions of the foundation and the anchor holes correspond to the assembly plan.

The foundation must be kept free of all contamination after it has been prepared for grouting. To continue with the leveling procedure:

1. Remove the pump and driver from the base to facilitate the leveling procedure.

2. Remove base plate from wooden skid.

3. Attach lifting rig hooks to lifting lugs of base plate.

4. Guide base plate to position above foundation bolts and lower baseplate into position over foundation bolts; be sure to respect the above-mentioned clearance between concrete and base plate.
5. There should be a minimum annular clearance of 1/8 inch (3 mm) between anchor bolt holes and the anchor bolts to allow for field alignments.

6. Using a precision level across base plate pads, adjust jacking bolts as necessary to ensure that base plate is level in all directions (See Figure 8.2), within 0.002 in/ft (0.2 mm/m).

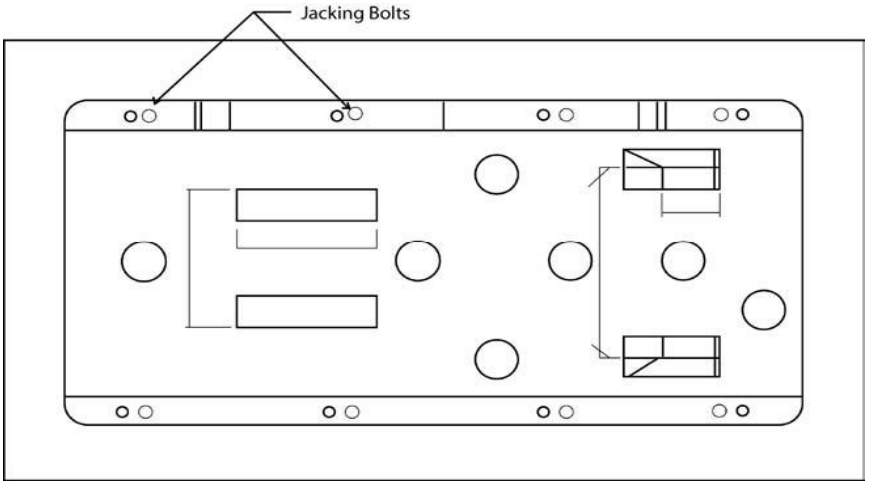

Figure 8.2 Base plate leveling planes.

7. The alignment of the base plate is effected only with the help of adjusting screws. Wedges may not be used for this purpose.

NOTE: Each jacking bolt should have a mounting pad, to distribute the stresses evenly.

NOTE: The base plate should be mounted without distortion. Under no circumstances should the driver be higher than the pump.

8. When base plate is level, 'snug' the foundation bolt nuts, but do not tighten completely.

8.3. Grouting

8.3.1. Equipment/Material Required

- Grout Mix: Non Shrink Type
- Sufficient lumber for foundation template and grout trough.
- Risers or funnels for guiding grout.
- Sufficient oil paint for grout protective covering.
- Dial indicator.
- One bracket, suitably stiff having an arm length of sufficient length to extend from the driver coupling hub to the pump coupling hub.

8.3.2. Grouting Precautions

During all the grouting process, the involved personnel must follow these safety precautions:

- Wear goggles or face shields, aprons, and protective gloves at all times.
- Wear dust masks if in contact with the dry aggregates.

- Wash hands regularly with soap and water.
- Some epoxy grouts have highly exothermic reactive properties; they should be handled with care. They may become extremely hot and cause severe burns.

8.3.3. Grouting Procedure

a) Verify that anchored bolt sleeves are clean and dry. Fill them with a nonbonding moldable material to prevent them from being grouted.

b) The anchor bolt threads should be protected with tape before grouting.

c) Provide a form around the baseplate to contain the grout. The form should be chamfered at all corners.
   - Grout forms should be attached with drilled anchors. Do not power nail.
   - Apply three coats of paste wax to the inside surfaces of the forms in order to prevent adherence. Do not use oil or liquid wax.
   - Prevent grout leakage, as leaks will not self-seal.
   - Apply the grout, starting at one end of the form and advancing toward the other end. The use of push tools to get rid of trapped air is allowed if done in long strokes.
   - Do not vibrate or violently ram the grout (it may cause the aggregates to separate).
   - Do not plug any baseplate fill or vent holes until the grout has set to avoid base plate distortion.
   - Check with the supplier of the grout the preferred thickness for your installation.

d) Tap base plate to eliminate air pockets.
   - It is imperative to get rid of all trapped air before the grout hardens.
   - Check frequently for grout leaks.
   - Leaks will not self-seal and may cause voids.

e) Remove jackscrews and grout-forms once the grout has completely hardened (takes around 3 days).

f) Do not use grout to fill the jackscrew’s holes; use a sealant material instead.

g) Tighten the foundation bolts.

h) Apply oil paint to exposed grout to protect from air and moisture.

i) Use a lifting rig to position the pump and driver on their baseplate so that the mounting feet line up with their respective tapped holes.

j) Fasten the pump and driver hold down bolts, attach all auxiliary piping and wiring.

9.0 PIPING AND ALIGNMENT

The pump and motor shaft MUST be perfectly aligned to ensure a long trouble-free life for the bearing and coupling. The shafts are aligned before dispatch but the settings may be disturbed during transport. Furthermore, the base is flexible to a certain extent, and will distort slightly if it bolted to a foundation that it not flat. The resulting misalignment would cause:

- Rapid wear to the coupling parts.
- Overheating and rapid wear to the pump and motor bearings.
- Vibration

To avoid these problems, it is important to install the machine correctly, according to the following procedure. First, attentively examine the machine to see that the components have not moved on the base during transport, and that the shaft ends are not out of fire.

a) The foundation must be rigid, level and flat. The holes for the anchor bolts must have a chamfer cut in the edge, emerging beyond the edge of the base plate, for pouring in the grout.

b) Fit the machine on the foundation with the anchor bolts while placing steel shims under the base plate. Shims must be at least 10 mm thick and placed close to the bolts, on either side, and in the middle of the base plate. Ensure that the shims are in intimate contact with foundation by smoothing out the seating areas carefully.

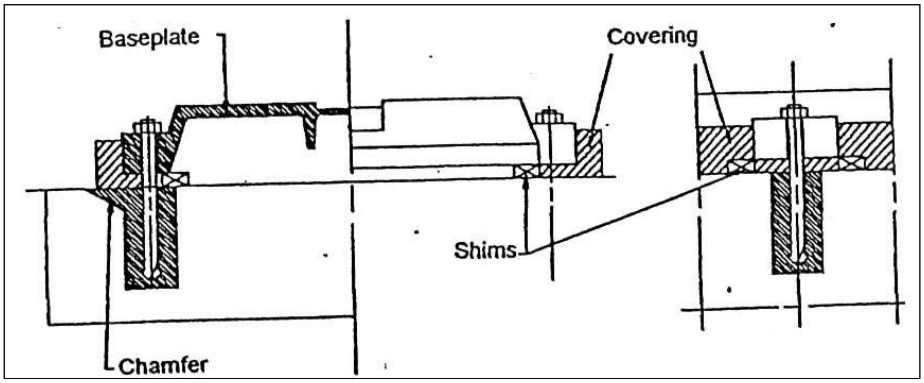

Fig. 9.1. Anchor bolts configuration

- Do not grout in the holding down bolts until all the pipe work to the pump has been permanently assembled.
- The connection of the piping must be carried out with utmost care; otherwise, the pumping medium can escape during operation, which can seriously endanger the operating personnel.
- Do not start the piping and alignment procedures until grouting, preliminary alignment (as seen in the previous sections of this manual) and on site welding have been performed.
- In a new installation, great care should be taken to prevent dirt, scale, welding beads, and other items from entering the pump. The suction system should be thoroughly flushed before installing the suction strainer and suction piping.
- Suction and discharge piping should be of ample size, be installed in direct runs with minimum bends.
- Short radius elbows shall be avoided near the suction nozzle. If an elbow is necessary, it should be of the long radius type.

- Suction and discharge piping configurations should be in accordance with the Hydraulic Institute Standards.
- Suction and discharge piping, fittings, and valves must be adequately supported and anchored close to the pump flanges to eliminate strains imposed on the pump casing, prevent excessive nozzle loads, maintain pump/driver alignment, and avoid pipe-induced vibration.

9.1. External nozzle forces and moments

Steel and alloy-steel horizontal pumps and their baseplates, vertical in-line pumps with supports anchored to the foundation, and vertically suspended pumps shall be designed for satisfactory performance if subjected to the forces and moments in Table 9.1 applied simultaneously to both suction and discharge nozzles in the worst-case combination for the pump in question. For horizontal pumps, two effects of nozzle loads are considered: distortion of the pump casing and misalignment of the pump and driver shafts. (API 610)

Location/orientation	Nozzle-loading force as a function of flange size — SI units N								
	Nominal size of flange (DN)								
	≤ 50	80	100	150	200	250	300	350	400
Each top nozzle									
F_X	710	1 070	1 420	2 490	3 780	5 340	6 670	7 120	8 450
F_Y	580	890	1 160	2 050	3 110	4 450	5 340	5 780	6 670
F_Z	890	1 330	1 780	3 110	4 890	6 670	8 000	8 900	10 230
F_R	1 280	1 930	2 560	4 480	6 920	9 630	11 700	12 780	14 850
Each side nozzle									
F_X	710	1 070	1 420	2 490	3 780	5 340	6 670	7 120	8 450
F_Y	890	1 330	1 780	3 110	4 890	6 670	8 000	8 900	10 230
F_Z	580	890	1 160	2 050	3 110	4 450	5 340	5 780	6 670
F_R	1 280	1 930	2 560	4 480	6 920	9 630	11 700	12 780	14 850
Each end nozzle									
F_X	890	1 330	1 780	3 110	4 890	6 670	8 000	8 900	10 230
F_Y	710	1 070	1 420	2 490	3 780	5 340	6 670	7 120	8 450
F_Z	580	890	1 160	2 050	3 110	4 450	5 340	5 780	6 670
F_R	1 280	1 930	2 560	4 480	6 920	9 630	11 700	12 780	14 850
Moment N·m									
Each nozzle									
M_X	460	950	1 330	2 300	3 530	5 020	6 100	6 370	7 320
M_Y	230	470	680	1 180	1 760	2 440	2 980	3 120	3 660
M_Z	350	720	1 000	1 760	2 580	3 800	4 610	4 750	5 420
M_R	620	1 280	1 800	3 130	4 710	6 750	8 210	8 540	9 820

Table 9.1. Nozzle Loads

9.2. Piping the System

The pipe work must never apply any strain to the pump flanges, since it might lead to internal and external deformations on the pump and misalignment of the pump-motor shafts.

THE PUMP MUST NEVER BEAR THE WEIGHT OF THE PIPWORK

To avoid air pockets and resulting risk of running dry, the suction pipe must be inclined upwards unit it meets the pump. If the suction pipe bore is larger than the pump inlet diameter, the reduction connection must have its top line horizontal. Fit vents to high points on discharge piping as required. It is recommended that (if applicable) the valve should be downstream of the check valve.
All pip work, especially the suction pipe, must be free from leaks and air–tight. Also check that foot valve (if fitted) if free from leaks.

1. Check whether the piping is loosely laid, so that no strain is placed on the pump.
   Note: Piping layout and installation shall provide adequate maintenance and operation accessibility. Field installed auxiliary equipment shall not interfere with removal of the machine or driver.

2. Remove the covers of the pump flanges.

3. Check whether the seals are correctly mounted.

4. Install a check valve and a gate valve in the discharge pipe. When the pump is stopped, the check valve will protect the pump against excessive back-flow pressure and will prevent the pump from running backward.
   Note: The check valve should be installed between the gate valve and discharge flange in order to permit its inspection.

5. A spool piece should be installed in suction line so that the suction strainer may be installed and removed with a pressure gauge between the strainer and pump.

6. The suction strainer should be installed between 5 to 20 pipe diameters upstream from the suction flange.

7. Cone type strainers (otherwise known as “witches –hat” strainers) should be mounted as recommended within the Hydraulic Institute, with the cone pointing upstream away from the pump, into the oncoming flow. As the strainer gradually gathers particles from the liquid and blocks up, this direction will result in the lowest turbulence impact onto the liquid flow entering the pump.

8. Disconnect the piping from the pump if you heat one side of the pipe to align the pipe to the pump.

9. Pump and pipe flanges must be parallel; they should mate together without effort, and with the bolt holes properly in line.

10. Check the fine alignment by clocking or using a Dial Type Indicator (DTI) on the coupling. Check the operating instruction for the coupling.

11. Connect and tighten the suction pipe and compare the alignment with the values of the fine alignment. In the case of deviations, warm the pipe so that the values of the fine alignment are reached.

