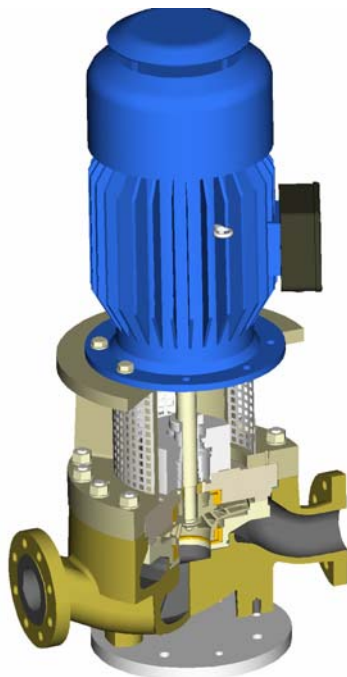




Pump Division



Type: PVML

CENTRIFUGAL PUMPS

*USER INSTRUCTIONS:
INSTALLATION, OPERATION, MAINTENANCE*

PCN=00079591, ed. 01-05 (E)



*These instructions should be read prior to installing,
operating, using and maintaining this equipment.*

1 INTRODUCTION AND SAFETY

1.1 General



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

Flowserve'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, utilising sophisticated quality techniques, and safety requirements.

Flowserve 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.

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. The instructions may not take into account local regulations; ensure such regulations are observed by all, including those installing the product. Always coordinate repair activity with operations personnel, and follow all plant safety requirements and applicable safety and health laws and regulations.



These instructions should be read prior to installing, operating, using and maintaining the equipment in any region worldwide. 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

It is a legal requirement that machinery and equipment put into service within certain regions of the world shall conform with the applicable CE Marking Directives covering Machinery and, where applicable, Low Voltage Equipment, Electromagnetic Compatibility (EMC), Pressure Equipment Directive (PED) and Equipment for Potentially Explosive Atmospheres (ATEX).

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. To confirm the Approvals applying and if the product is CE marked, check the serial number plate markings and the Certification. (See section 9, *Certification*.)

1.3 Disclaimer

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

Flowserve manufactures products to exacting International Quality Management System Standards as certified and audited by external Quality Assurance organisations. Genuine parts and accessories have been designed, tested and incorporated into the products to help ensure their continued product quality and performance in use. As Flowserve cannot test parts and accessories sourced from other vendors the incorrect incorporation of such parts and accessories may adversely affect the performance and safety features of the products. The failure to properly select, install or use authorised Flowserve parts and accessories is considered to be misuse. Damage or failure caused by misuse is not covered by Flowserve's warranty. In addition, any modification of Flowserve products or removal of original components may impair the safety of these products in their use.

1.4 Copyright

All rights reserved. No part of these instructions may be reproduced, stored in a retrieval system or transmitted in any form or by any means without prior permission of Flowserve Pump Division.

1.5 Duty conditions

This product has been selected to meet the specifications of your purchaser order. The acknowledgement of these conditions has been sent separately to the Purchaser. A copy should be kept with these instructions.



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 Flowserve for advice, quoting the serial number.

If the conditions of service on your purchase order are going to be changed (for example liquid pumped, temperature or duty) it is requested that the user seeks Flowserve's written agreement before start up.

1.6 Safety

1.6.1 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:



DANGER

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 and toxic fluid” safety instructions where non-compliance would affect personal safety and could result in loss of life.

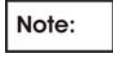


CAUTION

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 zone 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 sign is not a safety symbol but indicates an important instruction in the assembly process.

1.6.2 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 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 coordinate repair activity with operations and health and safety personnel, and follow all plant safety requirements and applicable safety and health laws and regulations.

1.6.3 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.



DANGER

NEVER DO MAINTENANCE WORK WHEN THE UNIT IS CONNECTED TO POWER



GUARDS MUST NOT BE REMOVED WHILE THE PUMP IS OPERATIONAL



DRAIN THE PUMP AND ISOLATE PIPEWORK BEFORE DISMANTLING THE PUMP

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



FLUORO-ELASTOMERS (When fitted.)

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



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.



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.



NEVER APPLY HEAT TO REMOVE IMPELLER
Trapped lubricant or vapour could cause an explosion.



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 68 °C (175 °F) or below 5 °C (20 °F) in a restricted zone, or exceeds local regulations, action as above shall be taken.



HAZARDOUS LIQUIDS

When the pump is handling hazardous liquids care must be taken to avoid exposure to the liquid by appropriate siting 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.

CAUTION 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.

CAUTION ENSURE CORRECT LUBRICATION
(See section 5, *Commissioning, start-up, operation and shutdown.*)

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 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. (See section 5, *Commissioning start-up, operation and shutdown.*)

CAUTION 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 seal.

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 back pressure 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.

1.6.4 Products used in potentially explosive atmospheres

Measures are required to:

- Avoid excess temperature
- Prevent build up 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.

1.6.4.1 Scope of compliance

Use equipment only in the zone for which it is

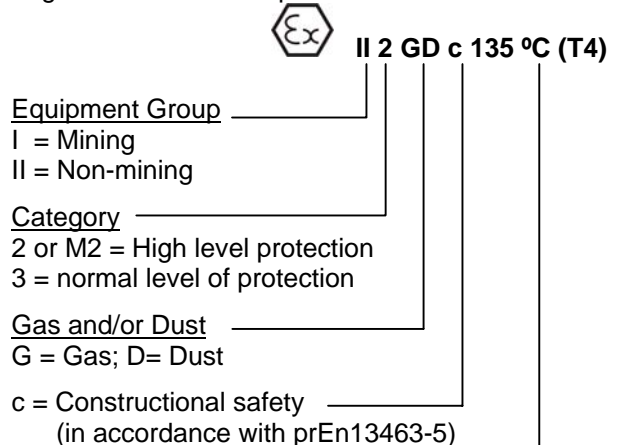
appropriate. Always check that the driver, seal and pump equipment are suitably rated and/or certified for the classification of the specific atmosphere in which they are to be installed.

Where Flowserve has supplied only the bare shaft pump, which is quite unusual for a PVML pump due to the closed coupled design, the Ex rating applies only to the pump. The party responsible for assembling the pump set shall select the driver and any additional equipment, with the necessary CE Certificate/ Declaration of Conformity establishing it is suitable for the area in which it is to be installed.

The output from a variable frequency drive (VFD) can cause additional heating affects in the motor and so, for pumps sets with a VFD, the ATEX Certification for the motor must state that it covers the situation where electrical supply is from the VFD. This particular requirement still applies even if the VFD is in a safe area.

1.6.4.2 Marking

An example of ATEX equipment marking is shown below. The actual classification of the pump will be engraved on the nameplate.



1.6.4.3 Avoiding excessive surface temperatures

ENSURE THE EQUIPMENT TEMPERATURE CLASS IS SUITABLE FOR THE HAZARD ZONE

Pumps have a temperature class as stated in the ATEX Ex rating on the nameplate. These are based on a maximum ambient of 40 °C (104 °F); refer to Flowserve for higher ambient temperatures.

The surface temperature on the pump is influenced by the temperature of the liquid handled. The maximum permissible liquid temperature depends on the temperature class and must not exceed the values in the table that follows.

The temperature rise at the seals and bearings and due to the minimum permitted flow rate is taken into account in the temperatures stated.

| Temperature class to prEN 13463-1 | Maximum surface temperature permitted | Temperature limit of liquid handled (* depending on material and construction variant - check which is lower) |
|-----------------------------------|---------------------------------------|---|
| T6 | 85 °C (185 °F) | Consult Flowserve |
| T5 | 100 °C (212 °F) | Consult Flowserve |
| T4 | 135 °C (275 °F) | 115 °C (239 °F) * |
| T3 | 200 °C (392 °F) | 180 °C (356 °F) * |
| T2 | 300 °C (572 °F) | 275 °C (527 °F) * |
| T1 | 450 °C (842 °F) | 400 °C (752 °F) * |

The responsibility for compliance with the specified maximum liquid temperature is with the plant operator.

Temperature classification “Tx” is used when the liquid temperature varies and the pump could be installed in different hazardous atmospheres. In this case the user is responsible for ensuring that the pump surface temperature does not exceed that permitted in the particular hazardous atmosphere.

If an explosive atmosphere exists during the installation, do not attempt to check the direction of rotation by starting the pump unfilled. Even a short run time may give a high temperature resulting from contact between rotating and stationary components.

Where there is any risk of the pump being run against a closed valve generating high liquid and casing external surface temperatures it is recommended that users fit an external surface temperature protection device.

Avoid mechanical, hydraulic or electrical overload by using motor overload trips, temperature monitor or a power monitor and make routine vibration monitoring checks.

In dirty or dusty environments, regular checks must be made and dirt removed from areas around close clearances and motors.

1.6.4.4 Preventing the build up of explosive mixtures



ENSURE THE PUMP IS PROPERLY FILLED AND VENTED AND DOES NOT RUN DRY

Ensure the pump and relevant suction and discharge pipeline system is totally filled with liquid at all times during the pump operation, so that an explosive atmosphere is prevented. In addition it is essential to make sure that seal chambers, auxiliary shaft seal systems and any heating and cooling systems are properly filled.

If the operation of the system cannot avoid this condition the fitting of an appropriate dry run protection device is recommended (eg liquid detection or a power monitor).

To avoid potential hazards from fugitive emissions of vapour or gas to atmosphere the surrounding area must be well ventilated.

1.6.4.5 Preventing sparks



To prevent a potential hazard from mechanical contact, the motor stool guard must be non-sparking and anti-static for Category 2.

To avoid the potential hazard from random induced current generating a spark, the earth contact on the levelling plate or base plate must be used.

Avoid electrostatic charge: do not rub non-metallic surfaces with a dry cloth; ensure cloth is damp.

1.6.4.6 Preventing leakage



The pump must only be used to handle liquids for which it has been approved to have the correct corrosion resistance.

Avoid entrapment of liquid in the pump and associated piping due to closing of suction and discharge valves, which could cause dangerous excessive pressures to occur if there is heat input to the liquid. This can occur if the pump is stationary or running.

Bursting of liquid containing parts due to freezing must be avoided by draining or protecting the pump and ancillary systems.

Where there is the potential hazard of a loss of a seal barrier fluid or external flush, the fluid must be monitored.

If leakage of liquid to atmosphere can result in a hazard, the installation of a liquid detection device is recommended.

1.6.4.7 Maintenance to avoid the hazard



CORRECT MAINTENANCE IS REQUIRED TO AVOID POTENTIAL HAZARDS WHICH GIVE A RISK OF EXPLOSION

The responsibility for compliance with maintenance instructions is with the plant operator.

