PUMPIRAN
WATER . OIL . ENERGY

PB3 User Instruction

PB3 centrifugal pumps

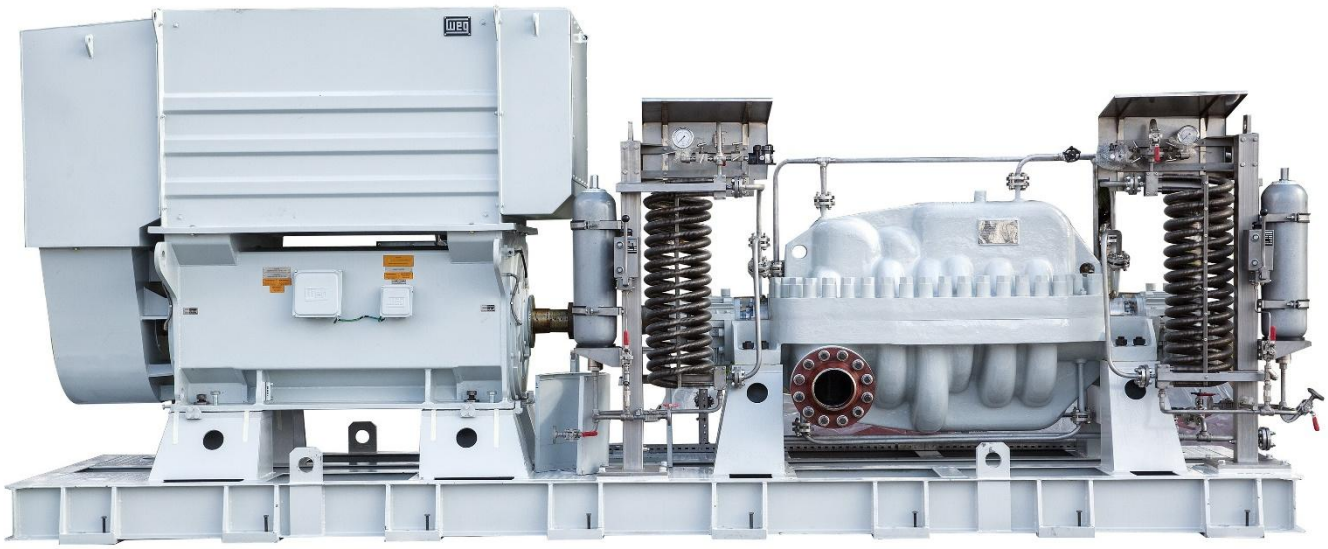
Installation

Operation

Maintenance

Multistage, double suction, horizontally split, centrifugal pump

Doc. No.:



These Operating Instructions Contain Fundamental Information &Precautionary Notes. Please Read The User Instruction Prior To Installation Of Unit, Electrical Connection & Commissioning. It is Imperative to Comply with All Other Operating Instructions Referring to Components of Individual Units.

CONTENTS PAGE

1. INTRODUCTION AND SAFETY

1.1 General

	**WARNING**
	These Instructions must always be kept close to product's operating location or directly with the product.

PUMPIRAN's products are designed, developed and manufactured with state-of-the-art technologies in modern facilities. The unit is produced with great care and commitment to continuous quality control, utilizing sophisticated quality techniques, and safety requirements.
PUMPIRAN is committed to continuous quality improvement and being at service for any further information about the product in its installation and operation or about its support products, repair and diagnostic services.

	**WARNING**
	These instructions are intended to facilitate familiarization with the product and its permitted use. Operating the product in compliance with these instructions is important to help ensure reliability in service and avoid risks. These instructions must be read prior to installing, operating, using and maintaining the equipment. The equipment must not be put into service until all the conditions relating to safety, noted in the instructions, have been met.

1.2 CE marking and approvals

Where applicable, the Directives and any additional Approvals, cover important safety aspects relating to machinery and equipment and the satisfactory provision of technical documents and safety instructions. Where applicable this document incorporates information relevant to these Directives and Approvals.

1.3 Disclaimer

Information in these User Instructions is believed to be reliable. In spite of all the efforts of PUMPIRAN to provide sound and all necessary information the content of this manual may appear insufficient and is not guaranteed by PUMPIRAN as to its completeness or accuracy.

PUMPIRAN manufactures products to exacting International Quality Management System Standards as certified and audited by external Quality Assurance organizations. The failure to properly select, install or use authorized PUMPIRAN parts and accessories is considered to be misuse. Damage or failure caused by misuse is not covered by PUMPIRAN's warranty.

1.4 Duty conditions

This product has been selected to meet the specifications of your purchase order. The acknowledgement of these conditions has been sent separately to the Purchaser.

	**WARNING**
	The product must not be operated beyond the parameters specified for the application. If there is any doubt as to the suitability of the product for the application intended, contact PUMPIRAN for advice, quoting the serial number.

1.5 Safety

1.5.1 Summary of safety markings

These user instructions contain specific safety markings where non-observance of an instruction would cause hazards. The specific safety markings are:

Symbol	Description
	This symbol indicates electrical safety instructions where non-compliance will involve a high risk to personal safety or the loss of life.
	This symbol indicates safety instructions where non-compliance would affect personal safety and could result in loss of life.
	This symbol indicates “hazardous substances and toxic fluid” safety instructions where noncompliance would affect personal safety and could result in loss of life.
	This symbol indicates safety instructions where non-compliance will involve some risk to safe operation and personal safety and would damage the equipment or property.
	This symbol indicates explosive atmosphere marking according to ATEX. It is used in safety instructions where non-compliance in the hazardous area would cause the risk of an explosion.
	This symbol indicates is used in safety instructions to remind not to rub non-metallic surfaces with a dry cloth; ensure cloth is damp. It is used where non-compliance in the hazardous area would cause the risk of an explosion.
	This sign is not a safety symbol but indicates an important instruction in the assembly process.

1.5.2 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 quetion 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.

1.5.3 Safety action

This is a summary of conditions and actions to prevent injury to personnel and damage to the environment and to equipment. (For products used in potentially explosive atmospheres section 1.6.4 also applies.)

	Caution
	Prevent excessive external pipe load. Do not use pump as a support for piping. Do not mount expansion joints, unless authorized by Pumpiran in writing, so that their force, due to internal pressure, acts on pump flange.

	Caution
	Ensure correct lubrication.

	**Caution**
	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 at full flow and damaging the pump at 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. (See section 4, Commissioning start-up, operation and shutdown.) - Never run the pump dry.

	**Caution**
	- 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 pump and seals. - Low flow rates may cause a reduction in pump/bearing life, overheating of the pump, instability and cavitation/ vibration.

	**Caution**
	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 pump cavitation.

	**DANGER**
	Never do maintenance work when the unit is connected to power.

	**hazardous substances and toxic fluid**
	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

	**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 use an appropriate crane for the mass and in accordance with current local regulations.

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

	**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 are. Note/; bearing housings must not be insulated and drive motors and bearings may be hot. If the temperature is greater than 68 °C (154°F) or below -5 °C (20 °F) in a restricted zone, or exceeds local regulations, action as above shall be taken.

1.5.4 Products used in potentially explosive atmospheres

	**explosive atmosphere**
	Measures are required to: - Avoid excessive temperature - Prevent the buildup of explosive mixtures - Prevent the generation of sparks - Prevent leakages - Maintain the pump to avoid hazard

The following instructions for pumps and pump units when installed in potentially explosive atmospheres must be followed to help ensure explosion protection.
Both electrical and non-electrical equipment must meet the requirements of European Directive 94/9/EC.

1.6 Noise level

Attention must be given to the exposure of personnel to the noise, and local legislation will define when guidance to personnel on noise limitation is required, and when noise exposure reduction is mandatory. This is typically 80 to 85 dBA.

The usual approach is to control the exposure time to the noise or to enclose the machine to reduce emitted sound. Pump noise level is dependent on a number of operational factors, flow rate, pipe work design and acoustic characteristics of the building, and so the values given are subject to a 3 dBA tolerance and cannot be guaranteed.

1.6.1 Overall noise level

Tables below show dBA levels for two stage and three or more stage pumps, based on the best efficiency point BEP at design RPM and required impeller diameter.

For specific gravities less than 1.0, use 1.0 specific gravity. For specific gravities above 1.0, use the actual specific gravity.

When the required condition flow falls outside the range of 75% to 125% of BEP, a Part Load Correction (PLC) must be added to the noise levels as follows:

Percent of BEP at required Impeller Diameter	PLC DB
74 to 62 % or 126 to 136 %	+1
61 to 50 % or 137 to 150 %	+2
49 to 38 %	+3
37 to 25 %	+4

Brake Horse Power at BEP	dBA
2 stages pump	
250 to 350	87
350 to 500	88
500 to 700	89
700 to 940	90
940 to 1100	91
1100 to 1300	92
1300 to 1500	93
Above 1500, Pumpiran	94

Brake Horse Power at BEP	dBA
3 to 14 Stages	
90 to 110	79
110 to 140	80
140 to 180	81
180 to 220	82
220 to 280	83
280 to 360	84
360 to 450	85
450 to 560	86
560 to 720	87
720 to 900	88
900 to 1125	89
1125 to 1400	90
1400 to 1800	91
1800 to 2250	92
2250 to 2800	93
2800 to 3600	94
3600 to 4500	95
4500 to 5700	96
5700 to 7200	97
7200 to 9000	98
9000 to 11000	99
11000 to 14000	100

2 TRANSPORT AND STORAGE

2.1 Consignment receipt and unpacking

Immediately after receipt of the equipment it must be checked against the delivery/shipping documents for its completeness and that there has been no damage in transportation.