12. When heating takes place close to the flange, there is a danger that the flange seal will become rippled and leaky. No more welding work can be carried out on the piping when it is screwed to the pump.

13. Proceed in the same way with the discharge pipe.

14. Make sure that there are isolation block valves at the pump for each type of auxiliary piping.

15. Consider a slope in the suction piping to avoid high points.

16. In horizontal suction lines, reducers should be eccentric (with the flat side of the reducer on top).

17. No obstruction within at least five pipe diameters of the suction flange should be fitted.

18. Do not install unsupported piping on the pump.

19. Make sure electrical connections do not impose any stress on the pump unit.

20. Remember that the pump must not be moved once the base plate has been set: the piping (both suction and discharge) is the one aligned to the pump.

21. When aligning, all the elements to be aligned (including the pipes) should be at the same temperature (ambient).

22. It is important to confirm that the pump can be moved out from the base plate without cutting or welding (only by adjusting connections and flanges).

23. Do not use drifts or cheater bars to force alignment of bolt holes – serious damage to the pump will result.

9.3. Alignment

In the following pages, alignment procedures are explained with dial indicators. Laser alignment is also possible. The specific method in laser alignment will depend on the manufacturer's instructions; however, the basic principles and rotation of the shafts apply, as in the Reverse Indicator Alignment Method. Therefore, for laser alignment, you may follow the steps detailed on the next pages, mounting a laser bracket with a measurement device on each shaft and then proceed with the rotation of the shafts to obtain the readings to determine the misalignment and correct it.

NOTE: The pump case has centerline support feet integrally cast with the case for equal thermal expansion or contraction. This minimizes alignment problems caused by case movement due to temperature conditions between operating and ambient conditions and thus negates the need for “hot” alignment, except for the highest operating temperatures.

9.4. Alignment of Equipment

Correct alignment is mandatory for the successful operation of rotating equipment. A flexible coupling is no excuse for misalignment. The relationship between shaft centerlines can easily be determined by 1) two step dial indicator method, 2) reverse indicator alignment, 3) across the disc pack alignment. These can all be solved by a graphical approach. This procedure will discuss methods 2 and 3. Method 1 is covered in Rexnord's Manual MT-SS-04-001, "Two Step Dial Indicator Method". Before we get into this alignment procedure, several items should be considered at this point.

1. Indicator Set-Up

No matter what arrangement you use, indicator sag must be determined. This can easily be determined by clamping the set-up onto a rigid piece of pipe, rolling the indicator from top to bottom, and reading the difference. Once the indicator sag set-up has been determined, this number can be algebraically subtracted from the alignment readings obtain at the bottom. There is no need to be concerned about the side to side readings as the sag is equal on both sides.

2. Taking Alignment Readings

It is suggested that the dial indicator be zeroed at the top. For convenience, you should mark your coupling at 0°, 90°, 180°, and 270° with a reference mark on the case so that you can be sure to turn the unit exactly 90°. Both shafts should be turned an equal amount if the coupling is not put together. Now rotate the coupling in 90° increments recording all readings. It is important to keep your side to side readings straight. A suggestion is to show compass orientation so that you know which reading to use. After you have made your four position check and have returned back to the top, it is absolutely necessary that the indicator return to zero where it started. If it did not, repeat your readings. It is also advisable to check the readings several times to make sure that they are repeatable.

3. Thermal Growth

If there are thermal growth considerations on the piece of equipment, it is a good idea to get these numbers so that they can be added to or subtracted from the graphical solution before the equipment move is made, this is known as “Hot alignment”.

4. Soft Foot

The fact that your equipment could have a soft foot can affect the alignment readings that you obtain. The soft foot should be checked first and eliminated. This can easily be done by mounting a dial indicator on the base plate indicating off the top of foot on the machine to be checked. Each foot in rotation is then checked by loosening only the bolt with the rest of the bolts being tight. A soft foot check should be carried out when the unit is stationary for safety reasons, and should be carried out on whole drive train. It should never be necessary to shim under the pump mounting feet. Soft foot issues could indicate excessive piping loads transmitted to the pump, or that the baseplate has been twisted, and is not

grouted and mounted flat.

9.5. Reverse Indicator Alignment Graphical Analysis

On a sheet of graph paper, lay out the equipment that you are trying to align. You should use a scale that is convenient to the size of the graph paper. The distances that are critical are:

1. Distance from where the first indicator rides on the pump hub to where the second indicator rides on the motor hub. In the example shown below, this is 10-1/2 inches (266.7 mm).
2. Distance from where the second indicator rides on the motor hub to the center of the front motor feet. In the example below, this is 2-1/2 inches (63.5 mm).
3. Distance from the center of the motor front feet to the center of the motor back feet. In the example shown below, this is 5-1/4 inches (133.4 mm).

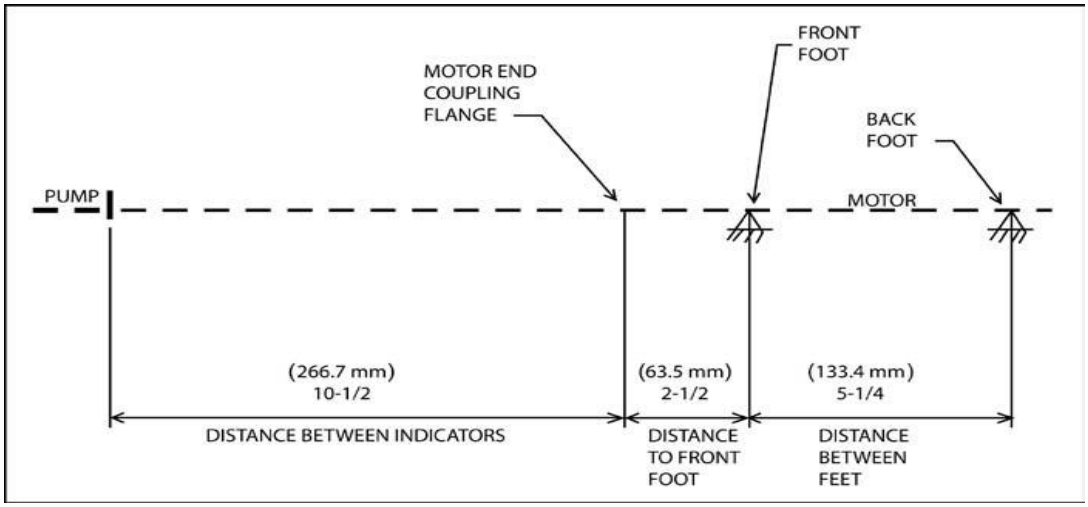

Figure9.2. Example for reverse indicator graphical analysis

The next step is to determine indicator sag. Set up your bracket arrangement on a pipe. Set the indicator at '0' on top. Roll set up until indicator is at the bottom of pipe. It will read negative. In this example, it is found to be -0.005 inch (-0.127 mm).

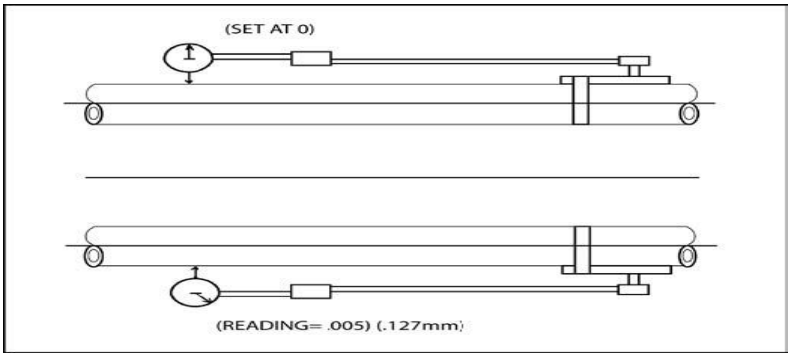

Fig 9.3. Indicator sag

With the indicator bracket attached to the motor hub reading off the pump hub, rotate unit in 90° increments and take readings.

Bottom reading is then corrected for indicator sag. Indicator sag in the example was determined to be 0.005 inch (0.127 mm). The -0.005 inch (-0.127 mm) was subtracted from the -0.025 inch (-0.639 mm) indicator reading to give an actual -0.020 inch (-0.508 mm) reading.

As this is a TIR (Total Indicator Readout) it is two times the actual shaft to shaft rotation 0.020 inch (0.508 mm)/ 2 inch (50.8 mm) or 0.010 inch (0.254 mm) is used to show where the motor shaft extension is relative to the pump shaft center line at the hub. Minus at the bottom indicated motor shaft extension is low compared to the pump. Using a scale of one small division on the graph equals 0.001 inch (0.0254 mm); plot this point as show in the example.

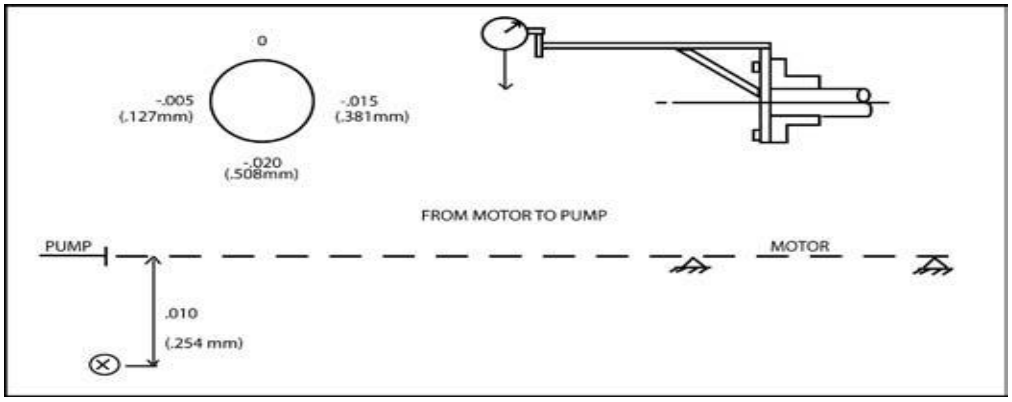

Fig 9.4. Motor shaft extension relative to the pump shaft center line.

Now with the indicator bracket attached to the pump hub reading off the motor hub, rotate unit again in 90° increments.

NOTE: If you can set up both indicators at once, both sets of readings can be taken at one time.

Bottom reading is then corrected for indicator sag. The -0.005 inch (-0.127 mm) was subtracted from the +0.005 inch (+0.127 mm) indicator reading to give an actual +0.010 inch (+0.254 mm) reading.

The +0.010 inch (+0.254 mm) is divided by two to give +0.005 inch (+0.127 mm) which is the actual shaft extension to shaft relationship.

In this case, a plus reading at the bottom indicates the motor shaft is low compared to the pump shaft extension. Plot this point as shown in the example.

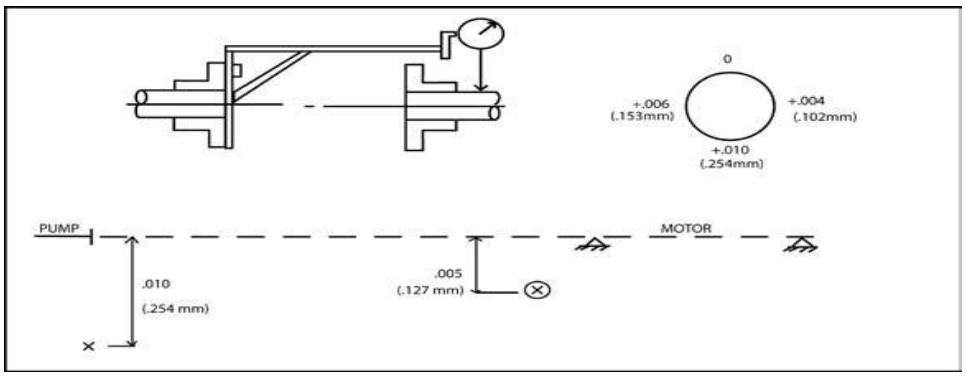

Fig 9.5. T.I.R. second reading

We have now located the motor shaft theoretical extension in two places:

A. In the plane of the pump hub.
B. In the plane of the motor hub.

Drawing a straight line through these two points crossing the plane of the two motor feet. The shim adjustment can now be read directly off the graph. In this example, 0.004 inch (0.102 mm) should be added to the front foot and 0.001 inch (0.025 mm) should be added to the back foot.
This solution can also be done by the use of pre-programmed, hand calculators for faster results.
For the horizontal (side to side) results, the same procedure is used. Algebraically subtract the side to side readings. Indicator sag can be ignored as it cancels out. Plot these readings and the results can be read off the graph plot.