To avoid potential explosion hazards during maintenance, the tools, cleaning and painting materials used must not give rise to sparking or adversely affect the ambient conditions. Where there is a risk from such tools or materials, maintenance must be conducted in a safe area.










It is recommended that a maintenance plan and schedule is adopted. (See section 6, *Maintenance*.)

1.7 Nameplate and warning labels

1.7.1 Nameplate

For details of nameplate, see the *Declaration of Conformity*.

1.7.2 Warning labels

|  | | WARNING | J218JZ250 |
|---|---|--|---|
| ESSENTIAL PROCEDURES BEFORE STARTING: | | | |
|  INSTALL AND OPERATE EQUIPMENT IN ACCORDANCE WITH THE INSTRUCTION MANUAL SUPPLIED SEPARATELY. |  | ENSURE ALL EXTERNAL CONNECTIONS TO THE PUMP / SHAFT SEALING AND DRIVER ARE CONNECTED AND OPERATIONAL. | |
|  |  | FULLY PRIME UNIT AND SYSTEM. DO NOT RUN UNIT DRY. | |
|  |  | FAILURE TO FOLLOW THESE PROCEDURES MAY RESULT IN PERSONAL INJURY AND / OR EQUIPMENT DAMAGE | |
|  | ENSURE CORRECT DIRECTION OF ROTATION. | |  |

1.8 Specific machine performance

For performance parameters see section 1.5, *Duty conditions*. When the contract requirement specifies these to be incorporated into User Instructions these are included here. Where performance data has been supplied separately to the purchaser these should be obtained and retained with these User Instructions if required.

1.9 Noise level

When pump noise level exceeds 85 dBA attention must be given to prevailing Health and Safety Legislation, to limit the exposure of plant operating personnel to the noise. The usual approach is to control exposure time to the noise or to enclose the machine to reduce emitted sound. You may have already specified a limiting noise level when the equipment was ordered, however if no noise requirements were defined then machines above a certain power level will exceed 85 dBA. In such situations consideration must be given to the fitting of an acoustic enclosure to meet local regulations.

Pump noise level is dependent on a number of factors - the type of motor fitted, the operating capacity, pipework design and acoustic characteristics of the building. Typical sound pressure levels measured in dB, and A-weighted are shown in the table below ($L_{p(A)}$). The figures are indicative only, they are subject to a +3 dB tolerance, and cannot be guaranteed.

The values are based on the noisiest electric motors that are likely to be encountered. They represent sound pressure levels at 1 m (3.3 ft) from the directly driven pump, for "free field over a reflecting plane".

If a pump unit only has been purchased, for fitting with your own driver, then the "pump only" noise levels from the table should be combined with the level for the driver obtained from the supplier. If the motor is driven by an inverter, it may show an increase in noise level at some speeds. Consult a Noise Specialist for the combined calculation.



For units driven by equipment other than electric motors or units contained within enclosures, see the accompanying information sheets and manuals.

Typical sound pressure level, dBA (L_{pA} at 1 m reference 20 μ Pa)

| Motor size and speed | | 3550 r/min | | 2900 r/min | | 1750 r/min | | 1450 r/min | |
|----------------------|-------|--------------------|---------------|--------------------|---------------|--------------------|---------------|--------------------|---------------|
| | | Pump and motor dBA | Pump only dBA | Pump and motor dBA | Pump only dBA | Pump and motor dBA | Pump only dBA | Pump and motor dBA | Pump only dBA |
| KW | (hp) | | | | | | | | |
| 2.2 | (3) | 78 | 72 | 71 | 68 | 71 | 68 | 68 | 68 |
| 3 | (4) | 81 | 74 | 74 | 70 | 74 | 70 | 70 | 70 |
| 4 | (5) | 82 | 75 | 75 | 71 | 75 | 71 | 71 | 71 |
| 5.5 | (7.5) | 90 | 77 | 83 | 73 | 76 | 73 | 72 | 71 |
| 7.5 | (10) | 90 | 78 | 83 | 74 | 77 | 74 | 73 | 72 |
| 11 | (15) | 91 | 80 | 84 | 76 | 78 | 76 | 74 | 73 |
| 15 | (20) | 92 | 83 | 85 | 79 | 80 | 79 | 76 | 75 |
| 18.5 | (25) | 92 | 83 | 85 | 79 | 80 | 79 | 76 | 75 |
| 22 | (30) | 92 | 83 | 85 | 79 | 81 | 79 | 77 | 75 |
| 30 | (40) | 100 | 85 | 93 | 81 | 84 | 80 | 80 | 76 |
| 37 | (50) | 100 | 86 | 93 | 82 | 84 | 80 | 80 | 76 |
| 45 | (60) | 100 | 87 | 93 | 83 | 84 | 80 | 80 | 76 |
| 55 | (75) | 102 | 88 | 95 | 84 | 86 | 81 | 82 | 77 |
| 75 | (100) | 100 | 90 | 95 | 86 | 88 | 81 | 83 | 78 |
| 90 | (120) | 100 | 90 | 95 | 86 | 90 | 81 | 85 | 78 |
| 110 | (150) | 100 | 91 | 95 | 87 | 91 | 83 | 86 | 79 |
| 150 | (200) | 101 | 92 | 96 | 88 | 91 | 83 | 86 | 79 |
| 200 | (270) | ← | ← | ← | ← | ← | 83 | ← | 80 |
| 300 | (400) | - | - | - | - | ← | 84 | ← | 81 |

← Motors in this range are generally job specific and noise levels should be calculated based on actual equipment installed.
For 960 rpm reduce 1450 rpm values by 5 dBA.

2 TRANSPORT AND STORAGE

2.1 Consignment receipt and unpacking

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

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

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

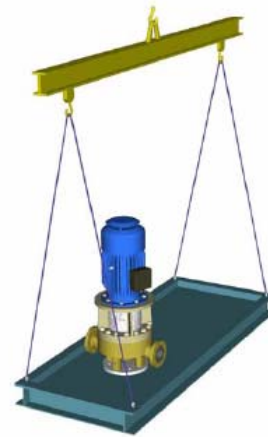
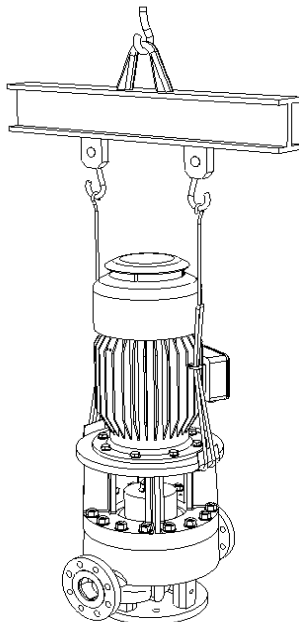
Each product has a unique serial number. Check that this number corresponds with that advised and always quote this number in correspondence as well as when ordering spare parts or further accessories.

2.2 Handling

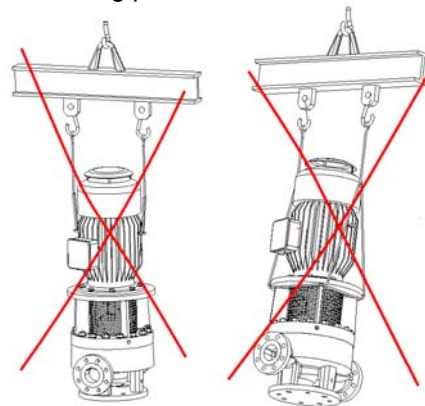
Boxes, crates, pallets or cartons may be unloaded using fork-lift vehicles or slings dependent on their size and construction.

2.3 Lifting

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



Typical lifting of a PVML with base plate or extended levelling plate



CAUTION Unsafe lifting is never allowed!

CAUTION A crane must be used for all pump sets in excess of 25 kg (55 lb). Fully trained personnel must carry out lifting, in accordance with local regulations. The driver and pump weights are recorded on their respective nameplates.

2.4 Storage

CAUTION Store the pump in a clean, dry location away from vibration. Leave piping connection covers in place to keep dirt and other foreign material out of pump casing. Turn pump at intervals to prevent brinelling of the bearings and the seal faces, if fitted, from sticking.

The pump may be stored as above for up to 6 months. Consult Flowserve for preservative actions when a longer storage period is needed.

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 that 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 that may be used in the "seal system" or other utilities.



Make sure that hazardous substances 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 PUMP DESCRIPTION

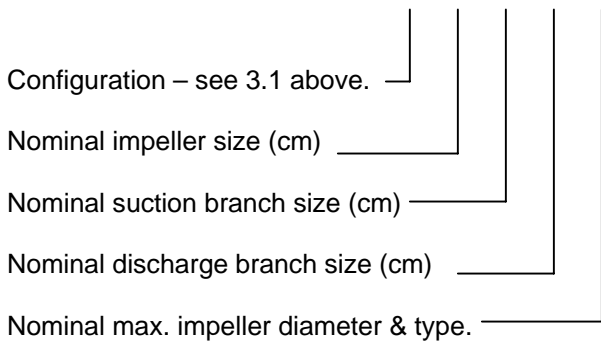
3.1 Configuration

The PVML type pump is a heavy duty, single stage, vertical closed coupled type centrifugal pump, designed for petrochemical complexes, chemical plants, general service and circulating applications. It can only be used with an electric motor.

3.2 Name nomenclature

The pump size will be engraved on the nameplate typically as below:

PVML 30-20-20-30F



The typical nomenclature above is the general guide to the PVML configuration description. Identify the actual pump size and serial number from the pump nameplate. Check that this agrees with the applicable certification provided.

3.3 Design of major parts

3.3.1 Pump casing

The pump has its main casing gasket axial to the shaft allowing maintenance to the rotating element by removing the back pull out unit. Suction and discharge branches are at the casing and therefore its piping remain undisturbed at maintenance.

3.3.2 Impeller

The impeller is fully shrouded and is fitted with impeller wear rings.

3.3.3 Diffuser

The diffuser is tuned to the impeller and the multi channel diffuser is concentric aligned around the impeller

3.3.4 Extended Motor Shaft

The extended motor shaft, mounted on the motor bearings is of the dry shaft design and has a keyed drive end.

3.3.6 Stuffing box

The stuffing box has a spigot (rabbet) fit between the pump casing and seal plate for optimum concentricity. The design enables a number of sealing options to be fitted.

3.3.7 Shaft seal

The mechanical seal(s) attached to the pump shaft seals the pumped liquid from the environment. Gland packing may be fitted as an option, for non-hazardous service only.

3.3.8 Driver

The driver is an electric motor.

3.3.9 Accessories

Accessories may be fitted when specified by the customer.

3.4 Performance and operating limits

This product has been selected to meet the specifications of your purchase order. See section 1.5.