Any shortage and or damage must be reported immediately to PUMPIRAN and received in writing within one month of receipt of the equipment. Later claims cannot be accepted.

Check any crates, boxes and wrappings for any accessories or spare parts which may be packed separately with the equipment or attached to side walls of the box or equipment.

Each product has a unique serial number. Checks that this number corresponds with that advised and always quote this number in correspondence as well as when ordering spare parts or further accessories.

2.1.1 Receipt inspection

	**NOTE**
	The following information regarding receiving is only offered as a general guideline to the customer. PUMPIRAN requires that all receiving be conducted in accordance with specifications set forth in Chapter 3, Jobsite Receiving and Protection from API Recommended Practices 686/PIP REIE 686, First Edition.

The pump and its associated equipment were carefully inspected at the factory prior to shipment to ensure quality compliance. It is suggested that the pump be inspected upon arrival and that any irregularities or damage be reported to the carrier immediately.

The protective covers on the pump nozzles should be in place and undamaged.

2.1.2 Unpacking

The pump should arrive already mounted on the base plate and it is therefore suggested that the unpacking of the equipment should proceed per instruction as outlined in this manual.

In general, care is to be taken when removing crating, coverings, and strapping in order not to damage any auxiliary equipment and/or the paint finish.

2.1.3 Paint/rust preventive

Internal parts of the pump and bearing housings are protected prior to shipment with a rust preventive such as Dasco guard 2408M. This can be removed with petroleum solvents.

External non-machined surfaces are painted with one of applicable PUMPIRAN coating. Parts ordered separately are protected with a rust preventive such as Dasco guard 2408M. This can be removed with petroleum solvents.

2.2 Handling

Boxes, crates, pallets or cartons may be unloaded using forklift vehicles or slings dependent on their size and construction.

2.3 Lifting

	**Caution**
	To avoid distortion, the pump unit should be lifted as shown.

2.3.1 Lifting equipment

	**NOTE**
	The following information regarding lifting is only offered as a general guideline. PUMPIRAN requires that all lifting and rigging be performed in accordance with specifications set forth in Chapter 2, Lifting and Rigging from API Recommended Practices 686/PIP REIE 686, First Edition.

	**WARNING** EQUIPMENT CAPACITY
	Make sure that any equipment used to lift the pump or any other of its components is capable of supporting the total weight encountered. Make sure that all parts are properly rigged before attempting to lift.

2.3.2 To lift unit

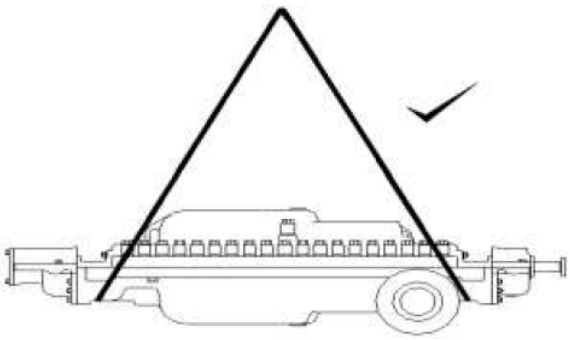
	**Caution**
	The complete unit with pump, driver and auxiliary equipment all mounted on the base plate can NOT be lifted as a unit. Driver must be removed from base plate before lifting. To lift unit sling base plate from all lifting eyes. Failure to do this may result in permanent deformation of base plate. Damage to base plate caused by mishandling or improper setting prior to grouting is not covered by PUMPIRAN's warranty

2.3.3 To lift driver

Refer to driver manufacturer's instructions.

2.3.4 To lift pump

Install sling from overhead hoist and under bearing housing mounting brackets (cast portion of casing where bearing housings attach).

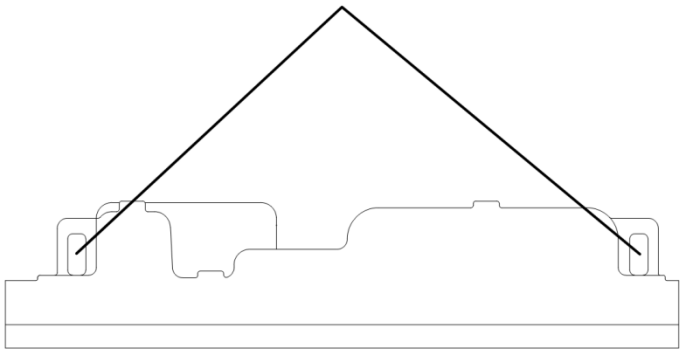


Proper lifting practice for pump

	**WARNING** LIFTING PRACTICE
	Do not lift entire pump from cast lifting lugs on upper half casings. These lugs are for lifting upper half casing only.

2.3.5 To lift half casing

To lift upper half casing, rig to overhead hoist from cast lifting lugs provided.

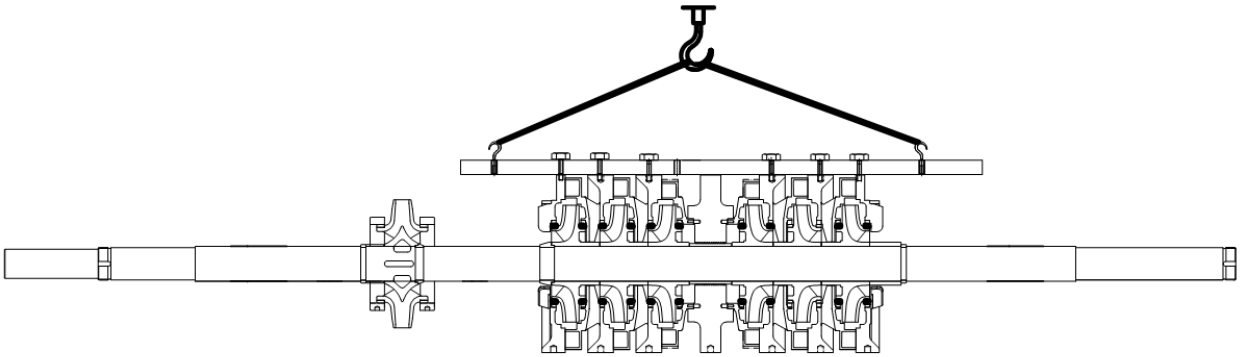


Proper lifting practice for upper case

To lift the pump bottom half casing, slings can be attached to the pump feet, casing bolt holes or padded slings can be used around the outer casing.

2.3.6 To lift pump rotor

Using slings that will not damage shaft, rig around shaft close to the impellers and to overhead hoist. Carefully lift rotor from lower half casing.



Proper lifting practice for pump

2.4 Extended storage

	NOTE
	The following information regarding receiving is only offered as a general guideline. PUMPIRAN requires that all receiving be conducted in accordance with specifications set forth in Chapter 3, Jobsite Receiving and Protection from API recommended Practices 686/PIP REIE 686, First Edition.

During extended periods of storage prior to installation and from the time of installation until commercial operation, precautions must be taken to protect the pump from deterioration. The various parts of the pump are protected prior to shipment by applying varying grades of preservative and paint. However, during shipment and handling, the preservatives are subjected to conditions that can cause their removal. Also, during extended. the

experience of the person(s) performing the tasks. It should be noted, full responsibility and costs associated with the storage and inspection of this equipment rests with the customer.

	Caution
	If pump is equipped with a mechanical seal and is stored or has not been run for 1 year or more, the mechanical seal must be removed before start-up and faces re-lapped to guard against the possibility of seal leakage. When reinstalling the seal, new "O" rings and gaskets must be used.

2.4.1 Pump inspection upon arrival

When the pump is received, it should be inspected for damage or other signs of rough handling. Any damage if found should be reported to the carrier immediately.

Inspect the preservative coating on the various parts. If necessary, renew the preservative in areas where it has rubbed off or scraped.

Inspect all painted surfaces. If necessary, touch up the areas where paint has been chipped or scraped.

Inspect all covers over pump openings and piping connections. If covers or seals for the covers are damaged or lose, they are to be removed.

2.4.2 Storage area

When selecting a storage ara, the following should be taken into consideration

a) The deterioration of the equipment will be proportionate to class/type of storage provided.

b)The expense involved in restoring the equipment at time of operation will be proportionate to the class/type of storage provided,

2.4.3 Storage preferred (dry)

If at all possible, the pump and its components should be stored indoors where they will be protected from the elements. If it is not possible to store the pump and its components indoors, precautions must be taken to protect them from the elements.

2.4.3.1 Rotor storage

It is recommended that pump rotor be removed from pump and stored vertically. Rotors may also be stored horizontally in the pump. Rotors that have to be stored horizontally outside the pump must be supported close to impeller to eliminate sag that may cause rotor to take a permanent set.