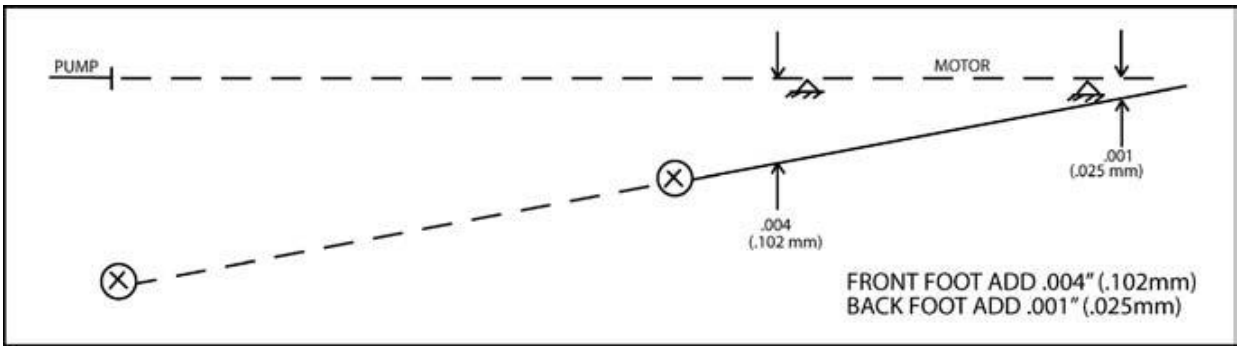

Figure 9.6 Final graph plot for reverse indicator alignment graphical analysis.

9.6. Reverse Indicator Alignment More Than Two Units Graphical Analysis

This method lends itself very well in solving alignment problems of three or more pieces of equipment in a line.
To solve this problem, follow the steps already outlined for each coupling in the train. Plot the shaft to shaft relationship of each set of shafts. Look at the total picture. In this example, a line was drawn through the average of all points plotted. The units were then aligned to this mean line.

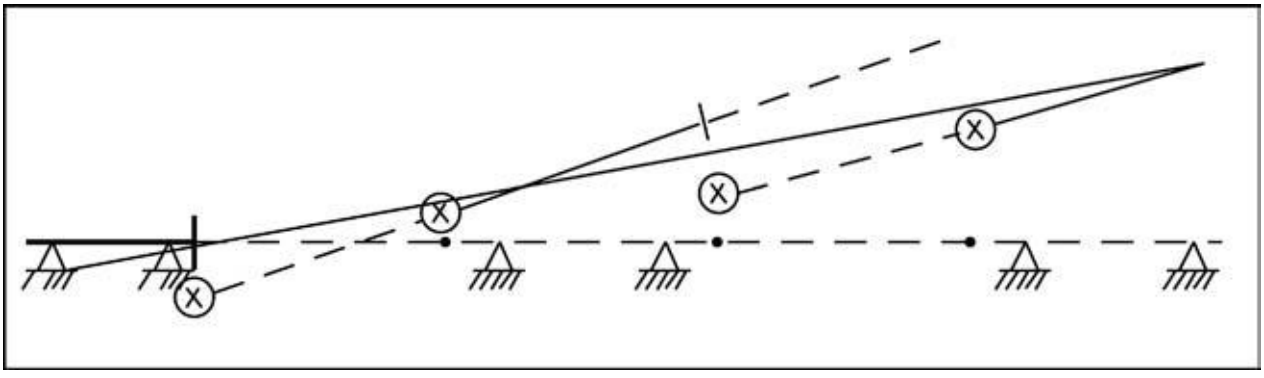

Figure 9.7 Reverse indicator alignment of more than two units.

9.7. Across the Disk Pack Alignment Graphical Analysis

When the distance between disc packs is long where it is not practical to try to span the distance with indicator bracketry, the 'across the disc pack method' can be used.
On a sheet of graph paper, lay out the equipment that you are trying to align. You should use a scale that is convenient to the size of the graph paper. The distances that are critical are:

1. Distance from centerline of one disc pack to the centerline of the other disc pack. In the example, it is 9-1/2 inches (241.3 mm).
2. Distance from centerline of motor disc pack to center of front motor foot. In this example, it is 3 inches (76.2 mm).
3. Distance from the center of the motor front feet to the center of the motor back feet. In this example, it is 5-1/4 inches (133.4 mm).
4. Distance from disc pack to dial indicator on center member. In this example, the distance is 8 inches (203.2 mm).

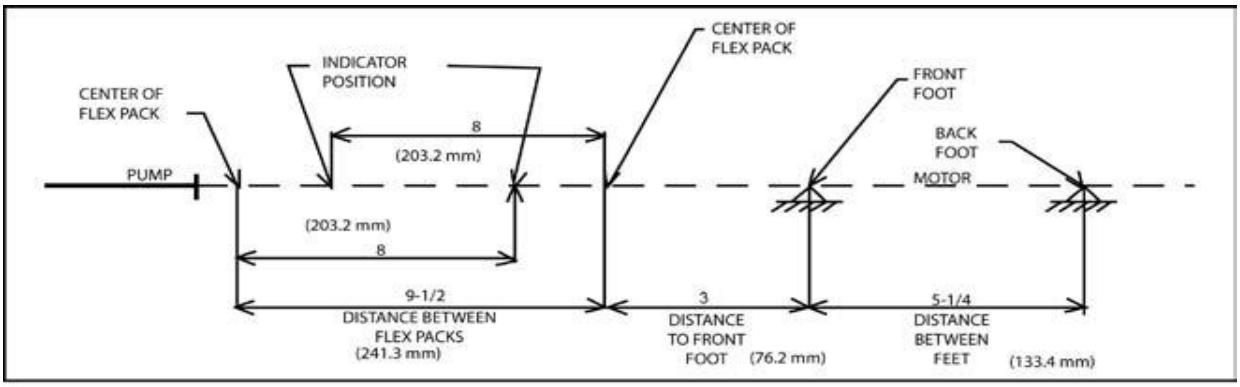

Figure 9.8 Across the disc pack alignment graphical analysis example.

The next step is to determine indicator sag. Set up your bracket arrangement on a pipe. Set the indicator at '0' on top. Roll set up until indicator is at the bottom of pipe. It will read negative. In this example, it was found to be -0.004 inch (-0.102 mm).

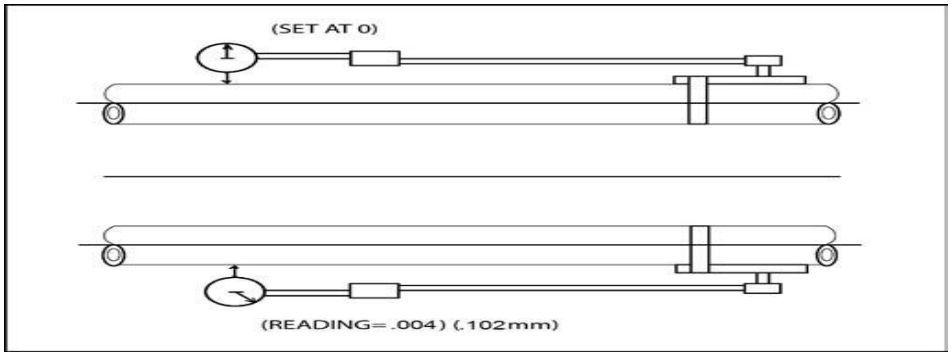

Figure 9.9 Indicator sag in across the disc pack alignment analysis example.

With the indicator bracket attached to the pump hub, reading out the center member a convenient distance, (in this example 8 inches [203.2 mm] was used) rotate the unit in 90° increments and take readings.

Bottom reading is then corrected for indicator sag. The indicator sag in the example was determined to be -0.004 inch (-0.102 mm). The -0.004 inch (-0.102 mm) was subtracted from -0.025 inch (-0.635 mm) indicator reading to give an actual of -0.020 inch (-0.508 mm) reading.

As this is a TIR (Total Indicator Reading) it is two times the actual center member center line location relative to the pump shaft extension or -0.020 inch (-0.508 mm) / 2 inches (50.8 mm) = -0.010 inch (0.254 mm). (What we are trying to do here is to determine the angle the center member makes with respect to the pump shaft.)

A plus reading at the bottom indicates that the center member tips down as it extends away from the pump. Using a scale of one small division on the graph equals 0.001 inch (0.0254 mm); plot the 0.010 inch (0.254 mm) as shown in the example.

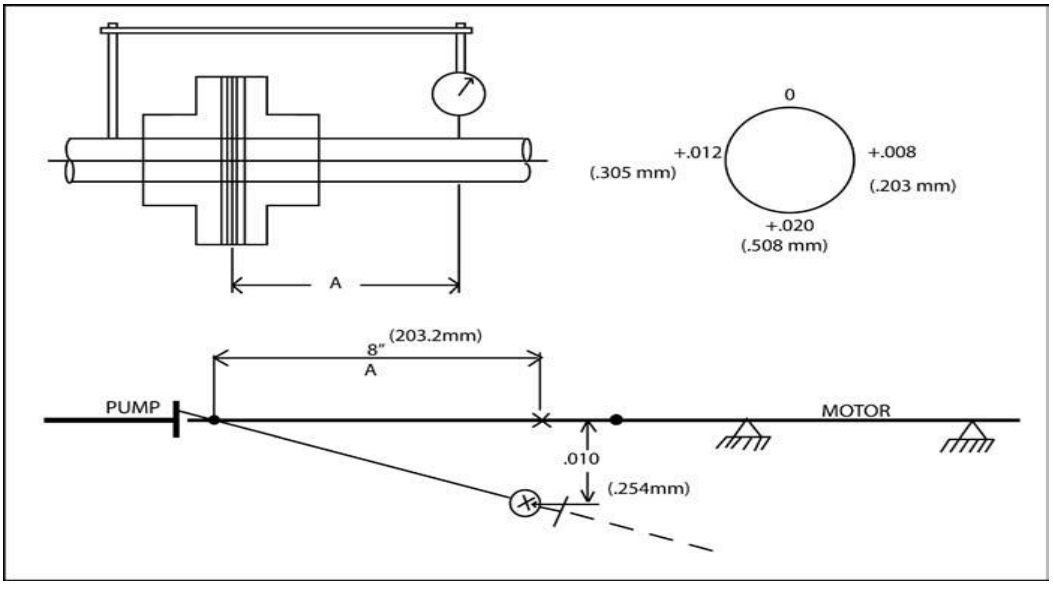

Figure 9.10 Plot of the plus reading in the across the disc pack alignment analysis example

Now with the indicator bracket attached to the motor hub reading out on the center member, rotate the unit in 90° increments and take readings.

Bottom reading is corrected for indicator sag: ±0.008 inch (±0.203 mm) -0.004 inch (0.102 mm) = +0.012 inch (+0.309 mm). This is TIR so actual is +0.006 inch (+0.152 mm). (What we are trying to do here is determine the angle the center member makes with respect to the motor shaft.)

The minus reading on the bottom indicates that the center member tips up as it extends away from the motor. Using a scale of one small division on the graph equals 0.001 inch (0.025 mm), plot the 0.006 inch (0.192 mm) as shown on the example.

The motor shaft can now be drawn in because two points along it have been defined: 1. Center of the flex element. 2. The point just plotted 0.006 inch (0.152 mm) below center member. The shimming requirements can now be read off the plot where the motor shaft intersects the planes of the motor feet.