The following data is included as additional information to help with your installation. It is typical, and factors such as temperature, materials, and seal type may influence this data. If required, a definitive statement for your particular application can be obtained from Flowserve.

3.4.1 Operating limits

| | |
|------------------------------------|---|
| Pumped liquid temperature limits* | up to +260 °C (500 °F) |
| Maximum ambient temperature* | up to +40 °C (104 °F) |
| Maximum soft solids in suspension* | up to 1 % by volume (refer for size limits) |
| Maximum pump speed | refer to the nameplate |

3.4.2 Pump and impeller data

| Pump size | Impeller maximum size mm (in.) | Nominal wear ring diameter Small / large mm (in.) | Min. diametral wear ring clearance mm (in.) |
|---------------|--------------------------------|---|---|
| PVML 25.04.04 | 220 (8.66) | 90/-- (3.54/--) | 0.35/-- (0.014/--) |
| PVML 25.08.08 | 240 (9.45) | 90/130 (3.54/5.12) | 0.35/0.43 (0.014/0.017) |
| PVML 25.10.10 | 235 (9.25) | 130/-- (5.12/--) | 0.43/-- (0.017/--) |
| PVML 25.15.15 | 242 (9.53) | 165/200 (6.50/7.87) | 0.45/0.50 (0.018/0.020) |
| PVML 30.20.20 | 290 (11.42) | 220/265 (8.66/10.43) | 0.50/0.55 (0.020/0.022) |
| PVML 35.08.08 | 370 (14.57) | 110/130 (4.33/5.12) | 0.38/0.43 (0.015/0.017) |
| PVML 35.10.10 | 370 (14.57) | 130/140 (5.12/5.51) | 0.43/0.43 (0.017/0.017) |
| PVML 35.15.15 | 354 (13.93) | 180/220 (7.09/10.43) | 0.48/0.50 (0.019/0.020) |
| PVML 35.20.20 | 350 (13.78) | 220/275 (7.09/10.83) | 0.50/0.58 (0.020/0.023) |
| PVML 40.10.10 | 420 (16.54) | 130/140 (5.12/5.51) | 0.43/0.43 (0.017/0.017) |
| PVML 40.15.15 | 420 (16.54) | 220/275 (7.09/10.83) | 0.50/0.58 (0.020/0.023) |

4 INSTALLATION



Equipment operated in hazardous locations must comply with the relevant explosion protection regulations. See section 1.6.4, *Products used in potentially explosive atmospheres*.

4.1 Location

The pump should be located to allow room for access, ventilation, maintenance and inspection with ample headroom for lifting and should be as close as practicable to the supply of liquid to be pumped.

Refer to the general arrangement drawing for the pump set.

4.2 Part assemblies

Seal systems for dual seal arrangements may be supplied loose on PVML pumps. It is the responsibility of the installer to ensure that the seal system is properly installed to the pump.

4.3 Foundation



There are many methods of installing pump units to their foundations. The correct method depends on the size of the pump unit, its location and noise vibration limitations. Non-compliance with the provision of correct foundation and installation may lead to failure of the pump and, as such, would be outside the terms of the warranty. Ensure the following are met.

The levelling plate or base plate should be mounted onto a firm foundation, either an appropriate thickness of quality concrete or sturdy steel framework. (It should NOT be distorted or pulled down onto the surface of the foundation, but should be supported to maintain the original alignment.) Concrete is the most suitable material for the base.

The base should contain recesses for the grouting of the foundation bolts. Figure 3 shows a number of variations on the design of the foundation bolts.

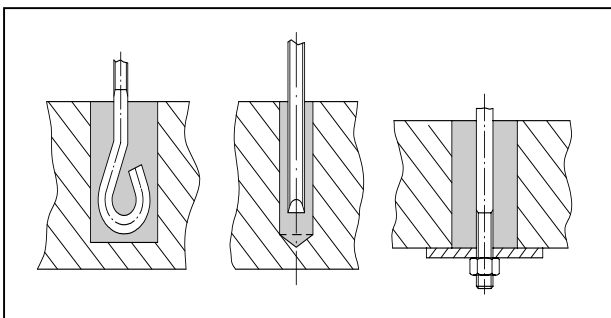


Figure: foundation bolts

- Make these recesses in the base in accordance with the above figure, referring to the dimensional drawing of the pump unit.

If a concrete base is used, observe the following points:

- do not place the pump unit on the base until it is **completely** set;
- fill the recesses with water at least 24 hours before grouting the foundation bolts. Wetting the recesses will strengthen the bond between the mortar of the foundation bolts and the base;
- remove the water from the recesses when the foundation bolts are being grouted;

4.3.1 Positioning the foundation bolts

Take the following points into account when positioning the pump unit:

- the foundation bolts should be suspended freely in the recesses of the base;

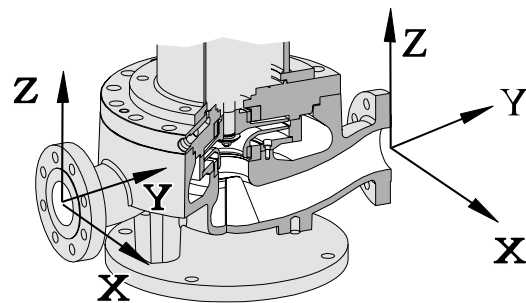


Figure 4: Forces and moments

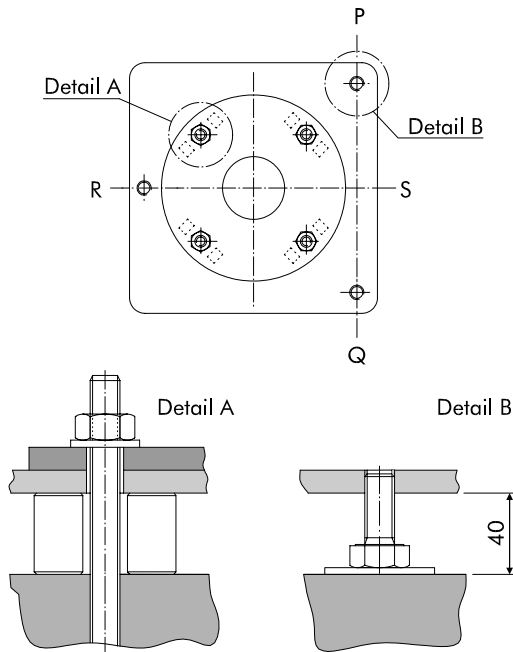
- the level of the centre line of the suction and discharge nozzles should correspond with the centre line of the pipes to be connected;
- the position of the suction and discharge nozzles in the x and z directions (see Figure 4) and
- the vertical distance between the base and the levelling plate (40 mm) before filling with mortar.

4.4 Grouting

For grouting the same steps are to be taken for a pump set with (extended) levelling plate or a base plate, with the distinction that a PVML pump will be mounted on the levelling plate after grouting of the levelling plate and a PVML pump on a base plate will be grouted as unit.

4.4.1 Grouting of a pump with levelling plate


See below figure for the following procedures.



- lay steel filler blocks on the base on either side of the foundation bolts;
- place the foundation bolts with nuts in the levelling plate;
- place the levelling plate on the filler blocks;
- lay thin filler plates under the adjusting bolts;
- remove the nuts from the foundation bolts;
- place the pump unit on the levelling plate in accordance with the lifting instructions described in § 3.1. The bolt holes in the base of the pump should correspond with the bolt holes in the levelling plate;
- replace the nuts on the foundation bolts;
- adjust the pump unit so that it is roughly level and at the required height by turning the adjusting bolts in the levelling plate. Position the levelling plate so that the suction and discharge flange can be mounted on the pipe flanges without stress. There should be a parallelism of 0.1 mm between the flanges to be connected;
- fill the space between the filler blocks and the levelling plate with filler plates;
- check that the bolts fit easily into the bolt holes of the flanges;
- fix the foundation bolts by filling the recesses with non-shrinkable mortar;
- let the mortar wet in accordance with the specifications.

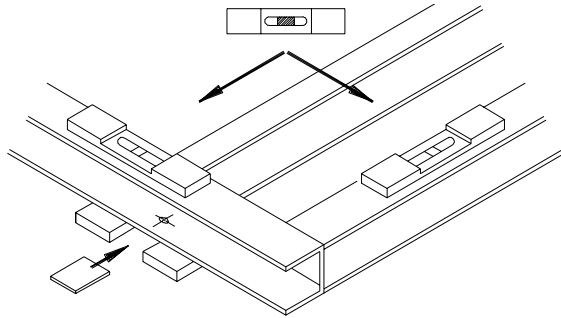
4.4.1.1 Adjusting the levelling plate

To make sure that the unit is level, use a calibrated machine level with an accuracy of 0.02 mm/m^1 . Measure along the shaft of the electric motor in both directions or, if this is not possible, along the seal plate. If the mechanical seal is fitted with a guard, this should be removed.

- level the levelling plate in the direction P-Q with an accuracy of $0.15 \text{ } \mu\text{m/m}$ (0.002 in./ft) using the adjusting bolts (see Figure 5). Fill the space between the filler blocks and the levelling plate with thin filler plates;
- level the levelling plate in the directions R-S with an accuracy of $0.15 \text{ } \mu\text{m/m}$ (0.002 in./ft) using the adjusting bolt. Fill the space between the filler blocks and the levelling plate with thin filler plates;
- tighten the foundation nuts provisionally by applying a moment equal to $\frac{1}{4}$ the maximum permissible moment (M_{max}) of the foundation bolt;
- check the position and level along the centreline of the suction and discharge nozzles. Adjust, if necessary, by following the procedures given above;
- fill in the outer edges of the levelling plate, including filler plates, **completely** using non-shrinkable mortar (e.g. Pagel V1 or equivalent) and let this cure in accordance with the specifications;
- remove the foundation nuts and the pump unit from the levelling plate;
-  grout the levelling plate, via the fill opening, **completely** using non-shrinkable concrete and let this cure in accordance with the specifications;
- replace the pump unit on the levelling plate and locate the foundation nuts with washers;
- tighten the foundation nuts permanently by applying a moment equal to $\frac{1}{4}$ the maximum permissible moment (M_{max}) of the foundation bolt;
- if the guard of the mechanical seal was removed for levelling, replace it in the correct position;
- if necessary, draw up a report on the whole adjustment procedure.

4.4.1 Grouting of a pump with base plate or extended levelling plate

- a) Install the base plate or extended levelling plate onto packing pieces evenly spaced and adjacent to foundation bolts.



- b) Level with shims between base plate and packing pieces [accuracy in both directions 0.15 $\mu\text{m}/\text{m}$ (0.002 in./ft)]

Where applicable, grout in the foundation bolts.