2.4.3.2 Customer inspection

The stored equipment is to be placed on a periodic inspection schedule by the customer.

	NOTE
	The responsibility for setting up an inspection and maintenance schedule rests with the customer and will be dependent upon the class/type of storage provided. It will be expected that initially inspection would occur weekly, then depending upon the inspection reports being favorable or unfavorable, inspection would continue weekly, monthly, or quarterly, as may be determined. Inspection reports must be kept on file.

Every inspection should consist of a general surface inspection.

a) Pump supports are firmly in place.
b) Pump covers over openings are firmly in place.

Pump coverings, plastics or tarps, are firmly in place. Any holes or tears must be repaired to prevent entrance of dirt or water.

c) Pump covers are periodically removed from openings and interior accessible areas inspected. If surface rusting has occurred, clean and repaint or re-coat with preservative.
d) If rusting occurs on exterior surfaces, clean and repaint or re-coat with preservative.
e) Loosen casing drain plugs to allow seepage of any accumulated moisture.
f) If the rotor is stored horizontally, rotate pump rotor 1-1/4 revolutions at least once a month to prevent rotor from taking a permanent set.

	**Caution**
	Make sure bearings have adequate lubrication before turning rotor. The oil inlet blanking plates should be removed and a small amount of oil injected into the bearings before turning. Refit blanking plates.

g) Periodically remove bearing covers and inspect for accumulation of moisture, rust and foreign material. As required, clean bearings and bearing housing and re-preserve. Install bearing cover and secure to assure maximum protection. Bearings removed for storage should be coated with preservative, wrapped in oil/wax paper, and stored in a warm dry area.
h) Check individually wrapped parts for signs of deterioration. If necessary, renew preservative and wrapping.

	**Caution**
	If storage is over one month, Instrumentation (Controls, Electrical devices, Temperature switches) should be removed and placed in a climate control environment if Instrumentation is not powered up.

2.4.4 Storage non-preferred (wet)

It is not recommended that the rotor be subjected to extended periods of submergence or wetting prior to start-up. However, it is recognized that in some cases, a long period of time may lapse from installation until commercial operation.

If the pump must be stored after being installed and wetted, the following inspection and maintenance should be performed.

- Isolate the pump with valving - tag (seal) all valves.
- Preserve the pump internals.

	**NOTE**
	If storage is over one month, Instrumentation (Controls, Electrical devices, Temperature switches) should be removed and placed in a climate controlled environment if Instrumentation is not powered up.

	**Caution**
	Electric motors (pump driver) should not be stored in damp places without special protection (refer to motor manufacturer's instructions).

2.4.4.1 Painting and preservation

Paints and preservatives used are either PUMPIRAN standard or special as required by the contract specification. Refer to 2.1.3, Paint/Rust Preventive for the description of paints and preservatives used in this order or contact the branch office through which the order was placed.

2.5 Recycling and end of product life

At the end of the service life of the product or its parts, the relevant materials and parts should be recycled or disposed of using an environmentally acceptable method and local regulations. If the product contains substances which are harmful to the environment, these should be removed and disposed of in accordance with current regulations. This also includes the liquids and or gases in the "seal system" or other utilities.

	**hazardous substances and toxic fluid**
	Make sure that hazardous substances or toxic fluids are disposed of safely and that the correct personal protective equipment is used. The safety specifications must be in accordance with the current regulations at all times

3 INSTALLATION

	**NOTE**
	The installation/commissioning of this equipment must be conducted in according with API Recommended Practicee 686/PIP REIE 686-First Edition.

3.1 Location

Install the unit close to the source of the liquid to be pumped.

	**explosive atmosphere**
	Equipment operated in hazardous locations must comply with the relevant explosion protection regulations.

When selecting the location, be sure to allow adequate space for operation as well as for maintenance operations involving dismantling and inspections of parts. Headroom is an important consideration as an overhead lift of some type is required.

3.2 Foundation

	**NOTE**
	The following information regarding foundation is only offered as a general guideline. PUMPIRAN requires that all foundations be designed and installed in accordance with specifications set forth in Chapter 4, Foundations from API Recommended Practices 686/PIP REIE 686, First Edition.

The design of foundation is not the responsibility of PUMPIRAN. It is therefore recommended that the customer consult a competent specialist skilled in the field of foundations, to insure proper design/installation of the foundation.

3.2.1 Installation check list

a) Level Base plate.
b) Preliminary Alignment.
c) Grout Base plate - Check Foundation Bolts
d) Alignment Shaft/Coupling.
e) Piping installed – correct vent, gauge, valve, suction strainer and pipe support locations?
f) Check Coupling Alignment.
g) Coupling guard correctly installed?

3.2.2 Level the baseplate

Before putting the unit on the foundation, thoroughly clean the top of the foundation. Break off any loose pieces of cement and roughen the top with a chisel to afford a good hold for grout.

	**NOTE**
	When lifting base plate with pump, sling base plate from all lifting eyes provided. Failure to do this may result in permanent deformation of base plate.

	**NOTE**
	Pump, driver auxiliary equipment and piping shall be removed from the base plate before leveling the baseplate.

Locate the base plate in its proper position on the concrete block together with the leveling screws as shown in the General Arrangement Drawing.

Using a precision level across the machined surfaces of the pump and driver mounting pads, adjust leveling screws as necessary to ensure that base plate is leveled in all directions.

When the base plate is leveled, snug the foundation bolts, but do not completely tighten.

Using the previous procedure, adjust base plate until pump and driver are within 0.1 mm .

3.3 Grouting

The following ASTM Specifications are furnished as references for test methods used in conjunction with installation of grouting materials and should be used to obtain proper results:

- ASTM C 78-84, Test Method for Flexural Strength for Concrete
- ASTM C 109-90, Test Method for Compressive Strength of Hydraulic Cement Mortars – Modified
- ASTM C 469-87a, Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression
- ASTM C 496-90, Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens
- ASTM C 531-85, Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical Resistant Grouts and Monolithic Surfacing – Modified
- ASTM C 666-90, Test Method for Resistance of Concrete to Rapid Freezing and Thawing
- ASTM C 939-87, Test Method for Flow of Grout for Preplaced Aggregate Concrete (Flow Cone Method)

3.4 Initial alignment

3.4.1 Shaft/coupling alignment

	NOTE
	The following information regarding shaft alignment is only offered as a general guideline. PUMPIRAN requires that all shaft alignment be performed in accordance with specifications set forth in Chapter 7, Shaft Alignment from API Recommended Practices 686/PIP REIE 686, First Edition.

	Caution
	Shaft alignment must be correct for successful operation. Rapid wear, noise, vibration and actual damage to the equipment may be caused by shaft misalignment. The shafts must be aligned within the limits given within this section

.

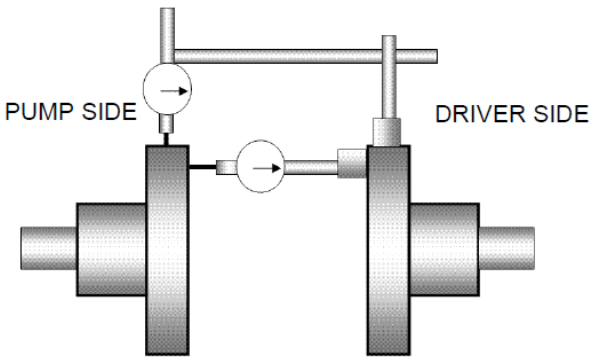
	NOTE
	Adjustment to correct the alignment in one direction may alter the alignment in another direction. Always check in all directions after making any adjustment.

Coupled equipment must be aligned to minimize unnecessary stresses in shafts, bearings and coupling. Flexible couplings will not compensate for appreciable misalignment. Foundation settling, thermal expansion or nozzle loads resulting in base plate/foundation deflection and vibration during operation may require the full coupling misalignment capability.

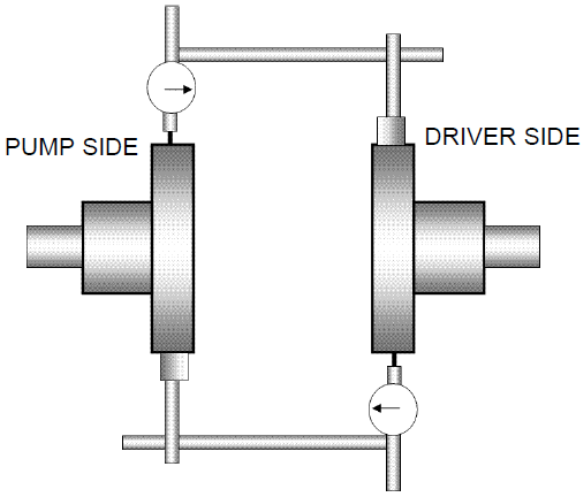
3.4.1.1 Alignment methods

The following methods may be used to align equipment train. The methods a) and b) are dial indicator based.

a) Rim and face alignment



b) Reverse rim indicator alignment



c) Laser alignment.