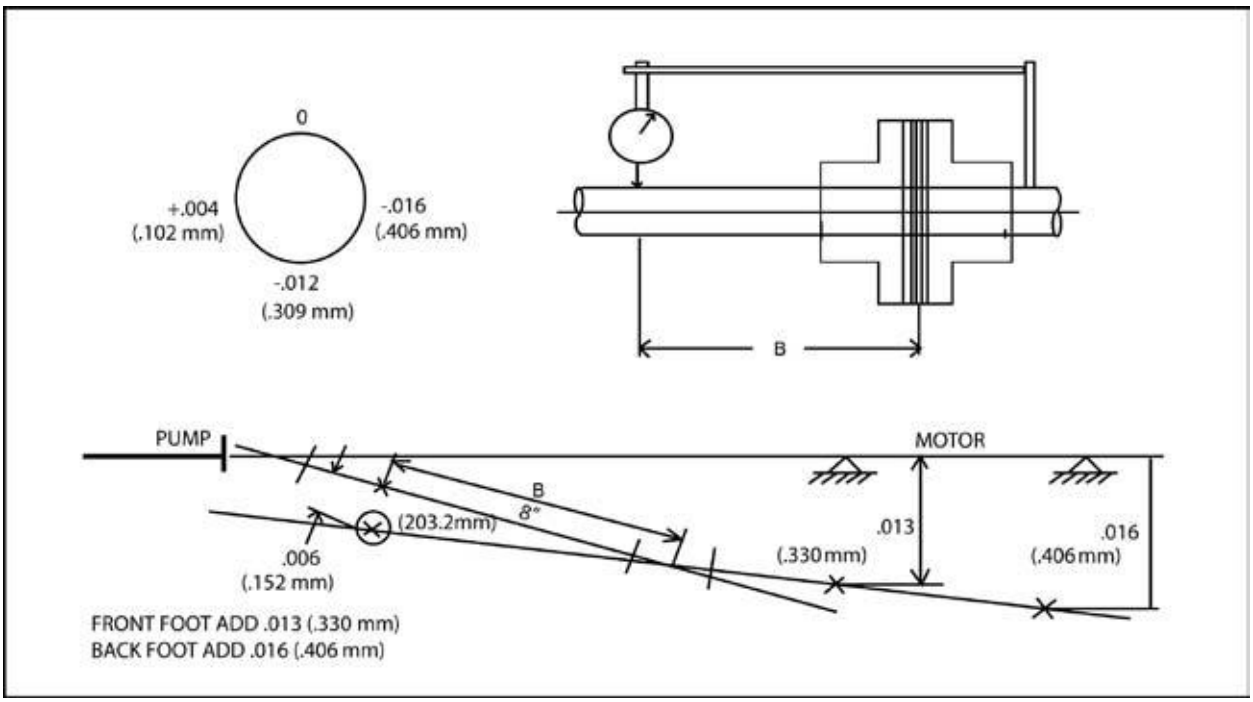

Figure 9.11 Plotting the motor in the across the disc pack alignment analysis example.

In this example, the motor should be shimmed up 0.013 inch (0.330 mm) under front feet and shimmed up 0.016 inch (0.406 mm) under back feet.
This solution can also be done by use of a pre-programmed, calculator for faster results.
For the horizontal (side to side) results, the same procedure is used. Algebraically subtract the side to side readings. Indicator sag can be ignored as it cancels out. Plot these readings and the results can be read off the graph.

10.0 INSTALLATION OF THE TRANSMISSION UNIT

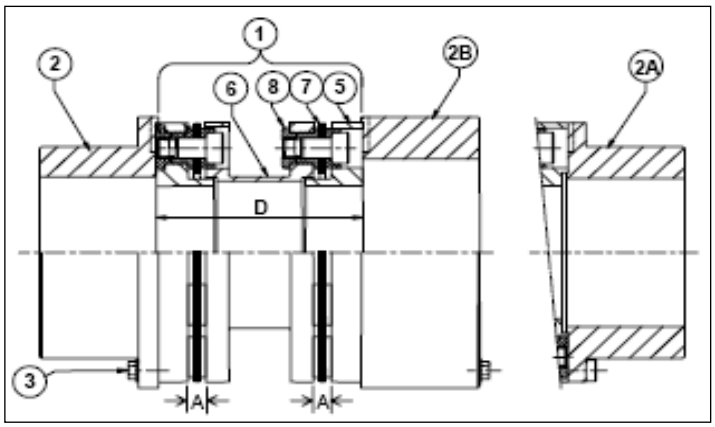

Figure 10.1

Reference	Description	Reference	Description
1	Transmission Units	5	Guard Ring
2	Standard Hub – External location [sizes 0013-0230]	6	Membrane Pack
2A	Standard Hub – Internal location [sizes 0350-1400]	7	Drive Bolt Assembly
2B	Large-bore Hub	8	Spacer
3	Hub Bolt		

Table 10.1. Coupling Part List

1. Check spigot and recess locations on the hubs and transmission unit for damage.

Note: The transmission unit must be adequately supported during installation to avoid accidental damage should it slip.

2. It may be necessary to compress the transmission unit whilst sliding it between the hubs. Lever slots are provided in the hub flanges to make this easier. Also the spacer flanges are drilled to allow hub bolts to be threaded into the guard ring. Tightening evenly will compress the transmission unit until clearance between the hub spigots and length of the transmission unit is achieved, allowing installation. (See Figure 10.1). Minimum gap of X should not be less than the values shown in Table 10.1, unless indicated otherwise on the general arrangement drawing.

Note: Always remove the compression bolts as soon as the transmission unit is in position, before fully tightening the hub bolts.

3. Align the hub/transmission unit flanges if they have been match marked.

4. It the hub bolts and tighten these evenly to locate the transmission unit, ensuring the spigots enter their recesses squarely. Bolt-threads should be lubricated with oil and tightened in a "diametrically opposite" sequence to the torque values shown in Table 10.2.

5. Measure dimension 'A (see Figure 10.1) on the transmission unit. Check against the minimum and maximum value in Table 10.2.

6. Rotate the machinery two or three times slowly to ensure it moves freely.

Coupling Size	Hub bolt Size	Hub bolt Tightening Torque Nm	Min gap X mm	Coupling Max Axial Deflection +/- mm	Dim'n 'A' (Min) mm	Dim'n 'A' (Max) mm
0013	M6	13	7.1	1.0	7.7	7.8
0033	M8	25	7.2	1.25	8.2	8.4
0075	M8	25	7.6	1.5	8.8	9.0
0135	M8	25	8.1	2.0	9.6	9.9
0230	M10	50	8.3	2.5	10.2	10.4
0350	M8	25	11.6	2.75	13.6	13.9
0500	M10	50	11.8	3.25	14.4	14.7
0740	M10	50	12.3	3.75	15.2	15.5
0930	M12	86	12.5	4.25	15.9	16.2
1400	M12	86	13.4	5.0	17.4	17.8
Maximum angular misalignment = 0.5 degrees up to 3600rpm; 0.33 degrees up to 7500rpm; 0.25 degrees above 7500rpm.						

Table 10.2. Maximum Misalignment

10.1. Transmission Unit Refurbishment

Metastream flexible power transmission couplings are designed and selected to give an unlimited service if used within the conditions for which they were specified. Failures are rare and can generally be attributed to excessive misalignment, severe overload, or a combination of both. In all cases of coupling failure it is advisable that the cause of failure is first identified and corrected. Failure of the coupling will generally be failure of a membrane assembly. Except for some special and large couplings, these cannot be reconditioned and should be replaced.

NOTE: For balanced TSK spacer couplings, the transmission unit is usually supplied as a factory assembled unit which should not be dismantled. However, when used at low or medium speeds, the transmission unit can be reconditioned but will require rebalancing. Membrane assemblies should be replaced in pairs, failure of one will usually result in damage to the other. To replace the transmission unit, first remove the hub bolts (3) then withdraw the transmission unit, using the lever slots in the hubs or jacking holes in the spacer flanges.

10.2. Membrane Unit Replacement

Remove the drive bolts (8B) and nuts (8N), and remove the membrane assemblies from the spacer piece (6), Do not attempt to dismantle the membrane assembly any further. Push washers (8S) from the holes in the spacer piece. Identify the fasteners on the new membrane assembly which attach to the spacer flanges. Remove the loosely assembled nuts (8N). With the bolts (8B) in position, carefully press on the

bolt heads to push the new sleeves (8S) into the holes in the spacer flange. Take care not to over-strain the flexible discs.

Place a small amount of thread locking compound on the protruding bolt threads and then assemble the nuts (8N). Holding the bolts firmly, turn the spacer nuts evenly to the correct tightening torque value given in Table 10.3. Complete the refurbishment of the transmission unit by replacing the second membrane assembly.

TSKS COUPLING SIZE	TIGHTENING TORQUE SPACER NUTS (8N) N-m
0011, **0013**	11
0027, **0033**	23
0060, **0075**	47
0110, **0135**	75
0180, **0230**	130
0260, **0350**	150
0400, **0500**	205
0560, **0740**	285
0750, **0930**	380
1120, **1400**	490

Table 10.3. Tightening Torque Spacer Nuts

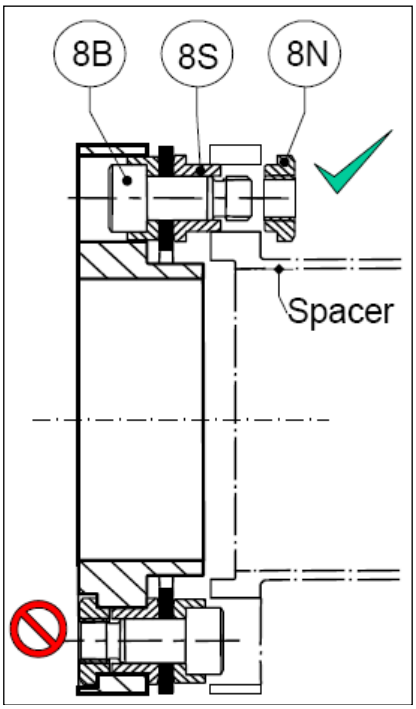

Figure 10.4. Spacer

11.0 LUBRICATION

11.1. Oil Lubricating

Recommended Lubricant

The recommended bearing housing oil is Industrial Gear Oil 150. Turbine quality oil is preferred. This oil may be used during break-in and normal operation.

Method of Application

Customer must fill before start up. The bearing bracket is supplied with a sight glass. Fill the bearing housing with oil according to the quantities specified in next section.

Start pouring oil into the bearing housing through the breather connection located at the top of the bearing housing. Place the breather back on its position. The correct level is observed between the low and high marks on oil sight glass.
Adjust the oil in accordance with directions enclosed within the oiler glass to maintain the oil at the sight glass level mark.

Note 1: Oil level should be determined by using sight glass in bearing housing.

Note 2: KALAYE PUMP takes every precaution during our assembly process and subsequent final assembly audits to ensure no Bearing Housing oil leaks exist prior to shipment. Oil can leak past the labyrinth seal in an "overfill" condition. Refer to the filling instructions for additional information.

Quantity

The combined quantity of initial fill for bearing housing and oiler is:

Row	Pump Model	Nozzle Size	Bearing Housing Size	Quantity (liter)
1	32 16	2" x 1 1/2"	25	1.2
2	32 20	2" x 1 1/2"		
3	32 26	2" x 1 1/2"		
4	40 16	3" x 2"		
5	40 20	3" x 2"		
6	40 26	3" x 2"		
7	50 26	3" x 2"		
8	50 32	3" x 2"		
9	65 20	4" x 3"		
10	65 26	4" x 3"	35	1.5
11	80 25	4" x 3"		
12	80 26	6" x 4"		
13	80 32	6" x 4"		
14	100 26	6" x 4"	45	2
15	100 40	6" x 4"		
16	125 32	6" x 4"		
17	150 32	8" x 6"	55	3

Table 11.1

Additional oil consumption, under normal operating conditions, is replenished by oil in sight glass.

Maintenance

Once every eight hours of pump operation, perform visual inspection of oil and oil level. Oil replenishment should not be required between changes. Oil in bearing housing should be changed every six months.

1. Drain bearing housing through drain location.
2. Flush bearing housing with clean lightweight oil (e.g. ATF).
3. Reinstall drain plug and refill bearing housing.

Note: If it is suspected that bearings have been exposed to dirt or moisture, thoroughly clean the bearings and housing with a solvent and air-dry the parts before adding lubricant.

Oil Change

The first oil change should be carried out three weeks after commissioning; all further oil changes take place every six months.

Note: Only change the oil when the machine is switched off.

Note: The drained oil is hot, and can cause severe burns.

The oil change should be carried out as follows:

1. Switch the drive motor off.
2. Drain the oil out and clean the bearing housing with a suitable cleaning liquid. Flushing the bearing housing with clean lightweight oil is possible (e.g. ATF).
3. Remove the breather connection located at the top of the bearing housing and pour the oil, Place the breather connection back on its position.
4. The level at the oil sight glass should be between the low and high level marks.

Grease Lubricating

Grease Selection

When studying the grease lubrication strategy, a good starting point is selecting the right grease. Simply choosing the best-quality grease is not as important as picking the correct grease for a given application. Too often, grease selection is oversimplified and the key properties overlooked. Grease selection is more complicated than lubricating oil selection. Due to the lack of specificity in most grease recommendations, it is important to learn how to properly select greases for certain applications. Proper grease specification involves all of the components of lubricating oil specification including base oil viscosity, additive requirements and base oil type, as well as other considerations including thickener type and concentration, consistency, dropping point and operating temperature range. While most users acknowledge grease quality, many don’t stop to make sure the right lubricant is being used.

Recommended Grease

Recommended bearing grease is Grease EP-2 (Lithium Base).

Method of Application

There are several different methods for applying grease. Grease can be applied through centralized application systems, single-point auto application systems, hand packing and, the more common, manual grease gun. A compelling argument can be made for the superiority of continuous application systems, but unfortunately, they are impractical for most applications. Therefore, the manual grease gun is the most common application method. Manual grease application, when performed correctly, is an effective method and provides certain advantages over automatic systems.