After adding pipework connections the baseplate should then be grouted in accordance with good engineering practice. Fabricated steel baseplates can be filled with grout. If in any doubt, please contact your nearest service centre for advice.

Grouting provides solid contact between the pump unit and foundation, prevents lateral movement of running equipment and dampens resonant vibrations.

Foundation bolts should only be fully tightened when the grout has cured.

4.5 Initial alignment

4.5.1 Thermal expansion

The PVML pump and motor are designed such that they will cope with the thermal expansion for pump application and cope with the pumping temperature as specified on the pump data sheet. There is no need to check the alignment at normal service conditions.

4.5.2 Alignment methods

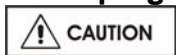


The alignment of the pump with the piping **MUST** be checked.



Complete piping as below.

4.6 Piping



Protective covers are fitted to the pipe connections to prevent foreign bodies entering during transportation and installation. Ensure that these covers are removed from the pump before connecting any pipes.

4.6.1 Suction and discharge pipework

In order to minimize friction losses and hydraulic noise in the pipework it is good practice to choose pipework that is one or two sizes larger than the pump suction and discharge. Typically main pipework velocities should not exceed 2 m/s (6 ft/sec) suction and 3 m/s (9 ft/sec) on the discharge.

Take into account the available NPSH which must be higher than the required NPSH of the pump.



Never use the pump as a support for piping.

Maximum forces and moments allowed on the pump flanges vary with the pump size and type. To minimize these forces and moments that may, if excessive, cause misalignment, hot bearings, vibration and the possible failure of the pump casing, the following points should be strictly followed:

- Prevent excessive external pipe load
- Never draw piping into place by applying force to pump flange connections
- Do not mount expansion joints so that their force, due to internal pressure, acts on the pump flange

The table on the general arrangement drawing summarizes the maximum forces and moments allowed on PVML pump casings. The allowable forces and moments are also listed in the addendum (Tab 1). Refer to Flowserve for other configurations.

Mount the flanges of the pipes and pump so that they are parallel with a tolerance of 0.1 mm. Make sure that the centrelines of the flanges are in line with each other.



Ensure piping and fittings are flushed before use.



Ensure piping for hazardous liquids is arranged to allow pump flushing before removal of the pump.

4.6.2 Suction piping

- The inlet pipe should be one or two sizes larger than the pump inlet bore and pipe bends should be as large a radius as possible.
- Pipework reducers should have a maximum total angle of divergence of 15 degrees.
- Keep the total length of the suction pipe as short as possible.
- A bend in the suction pipe should be located at a distance of at least 5 times the pipe bore from the suction flange

- e) Install as few bends as possible in the suction pipe and select the largest possible radius
- f) On suction lift the piping should be inclined up towards the pump inlet with eccentric reducers incorporated to prevent air locks.
- g) On positive suction, the inlet piping must have a constant fall towards the pump.
- h) Inlet strainers, when used, should have a net 'free area' of at least three times the inlet pipe area.
- i) Do not install elbows at an angle other than perpendicular to the shaft axis. Elbows parallel to the shaft axis will cause uneven flow.
- j) In the case of contaminated liquids, install a suction strainer or dirt trap with a bore which matches the bore of the pump..
- k) Fitting an isolation valve will allow easier maintenance.
- l) Never throttle pump on suction side and never place a valve directly on the pump inlet nozzle.

4.6.3 Maximum forces and moments allowed on PVML pump flanges

Refer to the General Arrangement drawing (tab 1)

4.6.4 Discharge piping

A non-return valve should be located in the discharge pipework to protect the pump from excessive back pressure and hence reverse rotation when the unit is stopped.

Pipework reducers should have a maximum total angle of divergence of 9 degrees.

Fitting an isolation valve will allow easier maintenance.

4.6.5 Auxiliary piping

4.6.5.1 Drains

Pipe pump casing drains and gland leakage to a convenient disposal point.

4.6.5.2 Pumps fitted with gland packing

When suction pressure is below ambient pressure, it is necessary to feed the gland packing with liquid to provide lubrication and prevent the ingress of air. This is normally achieved with a supply from the pump discharge volute to the stuffing box. A control valve or orifice plate may have been fitted into the supply line to control the pressure to the gland / stuffing box.

If the pumped liquid is dirty and cannot be used for sealing, a separate clean compatible liquid supply to the gland at 1.5 – 2.0 bar (20 –30 psi) above suction pressure is recommended.

4.6.5.3 Pumps fitted with mechanical seals

Single seals requiring re-circulation will normally be provided with the auxiliary piping from pump casing already fitted.

If the seal requires an auxiliary quench then a connection must be made to a suitable source of liquid flow, low pressure steam or static pressure from a header tank. Recommended pressure is 0.35 bar (5 psi) or less. Check *General arrangement drawing*.


Special seals may require different auxiliary piping to that described above. Consult separate User Instructions and/or Flowserve if unsure of correct method or arrangement.


For pumping hot liquids, to avoid seal damage, it is recommended that any external flush/cooling supply be continued after stopping the pump.


4.6.6 Final checks


Check the tightness of all bolts in the suction and discharge pipework. Check also the tightness of all foundation bolts.


4.7 Electrical connections

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

4.7.2  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.


4.7.3  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 Flowserve for advice.

4.7.4  **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.

4.7.5  A device to provide emergency stopping must be fitted.

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

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

4.7.8  See section 5.3, *Direction of rotation* before connecting the motor to the electrical supply.

4.7.9 This pump unit has an earthing boss for discharging (static) electricity. Connect the earthing boss of the pump unit in accordance with the applicable instructions or commission an approved electrical engineer to carry out the work.

4.8 Final shaft alignment check

Due to the vertical closed coupled design a final alignment check is not applicable.

4.9 Protection systems



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 Flowserve.

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 is installed.

To prevent excessive surface temperatures at bearings it is recommended that temperature or vibration monitoring are carried out. See sections 5.7.4 and 5.7.5.

5 COMMISSIONING, START-UP, OPERATION AND SHUTDOWN



These operations must be carried out by fully qualified personnel.

5.1 Pre-commissioning procedure



BEFORE START-UP REMOVE TEMPORARY RUBBER GASKET ABOVE SEAL DRIVE COLLAR. GASKET CAN BE EASILY REMOVED BY USING A KNIFE OR SCISSOR TO MAKE A RADIAL INCISION.

Before using the pump, flush it with hot water to remove any preservatives or contaminants. Drain off the flushing water from underneath the pump.

5.2 Pump lubricants

As the pump is of the Vertical Closed Coupled design the pump itself is not equipped with grease or oil connections.



See the electric motor instructions for the motor lubrication.

The bearings of the electric motor are either re-greasable or greased for life.

5.3 Impeller clearance

No functional adjustments are to be considered.

5.4 Direction of rotation



Ensure the pump is given the same rotation as the pump direction arrow mounted on the pump casing.

To avoid dry running the pump must be filled with liquid.



If maintenance work has been carried out to the site's electricity supply, the direction of rotation should be re-checked as above in case the supply phasing has been altered.

5.5 Guarding



Guarding is supplied fitted to the pump set. If this has been removed or disturbed ensure that all the protective guards around the exposed parts of the shaft are securely fixed.

5.6 Priming and auxiliary supplies



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.

5.6.1 Suction pressure above atmospheric pressure

the seal flush line at the mechanical seal/stuffing box to allow the trapped air to escape. Let liquid run out until free from air bubbles.


De-aerate the pump via the chamber of the mechanical seal or via the flange of a pipe connected to the mechanical seal

5.7 Starting the pump

- a)  Ensure flushing and/or cooling/heating liquid supplies are turned ON before starting the pump.
- b) CLOSE the outlet valve.
- c) OPEN all inlet valves.
- d) Prime the pump.
- e)  Ensure all vent connections are closed before starting.
- f) Start motor and check outlet pressure.
- g) If the pressure is satisfactory, slowly OPEN outlet control valve.
- h)  Do not run the pump with the outlet valve closed for a period longer than 30 seconds.
- i) If NO pressure, or LOW pressure, STOP the pump. Refer to section 7, *Faults; causes and remedies*, for fault diagnosis.

5.8 Running the pump


5.8.1 Venting the pump

 Vent the pump through the mechanical seal again, to enable all trapped air to escape taking due care with hot or hazardous liquids.

Under normal operating conditions, after the pump has been fully primed and vented, it should be unnecessary to re-vent the pump.


5.8.2 Pumps fitted with packed gland


If the pump has a packed gland there must be some leakage from the gland. Gland nuts should initially be finger-tight only. Leakage should take place soon after the stuffing box is pressurised.

 The gland must be adjusted evenly to give visible leakage and concentric alignment of the gland ring to avoid excess temperature. If no leakage takes place the packing will begin to overheat. If overheating takes place the pump should be stopped and allowed to cool before being re-started. When the pump is re-started, check to ensure leakage is taking place at the packed gland.

If hot liquids are being pumped it may be necessary to slacken the gland nuts to achieve leakage.


The pump should be run for 30 minutes with steady leakage and the gland nuts tightened by 10 degrees at a time until leakage is reduced to an acceptable level, normally a minimum of 120 drops per minute is required. Bedding in of the packing may take another 30 minutes.

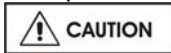
 Care must be taken when adjusting the gland on an operating pump. Safety gloves are essential. Loose clothing must not be worn to avoid being caught up by the pump shaft. Shaft guards must be replaced after the gland adjustment is complete.

 Never run gland packing dry, even for a short time.


5.8.3 Pumps fitted with mechanical seal
Mechanical seals require no adjustment. Any slight initial leakage will stop when the seal is run in.

Before pumping dirty liquids it is advisable, if possible, to run in the pump mechanical seal using clean liquid to safeguard the seal face.

 External flush or quench should be started before the pump is run and allowed to flow for a period after the pump has stopped.

 Never run a mechanical seal dry, even for a short time.

5.8.4 Bearings

 If the pumps are working in a potentially explosive atmosphere, temperature or vibration monitoring at the motor bearings is recommended.

If bearing temperatures are to be monitored it is essential that a benchmark temperature is recorded at the commissioning stage and after the bearing temperature has stabilized.

- Record the bearing temperature (t) and the ambient temperature (ta)
- Estimate the likely maximum ambient temperature (tb)
- Set the alarm at $(t+tb-ta+5) \text{ } ^\circ\text{C}$ [$(t+tb-ta+10) \text{ } ^\circ\text{F}$] and the trip at $100 \text{ } ^\circ\text{C}$ ($212 \text{ } ^\circ\text{F}$) for oil lubrication and $105 \text{ } ^\circ\text{C}$ ($220 \text{ } ^\circ\text{F}$) for grease lubrication

It is important, particularly with grease lubrication, to keep a check on bearing temperatures. After start up the temperature rise should be gradual, reaching a maximum after approximately 1.5 to 2 hours. This temperature rise should then remain constant or marginally reduce with time. (Refer to section 6.1.1 for further information.)