3.4.2 Dial-indicator-based alignment

3.4.2.1 Check soft foot

Soft foot can affect the alignment readings and should be checked first and eliminated on both pump and driver.

a) Tighten hold down bolts.
b) Set a dial indicator on one foot, loosen the bolt and check if there is an indicator reading. If so place a shim with the same thickness as the displacement.
c) Check and adjust all feet.

3.4.2.2 Set DBSE

The shaft gap, or distance between shaft ends (DBSE), must be in accordance with the certified General Arrangement Drawing and must be measured with pump and driver shafts in the center of their axial end float. Motor with sleeve bearings is to be aligned with rotor at magnetic center.

Move driver to insure proper gap distance.

	NOTE
	It is recommended that the pump hold down bolting be torqued before taking any alignment measurements. This makes the pump the fixed machine and driver the movable machine. In certain cases, however, it may be impractical to move the driver; therefore; the pump may have to be moved.

3.4.2.3 Determine bracket sag

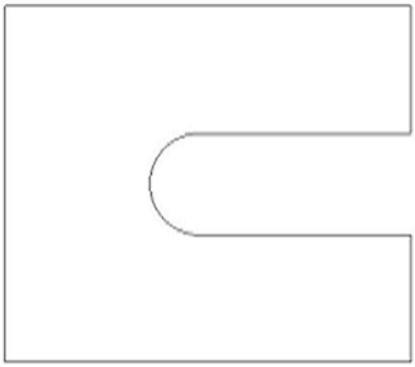
Bracket sag must be determined and included in the alignment calculation.

a) Install clip with extension pieces and dial indicator(s).
b) Place indicator on top and reset to zero, turn 180° and read indicator and register.
c) Record sag reading obtained at the bottom.
d) Side to side readings need not to be corrected as the sag is equal on both sides.

3.4.2.4 Determine misalignment and correct vertical plane

Before moving the equipment vertically, it is important that the vertical thermal expansion be taken into consideration. Refer to General Arrangement Drawing notes and/or driver instructions for recommended cold vertical setting (if thermal expansion is a factor).

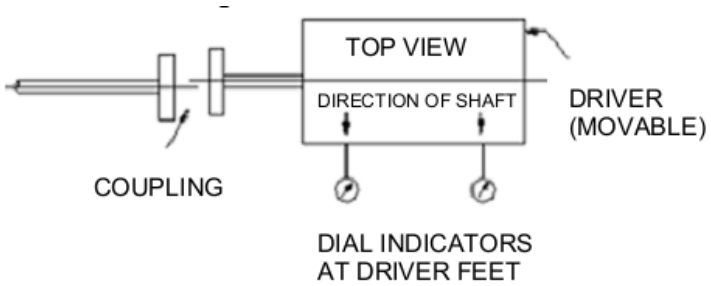
The shims between the motor feet and mounting surface should be clean and dry. This is especially critical for equipment that has been in service for some time and need to be realigned. Do not use many thin shims, as this may result in a spongy mounting.



Recommended shim design

3.4.2.5 Determine misalignment and correct horizontal plane

The dial indicators shown below are required to accurately measure the move in the horizontal direction. Move the driver by bumping with soft hammer/mallet or using the jack-screws (if provided). The amount of horizontal relocation required is calculated in alignment data sheet.



Dial indicators configuration

	NOTE
	It is recommended, the completed alignment document be retained as part of your permanent maintenance file.

3.4.3 Laser alignment

The use of laser alignment greatly simplifies the alignment process. Because of equipment and software differences, this will only describe laser alignment in general steps.

3.4.4 Check coupling alignment

The angular and offset coupling alignment must be rechecked.

a) Coupling faces are to be parallel within 0.0254 mm (0.001 in.) TIR.
b) Coupling outside diameters is to be aligned within 0.0762 mm (0.003 in.) TIR.
c) Motor-Driven: “Bump” the motor and check motor rotation.
d) Turbine-Driven: Check turbine rotation. (If wrong, consult turbine manufacturer.)

3.4.5 Assemble coupling

a) Assemble coupling per the manufacturer's instructions.
b) Install coupling guard.

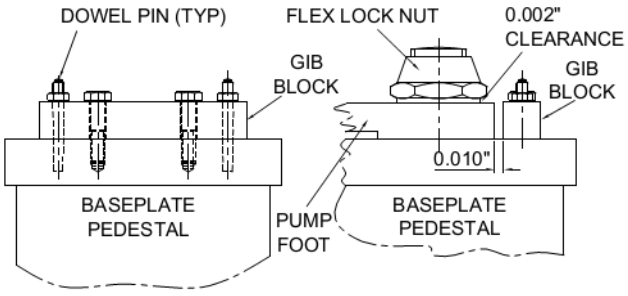
3.4.6 Dowel pump and driver

a) Cold Pumps (temperature below 93 °C (200 °F)) Pump hold down bolts are to be torqued to the proper value and dowel pins put in two diagonally opposite feet.
b) Hot Pumps

Pumps handling liquids at temperatures of 94 °C (200 °F) and over are designed to permit the casing to expand with temperature away from coupling end of pump. The units that come under this classification must have the pump support feet dowelled to the pedestal at the coupling end. This maintains the coupling gap at the desired amount.

The pump feet at the opposite end are held from moving vertically by the use of a self-locking nut. The clearance between the base of the nut and the top of the pump foot should be 0.05. A “Gib Block” running parallel to the length of the pump foot at each of the outboard feet controls the horizontal movement. The "Gib Blocks" are bolted and doweled to the pedestal. A 0.254 mm (0.010 in.) gap is maintained between the "Gib Block" and pump foot.

	**WARNING**
	The self-locking nuts, which hold the pump from moving in a vertical motion, are clamped tight to the pump foot at time of shipment. The 0.051 mm (0.002 in.) clearance must be established at time of installation.



Gib block installation sketch for hot pump

c) Pump Driver

Refer to General Arrangement Drawing and/or driver instructions for doweling information.

3.4.7 Gib block installation for hot applications

Gib blocks are installed to control the direction of the growth while maintaining pump-driver coupling alignment. They are installed after base plate has been leveled and grouted, suction and discharge piping connected, and final shaft coupling alignment is completed.

Gib blocks are shipped loose and field installed at the site. The following procedure must be followed for correct installation of gib blocks.

a) Fully torque the hold-down bolts in the driver end of pumps feet to torque values listed in the instruction manual.
b) Install the dowel pins in the pump drive end foot by drilling the foot and the base plate for the tapered dowel provided.
c) Position the gib blocks to obtain a 0.254 mm (0.010 in.) clearance between the gib block and the side of the non-drive end pump foot as noted on the attached figure. Drill and tap the cap screw holes for the gib blocks.
d) Tighten the hold-down bolts for the gib blocks.
e) Install the dowel pins in the gib blocks by reaming the block and base plate for the tapered dowel provided.
f) Tighten the hold-down locknuts on the non-drive end pump feet to establish a 0.051 mm (0.002 in.) gap between the locknut and the pump foot.

3.4.8 Hot alignment check

A hot check can only be made after the unit has been in operation a sufficient length of time to assume its NORMAL operating temperature and conditions. If the unit has been correctly cold set, the offset misalignment will be within 0.076 mm (0.003 in.) TIR and the angular misalignment will be within 0.0254 mm (0.001 in.) TIR when in operation. If not, make adjustments.

	**WARNING**
	Do not attempt any maintenance, inspection, repair or cleaning in the vicinity of rotating equipment. Such action could result in injury to operating personnel

	**WARNING**
	Before attempting any inspection or repair on the pump the driver controls must be in the "off" position, locked and tagged to prevent restarting equipment and injury to personnel performing service on the pump.

3.5 Piping

	**Caution**
	The following information regarding piping is only offered as a general guideline to the customer. PUMPIRAN requires that all piping and related systems be designed/installed in accordance with specifications set forth in Chapter 6, Piping from API recommended practices 686/PIP REIE 686, First Edition.

The design of piping, and related systems, is not the responsibility of PUMPIRAN. It is therefore recommended that the customer consult a competent specialist skilled in the field of piping, to insure proper design/installation of all piping.

3.5.1 Suction and discharge piping

These units are furnished for a particular service condition. Changes in the hydraulic system may affect performance adversely. This is especially true if the changes reduce the pressure at the suction or if the liquid temperature is increased.

Suction and discharge piping should be of ample size, be installed in direct runs, and have a minimum of bends. Eccentric reducer shall be flat on top (FOT).

It is desirable to have at least (7) diameter of straight pipe between the first elbow and the pump suction. Elbow in the piping to pump's suction nozzle should be of the long radius type.

Seven (7) diameters of straight pipe should be used between two elbows in series and the pump suction.

Elbows in more than one plane should not be used without splitters.

Splitters are placed in the elbow in the mean radius line perpendicular to the plane of the elbow.

	**Caution**
	Provision must be made to support piping external to the pump to prevent excessive nozzle loads, maintain pump/driver alignment and avoid pipe- induced vibrations.

Install a check valve and a gate valve in the discharge pipe of the pump. When the pump is stopped, the check valve will protect the pump against excessive pressure and will prevent the pump from running backward. The check valve should be installed between the gate valve and the pump nozzle in order to permit its inspection. The gate valve is also useful in priming and starting the pump.