One requirement of manual application is for the technician to be in close proximity to the lubricated component. This allows for inspections to be made in conjunction with relubrication. In addition to sensory observations such as sight, smell and sound - instrument inspections, such as ultrasonic monitoring and temperature readings, may be used to provide component condition information and to fine-tune the lubrication activity. The addition of ultrasonic monitoring to an already developed greasing strategy will help take the lubrication program to a world-class level.

Grease Lubrication Quantity

One of the more important and frequently botched components of the greasing strategy is relubrication volume. There are many acceptable methods for estimating the appropriate relubrication volume. A common method is recommended by SKF, where grease replenishment volume is defined by the following equation:

$$Gp = 0.005 * D * B$$

where
Gp=grease replenishment amount(gm), D = bearing outside diameter (mm), B = total bearing width (mm)

This method generally provides positive results.

Application Frequency

The component of the greasing strategy that holds the most variability is the frequency of relubrication. Many factors must be considered to be even reasonably precise in determining the best application frequency. Such factors as operating temperature, seal type and condition, particle contamination, moisture, vibration and grease type all play a role in determining reapplication frequency. Although there are several methods for calculating frequency, some of which take many of these factors into consideration, they can still generate different values. Figure 11.1 charts correction factors from SKF - a common method used to calculate frequency.

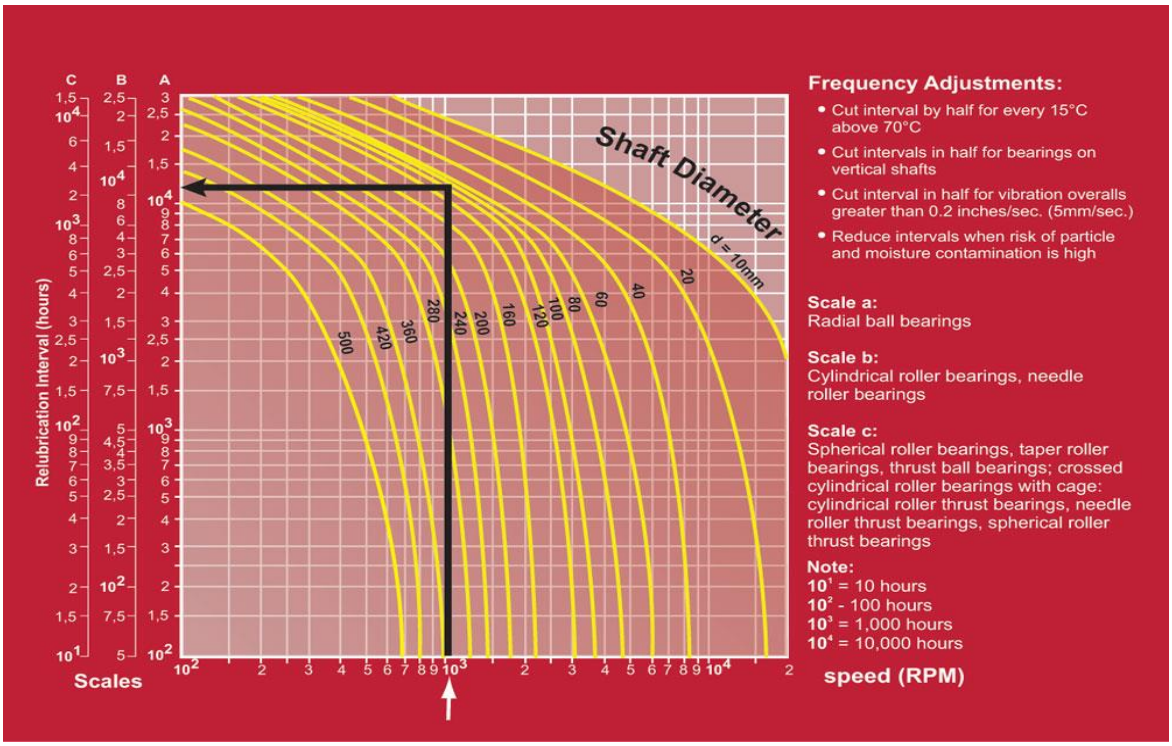

Figure 11.1. Frequency Calculation (Courtesy of SKF)

Once again, to be precise, feedback is needed from the lubricated components to verify the proper frequency has been chosen. A conservative approach is to use a frequency generation method as a starting point, and continuously refine that value based on feedback from the ultrasonic equipment or other physical observations.

12.0 STARTING-UP

12.1. Preliminary operations and checks

- **Flushing out of pipe work:** The pipe work must be free from all foreign matter liable to have been drawn into the pump. It might be advisable to fit a screen on the pump suction end when starting for the first time, to trap any solids.

- **Filling of pump:** The pump must be primed before starting. Close discharge valve, fill pump and suction pipe through filling port. If there is a head on the discharge pipe and there is a by-pass valve on the check valve, open slightly the discharge valve and by-pass of the check valve and leave the filling port open to act as an air vent.

- Pumps handling hot (>500 °F, >260 °C) fluids must be gradually preheated to operating temperature. The most common method used for warming a pump, or maintaining a standby pump in a warm condition, is the use of a warming line and orifice, thus circulating the hot pumpage through the idle pump.

  Note: It is recommended that the pump be warmed at the rate of 100 °F (55 °C) rise per hour for normal warming, or 268 °F (149 °C) rise per hour for emergency warming.

  Note: It recommended that the idle pump temperature be maintained within 36 °F (20 °C) of the system operating temperature.

- Circulation can be easily accomplished by guiding a small amount of flow from the discharge side of the system beyond the check valve via a multiple breakdown orifice into the bottom of the pump case. The hot liquid will then pass through the case and out the suction and return to some low pressure point in the system. In many cases, the pump drain line is used for the warming connection.

- Once the suction line and pump casing are full, turn the pump shaft over by hand two or three turns (in the proper direction). When all air has been removed from the system, close the filling port, check valve, bypass and discharge valve.

12.2. Start Up

- Every time before the pump is started up the safety devices must be mounted and fastened.
- In order to avoid risks of injury or damage, all pump units must be equipped with emergency-stop devices.

- For operation of electrical drives, control systems and their cable routes, the safety instructions issued by their manufacturers must be observed.

The start up procedure is as follows:

1. Before starting the pump, check the security of all bolting, piping, and wiring.
2. Check all gauges, valves and instruments for proper working order.
3. Check all equipment for proper lubrication and correct rotation.
4. Check the oil level in oil housing via sight glass.
5. Verify that the discharge valve is closed.
6. Open the suction valve.
7. Open discharge valve and allow pump to fill with fluid (pump is self-venting).
8. Keep the valves open approximately 60 seconds to ensure that pump is completely full of fluid.
9. Close discharge valve.
10. Uncouple the driver and the pump.
11. Start, and IMMEDIATELY STOP, the driver and observe the rotation of the shaft.
12. Correct rotation should be in direction of rotation arrow.
13. Priming accomplished and correct shaft rotation established, the pump is ready for continued operation.
14. Securely couple the driver and the pump, and ensure the discharge valve is open to approximately ¼ fully open.
15. Start driver again, and completely open the discharge valve IMMEDIATELY when the operating speed has been reached.
    Danger: Do not allow discharge valve to remain closed for any length of time. Pumped fluid temperature will rise excessively causing damage to pump.

A MECHANICAL SEAL MUST NEVER RUN DRY, EVEN FOR A BRIEF INSTANT.

12.3. Operating Check

During the initial operating hours, the pump should be monitored constantly. It is thus possible to detect irregularities immediately and to take appropriate measures for their elimination. To monitor flow, pressure, temperature, and lubrication, regular visual inspection and monitoring is advisable and/or necessary during operation.

KALAYE PUMP recommends checking the pump constantly at regular intervals in order to detect problems early, in case they arise. The operational check routine must include minimum the following points:

- Beware of freely rotating parts, when the pump is in operation there is a high risk of injury.
- Check at regular intervals that the safety equipment is sound and is arranged and fastened according to the regulations, and energized where applicable.
- Check the security of all bolting, piping, and wiring.
- Check all gauges, valves and instruments for proper working order.
- Check all equipment for proper lubrication and correct rotation.
- Check the oil level and validate that the correct oil grade is installed.

- Check the oil level in oil housing via sight glass.
- Check the temperature of the bearing housing surface. It should not exceed 185 °F (85 °C).
- Check that the pumping unit is running quietly and without vibrating.
- Unusual or too loud noises point towards a possible fault.
- Monitor the power consumption of the drive motor. Low or excessive power consumption indicates a possible fault.
- Check the sealing system:
  a) Refer to the seal manufacturer for his estimate of maximum acceptable leakage rate, as this will depend on application, design, location and the sealed liquid characteristics.
  b) If leakage excessive, switch the pump off as quickly as possible, isolate the pump by closing the discharge and suction valves or using some other approved method designated as safe for your system, and check the rotating seal ring and the stationary seal ring.
- If the sealing system of the mechanical seal fails, the pump must be taken out of operation immediately.
- The pump may only be operated under the minimum operating range for short periods. The minimum pump flow is given in the characteristic line.

12.4. Doweling

When the pump has reached operating temperature and pressure,

1. Stop pump.
2. Check alignment and reset the equipment, if required.
3. Dowel the pump.
4. Dowel the driver.
5. Start the pump as defined in section "START UP".

12.5. Stopping

1. Throttle pump discharge to minimum flow.

   Note: Warning: do not close suction valve, this will cause the pump to run dry.

2. Turn the power off to the driver.
3. Close the pump discharge valve.
4. Observe the run - down of the pump until full stop.

   Note: If the rotor is jerky or suddenly stops, there is a danger that the rotor has become blocked. The pump must be opened and all running clearances checked.

5. Close the suction valve when the pump shaft stops rotating as the pump must be isolated before examination and made safe.

   Note: Do not close the suction valve until the pump has come to a full stop, as it may cause the pump to run dry.

6. Ensure the drive motor cannot be unintentionally turned on.
7. Ensure the shut-off devices in the suction and pressure pipes cannot be unintentionally opened.
8. Drain the pump and the auxiliary piping.

Note: If the outside temperature is below 32 °F (0 °C), all cooling chambers must be emptied, and all seal system cooling coils must be drained.

12.6. Short Term Shut Down

If the pump has switched off correctly and has not suddenly come to a halt, it may be re-started without the need to take any special measures. If the pump comes to a sudden halt, or if the pump was switched off because of a possible danger, it must be checked for damage.

12.7. Long Term Shut Down

1. Follow the stopping procedure described in SECTION 12.5 - STOPPING.
2. Disconnect the vent filter and seal openings on the bearing housing to lessen the exchange of air.
3. While the unit is idle:
   a) If the plant is in an operational state, warm up and start the unit at monthly intervals (see SECTION 12.2 - STARTUP for details).
   b) If the plant is not in an operational state, turn the unit over by hand a couple of times at monthly intervals, ensuring the shaft is not returned to the same position, to allow the bearings to rest in a different position every time.
4. If there is danger of freezing, drain the pump, drain the oil from the pump bearings and all the auxiliary piping.
5. Change the oil before recommencing operation, ensuring the correct grade and the correct volume has been installed in the bearing housing (see SECTION 11 - LUBRICATION for details).

13.0 MAINTENANCE

It is recommended that a maintenance plan and schedule is adopted, in line with these User Instructions, to include the following:

a) Any auxiliary systems installed must be monitored, if necessary, to ensure they function correctly.

b) Check for any leaks from gaskets and seals. The correct functioning of the shaft seal must be checked regularly.

c) Check bearing lubricant level, and if the hours run show a lubricant change is required.

d) Check that the duty condition is in the safe operating range for the pump.

e) Check vibration, noise level and surface temperature at the bearings to confirm satisfactory operation.

f) Check dirt and dust is removed from areas around close clearances, bearing housings and motors.

g) Check coupling alignment and re-align if necessary.

KPC specialist service personnel can help with preventative maintenance records and provide condition monitoring for temperature and vibration to identify the onset of potential problems.
If any problems are found the following sequence of actions should take place:

a) Refer to section 14.0, for fault diagnosis and troubleshooting.
b) Ensure equipment complies with the recommendations in this manual.
c) Contact KPC if the problem persists.

The following table (Table 13.1) illustrates the maintenance schedule for routine and periodic inspection.