5.8.5 Normal vibration levels, alarm and trip

For guidance, pumps generally fall under a classification for rigid support machines within the International rotating machinery standards (API 610, latest ed./ISO 13709, latest ed.) and the recommended maximum levels below are based on those standards.



Alarm and trip values for installed pumps should be based on the actual measurements (N) taken on the pump in the fully commissioned as new condition. Measuring vibration at regular intervals will then show any deterioration in pump or system operating conditions.

| Vibration velocity – unfiltered mm/s (in./s) r.m.s. | Overhung pumps |
|--|----------------|
| Normal N | ≤ 3.0 (0.12) |
| Alarm N x 1.25 | ≤ 3.9 (0.15) |
| Shutdown trip N x 2.0 | ≤ 4.5 (0.18) |

5.8.6 Stop/start frequency

Pump sets are normally suitable for the number of equally spaced stop/starts per hour shown in the table below. Check actual capability of the driver and control/starting system before commissioning.

| Motor rating kW (hp) | Maximum stop/starts per hour |
|------------------------------|------------------------------|
| Up to 15 (20) | 15 |
| Between 15 (20) and 90 (120) | 10 |
| Above 90 (120) | 6 |

Where duty and standby pumps are installed it is recommended that they are run alternately every week.

5.9 Stopping and shutdown

- a) Close the outlet valve, but ensure that the pump runs in this condition for no more than a few seconds.
- b) Stop the pump.
- c) Switch off flushing and/or cooling/heating liquid supplies at a time appropriate to the process.
- d) For prolonged shut-downs and especially when ambient temperatures are likely to drop below freezing point, the pump and any cooling and flushing arrangements must be drained or otherwise protected.

5.10 Hydraulic, mechanical and electrical duty

This product has been supplied to meet the performance specifications of your purchase order, however it is understood that during the life of the product these may change. The following notes may help the user decide how to evaluate the implications

of any change. If in doubt contact your nearest Flowserve office.

5.10.1 Specific gravity (SG)

Pump capacity and total head in metres (feet) do not change with SG, however pressure displayed on a pressure gauge is directly proportional to SG. Power absorbed is also directly proportional to SG. It is therefore important to check that any change in SG will not overload the pump driver or over-pressurize the pump.

5.10.2 Viscosity

For a given flow rate the total head reduces with increased viscosity and increases with reduced viscosity. Also for a given flow rate the power absorbed increases with increased viscosity, and reduces with reduced viscosity. It is important that checks are made with your nearest Flowserve office if changes in viscosity are planned.

5.10.3 Pump speed

Changing pump speed effects flow, total head, power absorbed, NPSH_R, noise and vibration. Flow varies in direct proportion to pump speed, head varies as speed ratio squared and power varies as speed ratio cubed. The new duty, however, will also be dependent on the system curve. If increasing the speed, it is important therefore to ensure the maximum pump working pressure is not exceeded, the driver is not overloaded, NPSH_A > NPSH_R, and that noise and vibration are within local requirements and regulations.

5.10.4 Net positive suction head (NPSH_A)

NPSH available (NPSH_A) is a measure of the head available in the pumped liquid, above its vapour pressure, at the pump suction branch.

NPSH required (NPSH_R) is a measure of the head required in the pumped liquid, above its vapour pressure, to prevent the pump from cavitating. It is important that NPSH_A > NPSH_R. The margin between NPSH_A > NPSH_R should be as large as possible.

If any change in NPSH_A is proposed, ensure these margins are not significantly eroded. Refer to the pump performance curve to determine exact requirements particularly if flow has changed. If in doubt please consult your nearest Flowserve office for advice and details of the minimum allowable margin for your application.

5.10.5 Pumped flow

Flow must not fall outside the minimum and maximum continuous safe flow shown on the pump performance curve and or data sheet.

6 MAINTENANCE

6.0 General



It is the plant operator's responsibility to ensure that all maintenance, inspection and assembly work is carried out by authorized and qualified personnel who have adequately familiarized themselves with the subject matter by studying this manual in detail. (See also section 1.6.2.)

Any work on the machine must be performed when it is at a standstill. It is imperative that the procedure for shutting down the machine is followed, as described in section 5.8.

On completion of work all guards and safety devices must be re-installed and made operative again.

Before restarting the machine, the relevant instructions listed in section 5, *Commissioning, start up, operation and shut down* must be observed.

Oil and grease leaks may make the ground slippery. Machine maintenance must always begin and finish by cleaning the ground and the exterior of the machine.

If platforms, stairs and guard rails are required for maintenance, they must be placed for easy access to areas where maintenance and inspection are to be carried out. The positioning of these accessories must not limit access or hinder the lifting of the part to be serviced.

When air or compressed inert gas is used in the maintenance process, the operator and anyone in the vicinity must be careful and have the appropriate protection.

Do not spray air or compressed inert gas on skin.

Do not direct an air or gas jet towards other people.

Never use air or compressed inert gas to clean clothes.

Before working on the pump, take measures to prevent an uncontrolled start. Put a warning board on the starting device with the words:
"Machine under repair: do not start".

With electric drive equipment, lock the main switch open and withdraw any fuses. Put a warning board on the fuse box or main switch with the words:
"Machine under repair: do not connect".

Never clean equipment with inflammable solvents or carbon tetrachloride. Protect yourself against toxic fumes when using cleaning agents.

6.1 Maintenance schedule



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

- a) Any auxiliary systems installed must be monitored, if necessary, to ensure they function correctly.
- b) Gland packings (if applied instead of a mechanical seal) must be adjusted correctly to give visible leakage and concentric alignment of the gland follower to prevent excessive temperature of the packing or follower.
- c) Check for any leaks from gaskets and seals. The correct functioning of the shaft seal must be checked regularly.
- d) Check motorbearing lubricant at intervals as described in the motor instructions.
- e) Check that the duty condition is in the safe operating range for the pump.
- f) Check vibration, noise level and surface temperature at the bearings to confirm satisfactory operation.
- g) Check dirt and dust is removed from areas around close clearances and motors.

Our 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 7, *Faults; causes and remedies*, for fault diagnosis.
- b) Ensure equipment complies with the recommendations in this manual.
- c) Contact Flowserve if the problem persists.

6.1.1 Routine inspection (daily/weekly)




The following checks should be made and the appropriate action taken to remedy any deviations:

- a) Check operating behaviour. Ensure noise, vibration and bearing temperatures are normal.
- b) 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.
- c) Check that shaft seal leaks are within acceptable limits.
- d) For motors with recharge filled bearings, check running hours since last recharge of grease or complete grease change.
- e) Check any auxiliary supplies e.g. heating/cooling, if fitted, are functioning correctly.



Refer to the manuals of any associated equipment for routine checks needed.

6.1.2 Periodic inspection (six monthly)

- a)  Check foundation bolts for security of attachment and corrosion.
- b) Check pump running records for hourly usage to determine if motor bearing lubricant requires changing.



Refer to the manuals of any associated equipment for periodic checks needed.

6.1.3 Mechanical seals

No adjustment is possible. When leakage reaches an unacceptable level the seal will need replacement.

6.1.4 Gland packing

The stuffing box split gland can be completely removed for re-packing or to enable the addition of extra rings of packing.

The stuffing box is normally supplied with a lantern ring to enable a clean or pressurised flush to the centre of the packing. If not required, this can be replaced by an extra 2 rings of packing.

There must always be a small leakage, normally a minimum of 120 drops per minute to atmosphere to lubricate and cool the packing is required.

6.2 Spare parts

6.2.1 Ordering of spares

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

- 1) Pump serial number.
- 2) Pump size.
- 3) Part name – taken from section 8 and relevant P.O. related parts list. (Tab 1)
- 4) Part number – taken from relevant P.O. related parts list. (Tab 1)
- 5) Number of parts required.

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

To ensure continued satisfactory operation, replacement parts to the original design specification should be obtained from Flowserve.

Any change to the original design specification (modification or use of a non-standard part) will invalidate the pump's safety certification.

6.2.2 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.

6.3 Recommended spares and consumable items

For start up purposes (Initial spares):

- 1 - set of gaskets and seals
- (optional: 1 - complete set of gland packing)

For initial stock (Normal spares):

- 1 - set of motor bearings (line and thrust)
- 1 - mechanical seal or set of seal faces
- 2 - sets of gaskets and seals
- 2 - casing wear rings
- (optional: 2 - sets of gland packing
- 2 - shaft sleeves
- 2 - lantern rings
- 2 - impeller wear rings)

For 2 years operation:

- 1 - set of motor bearings (line and thrust)
- 1 - mechanical seal
- 2 - sets of gaskets and seals
- 2 - casing wear rings
- 2 - impeller wear rings
- 1 - impeller
- 1 - diffuser
- (optional: 2 - sets of gland packing
- 2 - shaft sleeves
- 2 - lantern rings
- 2 - impeller wear rings)

6.4 Tools required

A typical range of tools that will be required to maintain these pumps is listed below.

Readily available in standard tool kits, and dependent on pump size:

- Open ended spanners (wrenches) to suit up to M 48 screws/nuts
- Socket spanners (wrenches), up to M 48 screws
- Allen keys, up to 10 mm (A/F)
- Range of screwdrivers
- Soft mallet

More specialized equipment:

- Bearing pullers
- Bearing induction heater
- Dial test indicator

6.5 Fastener torques

| Application | Torque Nm (lb•ft) | |
|--|-------------------|----------------|
| | Lubricated | Not lubricated |
| Casing studs | | |
| M 12 | 55 (41) | 65 (48) |
| M 16 | 110 (81) | 165 (122) |
| M 20 | 170 (126) | 285 (211) |
| M 24 | 247 (182) | 375 (277) |
| M 30 | 519 (383) | 540 (399) |
| Seal studs, all cases (back mounted seal) | 125 | 145 |
| Seal bolts (front mounted seal) | | |
| M10 | 25 (18) | 30 (22) |
| M12 | 34 (25) | 40 (30) |
| Packed gland studs | Finger tight | Finger tight |
| Impeller screw | | |
| M8 | 6 (4.5) | 7 (5.2) |
| M12 | 23 (17) | 25 (18) |
| M16 | 57 (42) | 60 (44) |
| M20 | 114 (84) | 120 (89) |
| M24 | 180 (133) | 190 (140) |

6.6 Setting impeller clearance

As wear takes place between the impeller and casing ring the overall efficiency of the pump set will decrease. To maintain optimum efficiency it is recommended that rings are replaced and the impeller renovated when the diametral clearance detailed in section 3.4.2 has doubled to 0.7 to 1.1 mm (0.028 to 0.043 in.), depending on pump size and wearing ring diameter.