Keep the suction pipe short and direct. Use a suction pipe equal to or one size larger than the pump suction nozzle. Keep the suction pipe free of all air pockets. A spool piece should be installed in suction line so that the suction screen may be installed and removed.

	**Caution**
	Operation at low flows results in pump power heating the liquid. A bypass may be required to prevent vaporization and subsequent pump damage. Mechanical damage may result from continuous operation at flows less the minimum flow of design operating point.

	**WARNING**
	When pump is equipped with manifolded vent and drain lines, each line must be equipped with an individual valve to prevent any liquid from a high pressure line flowing into a low pressure line. These valves must be kept in the closed position during pump operation.

3.5.2 Suction strainer

In a new installation, great care should be taken to prevent dirt, scale and welding beads from entering the pump. Even when piping has been previously flushed, it is difficult to break loose the oxides and mill scale, which will become free when the pipe heats and cools several times. PUMPIRAN pumps are provided with running clearances ranging typically from 0.12 mm (0.005 in.) to 0.80 mm (0.030 in.), depending on the service

and the pump size. It is impractical to install a suction strainer to remove particulate of this size. Such particles will normally pass through the pump without causing damage, provided the concentrations are minor.

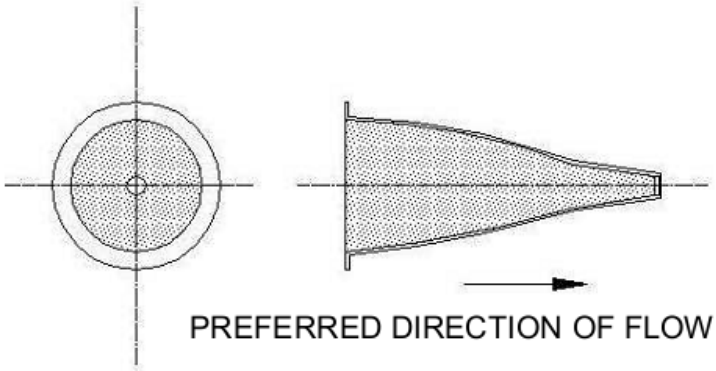
The possibility exists that, on shutdown of the pump, such particles can become trapped in the close running clearances during coast down, causing binding.

	Caution
	Excessive force used to try to free a bound rotor may cause damage beyond minor cleanup and repair of rotor parts.

Generally, a pump should not be installed without start-up strainer protection. The suction piping should be thoroughly flushed before installing the suction strainer and connecting the suction piping to the pump. The strainer should be installed in the inlet piping near the pump, making certain that it is located where it may be readily serviced (cleaned). Be sure, however, that the installed strainer will not distort the flow to the pump suction nozzle.

Do not install the strainer directly on the pump suction nozzle. For a cone-type strainer, the downstream end of the cone should be no closer than four (4) pipe diameters from the pump suction nozzle. Basket-type strainers typically introduce greater flow disturbances and should be installed at least six (6) pipe diameters from the pump suction nozzle.

The PUMPIRAN standard for suction strainers consists of conical-shaped steel plate with 1/8 in. perforations see the below picture. The open area of the strainer should be a minimum of three times the area of the pump suction.



At all times when using suction strainers, it is critical that the pressure drop across the strainer be constantly monitored to ensure that the pump suction pressure does not fall below that required to prevent pump cavitation. Pressure (or vacuum) gauges should be installed on both sides of the strainer so that the pressure drop across the strainer can be monitored. During start-up of the system, the gauges should be monitored continuously. Consult the plant engineer or system designer for the allowable pressure differential across the strainer prior to operating the pump. Pressure differential across the strainer and/or screen is typically no more than 2 – 3 psig. An increase in the differential pressure between the two gauges indicates that the strainer or screen is becoming clogged with dirt and scale. Before the pressure drop becomes so severe that cavitation occurs, the pump should be shut down and the strainer cleaned. Alarm settings to protect the pump from damaging cavitation and loss of suction need to be supplied by the plant engineer or system designer prior to operating the pump. Typical alarm settings to protect the pump from damaging cavitation and loss of suction would be 5 psig differential pressures across the strainer (screen). The suction piping should be arranged such that the ultimate strainer configuration (location) allows ready access for cleaning.

The strainer may be fitted with a finer screen to filter the inlet flow. When this is done, 40 mesh screens is typically used for start-up operation, at reduced flow rates. For final operation in a closed system, the suction strainers are normally removed after the system is cleaned. For critical pump applications, where continuous screening of suction flow is desirable, and in open systems, 20-mesh screening is typically used for permanent strainers. At all times, when using screens and suction strainers, it is critical that pressure drop across the screen and/or strainer be constantly monitored to ensure that the pump suction pressure does not fall below that required to prevent cavitation.

When dirt and scale have been removed from the system, as indicated by no further change in pressure drop across the strainer with time, the start-up strainer may be removed or the screen may be replaced with one having larger openings. If a permanent strainer will be used during normal operation, the pressure differential needs to be monitored on a continuous basis. If a permanent strainer is not used, the start-up strainer needs to be temporarily reinstalled whenever the system is opened up for repair or routine maintenance. As long as a suction strainer or screen remains in place, the differential pressure should be monitored on a regular basis.

	Caution
	The pressure drop across the strainer is a direct reduction in the NPSH available to the pump. NPSH available must always exceed the NPSH required by the pump. This requirement may limit the pump flow rate, particularly during start-up operation. Alarms or automatic pump shutdown devices should be installed to minimize the possibility of pump damage. It is the responsibility of the pump operator to obtain the allowable pressure drop across the strainer for safe pump operation from the plant engineer or system designer prior to operation of the pump.

3.5.3 Coupling alignment check

Refer to section entitled shaft/coupling alignment and perform a coupling alignment check as outlined. This check is recommended to insure the alignment has not been disturbed during installing suction and discharge piping.

3.6 Electrical connections

	DANGER
	**Electrical connections must be made by a qualified Electrician in accordance with relevant local national and international regulations.**

	DANGER
	It is important to be aware of the EUROPEAN DIRECTIVE on potentially explosive areas where compliance with IEC60079-14 is an additional requirement for making electrical connections.

	WARNING
	**It is important to be aware of the EUROPEAN DIRECTIVE on electromagnetic compatibility when wiring up and installing equipment on site. Attention must be paid to ensure that the techniques used during wiring/installation do not increase electromagnetic emissions or decrease the electromagnetic immunity of the equipment, wiring or any connected devices. If in any doubt contact PUMPIRAN for advice.**

	**DANGER**
	The motor must be wired up in accordance with the motor manufacturer's instructions (normally supplied within the terminal box) including any temperature, earth leakage, current and other protective devices as appropriate. **The identification nameplate should be checked to ensure the power supply is appropriate.**

	**WARNING**
	A device to provide emergency stopping must be fitted.

If pre-wired is not supplied to the pump unit, the controller/starter electrical details will also be supplied within the controller/starter.

For electrical details on pump sets with controllers see the separate wiring diagram.

	**Caution**
	Direction of rotation has to be checked with pump uncoupled.

3.7 Final shaft alignment check

After connecting piping to the pump, rotate the shaft several times by hand to ensure there is no binding and all parts are free.

Recheck the coupling alignment, as previously described, to ensure no pipe strain. If pipe strain exists, correct piping.

	**Caution**
	Refer to section entitled shaft/coupling alignment and perform a coupling alignment check as outlined. This check is recommended to insure the alignment has not been disturbed during the grouting of the base plate or while installing suction and discharge piping.

3.8 Protection systems

	**explosive atmosphere**
	The following protection systems are recommended particularly if the pump is installed in a potentially explosive area or is handling a hazardous liquid. If in doubt consult PUMPIRAN.

If there is any possibility of the system allowing the pump to run against a closed valve or below minimum continuous safe flow a protection device should be installed to ensure the temperature of the liquid does not rise to an unsafe level.

If there are any circumstances in which the system can allow the pump to run dry, or start up empty, a power monitor should be fitted to stop the pump or prevent it from being started. This is particularly relevant if the pump is handling a flammable liquid.

If leakage of product from the pump or its associated sealing system can cause a hazard it is recommended that an appropriate leakage detection system be installed.

To prevent excessive surface temperatures at bearings it is recommended that temperature or vibration monitoring are carried out.

4 COMMISSIONING, START-UP, OPERATION AND SHUTDOWN

	**NOTE**
	Commissioning of all equipment must be performed in accordance with specifications set forth in Chapter 9, Commissioning from API Recommended Practices 686/PIP REIE 686, First Edition.

	**Caution**
	These operations must be carried out by fully qualified personnel.

4.1 Precommissioning procedure

a) Never operate the pump with suction valve closed.
b) Never operate pump unless it is filled with liquid and vented.
c) Never operate the pump unless a liquid source is available.
d) Never operate the pump without proper lubrication.

4.1.1 Pre-operational checks

At initial start-up and after the equipment has been overhauled:

a) Ensure pump and piping are clean. Before putting the pump into operation, it should be thoroughly flushed to remove the rust preventive as well as any foreign matter, which may have accumulated during installation.