Type of Inspection	Check / Action
Routine (Daily/ Weekly)	The following checks should be made and the appropriate action taken to remedy any deviations: a) Check suction and discharge gauges. b) Check for abnormal operating conditions (high/low temperature, flow, vibration, pressure etc.) c) Check motor current/driver power. d) Check that there are no abnormal fluid or lubricant leaks (static and dynamic seals) and that any sealant systems (if fitted) are full and operating normally. e) Check that shaft seal leaks are within acceptable limits. f) Check all lubricant levels as applicable; ie. bearing housing oilers, seal Plan and seal supply systems. g) On grease lubricated pumps, check running hours since last recharge of grease or complete grease change. h) Check any auxiliary supplies e.g. heating/cooling (if fitted) are functioning correctly. i) Check stand by pump is at applicable temperature and available to start as required. Refer to the manuals of any associated equipment for routine checks needed.
Periodic (monthly)	a) Check for lubricant contamination whether bearing oil, or seal oil (if applicable) by sample analysis. b) Check all paint or protective coatings. c) Check all power/instrument cable glands for tightness. Refer to the manuals of any associated equipment for periodic checks needed.
Periodic (six monthly)	a) Check foundation bolts for security of attachment, corrosion. Check grouting for looseness, cracking or general distress. b) Change lubricants. c) Check calibration of instruments. d) The coupling should be checked for correct alignment and worn driving elements. Refer to the manuals of any associated equipment for periodic checks needed.
After 3 years	a) Check internal condition of pump and all ancillary pipework for corrosion/erosion. b) Check internal pump components for wear. c) Change bearings

Table 13.1

Before initiating maintenance procedures disconnect all power sources to the equipment and discharge any parts which may retain an electric charge. Use proper locks to avoid accidental start-up of the pump

system. Failure to comply may result in severe personal injury. When performing the maintenance of the pump, use the safety equipment appropriate for the pumped fluid, materials, and location of the equipment, such as gloves, safety glasses, harnesses and other equipment regarded as mandatory by the plant's safety instructions.

13.1. Disassembly

1. Stop the pump. See SECTION 12.5 - STOPPING.
2. Drain all possible fluids from the pump case and bearing housing.
3. Disconnect any auxiliary piping and wiring that could interfere with disassembly.
4. Disconnect the driver-to-pump coupling and remove coupling spacer.
5. When disassembling the pump, match mark, tag or otherwise identify all parts, and provide separate containers for small parts.
6. To separate pump cover from pump case, first remove the stud nuts, then use back-off screws in the taps provided to break the cover-to-case gasket joint.
7. Remove the pump cover-bearing bracket assembly by providing a chain or sling support for the assembly.

Note: Avoid bumping the impeller or the pump half coupling.

8. After removal, place the pump cover-bearing bracket safely on suitable horizontal supports.
9. To remove the impeller, first free and remove the cover-to-case gasket, then remove the impeller nut, set screw and nut, impeller, and key.

Note: Do not heat the impeller.
Note: Impeller nut is a right hand thread.

10. Exercise care and remove mechanical seal as follows:
    a) If seal has an outside drive collar, engage seal setter, then loosen setscrews prior to removal of assembly.
b) Remove bearing bracket-to-cover cap screws.
    c) Slide pump cover, with seal attached, off pump shaft. Place the cover, with seal flange facing upward, on worktable.
    d) Apply protective wrap and store seal components. Refer to seal manufacturer's literature for disassembly, inspection, cleaning, and reassembly of the mechanical seal.
11. Disassemble the bearing housing as follows:
    a) Remove pump half coupling and key. Application of heat is required for the removal and replacement of pump half coupling. Use a puller tool to remove the pump half coupling.

Note: Use a safe heating method and provide protection for personnel handling the heated half coupling.

    b) For fan cooled bearings only, remove self-tapping screws and remove the fan housing from bearing housing.
    c) Before removing the outboard cover/Bearing Isolator assembly, file or deburr keyway if there are

sharp corners or nicks. This is to avoid damaging the o-ring in the Bearing Isolator. Remove outboard cover cap screws and slide out the cover/Bearing Isolator assembly and gaskets.

d) Pump shaft can only be removed in one direction. Press pump shaft from impeller end through the bearing bracket. Remove radial bearing from shaft. Remove locknut and lock washer and remove thrust bearings from shaft.

13.2. Inspection and Cleaning

1. Thoroughly clean all parts with kerosene or equivalent and dry all parts with compressed air or a clean, lint free cloth.
2. Inspect all components for corrosion, erosion, pitting, and scoring. If required, replace with KALAYE PUMP O.E.M. genuine replacement parts.
3. Visual check all individual parts for any damage.
4. Check the casing for wear.
5. Check the impeller for wear.
6. To remove wear rings, first remove screw pins (if not welded), then either machine the wear rings off, or remove by segmenting with a diamond pointed chisel tool. Replacement wear rings are installed by a light shrink fit (see SECTION 13.3 - REASSEMBLY).
7. Check the radial clearance for wear.
8. Check the antifriction bearings.
9. Check all auxiliary piping.
10. Check for transmission elements of the coupling.
11. Set pump shaft between lathe centers and indicate shaft run out. Shaft run out should not exceed 0.001 inch (0.0254 mm).

13.3. Reassembly

Reassemble as follows:

Note: Mounting of bearings should be carried out in a dry, dust free area away from metal working or other machines producing shavings and dust to avoid contamination of bearings.

Note: The bearings should remain in their original packaging. Once they are to be assembled in the shaft, they must be removed from their packaging, and the preservative in the outside diameter and the bore must be wiped out.

1. Place and heat the two thrust bearings in an induction heater. Turn on the heater. Continuously measure the temperature of the inner race, looking to reach 230 °F (110 °C).

Note: Measure the temperature continuously with an infrared thermometer, pointing to the inner race of the bearings.

Figure 13.1 Heating the thrust bearings.

2. Position the shaft vertically (with the coupling side upward) in a press.

Note: Cover the jaws of the press with soft material to prevent damaging the shaft.

3. Put oil in the shaft to lubricate for bearing installation and parts preservation.

Figure 13.2 Lubricating the shaft.

4. As soon as the bearings have reached the temperature of 230 °F (110 °C), place the bearings on the shaft in a back to back arrangement.

Figure 13.3 Positioning the thrust bearings.

Note: Wear sufficient hand protection to avoid personal injury.

5. With the locknut, but not the lock washer, tighten with a spanner wrench until snug, to ensure that there is no gap between both thrust bearings.

Important: wait until both bearings have cooled down to room temperature before starting the next step. This cooling period is critical to ensure the final contraction of both bearings before the next adjustments.

6. Now, remove the locknut and position the lock washer so that it is in contact with the thrust bearings on the coupling side. The tab on the lock washer inner diameter must be bent to fit into the small keyway recess cut into shaft threads, to prevent rotation of the bearing locknut.

Figure 13.4 Positioning the lock washer.

7. Position the locknut with the taper towards the side of the lock washer at full-stop.

Figure 13.5 Positioning the locknut.

8. Tighten the bearing locknut as tight as possible by hand using a spanner wrench. Now, with the help of a hammer and the spanner wrench, advance the locknut at least one-eighth (1/8) and up to one-quarter (1/4) turn, to firmly snug the assembly, ensuring, at the end of the tightening process, that one of the lock washer tabs lines up with the slots in the locknut.

Figure 13.6 Tightening the locknut.

9. The tab that aligns with one of the slots is bent into the slot so it works as a lock and the locknut cannot be loosened. Use a screwdriver and a hammer.

Figure 13.7 Bending a tab of the lock washer in the locknut.

Inspection point: Inspect that the bearings are adjacent to each other, and that both are assembled seated against the shaft shoulder. The thrust bearings must be able to run in opposite directions; if one or the

other cannot rotate, there is a problem with the assembly.

10. Now take the shaft out of the press and turn it over 180°, place it back in the press to reassemble the radial bearing.
11. There are two possible options depending on the type of radial bearing of your pump. Choose either (a) or (b) accordingly.

a) In case of radial ball bearing, place the bearing in the induction heater. Turn on the heater. Continuously measure the temperature of the inner race, looking to reach 230 °F (110 °C).

Note: Measure the temperature continuously with an infrared thermometer, pointing to the inner race of the bearing.

Figure 13.8 Heating the radial ball bearing.

b) In case of radial roller bearing, place only the inner race of the radial bearing in an induction heater. Turn on the heater and continuously measure the temperature of the inner race, looking to reach 230 °F (110 °C).

Note: Measure the temperature continuously with an infrared thermometer.

Figure 13.9 Heating the inner race of the radial roller bearing.

12. Put some oil to lubricate the shaft's radial-bearing area for bearing installation and parts preservation.

Figure 13.10 Lubrication of the shaft.

13. In this step, the procedure is also different depending on the type of radial bearing of your pump.

a) In case of radial ball bearing . As soon as the bearing reaches the 230 °F (110 °C) temperature, it is manually positioned in the shaft (with the serial number visible from the outside). The bearing is maintained in position until it cools down enough to stay in place (to room temperature).

Figure 13.11 Positioning the radial ball bearing.

b) In case of radial roller bearing, as soon as the bearing's inner race reaches the 230 °F (110 °C) temperature, it is manually positioned in the shaft. The bearing's inner race is maintained in position until it cools down enough to stay in place (to room temperature).

Figure 13.12 Positioning the radial roller bearing's inner race.

Note: Wear sufficient hand protection to avoid personal injury.

Inspection point: Now that both thrust bearings and the radial bearing/radial bearing's inner race have been reassembled in the shaft, make sure that there is no gap between both thrust bearings, by holding them and trying to move them.

Note: Protect the bearings with oil and cling wrap plastic if you are not going to continue the assembling process immediately. When resuming the assembling process, remove this protection

Figure 13.13 Protecting the bearings if making a pause.

14. To insert the labyrinth seals into the covers, follow these steps:
a) Lubricate the outside ring of the labyrinth seal.

Figure 13.14 Lubricating the labyrinth seal.

b) Position the labyrinth seal at the bearing cover in its correct position.
c) Ensure the labyrinth seal is perpendicular to bore before insertion.
d) Using a sleeve and a flat surface (hard plastic) with the help of an arbor press, insert the labyrinth seal.

Figure 13.15 Inserting the labyrinth seal.

Note: Do not use a hydraulic press, since the seal can be broken.

e) Perform this procedure on both covers.

15. This step applies only for pumps with a radial roller bearing. You will need a hard plastic block. After oiling the bearing races and the bracket, position the outer race of the radial bearing (this must be aligned to ensure a correct assembly). Now, with a rubber mallet, hit (softly) the hard plastic block to insert the outer race all the way in (ensure the sleeve or block dimensions are similar to the outer race of the bearing).

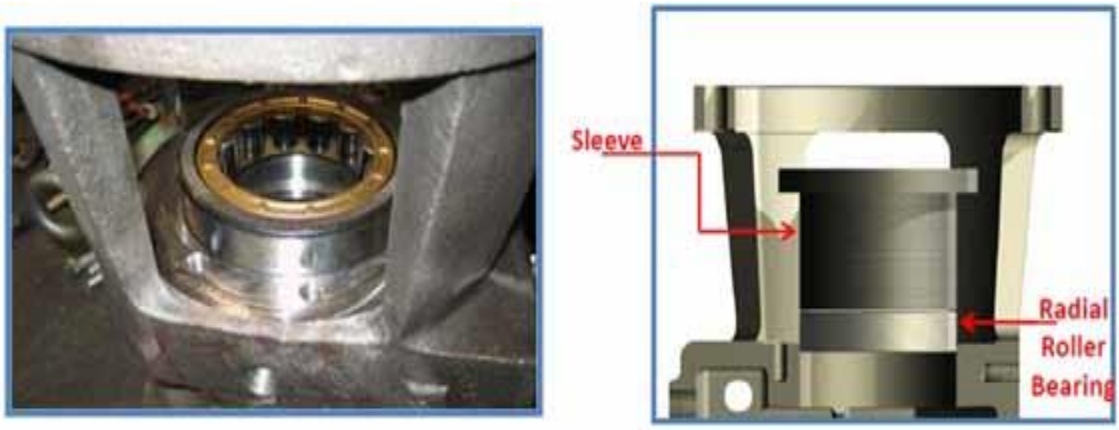

Figure 13.16 Inserting radial roller bearing.

Note: Check visually that the outer race of the radial bearing has reached its limit within the housing.

16. Position the radial gasket at the cover, taking care of not covering the oil returns and ensuring all the slots match. Position manually the cover on the bearing housing, ensuring the cover is rotated in the correct position.

Figure 13.17 Positioning the radial gasket.

17. Position the bolts by hand (previously treated with anti seize).

Figure 13.18 Positioning the bolts manually.

18. Now tighten these bolts diagonally (crosswise) to ensure correct reassembly, using the torque values of the next table.

Figure 13.19 Tightening the bolts.