6.7 Disassembly



Refer to section 1.6, *Safety*, before dismantling the pump.



Before dismantling the pump for overhaul, ensure genuine Flowserve replacement parts are available. Refer to sectional drawings for part numbers and identification.

6.7.1 Removing the 'back pull out' unit

The 'back pull out' unit is removed by following the procedure given below:

- remove the nuts [6581.1] from the casing cover.
- attach the lifting devices to the appropriate lifting points, see Figure 1. Observe the lifting instructions described in section 2.3.
- lift the casing cover up. Work carefully as there is not much clearance between the diffuser and the pump casing.
- remove the packing ring [4590.2] from the pump casing and dispose of this in the proper way.



This type of packing may only be used once.

6.7.2 Removing the diffuser

This procedure describes removal of the diffuser from the casing cover.

- Bend open the lock washers [6541] and remove the hexagon head bolts [6577.1] from the diffuser.
- Remove the diffuser.

6.7.2 Removing the impeller

This procedure describes removal of the impeller from the shaft of the electric motor.

- fix the shaft sleeve of the mechanical seal in place using the face plates on top of the cover of the mechanical seal.
- undo the impeller screw [2913] with left-hand thread. The impeller screw is locked in the bore hole in the impeller by twisting the impeller screw.
- remove the impeller screw and the packing ring [4590.4] between impeller and impeller screw. **This type of packing may only be used once.** Dispose of the packing ring in the proper way.
- push the impeller from the shaft of the electric motor and remove the released key [6700].
- remove packing ring [4590.3] between the impeller and the shaft sleeve of the mechanical seal.



This type of packing may only be used once. Dispose of the packing ring in the proper way.

6.7.3 Removing the motor stool

With a 'back mounted' construction, the mechanical seal is mounted on the top of the casing cover which means that the motor stool has to be detached from the casing cover before disassembling the mechanical seal.

- Place the bottom of the casing cover on a flat surface.
- Remove the bolts [6577.2].
- Lift the motor stool up vertically. Work carefully as long as the shaft of the electric motor is still inserted in the shaft sleeve.

6.7.4 Removing the electric motor

This procedure describes removal of the electric motor from the motor stool. .

- Place the bottom of the motor stool on a support due to the projecting shaft of the electric motor.
- If the pump is provided with an Inpro Seal, first release the thrower [2540]. For disassembly instructions see suppliers documentation.
- Remove the hexagon head bolts [6577.3].
- Lift the electric motor up vertically. Make sure that the centring rims are not damaged.
- Remove the thrower [2540] from the shaft of the electric motor.

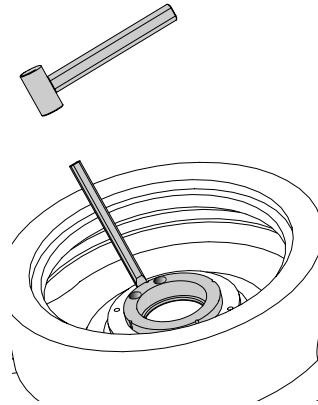


Figure : Removing the case wearing ring

- Chip off the remaining edges of the drilled holes using a hammer and chisel, see Figure. Make sure that the centring rim is not damaged.
- Remove the halves of the case wearing ring and the metal chips from the pump casing or casing cover.

6.7.5 Removing the mechanical seal

This procedure describes removal of the mechanical seal from the casing cover.

- Remove the nuts [6581.2] from the mechanical seal on top of the cover.
- Remove the mechanical seal.
- Do not dismantle the mechanical seal any further.

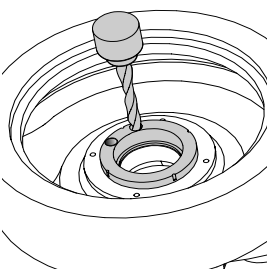
For further information on the mechanical seal, please refer to the instructions for use provided by the relevant supplier.

6.7.5 Removing the case wearing rings

This is the procedure to be followed when removing the case wearing ring from the diffuser and, if applicable, the case wearing ring in the casing cover. This depends on the structural design.

The case wearing ring has been pressed or shrunk into the centring rim during assembly which means that it will be necessary to drill or cut into the case wearing ring in order to weaken the upright edge.

- Remove the set screws [6570.1]. These set screws lock the case wearing ring against the diffuser [1410].
- Measure width & height of the case wearing ring.
- Take a drill with a slightly smaller diameter than the width of the case wearing ring.



- Drill two holes along the centre line of the upright edge of the case wearing ring, see Figure. Drill both holes not deeper than the measured height of the case wearing ring.

Figure : Drilling of the case wearing

6.7.6 Removing the impeller wearing rings

The impeller wearing rings [2300.1 & 2] have been shrunk or pressed onto the impeller during assembly. Therefore a suitable extraction tool must be used for disassembly.


- Remove set screws [6570.2]. These set screws lock the impeller wearing ring against the impeller.
- Remove the impeller wearing ring from the impeller using the extraction tool.
- Drill 3 holes at 120° intervals in the partition between impeller wearing ring and impeller. Drill the holes to a depth such that the set screws [6570.2] do not protrude above the surface of the impeller wearing ring and impeller.

6.7.7 Removing the neck bush

This procedure describes removal of the neck (throttle) bush from the casing cover.

- Remove set screws [6570.3] from the bottom of the casing cover. These set screws lock the neck bush [4132] against the casing cover.
- Remove the neck bush from the casing cover. If this cannot be done by hand, remove it from the casing cover by tapping with a suitable copper rod and a hammer.

6.8 Examination of parts

 **CAUTION** Used parts must be inspected before assembly to ensure the pump will subsequently run properly.

In particular, fault diagnosis is essential to enhance pump and plant reliability.

6.8.1 Casing, seal plate, diffuser and impeller

- a) Inspect for excessive wear, pitting, corrosion, erosion or damage and any sealing surface irregularities.
- b) Replace as necessary.

6.8.2 Motor shaft and stub sleeve (if fitted)

Although the pump is in most executions of the “dry shaft design” Replace if grooved, pitted or worn.

6.8.3 Gaskets and O-rings

After dismantling, discard and replace.

6.8.4 Motor bearings

- a) It is recommended that bearings are not re-used after any removal from the shaft.

6.9 Assembly

To assemble the pump consult the sectional drawings, see section 8, *Parts list and drawings*.

Ensure threads, gasket and O-ring mating faces are clean. Clean all parts carefully before assembly and replace any which are worn or damaged. Apply thread sealant to non-face sealing pipe thread fittings.

6.9.1 Fitting the neck bus

This procedure describes the fitting of the neck (throttle) bush into the casing cover.

- Clean the mounting surfaces of the neck bush [4132] and the casing cover.
- Fit the neck bush in the casing cover on the top side.

The neck bush should be fixed in relation to the casing cover using 3 set screws [6570.3].

- Drill 3 holes at 120° intervals in the partition between neck bush and casing cover. Drill the holes to a depth such that the set screws [6570.3] do not protrude above the surface of the neck bush and the casing cover.
- Tap screw thread into the 3 holes and remove the metal chips.
- Mount the set screws.
- Fix the set screws using a centre point.

6.9.2 Fitting the impeller wearing rings

The procedure specified below is to be followed with regard to the impeller wearing rings [2300.1 & 2] on one or both sides of the impeller.

- Clean the mounting surfaces of the impeller wearing ring and the impeller.



- Use the appropriate personal protection equipment when heating and positioning the impeller wearing ring.
- Heat the impeller wearing ring to a temperature of 120 to 150°C. Take care if the impeller wearing ring has a sprayed-on layer of chrome as this may break away if heating or cooling is carried out quickly.
- Push the impeller wearing ring right over the impeller and let the whole assembly cool down.
- Tap screw thread into the 3 holes and remove the metal chips.
- Mount the set screws [6570.2].
- Fix the set screws using a centre point.

6.9.3 Fitting the case wearing rings

The procedure specified below is to be followed with regard to the installation of the case wearing ring [1500.1] in the diffuser. The same procedure can be followed when installing the case wearing ring in the casing cover. Read casing cover instead of diffuser.

- Clean the mounting surfaces of the case wearing ring [1500.1 & 2], the diffuser gland and the pump casing.



- Use the correct personal protection equipment when cooling and positioning the case wearing ring.
- Cool the case wearing ring using liquid nitrogen.
- Lower the case wearing ring vertically in the diffuser and wait until the case wearing ring is tight.
- Drill 3 holes at 120° intervals in the partition between the case wearing ring and diffuser. Drill the holes to a depth such that the set screws [6570.2] do not protrude above the surface of the case wearing ring and the diffuser plate.
- Tap screw thread into the 3 holes and remove the metal chips.
- Mount the set screws [6570.2].
- Fix the set screws using a centre point.

6.9.4 Installing the mechanical seal

This procedure describes assembly of the mechanical seal to the casing cover.

- Clean the supporting surfaces of the mechanical seal and the casing cover.
- Place a new packing ring [see seal dwg.] in the casing cover or O-ring on the seal plate, depended from the seal type.
- Place the mechanical seal in the casing cover in accordance with the instructions for use provided by the relevant supplier.
- Tighten the nuts [6581.2] for fixing the mechanical seal to the casing cover by applying the prescribed torque, see section 6.5.

6.9.5 Fitting the electric motor

This procedure describes assembly of the electrical motor to the motor stool.

- If the pump is provided with an Inpro seal, it must be mounted first; for instructions see suppliers documentation.
- Attach the lifting devices to the appropriate lifting points. Observe the lifting instructions described in section 2.3.



The lifting lugs fixed to the motor are sufficient to lift the motor, but are not suitable to lift the total unit.

- Place the bottom of the motor stool on a support due to the protruding shaft of the electric motor.
- Clean the mounting surfaces of the electric motor and the motor stool.
- Carefully lower the flange of the electric motor vertically onto the motor stool. Make sure that the centring rims are not damaged.
- Assemble the hexagon head screws [6577.3].
- Fix the thrower [2540] on the shaft of the electric motor. Keep a distance of about 5 mm between the thrower and the electric motor.

6.9.6 Fitting the motor stool

This procedure describes assembly of the motor stool to the casing cover.

- Clean the mounting surfaces of the motor stool and the casing cover.
- Carefully place the shaft of the electric motor in the shaft sleeve so that the motor stool is resting.

- Tighten the bolts [6577.2].

6.9.7 Fitting the impeller

This procedure describes assembly of the impeller to the shaft of the electric motor.