Isolate the pump from pipe work, flush out the pipe work then flush the pump. This operation must be carried out thoroughly because the pump contains many close running clearances, which will be damaged by dirt particles. Take all possible care not to contaminate your system.

b) Clean and flush bearing housings and lubrication system.
c) Turn rotor by hand or with strap to make sure it turns freely.
d) Ensure that the mechanical seal is properly assembled and tightened.

	**Caution**
	Most cartridge seals are equipped with a spacer between the gland plates and drive collar. This spacer must be removed before starting unit.

e) Ensure coupling is properly aligned and lubricated; and pump and driver are properly doweled. (Refer to shaft /coupling alignment procedure).
f) Ensure coupling guard is in place.
g) Check torque of all bolting and plugs for tightness.

4.1.2 Initial startup procedure

a) Close discharge valve if a bypass system is used. If not, crack open the discharge valve.
b) Prepare the driver for start-up in accordance with the manufacturer's instructions.
c) Warm-up pump (if required).

Avoid severe thermal shocks to the pump as a result of sudden liquid temperature changes. The pump must be preheated prior to start-up. Unless otherwise specified, the external temperature of the casing must be within 55.6 °C (100 °F) of the temperature of the liquid to be pumped at time of start-up.

	**Caution**
	Pump temperature stratification could occur. A maximum temperature delta of 28 °C (50 °F) between the upper and lower case shall be checked prior to starting the pump

Due to the heavy metal sections, the casing will lag the liquid temperature during such changes, and severe temperature stresses and subsequent misalignment of machined fits may result. Preheating is accomplished by circulating a small amount of hot fluid through the casing by utilizing vents, drains or bypass from discharge and suction. Preheat pump slowly at a rate not to exceed 55.6 °C (100 °F) per hour.

d) Prime pump and ensure pump suction valve and bypass isolating valve are open.

	**Caution**
	Before starting or while operating the pump, the casing and suction line must be completely filled with the liquid being pumped. The rotating parts depend on this liquid for lubrication, and the pump may seize if operated without liquid.

e) Ensure pump recirculating line (if provided) is open and free of obstructions.
f) Check that pump is vented by observing leakage from casing vent and seal piping vent. Close vent when liquid is emitted.
g) Make sure seal piping is turned on.
h) Prepare the driver for start-up in accordance with the manufacturer's instructions.
i) Check pump rotation by starting unit momentarily. The direction of rotation is shown on 10-4, pump data sheet. Note the pump coasts to a gradual stop.

	**Caution**
	If pump stops abruptly when driver is shut down, investigate for pump binding. Take necessary remedial action before resuming operation.

j) Starting the driver (motor driven).
k) Starting the driver (turbine driven).
l) Start the turbine and bring it up to speed quickly.
m) As soon as the pump is up to rated speed, open discharge valve. This will avoid abrupt changes in velocity and prevent surging in the suction line.

4.2 Pump lubrication

4.2.1 Lubricating oil

Oil requires frequent replenishment at normal operating temperatures and very frequent replenishment at elevated operating temperatures. Oil is always subject to gradual deterioration from use and contamination from dirt and moisture. This deterioration and contamination will, in time, be harmful to the bearing and cause premature wear. For this reason, oil should be checked for contamination and deterioration regularly.

Mineral oils oxidize and should be replaced at intervals described in the table below.

Oil replacement interval			
Typical Oil Operating Temperature	Operating Cycle	Oil Change Interval	Notes
Ambient	Stand by	6 calendar months	-
Ambient – 71 °C (Ambient to 160 °F)	Continuous	3 calendar months	Longer intervals between replacements may be possible at these operating temperatures, but 3 month intervals are recommended to protect against normal oxidation.
71 °C – 82 °C (160 °F – 180 °F)	Continuous	3 calendar months	3 month intervals are recommended to protect against normal oxidation, contamination, and deterioration.
> 82 °C (> 180 °F)	Continuous	As specified by PUMPIRAN	Continuous operation at oil temperatures above 82 °C (180 °F) requires consultation with PUMPIRAN.

Oil specifications and characteristics		
Oil Characteristics	**Operating Oil Temperature**	
	16°C - 38°C (60°C -100°F)	38°C - 82°C (101°F -180°F)
Say bolt Viscosity (SSU) 38°C (100°F)	158 Seconds	215 Seconds
Pour Point	-7°C (20°F)	-7°C (20°F)
Flash Point	204°C (400°F)	204°C (400°F)
Recommended ISO Viscosity Grade (VG) Number	32	46

4.2.2 Oil specifications

Straight mineral oils without additives are generally preferred for bearing lubrication. It should preferably be of the turbine type and not contain free acid, chlorine, sulfur or more than a trace of free alkali. Quality mineral oils with a minimum Viscosity Index (VI) of 95 is recommended.

In the majority of instances, a turbine oil with a VG Number of 46 (nominally equivalent to SAE 20) will meet rolling element bearing lubrication requirements (see oil temperature).

	**Caution**
	Lubricant must be compatible with all parts requiring lubrication

4.2.3 Oil emperature

Oil temperature should be maintained between 16° C (60°F) and 82°C (180°F).

	Caution
	The minimum bearing oil temperature is 16°C (60°F). If necessary, prior to startup, one of the following procedures should be employed: a) Drain the oil in the bearing housing(s) and replace with warm oil. b) Heat the bearing housing(s) using heat tape (or other suitable means). c) Circulate warm liquid through the cooling jacket or immersion cooler (if supplied). d) Utilize oil with a lower viscosity, or VG number, or consider using a synthetics hydrocarbon oil with a low pour point to give a viscosity similar to that of ISO 46 (for maximum oil operating temperatures of 180°F) or ISO 32 (for maximum oil operating temperatures of 120°F).

	NOTE
	ISO 46 is recommended for continuous operating oil temperatures between 38°C (100°F) and 82 °C (180°F), with a minimum startup temperature of 16°C (60°F); ISO 32 may be considered for continuous operating oil temperatures between 16°C (60°F) and 49 °C (120 °F), with a minimum start up temperature of 4°C (40°F). For startup when oil temperature is below 4°C (40°F), oil preheating is recommended.

4.2.4 Cleaning the lubrication system prior to operation

Before operating the pump, the lubrication system should be thoroughly cleaned to remove any foreign matter that may have accumulated during shipment, storage or installation. To clean the lubrication system refer to the Sectional drawing and proceeds as follows:

a) Remove the bearing caps, bearing linings, thrust shoes and drain plugs.
b) Flush out the bearing housings with kerosene or other suitable solvent.
c) Wash the bearing linings and thrust shoes with a suitable solvent.
d) Flush the entire lubrication system with oil. Flushing oil should be compatible with lubricating.
e) During flushing operation, examine the piping for leaks and correct as necessary
f) After flushing, replace drain plugs. Reassemble bearings and torque end cover bolting
g) Refer to driver instruction book for instructions covering flushing of driver bearings.

4.3 Direction of rotation

	Caution
	Check pump rotating

4.4 Guarding

	WARNING
	- Guarding is supplied and fitted to the pump set. - Fasteners must remain captive in the guard when the guard is removed to comply with Machinery Directive 2006/42/EC.

4.5 Priming and auxiliary supplies

	**Caution**
	Ensure all electrical, hydraulic, pneumatic, sealant and lubrication systems (as applicable) are connected and operational. Ensure the inlet pipe and pump casing are completely full of liquid before starting continuous duty operation.

4.6 Starting the pump

4.6.1 Normal start up

The starting procedure to be followed for normal start-up is the same as that for initial start-up. When automatic recycle valve is used, discharge valve can be opened.

4.7 Running or operation

	**WARNING**
	Do not wipe down in the vicinity of rotating parts, if unusual noise or vibrations occur, secure the pump as soon as possible.

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

	**WARNING**
	When pump is equipped with manifolded vent and drain lines, each line must be equipped with an individual valve to prevent any liquid from a high pressure line flowing into a low pressure line. These valves must be kept in the closed position during pump operation.
	**WARNING**
	Observe extreme caution when venting and/or draining hazardous liquids. Wear protective clothing in the presence of caustic, corrosive, volatile, flammable, or hot liquids. Do not breathe toxic vapors. Do not allow sparking, flames, or hot surfacing in vicinity of the equipment.

	**Caution**
	The pump should not be operated outside of the design speed range.

a) Never operate the pump with suction valve closed.
b) Never operate pump unless it is filled with liquid and vented.
c) Never operate the pump unless a liquid source is available.

d) Never operate the pump without proper lubrication.

4.7.1 Operating checks

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

	**Caution**
	Operation at low flows results in pump power heating the liquid. A bypass may be required to prevent vaporization and subsequent pump damage. Mechanical damage may result from continuous operation at flows less than the minimum flow specified in the Data Sheet.

Immediately after start-up, and frequently during running, check the following:

a) Check suction and discharge pressure gauges.
b) Check pressure gauges on each side of suction strainer.
c) Check for excessive leakage.
d) Check for unusual noises.
e) Check lubrication system.
f) Check for adequate flow of cooling liquids.
g) After unit has been operated a sufficient length of time to reach normal operating temperature and condition, the unit is to be shut down and a “HOT” coupling alignment check must be made. (Refer to shaft /coupling alignment procedure).