Bracket size	Bolting size	Torque values lbf-ft (N-m)
35	3/8 – 16 UNC – 2B	29 (39)
55	1/2 – 13 UNC – 2B	73 (99)
75	1/2 – 13 UNC – 2B	73 (99)
90	3/4 – 10 UNC – 2B	258 (350)

Note: Make sure that the gasket has not moved out or is not pinched during the process since this can cause an oil leak.

19. To position the radial cover at the bearing bracket, first put some lubricant in the inner diameter of the radial labyrinth seal.

20. Position the rotor assembly on the bearing housing until thrust bearing seat against shoulder.

Figure 13.20 Positioning the rotor assembly on the bearing bracket.

21. Hit (softly) the shaft in the coupling side to ensure the correct assembly.

Figure 13.21 Hitting softly the coupling side of the shaft.

Inspection point: Check that the bearings enter evenly in the housing; the bearing should rest against the wall of the bearing housing. After this assembly, the shaft must be able to rotate by hand; however, there is some resistance to make it turn due to the action of the labyrinth seals.

22. End float between thrust bearings and cover. This dimension is already calculated with a non-asbestos gasket (thickness 1/32 inch [0.79 mm]). The end float would be between 0.001 inches (0.0254 mm) and 0.012 inches (0.3048 mm).

a) Use one or several hard plastic flat surfaces to hit (softly) with a rubber mallet, to ensure that the bearings are completely in contact with the shoulder of the bearing bracket.

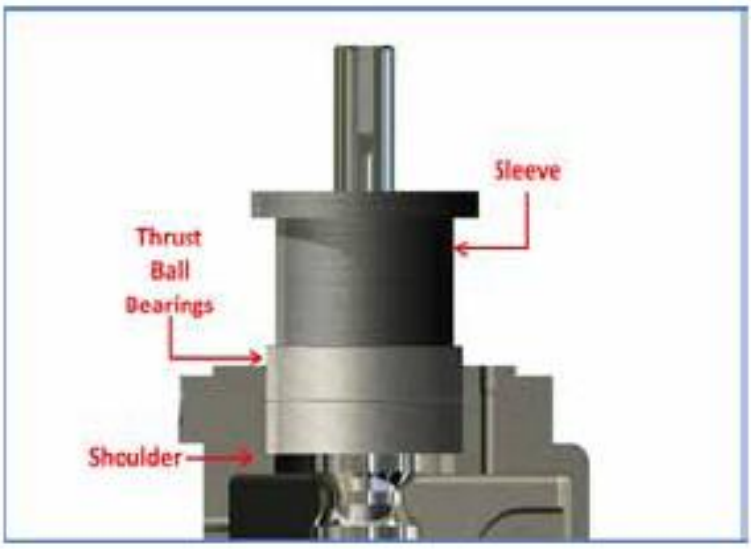

Figure 13.22 Ensuring bearings are in contact with the shoulder of the bearing housing.

23. To position the thrust cover at the bearing housing, first position the thrust gasket on the bearing housing, ensuring all the slots match.

Figure 13.23 Positioning the thrust gasket in the bearing housing.

Note: Do not cover the oil returns and check that all features at the bracket match.

24. Lubricate the internal diameter of the labyrinth seal.
25. Slide cover onto the shaft, ensuring cover is rotated to the correct position (do not use a hammer).
26. Position the bolts manually, but first protect them with anti seize protection. Tighten these bolts diagonally (crosswise) to ensure correct reassembly, using the torque values of the next table.

Bracket size	Bolting size	Torque values lbf-ft (N-m)
35	3/8 – 16 UNC – 2B	29 (39)
55	1/2 – 13 UNC – 2B	73 (99)
75	1/2 – 13 UNC – 2B	73 (99)
90	3/4 – 10 UNC – 2B	258 (350)

Note: Make sure that the gasket has not moved out or is not pinched during the process since this can cause an oil leakage.

27. Position all features and plugs in the bearing bracket. Use the proper wrench to install sight glass, oiler, breather, and any other plug necessary.

Figure 13.24 Identifying the plugs in the bearing bracket.

28. To insert the wear ring into the casing cover, follow these steps:
a) Place the wear ring in the freezer for 3 hours, to shrink it and facilitate the reassembly of the casing cover.
b) Insert the wear ring completely to the shoulder on the casing cover using a rubber mallet.

Figure 13.25 Positioning the wear ring.

Note: Insert the ring so that the shoulder rests towards the inside of the casing cover.

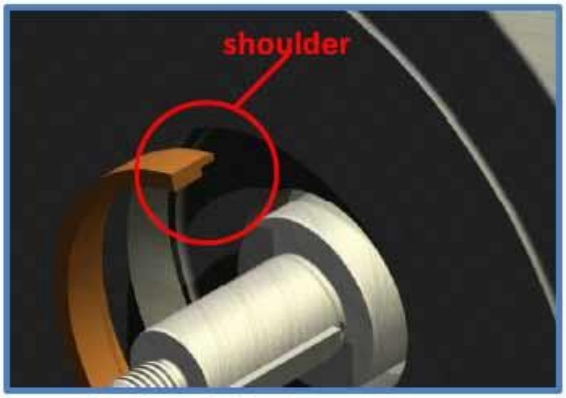

Figure 13.26 Verifying the position of the shoulder of the ring.

29. In the inner diameter of the casing cover, the wear ring that works with the shaft (throat bushing) is positioned. To do this, insert the throat bushing with the rubber mallet to the limit (it is installed by the outer side of the casing cover).

Figure 13.27 Positioning holes at 180°.

Inspection point: Check visually that the rings are assembled to their corresponding limits in the casing cover.

30. To place the wear ring that works with the casing, follow these steps:
a) Place the wear ring in the freezer for 3 hours, to shrink it and facilitate the reassembly of the casing cover.
b) Insert it in its position (to the limit) with a rubber mallet.

Figure 13.28 Positioning the wear ring.

Note: Insert the ring so that the shoulder rests towards the inside of the casing cover.

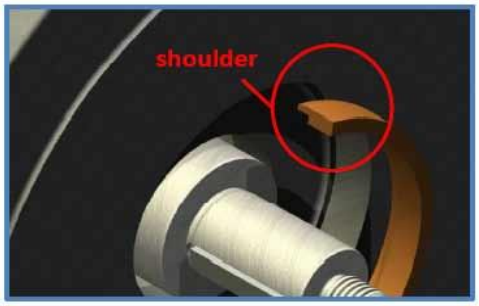

Figure 13.29 Verifying the position of the shoulder of the ring.

Inspection point: Check visually that the ring is assembled to the limit of the casing.

31. To position the wear rings of the impeller, follow these steps:
a) Each of the wear rings of the impeller (two, one for each side) is inserted into its position (to the limit where it stops) with the rubber mallet.

Figure 13.30 Positioning the wear rings of the impeller.

Inspection point: Check visually that each of the rings is assembled to its corresponding limit on each side of the impeller.

32. To place the mechanical seal in the casing cover, first check the drawing of the mechanical seal, to be sure of assembling the seal at its correct position.

Figure 13.31 Verifying the drawing of the mechanical seal.

Now:
a) Install the mechanical seal in the casing cover with the four studs and nuts.

Figure 13.32 Placing the mechanical seal at the casing cover.

b) Tighten these bolts diagonally (crosswise) to ensure correct assembly. The torque values are indicated in the next table.

Bracket size	Bolting size	Torque values lbf-ft (N-m)
35	5/8 – 11 UNC – 2B	144 (196)
55	5/8 – 11 UNC – 2B	144 (196)
75	5/8 – 11 UNC – 2B	144 (196)
90	3/4 – 10 UNC – 2B	258 (350)

Inspection point: The shaft must be able to rotate without problems.

33. To assemble the bearing bracket with the casing cover, follow these steps:
a) Lay casing cover down with bracket mounting surface up.
b) Lift the assembly of the bearing bracket and position it over the casing cover shoulder.

Figure 13.33 Positioning the bearing bracket assembly on the casing cover.

c) Position the bolts (previously protected with anti seize) by hand.
d) Tighten these bolts diagonally (crosswise) to ensure the correct assembly. The torque values are indicated in the next table.

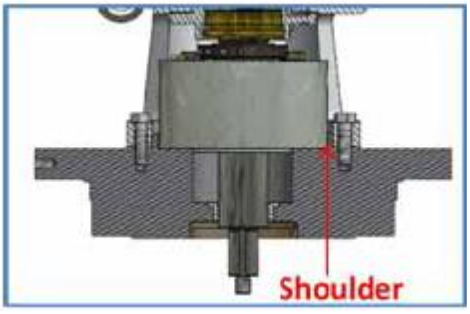

Figure 13.34 Positioning and tightening the bolts.

Bracket size	Bolting size	Torque values lbf-ft (N-m)
35	1/2 – 13 UNC – 2B	73 (99)
55	1/2 – 13 UNC – 2B	73 (99)
75	5/8 – 11 UNC – 2B	144 (196)
90	1 1/8 – 7 UNC – 2B	886 (1201)

34. To assemble the impeller on the shaft:
a) Position the key in the shaft.
b) Now position the impeller on the shaft until it stops on the shoulder.

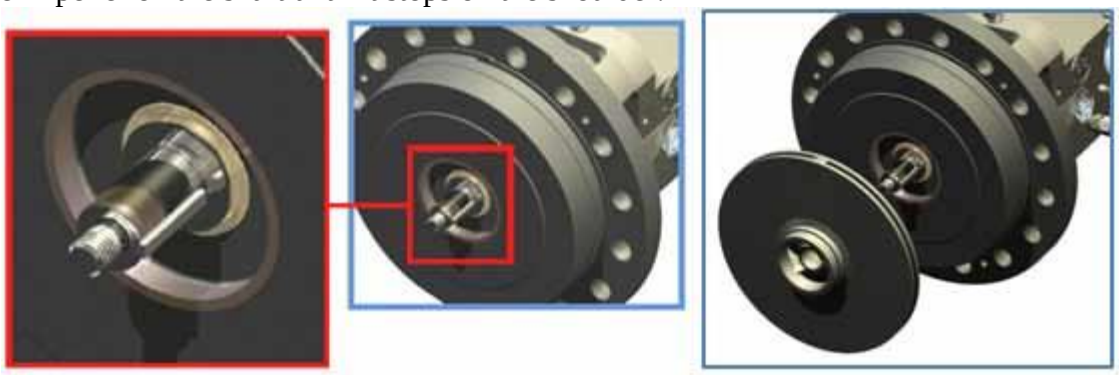

Figure 13.35 Positioning the impeller on the shaft.

Note: Make sure that the suction of the impeller is directed towards the opposite side.

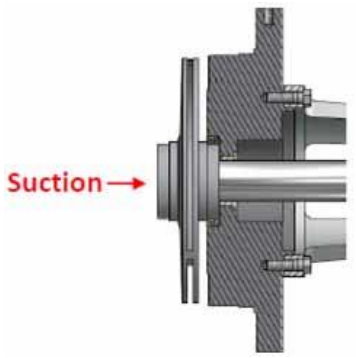

Figure 13.36 Verifying the direction of the suction.

c) Install the impeller nut ensuring it completely seats on the impeller (a pneumatic wrench is used).
d) Install the set screw with locktite and tighten it with an Allen key to secure the impeller nut.

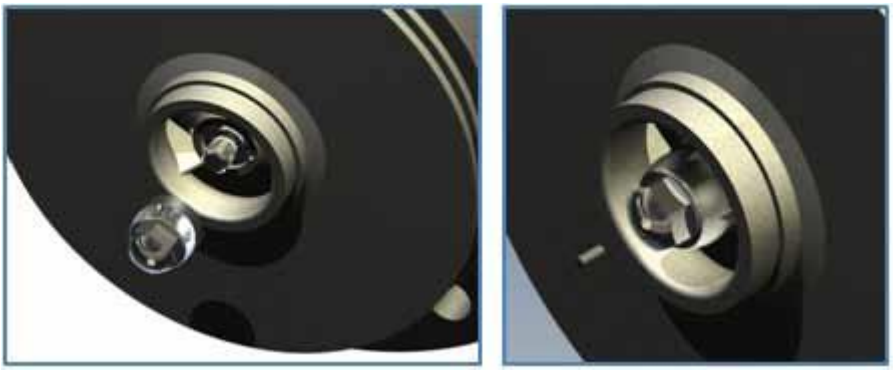

Figure 13.37 Positioning and tightening the set screw.

Inspection point: Rotate the impeller and make sure that the wear rings do not make contact.

35. To place the studs in the casing cover, follow these steps:
a) Clean the studs and threads on the casing so they are free of foreign materials.
b) Insert each stud (previously protected with an antiseize agent). Each one must be hand-tightened.

Figure 13.38 Positioning the studs manually.

c) Now, use the double nut technique to insert the studs all the way in (the studs do not require torque).

Figure 13.39 Tightening the studs.