- Attach the lifting devices to the appropriate lifting points and observe the lifting instructions described in section 2.3.
- Lift up the electric motor, the motor stool and the casing cover as a single assembly so that the end of the shaft of the electric motor is easily accessible.

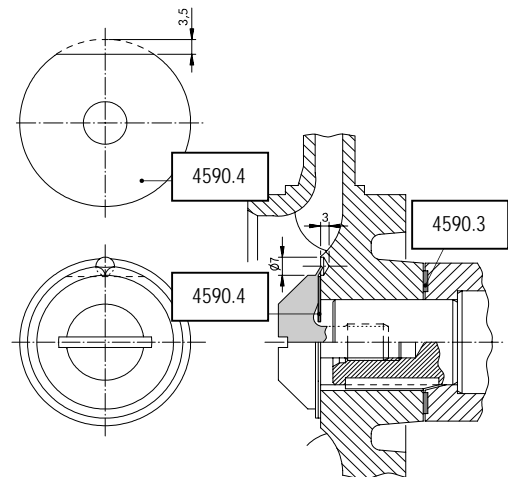


Figure: Locking impeller screw

- Place the key [6700] in the shaft of the electric motor with the beveled side towards the outside of the shaft of the electric motor in the direction of the electric motor. See Figure.
- Place a new packing ring [4590.3] against the shaft sleeve of the mechanical seal.
- Slide the impeller over the shaft of the electric motor.
- Fit a new packing ring [4590.4] according to Figure.
- Place the packing ring [4590.4] on the impeller screw [2913] with the cut off edge at the bore hole.
- Turn the impeller screw to the left by applying the prescribed torque, see section 6.5. Make sure that the cut off edge of the packing ring [4590.4] remains in.
- Lock the impeller screw by knocking the edge of the impeller screw into the bore hole in the impeller using a hammer and a centre punch.

Release the mounting of the shaft sleeve of the mechanical seal by sliding back the face plates and secure these in the retracted position.

6.9.8 Fitting the diffuser

This procedure describes assembly of the diffuser into the casing cover.

- Clean the surfaces of the diffuser and the casing cover.
- Place the diffuser [1410] on the casing cover. Make sure that the centring rim is not damaged.
- Mount the hexagon head bolts [6577.1] with lock washers [6541].
- Lock the hexagon head screws [6577.1] against the diffuser using the lock washers [6541].

- Connect all auxiliary pipes in accordance with the dimensioned drawing, the “Process and Instrumentation Diagram” (P&ID) or the “Auxiliary Piping Arrangement Drawing”.
- Reconnect the electric motor in accordance with the instructions for use provided by the relevant supplier.

6.9.9 Fitting the back pull out unit

This procedure describes assembly of the 'back pull out' unit to the pump casing.

- Clean the supporting surfaces of the casing cover and the pump casing.
- Clean internally machined surfaces which come into contact with liquid and surfaces where there is only a narrow gap between them and other finished surfaces. Treat these surfaces with e.g. Molykote G (spray or paste).
- Place a new packing ring [4590.2] onto the rim of the pump casing.
- Attach lifting devices at the appropriate lifting points. Observe the lifting instructions described in section 2.3.



The lifting lugs fixed to the motor are sufficient to lift the motor, but are not suitable to lift the total unit.

- Lift the casing cover above the pump casing and make sure that the casing cover is in the correct position in relation to the pump casing. There is only one way for the casing cover to fit onto the pump casing.
- Carefully place the casing cover on the pump casing. Work carefully as there is little clearance between the diffuser and the pump casing. Also make sure that the centering rim of the casing cover is not damaged.
- Tighten the nuts [6581.1] evenly across the casing cover by applying the prescribed tightening torque in accordance with table per section 6.5.

6.9.10 Fitting other parts

- Clean the supporting surfaces of the casing cover and the pump casing.

7 FAULTS; CAUSES AND REMEDIES

FAULT SYMPTOM

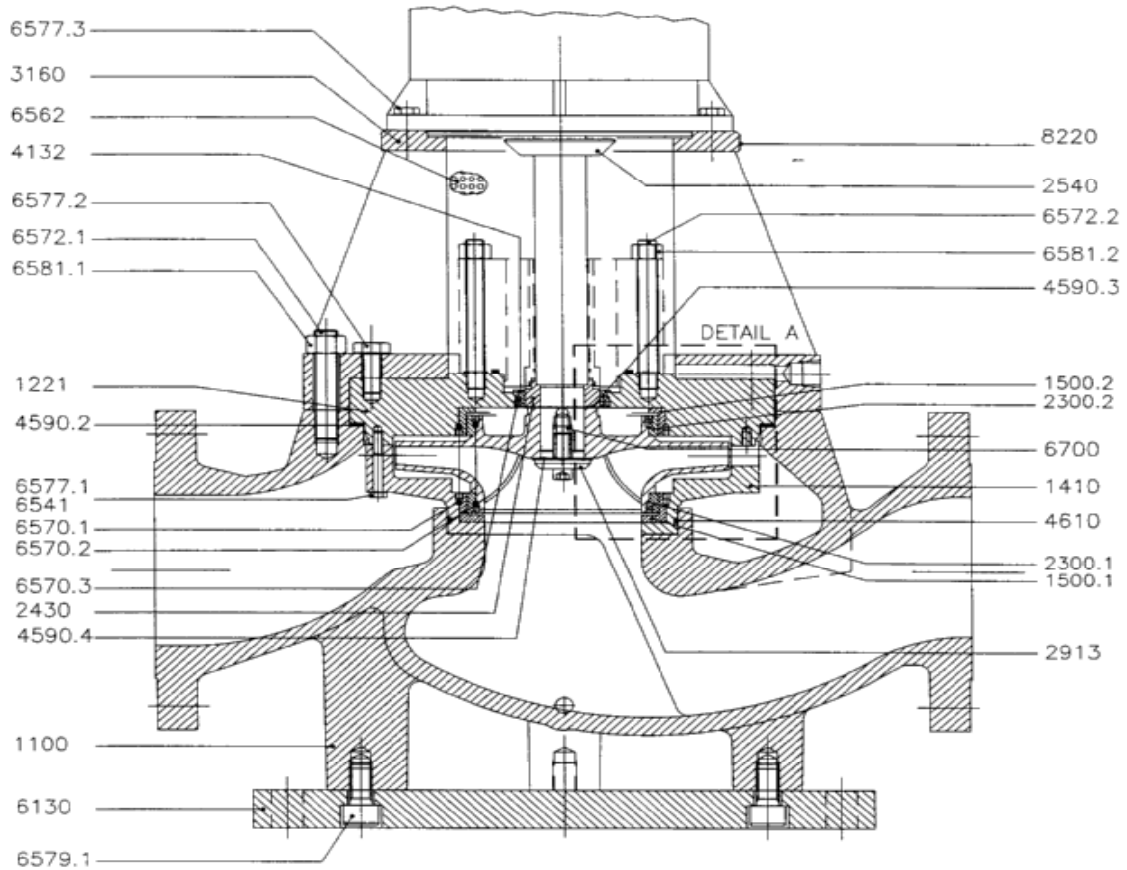
| Pump overheats and seizes | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| ↓ | 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 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | <table border="1"> <thead> <tr> <th>PROBABLE CAUSES</th> <th>POSSIBLE REMEDIES</th> </tr> </thead> <tbody> <tr> <td colspan="2" style="text-align: center;">A. System troubles</td> </tr> <tr> <td>● Pump not primed.</td> <td rowspan="2">Check complete filling. Vent and/or prime.</td> </tr> <tr> <td>● Pump or suction pipe not completely filled with liquid.</td> </tr> <tr> <td>● Suction lift too high or level too low.</td> <td rowspan="2">Check $NPSH_A > NPSH_R$, proper submergence, losses at strainers and fittings.</td> </tr> <tr> <td>● Insufficient margin between suction pressure and vapour pressure.</td> </tr> <tr> <td>● Excessive amount of air or gas in liquid.</td> <td>Check and purge pipes and system.</td> </tr> <tr> <td>● Air or vapour pocket in suction line.</td> <td>Check suction line design for vapour pockets.</td> </tr> <tr> <td>● Air leaks into suction line.</td> <td>Check suction pipe is airtight.</td> </tr> <tr> <td>● Air leaks into pump through mechanical seal, sleeve joints, casing joint or pipe plugs.</td> <td>Check and replace faulty parts. CONSULT FLOWSERVE.</td> </tr> <tr> <td>● Foot valve too small.</td> <td>Investigate replacing the foot valve.</td> </tr> <tr> <td>● Foot valve partially clogged.</td> <td>Clean foot valve.</td> </tr> <tr> <td>● Inlet of suction pipe insufficiently submerged.</td> <td>Check out system design.</td> </tr> <tr> <td>● Speed too low.</td> <td>CONSULT FLOWSERVE.</td> </tr> <tr> <td>● Speed too high.</td> <td>CONSULT FLOWSERVE.</td> </tr> <tr> <td>● Total head of system higher than differential head of pump.</td> <td rowspan="2">Check system losses. Remedy or CONSULT FLOWSERVE.</td> </tr> <tr> <td>● Total head of system lower than pump design head.</td> </tr> <tr> <td>● Specific gravity of liquid different from design.</td> <td rowspan="2">Check and CONSULT FLOWSERVE.</td> </tr> <tr> <td>● Viscosity of liquid differs from that for which designed.</td> </tr> <tr> <td>● Operation at very low capacity.</td> <td>Measure value and check minimum permitted. Remedy or CONSULT FLOWSERVE.</td> </tr> <tr> <td>● Operation at high capacity.</td> <td>Measure value and check maximum permitted. Remedy or CONSULT FLOWSERVE.</td> </tr> <tr> <td colspan="12" style="text-align: center;">B. Mechanical troubles</td> </tr> <tr> <td>● ● ● ● ● ●</td> <td colspan="5">Misalignment due to pipe strain.</td> <td colspan="6">Check the flange connections and eliminate strains using elastic couplings or a method permitted.</td> </tr> <tr> <td>●</td> <td colspan="5">Improperly designed foundation.</td> <td colspan="6">Check setting of levelling or base plate: tighten, adjust, grout base as required.</td> </tr> <tr> <td>● ● ● ● ●</td> <td colspan="5">Shaft bent.</td> <td colspan="6">Check shaft runouts are within acceptable values. CONSULT FLOWSERVE.</td> </tr> <tr> <td>● ● ● ● ●</td> <td colspan="5">Rotating part rubbing on stationary part internally.</td> <td colspan="6">Check and CONSULT FLOWSERVE, if necessary.</td> </tr> <tr> <td>● ● ● ● ●</td> <td colspan="5">Bearings worn</td> <td colspan="6">Replace bearings.</td> </tr> </tbody> </table> | PROBABLE CAUSES | POSSIBLE REMEDIES | A. System troubles | | ● Pump not primed. | Check complete filling. Vent and/or prime. | ● Pump or suction pipe not completely filled with liquid. | ● Suction lift too high or level too low. | Check $NPSH_A > NPSH_R$, proper submergence, losses at strainers and fittings. | ● Insufficient margin between suction pressure and vapour pressure. | ● Excessive amount of air or gas in liquid. | Check and purge pipes and system. | ● Air or vapour pocket in suction line. | Check suction line design for vapour pockets. | ● Air leaks into suction line. | Check suction pipe is airtight. | ● Air leaks into pump through mechanical seal, sleeve joints, casing joint or pipe plugs. | Check and replace faulty parts. CONSULT FLOWSERVE. | ● Foot valve too small. | Investigate replacing the foot valve. | ● Foot valve partially clogged. | Clean foot valve. | ● Inlet of suction pipe insufficiently submerged. | Check out system design. | ● Speed too low. | CONSULT FLOWSERVE. | ● Speed too high. | CONSULT FLOWSERVE. | ● Total head of system higher than differential head of pump. | Check system losses. Remedy or CONSULT FLOWSERVE. | ● Total head of system lower than pump design head. | ● Specific gravity of liquid different from design. | Check and CONSULT FLOWSERVE. | ● Viscosity of liquid differs from that for which designed. | ● Operation at very low capacity. | Measure value and check minimum permitted. Remedy or CONSULT FLOWSERVE. | ● Operation at high capacity. | Measure value and check maximum permitted. Remedy or CONSULT FLOWSERVE. | B. Mechanical troubles | | | | | | | | | | | | ● ● ● ● ● ● | Misalignment due to pipe strain. | | | | | Check the flange connections and eliminate strains using elastic couplings or a method permitted. | | | | | | ● | Improperly designed foundation. | | | | | Check setting of levelling or base plate: tighten, adjust, grout base as required. | | | | | | ● ● ● ● ● | Shaft bent. | | | | | Check shaft runouts are within acceptable values. CONSULT FLOWSERVE. | | | | | | ● ● ● ● ● | Rotating part rubbing on stationary part internally. | | | | | Check and CONSULT FLOWSERVE, if necessary. | | | | | | ● ● ● ● ● | Bearings worn | | | | | Replace bearings. | | | | | |
| PROBABLE CAUSES | POSSIBLE REMEDIES | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| A. System troubles | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ● Pump not primed. | Check complete filling. Vent and/or prime. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ● Pump or suction pipe not completely filled with liquid. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ● Suction lift too high or level too low. | Check $NPSH_A > NPSH_R$, proper submergence, losses at strainers and fittings. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ● Insufficient margin between suction pressure and vapour pressure. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ● Excessive amount of air or gas in liquid. | Check and purge pipes and system. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ● Air or vapour pocket in suction line. | Check suction line design for vapour pockets. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ● Air leaks into suction line. | Check suction pipe is airtight. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ● Air leaks into pump through mechanical seal, sleeve joints, casing joint or pipe plugs. | Check and replace faulty parts. CONSULT FLOWSERVE. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ● Foot valve too small. | Investigate replacing the foot valve. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ● Foot valve partially clogged. | Clean foot valve. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ● Inlet of suction pipe insufficiently submerged. | Check out system design. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ● Speed too low. | CONSULT FLOWSERVE. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ● Speed too high. | CONSULT FLOWSERVE. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ● Total head of system higher than differential head of pump. | Check system losses. Remedy or CONSULT FLOWSERVE. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ● Total head of system lower than pump design head. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ● Specific gravity of liquid different from design. | Check and CONSULT FLOWSERVE. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ● Viscosity of liquid differs from that for which designed. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ● Operation at very low capacity. | Measure value and check minimum permitted. Remedy or CONSULT FLOWSERVE. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ● Operation at high capacity. | Measure value and check maximum permitted. Remedy or CONSULT FLOWSERVE. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B. Mechanical troubles | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ● ● ● ● ● ● | Misalignment due to pipe strain. | | | | | Check the flange connections and eliminate strains using elastic couplings or a method permitted. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ● | Improperly designed foundation. | | | | | Check setting of levelling or base plate: tighten, adjust, grout base as required. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ● ● ● ● ● | Shaft bent. | | | | | Check shaft runouts are within acceptable values. CONSULT FLOWSERVE. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ● ● ● ● ● | Rotating part rubbing on stationary part internally. | | | | | Check and CONSULT FLOWSERVE, if necessary. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ● ● ● ● ● | Bearings worn | | | | | Replace bearings. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