	**WARNING**
	Operation of the unit without appropriate lubrication can result in overheating of the bearings, bearing failures, pump seizures and actual breakdown of the equipment, exposing operating personnel to injury.

4.8 Stopping and shutdown

If motor driven, de-energize driver circuit. If turbine driven, stop turbine-driven pumps by manually tripping the over speed trip.

	**NOTE**
	If pump stops abruptly when driver is shut down, investigate for pump binding. Take necessary remedial action before restarting pump.

	**Caution**
	If pump is subjected to freezing temperatures, the pump must be drained of liquid to prevent damage to pump.

a) Close the pump suction and discharge valve.
b) Close valve in bypass line.

c) Drain the pump.
d) Turn off the auxiliary oil pump and cooling liquid when supplied.

4.9 Hydraulic, mechanical and electrical duty

These pumps are furnished for a particular service condition. Changes in the operating system design may affect the pump's performance adversely. This is especially true if the changes reduce the pressure at the suction flange or if the liquid temperature is increased. In case of doubt, contact the nearest PUMPIRAN office.

4.9.1 Specific gravity (SG)

The capacity and total head in m (ft) of liquid developed by a centrifugal pump are fixed for every point on the curve and are always at the same speed. Neither capacity nor total head will be affected by a change in the specific gravity of the liquid pumped. Change in specific gravity will affect the discharge gauge pressure and power. Any changes should be noted, in that they may overload the pump's driver.

4.9.2 Viscosity

The pump is designed to deliver rated capacity at rated head for a liquid with a particular viscosity. When contemplating operation at some viscosity other than that for which the pump was originally designed and/or applied, the changed conditions should be referred to PUMPIRAN for recommendations.

4.9.3 Changing the Pump speed

Changing the speed of a centrifugal pump changes the capacity, total head and brake Horse Power. The capacity will vary in a direct ratio with the speed, whereas the total head will vary as the ratio of the speed squared. The brake Horse Power will vary as the ratio of the speed cubed except in cases where the speed change also affects the efficiency of the pump.

4.9.4 Net positive suction head (NPSH)

Any liquid, hot or cold, must be forced into the impeller of the pump without vaporization by the pressure of the vessel from which the pump takes its suction. The head of liquid necessary to force the required flow into the pump is called the Net Positive Suction Head (NPSH). There are two kinds of NPSH: The $NPSH_r$ by the pump, as shown on the pump curve, is the head needed to cover the losses in the pump suction. The second NPSH is that available in the system, taking into account the friction loss in suction piping, valves, fittings etc. In all cases the $NPSH_a$ must exceed the $NPSH_r$ in order to push the liquid into the pump.

Failure to have an adequate margin of $NPSH_a$ over $NPSH_r$ will cause a reduction of pump performance and internal damage to the pump.

5 MAINTENANCE

Your pump is a precision machine. Take every precaution to avoid damage or slight burrs to the shaft bearing areas, as well as any other ground, finished surface when dismantling your pump. It should be understood that the information contained in this manual does not relieve operating and maintenance personnel of the responsibility of exercising normal good judgment in operation and care of the pump and its components.

Before performing any disassembly, maintenance and/or inspection on the unit, the following steps should be taken and warnings observed.

a) Tag driver controls in the "off" position.

	**WARNING**
	Before attempting any inspection or repair on the pump, the driver controls must be in the "off" position, locked and tagged to prevent injury to personnel performing service on the pump.

b) Isolating Pump.

	**WARNING**
	Before attempting to disassemble pump, pump must be isolated from system, by closing suction and discharge system valves, drained of liquid and cooled, if pump is handling hot liquid.

c) Draining pump.

	**NOTE**
	Pump cannot be fully drained.

- If handling hot liquids

	**WARNING**
	When pump is handling "hot" liquid, extreme care must be taken to ensure safety of personnel when attempting to drain pump. Hot pumps must be allowed to cool before draining.

- If handling caustic liquids

	**WARNING**
	When pump is handling "caustic" liquid, extreme care must be taken to ensure safety of personnel when attempting to drain pump. Protective devices of suitable protective materials must be worn when draining pump.

If on vacuum service.

	**WARNING**
	Before attempting any maintenance work on pumps in vacuum service, pumps must be isolated from suction and discharge system then carefully vented to return pressure in pump casing to atmospheric pressure.

5.1 Maintenance schedule

Although your PUMPIRAN pump has been designed for extended, trouble-free service, certain preventive maintenance measures should be performed on a regular basis to ensure optimum performance. A well-planned program of routine maintenance is the best assurance of dependable operation. The following preventive maintenance (PM) inspections are suggested as a minimum, and may be supplemented by the experience of the operating personnel.

Preventive Maintenance	Item Instructions	Frequency
Suction strainer when used	Check pressure differential between the gauges located on each side of the strainer.	Daily
Pump Suction And Discharge Pressure/Flow Rate	Check suction and discharge pressure/flow rate for proper pump operation.	Daily
Mechanical Seal	Inspect visually	Daily
Instrumentation	Check all related pressure gauges, temperature and detectors, etc. to detect any abnormalities.	Daily
Shaft rotation (Down periods only)	During extended down periods rotate the shaft by hand 1-1/4 times to prevent shaft binding.	Monthly
Auxiliary piping	Check for leakage around connections, etc.	Weekly
Shaft/bearing housing vibration	Review all vibration data for any abnormalities and/or sudden changes in levels.	Weekly
Bolting tightness	Check all external bolting for proper torque.	Monthly
Cleanliness	General clean-up soiled areas	Quarterly
Oil system	Refer to Lubrication System section of instruction manual.	Periodically

5.2 Spare parts

5.2.1 Ordering of spares

PUMPIRAN keep records of all pumps that have been supplied. When ordering spares the following information should be quoted:

- Pump serial number
- Pump size/type
- Order number
- Part name – taken from section 7 or pump sectional drawing
- Part number – taken from section 7 or pump sectional drawing
- Number of parts required – taken from section 7 or pump sectional drawing

The pump size and serial number are shown on the pump nameplate.

To place an order, contact the PUMPIRAN office.

	**WARNING**
	The use of parts other than PUMPIRAN approved parts may create hazardous conditions over which PUMPIRAN has no control. Such hazardous conditions can lead to injury, or result in damage to the equipment. PUMPIRAN does not support nor will be responsible for the use of non-PUMPIRAN furnished parts or the use of materials that are not as originally furnished without the expressed written approval of PUMPIRAN.

5.2.2 Service instructions

For emergency repair service, contact the PUMPIRAN After Sale Service Department.

5.2.3 Storage of spares

Spares should be stored in a clean dry area away from vibration. Inspection and re-treatment of metallic surfaces (if necessary) with preservative is recommended at 6 monthly intervals.

5.3 Recommended spares and consumable items

A recommended spare parts classification is offered for PUMPIRAN parts furnished on this unit. The classification of a required part can be identified by referring to the appropriate assembly drawing and parts list included in section 7 of this manual.

The PUMPIRAN Sales Representative in your area will gladly review the class of spares best suited to your requirement.

	**NOTE**
	No special tools are required to assemble or disassemble the pump. Common mechanical tools are sufficient. However we recommend torque wrench to tighten and remove all fasteners.

5.4 Fastener torques

The tightening torques indicated for nuts and bolts shall be observed. The table below indicates the tightening torques for threads depending on material used.

Property class	(Material)	8.8	10.9	A.-50	A.-70	1.4462
0,2% yield stress $R_{p\,0,2}$ in N / mm² 1)		640	900	210	450 / 250	450
Metric ISO threads coarse-pitch	fine-pitch	Tightening torque M_A in Nm				
M4		3.1	4.4	1.0	2.5	
M5		6.1	8.7	2.00	4.5	
M6		10.4	14.9	3.40	7.30	
M8		25.2	36.1	8.30	17.7	
	M8x1	27.2	39.0	8.90	19.1	
M10		49,5	71.0	16.2	34.8	
	M10x1,25	52.5	75.4	17.3	36.9	
M12		85,2	122.2	28.0	59.9	
	M12x1,5	89.5	128.5	29.4	62.9	
	M12x1,25	93.9	134.7	30.8	66.0	
M16		211	302.7	69.2	148	
	M16x1,5	226	324.7	74.3	159	
M20		412	591.9	135	290	
	M20x1,5	461	661.0	151	324	
M24		710	1019.6	233	276	500
	M24x2	780	1118,6	256	305	548
M27		1050	1501.3	343	409	736
	M27x2	1130	1627.1	372	443	797
M30		1420	2036.4	466	554	1000
	M30x2	1580	2269.9	519	618	1110
M33		1940	2779.4	636	--	1360
	M33x2	2130	3062.6	700	--	1500
M36		2480	3552.3	812	--	1740
	M36x3	2630	3775.4	863	--	1850

1) Nominal values to DIN ISO 898 Part 1, DIN 267 Part 11 and DIN 267 Part 18

6 FAULTS; CAUSES AND REMEDIES

Pump overheats and seizes
Bearings have short life
Pump vibrates or is noisy
Mechanical seal has short life
Mechanical seal leaks excessively
Pump requires excessive power
Pump loses prime after starting
Insufficient pressure developed
Insufficient capacity delivered
Pump does not deliver liquid