Inspection point: Check visually that studs are fastened to the limit: all of them should have approximately the same height.

Figure 13.40 Visual inspection of the studs.

36. For the assembly of the casing with the rest of the pump, follow these steps:
a) Metal flange cover shall be attached to protect flange surfaces.
b) Position the casing vertically, supported over the suction.
c) Place the casing gasket on the casing cover. Use packing grease to hold gasket in place.

Note: The casing gasket must be changed every time the casing and the casing cover are disassembled and reassembled.

Figure 13.41 Identifying the casing gasket.

d) Position the whole assembly vertically over the casing. Lower assembly into casing. Ensure the gasket stays in position.

Note: Make sure that the vent of the bearing bracket and the lifting lug of the casing cover are oriented towards the discharge of the pump.

e) Apply anti seize protection on the studs, and position all the nuts in the studs. Tighten them diagonally (crosswise) using the torque values of the next table.

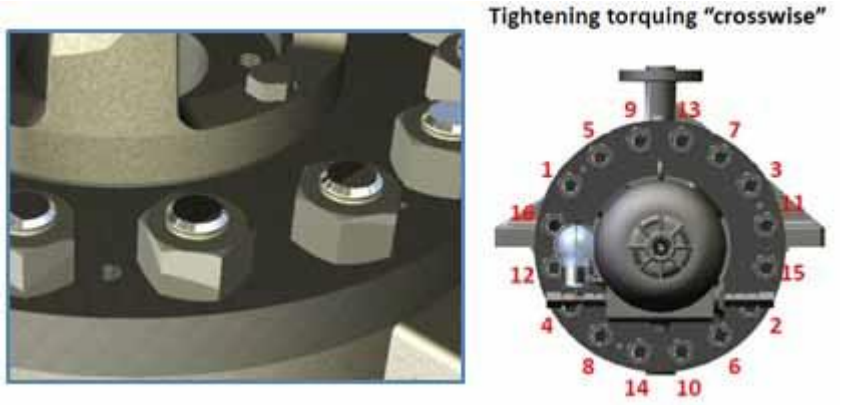

Figure 13.42 Positioning the nuts and tightening crosswise.

Bolting size	Torque values lbf-ft (N-m)
3/4 – 10 UNC – 2B	258 (350)
7/8 – 9 UNC – 2B	417 (566)
1 – 8 UNC – 2B	625 (848)
1 1/4 – 7 UNC – 2B	1 291 (1 750)
1 1/2 – 6 UNC – 2B	2 312 (3 134)

Inspection point: Rotate the shaft and make sure the wear rings do not make contact. After positioning the pump horizontally, rotate the shaft to verify again that the wear rings do not make contact.

37. Now to assemble the fan and the fan guard (if applicable), follow these steps:
a) Insert the fan on the shaft. Secure to the shaft using set screws. Ensure at least a ⅛ inch gap in between.

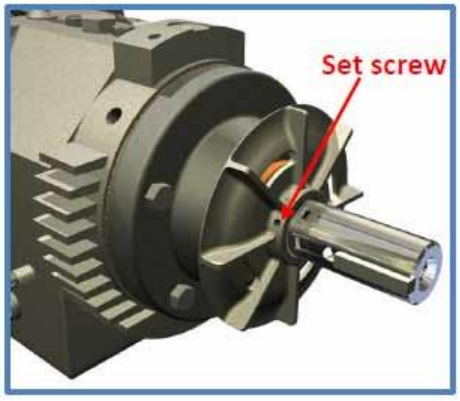

Figure 13.43 Tightening the set screw.

b) Now position fan guard, and align the holes to the bracket.
c) Once aligned the four holes to screw it, tighten these screws to secure it to the bearing bracket. This union does not require tightening torque.

Inspection point: Turn the pump shaft to ensure fan does not rub on fan guard.

38. Now place all features back to the pump.

14.0 TROUBLESHOOTING DURING OPERATION

Routine Inspection

Routine inspection while the pump is in service is based on the following basic Principles:

1. The pump should always run smoothly, without vibration.
2. The motor must not be overloaded. For example, discharge pressure or motor current must be watched and compared with those indicated on the nameplate.
3. Mechanical seal must never run dry.
4. Bearing temperature must never exceed 70-75 with oil.
5. The pump must never run at a capacity of less than 25% of B.E.P.
6. Thoroughly clean all parts with kerosene or equivalent and dry all parts with compressed air or a clean, lint free cloth.
7. Visual check all individual parts for any damage
8. Check the casing for wear.
9. Check the impeller for wear.
10. d. Check the radial clearance for wear.
11. e. Check the antifriction bearings.
12. f. Check all auxiliary piping.
13. g. Check for transmission elements of the coupling.
14. h. Set pump shaft between lathe centers and indicate shaft run out. Shaft run out should not exceed 0.001 inch (0.0254 mm) T.I.R.
15. With a mechanical seal, pressure-tightness is provided by (i) a pair of O-rings with the convex ring stationary and the dished ring on the rotating part, and (ii) contact between perfectly flat, polished surfaces (carbon/ceramic). These points must be checked if slight leakage is observed. If leakage persists, the seal must be changed.

Note: The assembly of the Mechanical Seal does not require any adjustment as it is supported sturdily against the impeller hub and this ensures the correct positioning.

Here is Troubleshooting tables:

TROUBLE	PROBABLE CAUSES	SUGGESTED SOLUTION
HOT BEARINGS	a. Insufficient Oil b. Contaminated Oil c. Misalignment d. Too much oil e. Pump is under tension stress f. Excessive axial thrust g. The given half-coupling spacing is not set h. Bearings are damaged	a. Add Oil. b. Drain and clean reservoir. Refill with clean oil. c. Check alignment of pump and driver. d. Drain to proper level. e. Check the piping for tension free connections f. Clean balance holes in the impeller and change the seal rings. g. Reset and give the correct spacing. h. Change damaged bearings.
LEAKAGE UNDER SHAFT SEAL	a. Shaft seal is damaged b. Pump unit is not properly aligned c. The given half-coupling spacing is not set	a. Replace damaged seal. b. Realign the pump. c. Reset and give the correct spacing.
PUMP DOES NOT DELIVER LIQUID	a. Inner pump parts are worn b. Density or viscosity of pumped fluid is not same as designed. c. The motor voltage is incorrect d. Motor runs only in two phase mode e. Pump not primed f. Speed too low g. Feed pipe or impeller plugged h. Clogged suction i. Damaged impeller j. Wrong rotation k. Pump or piping are not properly vented l. Formation of air pockets in the piping m. The counter pressure of the system is greater than the design point of the pump n. NPSHa too low	a. Change worn parts. b. Consult a KALAYE PUMP dealer. c. Apply correct voltage to the motor d. Check the cables, connections and fuses. e. Prime pump. f. Check driver input. g. Clean pipe and impeller. h. Clean out suction line. i. Replace impeller. j. Check driver rotation. k. Vent or top up. l. Install vent valve or lay piping elsewhere. m. Open discharge valve as wide as necessary to reach the operating point. n. Check the fluid level in the feed container. Open suction valve completely. Lay suction pipe elsewhere if friction losses are too big. Check for a possible filter in the feed pipe.

TROUBLE	PROBABLE CAUSES	SUGGESTED SOLUTION
CAPACITY OR DISCHARGE PRESSURE LOW	a. Air leaks into suction b. Speed too low c. Clogged suction d. Clogged impeller e. Damaged impeller f. Wrong rotation g. Pump or piping are not properly vented h. Feed pipe or impeller plugged i. Formation of air pockets in the piping j. Inner pump parts are worn k. Density or viscosity of pumped fluid is not same as designed. l. The motor voltage is incorrect m. Motor connected only in two-phase mode n. NPSHa too low	a. Check suction line for leaks. b. Check driver and its power source. c. Clean out suction line. d. Clean impeller. e. Replace impeller. f. Check driver rotation. g. Vent or top up. h. Clean pipe and impeller. i. Install vent valve or lay piping elsewhere. j. Change worn parts. k. Consult a KALAYE PUMP dealer. l. Apply correct voltage to the motor. m. Check the cables, connections and fuses. n. Check the fluid level in the feed container. Open suction valve completely. Lay suction pipe elsewhere is friction losses are too big. Check for a possible filter in the feed pipe.
DRIVER OVERLOAD	a. Density or viscosity of pumped fluid is not same as designed. b. Speed too high c. Pump unit is not properly aligned d. Pump is under tension e. The motor voltage is incorrect f. Motor connected only in two-phase mode g. Bearings are damaged h. System head lower than rating	a. Consult a KALAYE PUMP dealer. b. Decrease driver speed. c. Realign the pump. d. Check the piping for tension free connections. e. apply correct voltage to the motor. f. Check the cables, connections and fuses. g. Change damaged bearings. h. Check suction and discharge pressure. Set operating point with the discharge valve

Fig 14.1

15.0 SAFETY GUIDELINE

Personnel qualification and training

All personnel involved in the operation, installation, inspection and maintenance of the unit must be qualified to carry out the work involved. If the personnel in question do not already possess the necessary knowledge and skill, appropriate training and instruction must be provided. If required the operator may commission the manufacturer/supplier to provide applicable training.

Always co-ordinate repair activity with operations and health and safety personnel, and follow all plant safety requirements and applicable safety and health laws and regulations.

⚠ Safety actions

This is a summary of conditions and actions to help prevent injury to personnel and damage to the environment and to equipment.

1. NEVER DO MAINTENANCE WORK WHEN THE UNIT IS CONNECTED TO POWER.

2. GUARDS MUST NOT BE REMOVED WHILE THE PUMP IS OPERATIONAL.

- The unit must not be operated unless coupling guard is in place. Failure to observe this warning could result in injury to operating personnel.

3. DRAIN THE PUMP AND ISOLATE PIPEWORK BEFORE DISMANTLING THE PUMP

- The appropriate safety precautions should be taken where the pumped liquids are hazardous.

4. FLUORO-ELASTOMERS (When fitted.)

- When a pump has experienced temperatures over 250 ºC (482 ºF), partial decomposition of fluoro-elastomers (example: Viton) will occur. In this condition these are extremely dangerous and skin contact must be avoided.

5. HANDLING COMPONENTS

- Many precision parts have sharp corners and the wearing of appropriate safety gloves and equipment is required when handling these components. To lift heavy pieces above 25 kg (55 lb) use a crane appropriate for the mass and in accordance with current local regulations.

6. THERMAL SHOCK

- Rapid changes in the temperature of the liquid within the pump can cause thermal shock, which can result in damage or breakage of components and should be avoided.

7. NEVER APPLY HEAT TO REMOVE IMPELLER.

- Trapped lubricant or vapor could cause an explosion.

8. HOT (and cold) PARTS

- If hot or freezing components or auxiliary heating supplies can present a danger to operators and persons entering the immediate area action must be taken to avoid accidental contact. If complete protection is not possible, the machine access must be limited to maintenance staff only, with clear visual warnings and indicators to those entering the immediate area. Note: bearing housings must not be insulated and drive motors and bearings may be hot.

If the temperature is greater than 80 ºC (175 ºF) or below -5 ºC (23 ºF) in a restricted zone, or exceeds local regulations, action as above shall be taken.

9. HAZARDOUS LIQUIDS

- When the pump is handling hazardous liquids care must be taken to avoid exposure to the liquid by appropriate sitting of the pump, limiting personnel access and by operator training. If the liquid is flammable and or explosive, strict safety procedures must be applied.

Gland packing must not be used when pumping hazardous liquids.

10. PREVENT EXCESSIVE EXTERNAL PIPE LOAD

- Do not use pump as a support for piping. Do not mount expansion joints, unless allowed by Flowserve in writing, so that their force, due to internal pressure, acts on the pump flange.

11. NEVER RUN THE PUMP DRY

12. ENSURE CORRECT LUBRICATION

13. START THE PUMP WITH OUTLET VALVE PARTLY OPENED

(Unless otherwise instructed at a specific point in the User Instructions.)

- This is recommended to minimize the risk of overloading and damaging the pump motor at full or zero flow. Pumps may be started with the valve further open only on installations where this situation cannot occur. The pump outlet control valve may need to be adjusted to comply with the duty following the run-up process.

14. INLET VALVES TO BE FULLY OPEN WHEN PUMP IS RUNNING

- Running the pump at zero flow or below the recommended minimum flow continuously will cause damage to the seal.

15. DO NOT RUN THE PUMP AT ABNORMALLY HIGH OR LOW FLOW RATES.

- Operating at a flow rate higher than normal or at a flow rate with no backpressure on the pump may overload the motor and cause cavitation. Low flow rates may cause a reduction in pump/bearing life, overheating of the pump, instability and cavitation/vibration.