FAULT SYMPTOM

| | | | | | | | | | | | | |
|-------------------------------------|-----------------------------------|---|---|---|---|---|---|--|--|---|--|--|
| 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 | | | | | | | | | | | |
| | | | | | | | | | | | PROBABLE CAUSES | POSSIBLE REMEDIES |
| | | | | ● | ● | ● | | | | | Wearing ring surfaces worn. | Replace worn wear ring/surfaces. |
| | ● | | | | | ● | ● | | | | Impeller damaged or eroded. | Replace or CONSULT FLOWSERVE for improved material selection. |
| | | | | ● | | | | | | | Leakage under sleeve due to joint failure. | Replace joint and check for damage. |
| | | | | ● | ● | | | | | | Shaft sleeve worn or scored or running off centre. | Check and renew defective parts. |
| | | | | ● | ● | ● | | | | | Mechanical seal improperly installed. | Check alignment of faces or damaged parts and assembly method used. |
| | | | | ● | ● | ● | | | | | Incorrect type of mechanical seal for operating conditions. | CONSULT FLOWSERVE. |
| ● | ● | ● | ● | ● | | | | | | | Shaft running off centre because of worn bearings. | Check misalignment and correct if necessary. If alignment satisfactory check bearings for excessive wear. |
| ● | ● | ● | ● | ● | | | | | | | Impeller out of balance resulting in vibration. | Check and CONSULT FLOWSERVE. |
| | | | | ● | ● | ● | | | | | Abrasive solids in liquid pumped. | |
| | | | | ● | ● | | | | | | Internal misalignment of parts preventing seal ring and seat from mating properly. | |
| | | | | ● | ● | | | | | | Mechanical seal was run dry. | Check mechanical seal condition and source of dry running and repair. |
| | | | | ● | ● | | | | | | Internal misalignment due to improper repairs causing impeller to rub. | Check method of assembly, possible damage or state of cleanliness during assembly. Remedy or CONSULT FLOWSERVE, if necessary. |
| ● | ● | ● | | | | | | | | | Excessive thrust caused by a mechanical failure inside the pump. | Check wear condition of impeller, its clearances and liquid passages. |
| | ● | ● | | | | | | | | | Excessive grease in ball bearings. | Check method of regreasing. |
| | ● | ● | | | | | | | | | Lack of lubrication for bearings. | Check hours run since last change of lubricant, the schedule and its basis. |
| | ● | ● | | | | | | | | | 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 FLOWSERVE, if necessary. |
| | ● | ● | | | | | | | | | Damaged bearings due to contamination. | Check contamination source and replace damaged bearings. |
| C. MOTOR ELECTRICAL PROBLEMS | | | | | | | | | | | | |
| | | ● | | | ● | ● | ● | | | | Wrong direction of rotation. | Reverse 2 phases at motor terminal box. |
| | | | | ● | | | ● | | | | Motor running on 2 phases only. | Check supply and fuses. |
| | ● | ● | | | | | | | | ● | Motor running too slow. | Check motor terminal box connections and voltage. |

8 PARTS LIST AND DRAWINGS

8.1 Typical Sectional drawing



8.2 Typical Parts list

For P.O. related parts list see Tab 1

| Ref. no. | Description |
|----------|-------------------------------|
| 1100 | Casing |
| 1221 | Casing cover |
| 1410 | Diffuser |
| 1500.1 | Case wearing ring |
| 1500.2 | Case wearing ring |
| 2200 | Impeller |
| 2300.1 | Impeller wearing ring |
| 2300.2 | Impeller wearing ring |
| 2430 | Throttling sleeve-Stub sleeve |
| 2540 | Thrower |
| 2913 | Impeller screw |
| 3160 | Motor stool |
| 4132 | Neck bush |
| 4590.2 | Gasket |
| 4590.3 | Gasket |
| 4590.4 | Gasket |

| Ref. no. | Description |
|----------|---------------------------------|
| 4610 | O-ring |
| 6130 | Sole plate |
| 6541 | Lock washer |
| 6562 | Protective guard |
| 6570.1 | Screw |
| 6570.2 | Screw |
| 6570.3 | Screw |
| 6572.1 | Stud continuous |
| 6572.2 | Stud continuous |
| 6577.1 | Hexagon head bolt |
| 6577.2 | Hexagon head bolt |
| 6577.3 | Hexagon head bolt |
| 6581.1 | Hexagon nut |
| 6581.2 | Hexagon nut |
| 6700 | Key |
| 8220 | Direction of rotation indicator |

8.3 General arrangement drawing

The typical general arrangement drawing and any specific drawings required by the contract will be sent to the Purchaser separately unless the contract specifically calls for these to be included into the User Instructions. If required, copies of other drawings sent separately to the Purchaser should be obtained from the Purchaser and retained with these User Instructions.

9 CERTIFICATION

Certificates determined from the Contract requirements are provided with these Instructions where applicable. Examples are certificates for CE marking, ATEX marking etc. If required, copies of other certificates sent separately to the Purchaser should be obtained from the Purchaser for retention with these User Instructions.

10 OTHER RELEVANT DOCUMENTATION AND MANUALS

10.1 Supplementary User Instructions

Supplementary instructions such as for a driver, instrumentation, controller, seals, sealant system etc are provided as separate documents in their original format. If further copies of these are required they should be obtained from the supplier for retention with these User Instructions.

10.2 Change notes

If any changes, agreed with Flowserve Pump Division, are made to the product after its supply, a record of the details should be maintained with these User Instructions.

10.3 Additional sources of information

Reference 1:

API 610, 9th edition / ISO 13709, January 2003

Reference 2:

NPSH for Rotordynamic Pumps: a reference guide, Europump Guide No. 1, Europump & World Pumps, Elsevier Science, United Kingdom, 1999.

Reference 3:

Pumping Manual, 9th edition, T.C. Dickenson, Elsevier Advanced Technology, United Kingdom, 1995.

Reference 4:

Pump Handbook, 2nd edition, Igor J. Karassik et al, McGraw-Hill Inc., New York, 1993.

Reference 5:

ANSI/HI 1.1-1.5

Centrifugal Pumps - Nomenclature, Definitions, Application and Operation.

Reference 6:

ANSI B31.3 - Process Piping.

Reference 7:

Europump Terminology standard

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