										Cause	Remedy
										A. SYSTEM TROUBLES	
x									x	Pump not primed	Check complete filling. Vent and/or prime
		x				x		x	x	Pump or suction pipe not completely filled with liquid	
		x				x		x	x	Suction lift too high or level too low	Check $NPSH_a$>$NPSH_r$, proper submergence, losses at strainers and fittings
x		x						x	x	Insufficient margin between suction pressure and vapor pressure	
						x	x	x		Excessive amount of air or gas in liquid	Check and purge pipes and system
						x		x	x	Air or vapor pocket in suction line	Check suction line design for vapor pockets
						x		x		Air leaks into suction line	Check suction pipe is airtight
						x		x		Air leaks into pump through mechanical seal, sleeve joints, casing joint or pipe plugs	Check and replace faulty parts CONSULT PUMPIRAN
		x				x		x	x	Inlet of suction pipe insufficiently submerged	Check out system design
							x	x	x	Speed too low	CONSULT PUMPIRAN
					x					Speed too high	CONSULT PUMPIRAN
							x	x	x	Total head of system higher than differential head of pump	Check system losses Remedy or CONSULT PUMPIRAN
					x					Total head of system lower than pump design head	
					x					Specific gravity of liquid different from design	Check and CONSULT PUMPIRAN
					x		x	x		Viscosity of liquid differs from that for which designed	
x		x								Operation at very low capacity	Measure value and check minimum permitted Remedy or CONSULT PUMPIRAN
	x	x			x					Operation at high capacity	Measure value and check maximum permitted. Remedy or CONSULT PUMPIRAN
							x	x	x	Suction pressure too low Foreign material in suction line	Open suction valve, Check power supply to correct voltage, Dismantle suction line remove foreign material
										B. MECHANICAL TROUBLES	
x	x	x	x	x	x					Misalignment due to pipe strain	Check the flange connections and eliminate strains using elastic couplings or a method permitted
x	x	x	x	x	x					Misalignment due to improper pump/driver setup	Check alignment and correct as necessary
		x								Improperly designed foundation	Check setting of base plate: tighten, adjust, grout base as required

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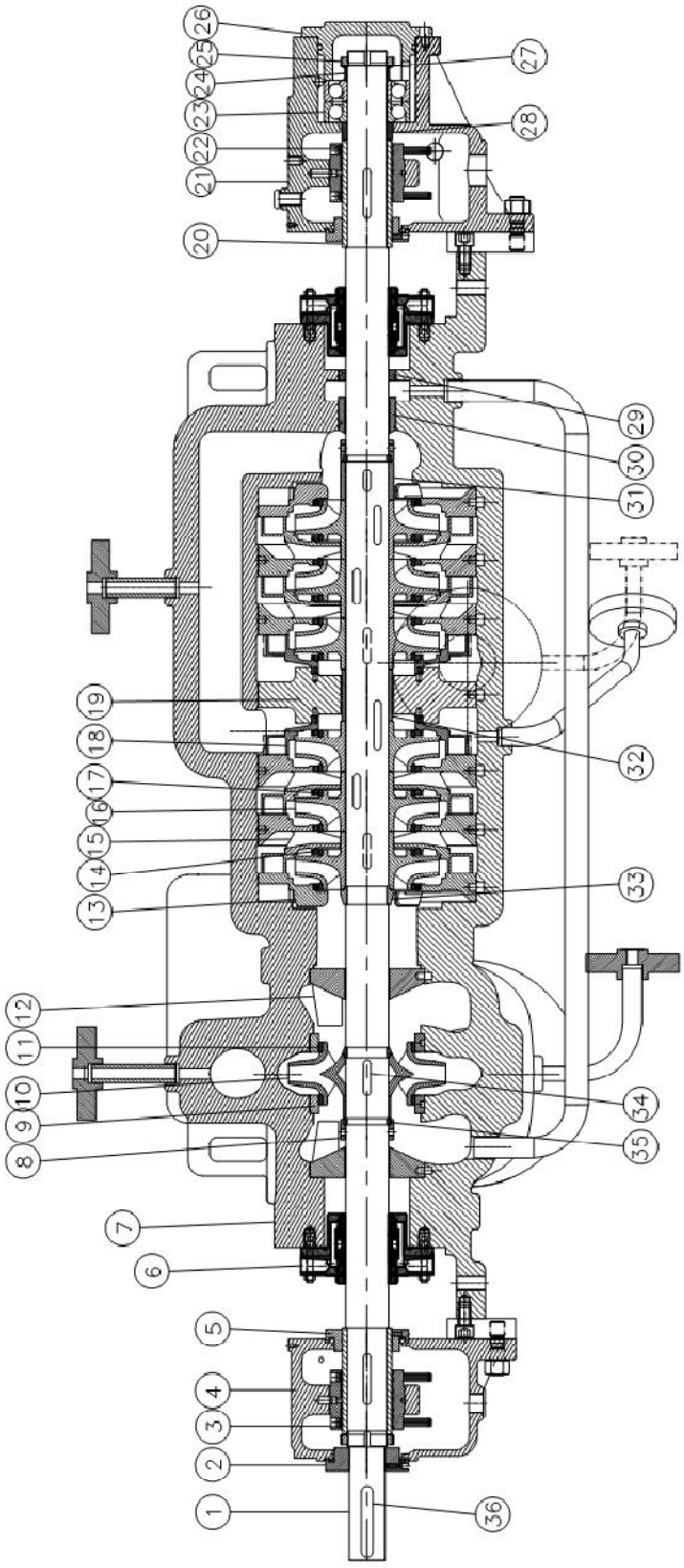
										Cause	Remedy
	x	x	x	x	x					Shaft bent (excessive run out)	Check shaft run outs are within acceptable values. CONSULT PUMPIRAN.
x	x	x			x					Rotating part rubbing on stationary part internally	Check and CONSULT PUMPIRAN, if necessary
x	x	x	x	x						Bearings worn	Replace bearings
					x		x	x		Wearing ring surfaces worn	Replace worn wear ring/ surfaces
		x					x	x		Impeller damaged or eroded	Replace or CONSULT PUMPIRAN for improved material selection
				x						Leakage under sleeve due to joint failure	Replace joint and check for damage
			x	x						Shaft sleeve worn or scored or running off center	Check and replace defective parts
			x	x	x					Mechanical seal improperly installed	Check alignment of faces or damaged parts and assembly method used. Refer to mechanical seal instructions
x	x	x	x	x						Shaft running off center because of worn bearings or misalignment	Check misalignment and correct if necessary. If alignment satisfactory check bearings for excessive wear
x	x	x	x	x						Impeller out of balance resulting in vibration	Check and CONSULT PUMPIRAN
			x	x	x					Abrasive solids in liquid pumped	
			x	x						Mechanical seal was run dry	Check mechanical seal condition and source of dry running and repair
x	x	x								Excessive thrust caused by a mechanical failure inside the pump	Check wear condition of Impeller, its clearances and liquid passages
	x	x								Lack of lubrication for bearings	Check hours run since last change of lubricant. Check oil level and add if necessary
	x	x								Improper installation of bearings (damage during assembly, incorrect assembly, wrong type of bearing etc.)	Check method of assembly, possible damage or state of cleanliness during assembly and type of bearing used. Remedy or CONSULT PUMPIRAN, if necessary
	x	x								Damaged bearings due to contamination	Check contamination source and replace damaged bearings
x	x	x	x	x						Rotating assembly out of balance	Check balance, run outs, balance as required CONSULT PUMPIRAN
x	x	x	x	x						Coupling out of balance	Check for missing parts or damage. CONSULT PUMPIRAN
		x								Cavitation	Check pump is primed check for obstruction in suction line
										C. ELECTRICAL TROUBLES	
		x			x		x	x		Wrong direction of rotation	Reverse 2 phases on motor terminal box
					x			x		Motor running on 2 phases only	Check supply and fuses
	x	x						x		Motor running too slow	Check motor terminal box connections and voltage

7 DRAWINGS AND PARTS LIST



No.	Part No.	Denomination
1	210	shaft
2	423	Labyrinth seal
3	370	Journal Bearing
4	350	Bearing Housing
5	423	Labyrinth Seal
6	433	Mechanical Seal
7	105	Casing
8	506	Retaining Ring
6	502	Stage Wear Ring
10	230	Double Entry Impeller
11	502	Impeller Wear Ring
12	441	Crossover Bush
13	269	Suction Ring
14	502	Diffuser Wear Ring
15	171.1	Diffuser A
16	230	Impeller
17	502.4	Wear Ring Impeller
18	171.2	Diffuser B
19	524	Center Bush
20	529	Bearing Sleeve
21	350	Bearing Housing
22	500	Oil Ring
23	321	Angular contact Ball Bearing
24	508	Oil Thrower
25	923	Lock Nut
26	360	Bearing Cover
27	931	Lock Washer
28	524	Spacer Sleeve
29	456	Stuffing Box Bush
30	531	Throttle Bush
31	524	Spacer Sleeve
32	524	Center Sleeve
33	501	Split ring-Impeller
34	940	Key
35	501	Split Ring
36	940	Key

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